Hagler Bailly Pakistan

2 × 660 MW Coal-Fired Power Plant near Hub

Environmental and Social Impact Assessment

Final Report

Volume 1 of 2
(Main Report)

HBP Ref.: R5V08HCC

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Hub Power Company

Karachi

Contents

Appendices:

Exhibits

Acronyms

ADB	Asian Development Bank
AFD	Acoustic Fish Deterrent
APCMA	All Pakistan Cement Manufacturer Association
ASGWS	Australian Soil, Ground Water and Sediment Standards
BEPA	Balochistan Environmental Protection Agency
BWZ	Bela-Waziristan Zone
BOD	Biological Oxygen Demand
BMCR	Boiler’s Maximum Continuous Rating
BOPL	Byco Oil Pakistan Limited
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSR	Corporate Social Responsibility
CSQG	Canadian Soil Quality Guidelines
DM	De-Mineralized
DCS	Distributed Control System
DTV	Dutch Target Values
DWT	Deadweight tonnage
E	East
EIA	Environmental Impact Assessment
ESP	Electrostatic Precipitators
EMP	Environmental Management Plan
ESIA	Environmental and Social Impact Assessment
FRR	Fish Recovery and Return
FGD	Flue Gas De-sulfurization
GSHAP	Global Seismic Hazard Map Project
GCV	Gross Calorific Value
GDP	Gross Domestic Product
HBP	Hagler Bailly Pakistan
HAB.	Harga Acuan Batubara
HVAC	Heating, Ventilation and Cooling
HP	High Pressure
HCM	Highway Capacity Manual
HUBCO	Hub Power Company limited
ID	Induced Draft
IEE	Initial Environmental Examinations
IAEA	International Atomic Energy Agency
IFC	International Finance Corporation

IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
IVI	Importance Value Index
KP	Karachi Port
KPT	Karachi Port Trust
LUAWMS	Lasbela University of Agriculture, Water and Marine Sciences
LP	Low Pressure
MSZ	Makran Subduction Zone
MW	Megawatt
N	North
NEQS	National Environmental Quality Standards
NEPPO	Near East Plant Protection Organization
NGO	Non-government Organisation
NOx	Nitrogen Oxides
OD	Operational Directive
PEPA	Pakistan Environmental Protection Act
PFF	Pakistan Fisherfolk Forum
PMD	Pakistan Meteorological Department
PM	Particulate Matter
PCU	Passenger Car Unit
PGA	Peak Ground Acceleration
PPE	Personal Protection Equipment
RFO	Refused Furnace Oil
S	South
SC.	sea concentration
SMART	Self-Monitoring and Reporting by Industry
SST	Soil Standards for Thailand
SO2	Sulfur Dioxide
SS	Suspended Solids
TCF	The Citizen Foundation
RO	Reverse Osmosis
TDS	Total dissolved solids
TSP	Total Suspended Particulate
TSS	Total suspended solids
USGS	United States Geological Survey
VRB	Variable
W	West
WB	World Bank
WWF	World Wildlife Fund

1. Introduction

The Hub Power Company limited (HUBCO) is planning to install a new 2 x 660 MW coal-fired power plant (the "Project") near Hub, Baluchistan.

In order to comply with environmental regulations, HUBCO acquired the services of Hagler Bailly Pakistan Pvt. Ltd (HBP) to carry out the environmental and social impact assessment (ESIA) of the proposed Project.

This ESIA report discusses the potential environmental and social impacts which may result from Project-related activities and suggests recommendations to mitigate adverse impacts. The ESIA process and report meets national and provincial regulatory standards enforced by the Baluchistan Environmental Protection Agency (BEPA).

1.1 Project Setting

The Project will be located along the Arabian Sea in the southwestern part of Gadani *tehsil*[1] in District Lasbela; in the province of Baluchistan. It will be developed on land currently owned by HUBCO. Hub Chowki or Hub, the capital city of the tehsil, is located east northeast of the proposed location of the Project, at a distance of, approximately, 25 km by road. Karachi, the capital city of the province of Sindh is located east southeast, at an aerial distance of, approximately, 38 km from the proposed Project.

There are two major industries located next to the proposed Project: HUBCO residual furnace oil (RFO) fired power plant and Byco Oil Pakistan oil refinery and chemical manufacturing plant. These are located, approximately, 1.3 km and 1.7 km south southwest of the proposed Project, respectively. Churna Island, a tourist attraction for deep-sea divers, is located, approximately, 8 km west southwest of the proposed location of the Project, separated by the Arabian Sea.

The Project site is accessible by road from Karachi city via three different routes. The route used frequently by the industries located close to the Project is via the National Highway (N-25) and Pirkas Road.

Error! Reference source not found. indicates the location of the Project on a map and Error! Reference source not found. illustrates the proposed layout of the Project.

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[1] A tehsil, also known as Taluka (or taluq/taluk) or mandal, is an administrative division of Pakistan. It is an area of land with a city or town that serves as its headquarters, with possible additional towns, and usually a number of villages (http://en.wikipedia.org/wiki/Tehsil; accessed on September 19, 2014).

Exhibit 1.1: Project Location

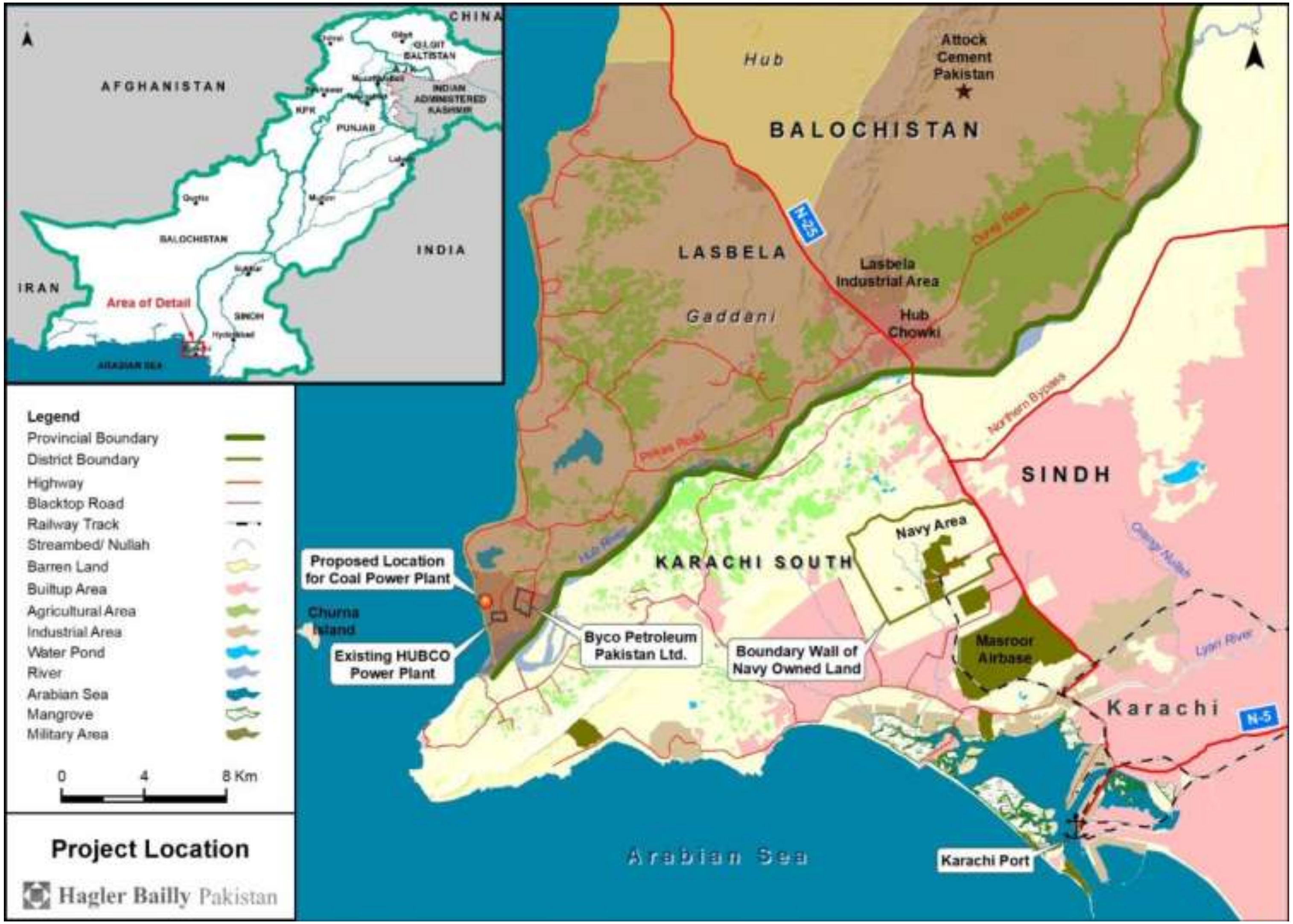
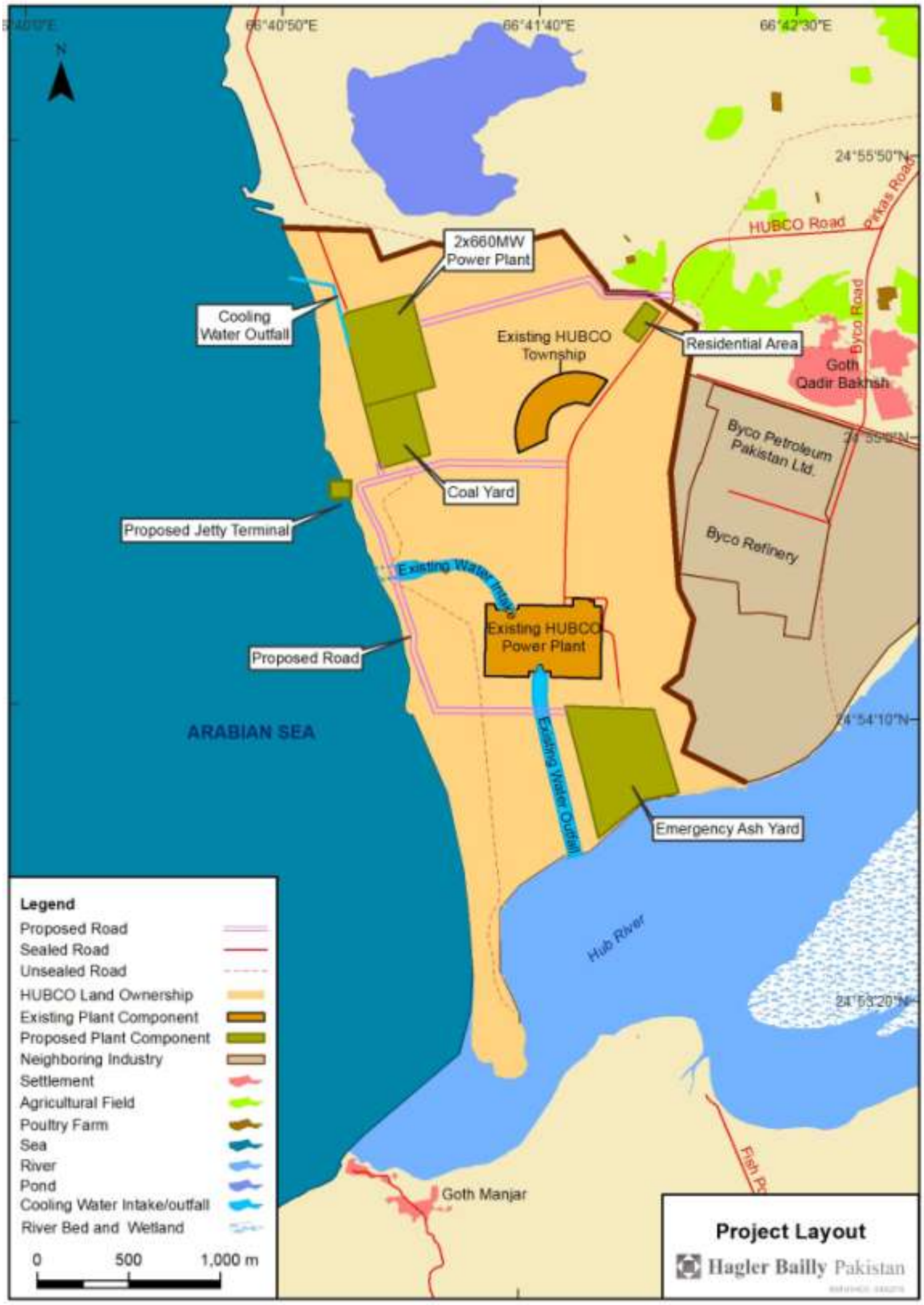


Exhibit 1.2: Proposed Project Layout



1.2 Project Outline

The proposed Project is a 2 x 660 MW (gross) supercritical coal-fired thermal power plant which will utilize imported coal from Indonesia and/or South Africa. The Project will incorporate state of the art waste treatment technologies to minimize and treat gaseous emissions and liquid effluents generated from plant processes.

The Project will comprise of two 660 MW (gross) supercritical boiler to generate 1214 MW (net) electric power to feed to the national grid. Supercritical boilers typically emit gases containing NO_x, SO_x, CO and Particulate Matter (PM) which are harmful for both humans and the environment. Using emission control systems, the Project will emit these pollutants at rates which comply with the limits prescribed by the National Environmental Quality Standards (NEQS) and the International Financial Corporation's (IFC) limits for emissions from coal-fired boilers. This will help ensure that the concentrations of these pollutants in ambient air will be within the ambient air quality levels prescribed by the NEQS.

The proposed power plant will be based on a once-through cooling system. The cooling-water requirement for the cooling system will be met by extracting water from the Arabian Sea.

Effluents from the plant will be treated and monitored for compliance with NEQS before being discharged into the sea. All other industrial effluents such as those from the boiler make-up water treatment system; oily waste and sanitary waste will be treated to comply with NEQS and re-used as far as possible.

Water will also be used to mix with ash to form ash slurry and for washing coal. Here too, water will be retreated and re-used.

Error! Reference source not found. provides a brief description of the main components associated with the Project while Error! Reference source not found. illustrates the layout of the same.

Exhibit 1.3: Brief Description of Main Project Components

Component	*Description*
Site Preparation	Land clearance for the construction of the power plant. Excavation for cooling water intake and outfall channels. Excavation and lining of ash pond site.
New Equipment	Construction works and installation of new equipment/boilers.
Coal Storage Facilities	Coal storage facility will be built within the proposed site of the project.
Transportation of Coal	Coal will be imported via a coal jetty near the project. A separate ESIA will be conducted for assessment of jetty related impatcs.

Component	*Description*
Emission Control	The Project will be equipped with the following systems and equipment to ensure compliance with national environmental standards and emission limits: ▶ Supercritical boiler technology with low NO_x burners (LNB) installed, which result in reduced generation of Nitrogen Oxides (NO_x). ▶ Sea Water Flue Gas De-sulfurization (FGD) system inside the boiler for reduced generation of Sulphur Oxides (SO_x) (92 % efficiency). ▶ Electrostatic Precipitators (ESP) to remove particulate matter (PM), particularly PM_{10} and $PM_{2.5}$, from the exhaust gases (99.7 % efficiency). ▶ Continuous Emission Monitoring system at emission ducts.
Ash Disposal	The location of the emergency ash yard will be within the boundaries of the Project and a separate study will be conducted for ash disposal site selection.
Other Facilities	Other facilities include a RO plant; water and high speed diesel (HSD) reservoirs; waste water treatment plant; control room; residence facilities and offices for staff; and a grid station.

1.3 Economic Justification for the Project

Prevailing power shortages present a serious constraint to economic growth in Pakistan. Power outages of the order of six to eight hours can be attributed to growth in demand for power; poor condition of thermal power plants in the public sector; shortfall in supply of natural gas to the combined cycle independent power producers (IPP); and, the circular debt arising out of withholding of payments by the government for fuel as well as power produced by the generating units.

Peak summer shortfall in 2012 touched 6,000 MW, corresponding to 32% of the demand in the country. In 2013, the estimated shortfall stayed at the same figure[2] and according to recent estimates, the summer shortfall in 2014 is expected to stand between 4,000 to 5,000 MW[3]. Pakistan, therefore, has an urgent requirement to generate additional power to feed into the national grid. Any slippage in the addition of new generation capacity or fuel availability will further widen the gap between supply and demand.

Closing the gap in the energy shortfall is also a high-priority matter for elected governments in Pakistan. In 2013, the Ministry of Water and Power (MoWP) of the Government of Pakistan developed a power policy[4] to support the current and future

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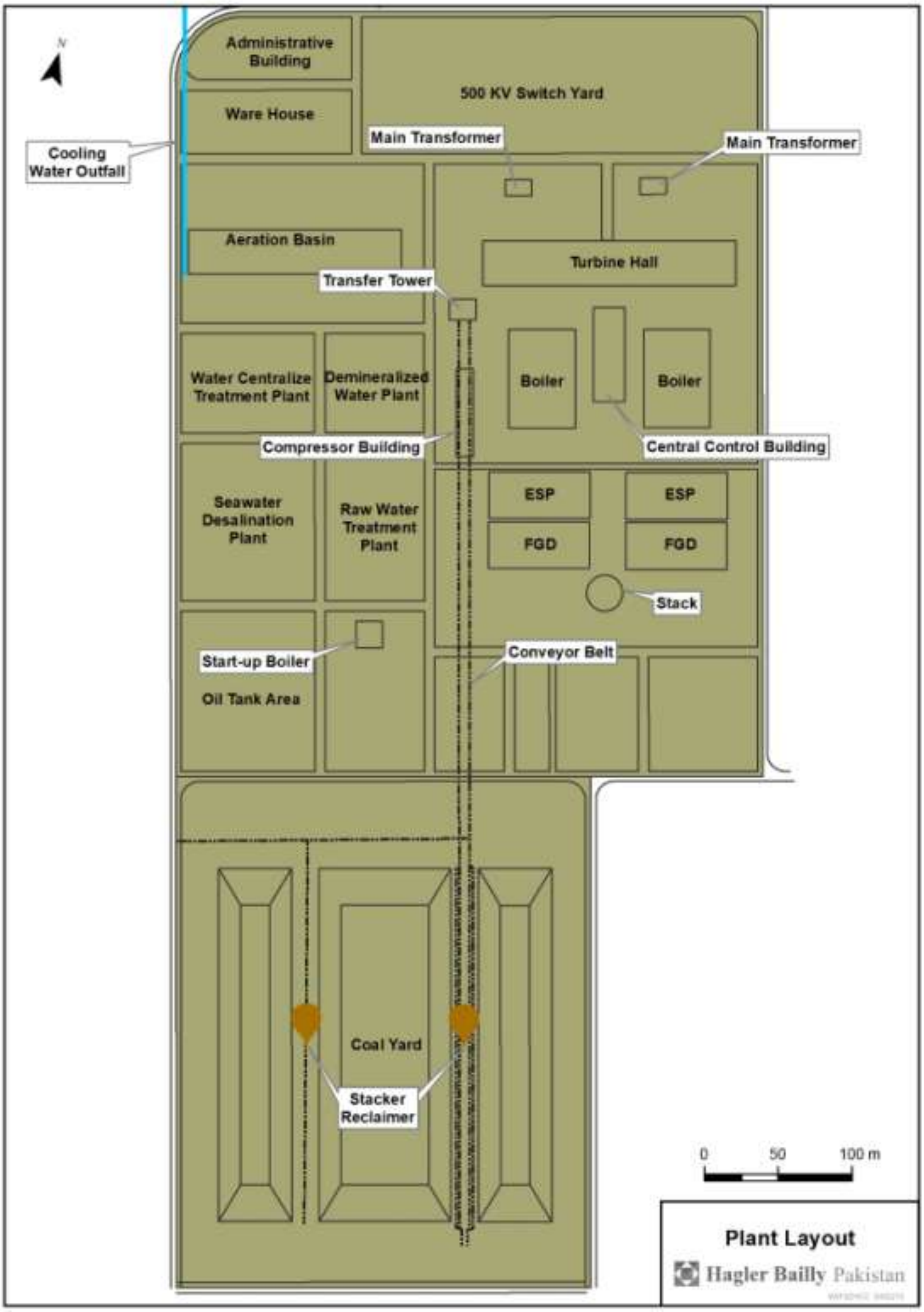
[2] Kazmi, Shabbir. "*Pakistan's Energy Crisis.*" The Diplomat. http://thediplomat.com/2013/08/pakistans-energy-crisis/ (accessed September 29, 2014).

[3] Ahmadani, Ahmad. "*Unannounced load shedding starts paralysing industry, life.*" Daily Times. http://www.dailytimes.com.pk/islamabad/28-Apr-2014/unannounced-load-shedding-starts-paralysing-industry-life (accessed September 29, 2014).

[4] Government of Pakistan, National Power Policy, 2013, http://pakistan.gov.pk/gop/index.php?q=aHR0cDovL3d3dy5tb3dwLmdvdi5way9nb3AvaW5kZXgucGhwP3E9YUhSMGNEb3ZMekU1TWk0eE5qZ3VOekF1TVRNMkwyMXZkM0F2

energy needs of the country. The policy aimed at addressing key challenges facing the power sector in order to provide much needed relief to the citizens of Pakistan.

Exhibit 1.4: Proposed Coal Power Plant Layout



One of the goals of the policy is to promote the generation of inexpensive and affordable electricity by shifting Pakistan's energy mix towards cheaper fuel such as coal through tariff incentives. It declares the development of coastal energy corridors based upon imported coal; rapid proliferation of coal mining all across the country – especially at Thar; and, conversion of expensive furnace-oil based plants to coal as the central tenets of promoting coal-based energy.

The 1320 MW (gross) coal-fired power plant proposed by HUBCO is in line with the government's power policy. The Project will generate low-cost coal-based energy which will cater for nearly 14 % of the current shortfall in energy in the country and is also expected to generate between 3,000 and 4,000 jobs during the construction phase and, approximately, 250 jobs once it is operational. The Project stands to benefit from the incentives placed by the government to attract development in the coal-fired power generation sector. The Project can also be considered as a pioneering effort as it will be the first large-size coal-based power project in Baluchistan.

1.4 Introduction to the ESIA

This ESIA has been conducted to meet the regulatory requirements of Pakistan contained in Pakistan Environmental Protection Act 1997 and its associated rules and regulations. The proposed Project will be subject to the pertinent legislative and regulatory requirements of the Government of Pakistan and the Government of Baluchistan. The legal statutes that have been reviewed include the Pakistan Environmental Protection Act 1997, the National Environmental Quality Standards (NEQS) 1993[5], Baluchistan Environmental Protection Act 2012 and there subservient rules, regulations, guidelines and standards.

1.4.1 Objectives of the ESIA

The objectives of the ESIA are to:

- Assess the existing environmental conditions in the Project area, including the identification of environmentally sensitive areas.
- Assess the proposed Project activities to identify their potential environmental and social impacts, evaluate the impacts, and determine their significance.
- Propose appropriate mitigation and monitoring measures that can be incorporated into the design of proposed activities to minimize any environmentally adverse effects as identified by the assessment.
- Assess the proposed Project activities and determine whether they comply with the relevant national and provincial environmental regulations.

The findings of the ESIA have been documented in the form of this report which is to be submitted to the Baluchistan Environmental Protection Agency (BEPA) as per regulatory requirements.

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[5] Including the latest NEQS rules: National Environmental Quality Standards (Self-Monitoring and Reporting by Industries) Rules, 2001.

1.5 Approach and Methodology

This ESIA report evaluates the physical, biological, and socioeconomic impacts of the following:

- Construction of the Project.
- Coal transportation to the site and storage on site.
- Operation of the new supercritical boiler and auxiliaries.
- Construction and operation of the ash pond for disposal of ash.

The methodology adopted for the assessment consists of the following steps:

1. Review of regulatory requirements based on: a) a preliminary assessment of proposed activities and the Project area; b) screening of relevant laws to prepare a list of those that are applicable; and c) review of the laws to identify specific regulatory requirements.
2. Collection of information on proposed project activities, project design and schedule, with an emphasis on aspects that have an interface with the natural and social environment.
3. Secondary literature search to collect environmental data about the Project area.
4. Site visits for collection of primary data related to various environmental aspects of the Project area.
5. Evaluation of environmental data and proposed Project activities to identify environmental parameters that are likely to undergo significant change due to the proposed Project.
6. Evaluation of each likely change in order to identify adverse environmental impacts.
7. Identification and evaluation of measures to mitigate the adverse impacts.
8. A stakeholder consultation to document the concerns of the local community and other stakeholders, and to identify issues that may require additional assessment in order to address these concerns.

Baseline Data Collection

Detailed environmental baseline surveys were conducted to collect primary data on the Project area to help identify sensitive receptors. Along with the primary data, secondary data available from environmental studies previously conducted in the region for other projects was reviewed. Aspects that were covered during the survey included:

- Community and socioeconomic indicators,
- Air quality,
- Traffic,
- Noise,
- Sensitive receptors,

- Marine ecology,
- Terrestrial ecology,
- Water quality, and
- Soil.

Impact Assessment

Each of the potential impacts identified was evaluated using the environmental, socioeconomic, and project information collected. Wherever relevant, quantitative models were used to predict the potential impact. In general, the impact assessment discussion covers the following aspects:

- The present baseline conditions.
- The potential change in environmental parameters likely to be affected by Project-related activities.
- The prediction of potential impacts.
- The evaluation of the likelihood and significance of potential impacts.
- Defining mitigation measures to reduce impacts to as low as practicable.
- The prediction of any residual impacts, including all long- and short-term, direct and indirect, and beneficial and adverse impacts.
- The monitoring of residual impacts.

1.6 Project Team

The following team of experts worked on the ESIA of this Project.

Team member	*Role*
Vaqar Zakaria	Quality Assurance
Hidayat Hasan	Technical Advisor
Hussain Ali	Team Leader
Dr Shahid Amjad	Marine Scientist
Fareeha Ovais	Ecology Expert
Zirgham Afridi	Environmental Engineer
Noor Kamal	Vegetation Expert
Aziz Karim	Environmental Expert
Bilal Khan	Environmental Expert
Liaqat Karim	Air Modeling Expert
Rashid Khan	Socioeconomic Expert
M Salman Ahmed	Socioeconomic Expert
Ghulam Murtaza	GIS Expert

1.7 Report Organization

Section 1 (*Introduction*) provides an overview of the Project, introduces the Project sponsors, and outlines the scope of this study.

Section 2 (*Legal and Policy Framework*) briefly discusses existing national and provincial policy and resulting legislation for sustainable development and environmental protection; and then presents the legislative requirements that need to be followed while conducting an ESIA.

Section 3 (*The Proposed Project*) contains information about key features of the proposed Project, such as its location, design, construction, operation, products and raw material requirements, suppliers, power generation, and waste disposal arrangements.

Section 4 (*Description of the Environment*) documents in detail the existing physical, biological, and socioeconomic conditions around the Project site and relevant transportation and access routes.

Section 5 (*Information Disclosure, Consultation and Participation*) presents the objectives and outcomes of stakeholder consultations which were conducted during the ESIA.

Section 6 (*Environmental Screening*) elaborates upon the screening methodology adopted for the ESIA of the Project. It also briefly describes environmental issues that are not expected to be significantly affected by the Project.

Section 7 (*Analysis of Alternatives*) discusses and evaluates the available alternatives for the Project as a whole and for different parts of it and compares them to the proposed project-design.

Section 8 (*Environmental Impacts and Mitigation Measures for the Proposed Project*) presents an assessment of the Project's impact to the physical, biological, and socioeconomic environment, as well as recommended mitigation measures.

Section 9 (*Environmental Management Plan*) presents the plans that need to be implemented to practice the mitigation measures recommended to control environmental impacts.

Section 10 (*Conclusions*) will summarize the findings and recommendations of this ESIA study.

2. Legal and Policy Framework

This chapter outlines the environmental and social legislation, standards and codes of practice governing the ESIA and the Project. The ESIA has been prepared in accordance with Section 15 of the Baluchistan Environmental Protection Act 2012. It will be submitted to the Baluchistan Environmental Protection Agency (BEPA), the authority responsible for granting approval subject to Section 15.2 (b) of the Act.

The abbreviation ESIA is one of several commonly used terms for impact assessment. Another frequently used abbreviation, "EIA" (environmental impact assessment), has been adopted by the Pakistan and Baluchistan legislation and guidelines. The term ESIA is used herein to emphasize the inclusion of social aspects in the impact assessment (environmental and social impact assessment) and refers to both the process undertaken and the resulting report. This ESIA is equivalent to the EIA referred to in the Pakistan and Baluchistan legislation and guidelines summarized below.

2.1 Statutory Framework

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency, the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards (NEQS) were established in 1993. The enactment of the Pakistan Environmental Protection Act (PEPA) 1997 conferred broad-based enforcement powers to the environmental protection agencies. The publication of the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations (IEE-EIA Regulations) 2000 provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA). In addition to the PEPA 1997, Pakistan's statute books contain a number of other laws that have clauses concerning the regulation and protection of the environment.

2.1.1 Constitutional Provision

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. The main consequences of this change are as follows:

- The Ministry of Environment at the federal level has been abolished. Its functions related to national environmental management have been transferred to the provinces. The international obligations in the context of environment will be managed by a ministry: the Ministry of Climate Change.
- The Pakistan Environmental Protection Act 1997 (PEPA 1997) is technically no longer applicable to the provinces. The provinces are required to enact their own legislation for environmental protection. Baluchistan has prepared the Baluchistan Environmental Protection Act, 2012 (BEPA 2012) which was passed by the Baluchistan Assembly on December 24, 2012 and assented to by the Governor, Baluchistan on January 9, 2013. The act will serve as a legal instrument to provide regulations and guidelines to ensure environmental protection. Salient features of BEPA 2012 applicable to the proposed Project are given below.

2.1.2 Baluchistan Environmental Protection Act, 2012

BEPA 2012 is the basic legislative tool empowering the provincial government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine, and noise pollution, as well as to the handling of hazardous wastes. The following articles of BEPA 2012 have a direct bearing on the proposed Project:

- Article 6(1) e: 'BEPA shall establish standards for the quality of ambient air, water and land, by notification in the official Gazette in consultation with other relevant Government Departments/Agencies.'
- Article 14(1): 'Subject to the provisions of this Act and the rules and regulations made thereunder no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the Environmental Quality Standards…'
- Up until the writing of this report, BEPA had not established its Environmental Quality Standards. Therefore, the proposed Project will be required to comply with NEQS with the anticipation that the provincial standards will be based on the NEQS and will provide the same level of protection. NEQS were established for gaseous emissions, liquid effluents, ambient air quality, noise, and drinking water and are provided in **Appendix A**.
- Article 15(1): 'No proponent of a project of public or private sector shall commence construction or operation unless he has filed an Initial Environmental Examination with the Government Agency designated by the Baluchistan Environmental Protection Agency, as the case may be, or, where the project is likely to cause adverse environmental effects, an Environmental Impact Assessment and has obtained from the Government Agency approval in respect thereof.'

- The ESIA of the proposed Project will be submitted to the Baluchistan Environmental Protection Agency (BEPA) for approval.
- Article 20 (1): 'All persons, for the purpose of protection, conservation, development, use, control and management of water resources, would take into account the following measures:
  a. protecting aquatic and associated ecosystems and their biological diversity;
  b. reducing and preventing pollution and degradation of water resources.'
- Article 21 (1): ' Subject to the provisions of this Act, and the rules and regulations, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the Environmental Quality Standards'
- Article 23(1): 'Subject to the provisions of this Act the Activities or concentration or levels of discharges of the following units established onshore and offshore shall be monitored strictly to prevent the pollution and environmental degradation caused by the following multi-magnitude and multidisciplinary units.
  a. shipping traffic and dredging,
  b. coastal power plant and energy sector.

2.1.3 Environmental Examinations and Assessment under BEPA 2012

- Article 15(1): 'No proponent of a project of public or private sector shall commence construction or operation unless he has filed an Initial Environmental Examination with the Government Agency designated by the Baluchistan Environmental Protection Agency, as the case may be, or, where the project is likely to cause adverse environmental effects, an Environmental Impact Assessment and has obtained from the Government Agency approval in respect thereof.'
- Article 15(2): The agency shall;
  - a) review the initial environmental examination and accord its approval, subject to such terms and conditions as it may prescribe, or require submission of an environmental impact assessment by the proponent; or
  - (b) review the environmental impact assessment and accord its approval subject to such terms and conditions as it may deem fit to impose or require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or decline approval of the environmental impact assessment as being contrary to environmental objectives.
- Article 15(3): 'Every review of an environment impact assessment shall be carried out with public participation…'
- Article 15(4): 'The Agency shall communicate its approval or otherwise within a period of four months from the date that the initial environmental examination is filed, and within a period of four months from the date that the environmental impact assessment is filed complete in all respects in accordance with the

regulations, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations'.

Self-Monitoring and Reporting by Industry Rules 2001

Under the *National Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules 2001* (the 'SMART' Rules), industrial units are responsible for monitoring their gaseous and liquid discharges and reporting them to the relevant environmental protection agency. As oil and coal fired thermal power plants fall under Category A for monitoring requirements for both liquid effluents (Schedule I) and gaseous emissions (Schedule II), the proposed coal-fired power plant will be required to submit environmental monitoring reports, for both emissions and effluents, to the relevant authorities on a monthly basis. The Project proponent will submit these reports to BEPA in accordance with the rules.

According to an amendment to the SMART rules in 2005, after proving compliance with NEQS for two consecutive years, the Project proponents may submit the monitoring reports on a quarterly basis.

2.1.4 Other Relevant Laws

Factories Act, 1934

Particular sections of the act applicable to this project are:

- Section 13(1): Every factory shall be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- Section 14(1): Effective arrangements shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on therein.
- Section 16(1): In every factory in which, by reason of the manufacturing process carried on, there is given off any dust or fume or other impurity of such a nature and to such an extent as is likely to be injurious or offensive to the workers employed therein, effective measures shall be taken to prevent its accumulation in any work-room and its inhalation by workers and if any exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust, fume or other impurity, and such point shall be enclosed so far as possible.
- Section 16(2): In any factory no stationary internal combustion engine shall be operated unless the exhaust is conducted into open air and exhaust pipes are insulated to prevent scalding and radiation heat, and no internal combustion engine shall be operated in any room unless effective measures have been taken to prevent such accumulation of fumes therefrom as are likely to be injurious to the workers employed in the work-room.
- Section 20(1): In every factory effective arrangements shall be made to provide and maintain at suitable points conveniently situated for all workers employed therein a sufficient supply of whole-some drinking water.

- Section 26(1) d (i): In every factory the following shall be securely fenced by the safeguards of substantial construction which shall be kept in position while the parts of machinery required to be fenced are in motion or in use, namely – (a) every part of an electric generator, a motor or rotary convertor.

2.1.5 Standards

The complete set of NEQS and ambient air quality standards for Baluchistan are included as **Appendix A**. Appendices include the following type of standards:

- Ambient air quality, (9 parameters)
- Drinking water (32 parameters)
- Ambient noise
- Industrial effluents (32 parameters)
- Industrial gaseous emissions (18 parameters).

2.2 Environmental Guidelines

2.2.1 Sectoral Guidelines for Thermal Power Stations, 1997

The sectoral guidelines deal with major thermal power plants producing electrical energy from fossil fuels (coal, gas, oil). The guideline is prepared to assist project proponents to identify the key environmental parameters those are required to be addressed to develop mitigation measures and alternatives that need to be considered in the EIA.

2.2.2 Environmental Assessment Procedures, 1997

The Federal EPA of Pakistan in collaboration of other key stakeholders, including provincial EPAs, other agencies, NGOs, academics and other stakeholders prepared a comprehensive procedures and guidelines for environmental assessment for development projects in the country. The following are the relevant guidelines applied to the project:

Policy and Procedures for the filling, review, and approval of environmental assessment, which sets out the key policy and procedures required for the development projects in the country. It contains a brief policy statement on the purpose of environmental assessment and the goal of sustainable development and also states that environmental assessment be integrated with feasibility studies.

Guidelines for the preparation and review of environmental reports which cover the following:

- Scoping, alternatives, site selection, and format of environmental reports;
- Identification, analysis and prediction, baseline data, and significance of impacts;
- Mitigation and impact management and preparing an environmental management plan;
- Reporting;
- Review and decision making;
- Monitoring and auditing;

- Project management.

Guidelines for Public Consultation which covers the following:

- Consultation, involvement and participation;
- Identifying stakeholders;
- Techniques for public consultation (principles, levels of involvement, tools, building trust);
- Effective public consultation (planning, stages of EIA where consultation is appropriate);
- Consensus building and dispute resolution;

Facilitating involvement (including the poor, women, building community, and NGO capacity)

2.3 Institutional Framework

The success of environmental assessment as a means of ensuring that development projects are environmentally sound and sustainable depends in large measure on the capability of regulatory institutions for environmental management. The institutional framework for decision-making and policy formulation in environmental and conservation issues in Baluchistan is briefly described below.

Environmental Protection Agency, Baluchistan (BEPA) was created on February 22, 1992 and under the administrative control of the Urban Planning and Development Department. Subsequently it was relocated under the administrative control of the Department of Environment, which was abolished and put under the administrative control of Environment, Wildlife Livestock and tourism Department. At present due to the long consultations and endeavor the Government of Baluchistan has notified it as a separate department headed by Secretary Environment and Sports.

Baluchistan Environmental Protection Agency's role is to serve as main environment regulatory body for Baluchistan Province, responsible for implementing National and Provincial Laws, and improving the protection of the Environmental and Natural Resources of Baluchistan, developing policies for improvement and sustainable use of natural resources.

2.4 International Treaties

Important international environmental treaties that have been signed by Pakistan and may have relevance to the Project are listed in **Exhibit 2.1**. They concern: climate change and depletion of the ozone layer; biological diversity and trade in wild flora and fauna; desertification; waste and pollution; and cultural heritage.

Exhibit 2.1: International Environmental Treaties Endorsed by Pakistan

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
Climate change and the ozone layer	United Nations Framework Convention on Climate Change - the primary objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	1992	1994
	Kyoto Protocol to the United Nations Framework Convention on Climate Change - enabled by the above Convention on Climate Change. It has more powerful and legally binding measures. It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions.	1997	2005
	Vienna Convention for the Protection of the Ozone Layer - acts as a framework for the international efforts to protect the ozone layer with a primary objective to protect human health and the environment against adverse effects resulting from human activities that modify or are likely to modify the ozone layer.	1985	1993
	The Montreal Protocol on Substances that Deplete Ozone Layer and associated amendments - enabled by the Vienna Convention, it is designed to protect the ozone layer by phasing out the production and consumption of a number of substances believed to be responsible for ozone depletion.	1987	1993
Waste and pollution	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal - regulates the transboundary movement of hazardous waste and other waste with a stated purpose to protect human health and the environment against the adverse effects from generation and management of hazardous waste and other waste. The Convention provides for three sets of measures with binding obligations. These are: Strict control of transboundary movement of hazardous waste; Environmentally sound management of hazardous waste; and Enforcement and implementation of the provisions of the convention at international and national levels.	1989	1994
	International Convention on Oil Pollution Preparedness, Response and Co-operation	1990	1995
	Stockholm Convention on Persistent Organic Pollutants - seeks to protect human health and the environment from Persistent Organic Pollutants, which are chemicals that remain intact in the	2001	2008

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
	environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife.		
	International Convention for the Prevention of Pollution from Ships (MARPOL) – is the main international convention that's covers prevention of pollution of the marine environment by ships from operational or accidental causes. The Convention includes regulations aimed at preventing and minimizing pollution from ships, both accidental pollution and that from routine operations, and currently includes six technical Annexes.	1983	
Desertification	International Convention to Combat Desertification – with an objective to combat desertification and mitigate the effects of drought. It is supported by international cooperation and partnership arrangements, with the aim of achieving sustainable use of land and water resources and sustainable development in affected areas.	1994	1997
Biodiversity and the protection of plants and animals	Convention on Biological Diversity – covering ecosystems, species, and genetic resources and also the field of biotechnology. The objectives are: conserve of biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources.	1992	1994
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity - addresses potential risks posed by living modified organisms resulting from modern biotechnology.	2000	2009
	Bonn Convention on the Conservation of Migratory Species of Wild Animals - aims to conserve terrestrial, marine and avian migratory species throughout their range. It is concerned with the conservation of wildlife and habitats on a global scale.	1979	1987
	Memorandum of Understanding concerning Conservation Measures for the Siberian Crane - parties undertakes to provide strict protection to Siberian Cranes, and identify and conserve wetland habitats essential for their survival.	1998	1999
	Convention on International Trade in Endangered	1973	1976
	Species of Wild Fauna and Flora - to ensure that international trade in specimens of wild animals and plants does not threaten their survival.		

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
	International Plant Protection Convention (1997 Revised Text) - to prevent the international spread of pests and plant diseases. It requires maintenance of lists of plant pests, tracking of pest outbreaks, and coordination of technical assistance between member nations.	1951/52	1954
	Agreement for the Establishment of the Near East Plant Protection Organization - to establish the Near East Plant Protection Organization (NEPPO), which promotes international co-operation with a view to implementing International Plant Protection Convention.	1993	2009
	Plant Protection Agreement for the Asia and Pacific Region and amendments – establishes the Asia and Pacific Plant Protection Commission to review and promote the region's progress in the implementation of the Agreement. Trade in plants and plant products are regulated by certification, prohibition, inspection, disinfection, quarantine, destruction, etc., as necessary.	1955 (amendment 1967)	1958 (amendment 1969)
	Convention on Wetlands of International Importance especially as Waterfowl Habitat and associated protocols and amendments - to promote conservation and sustainable use of wetlands. The Ramsar List of Wetlands of International Importance now includes almost 1,800 sites (known as Ramsar Sites). There are currently 19 Ramsar sites in Pakistan.	1971 (amended 1987)	1976 (amended 1994)
Cultural heritage	Convention concerning the Protection of the World Cultural and Natural Heritage - requires parties to adapt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.	1972	1976

The transportation of coal using Supramax-type coal carrying vessels must comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) and Convention of the Prevention of Marine Pollution by Dumping of Waste and Other Matter (London Convention 1972). Pakistan is a signatory to these conventions, therefore both these conventions will act as legal instruments to ensure prevention of pollution during coal transportation, handling and dumping of dredged material if any. Salient features of MARPOL and London Convention 1972 are provided below:

2.4.1 MARPOL

International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes[1].

The MARPOL Convention was adopted on November 2, 1973 at International Maritime Organization (IMO). The Convention includes regulations aimed at preventing and minimizing pollution from ships—both accidental pollution and that from routine operations, and currently includes six technical Annexes which are summarized here.

Annex 1; Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)

Covers prevention of pollution by oil from operational measures as well as from accidental discharges;

Annex II; Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)

Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk; some 250 substances were evaluated and included in the list appended to the Convention

In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.

Annex III; Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)

Annex contains general requirements for the issuing of detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications.

Annex IV; Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)

Contains requirements to control pollution of the sea by sewage; the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system.

Annex V; Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988)

Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of; the most important feature of the Annex is the complete ban imposed on the disposal into the sea of all forms of plastics.

[1] For more information on MARPOL, please visit http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

Annex VI; Prevention of Air Pollution from Ships (entered into force 19 May 2005)

Sets limits on sulfur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances; designated emission control areas set more stringent standards for SO_x, NO_x and particulate matter.

In 2011, after extensive work and debate, IMO adopted ground breaking mandatory technical and operational energy efficiency measures which will significantly reduce the amount of greenhouse gas emissions from ships; these measures were included in Annex VI of MARPOL and were expected to enter into force on 1 January 2013.

2.4.2 London Convention 1972

The London Convention was first adopted on November 13, 1972 and entered into force on August 30, 1975. The Convention aims to prevent dumping of wastes into the oceans through an outright ban on some substances and a state-sponsored permitting program for other substances. The Convention groups various wastes into one of three categories in Annex I, II, and III (commonly referred to as the Black List, the Grey List, and the White List)[2].

Annex I: The Black List

The dumping of any item listed in Annex I is expressly prohibited by the Convention. It should be noted that while Annex I is an exclusive list, the Convention does recognize that individual States may have their own regulations that ban dumping of certain materials from ships flying the flag of said State. Banned materials include:

- Organohalogen compounds
- Mercury, cadmium, or compounds containing those elements
- Persistent plastics that may float on the surface and interfere with fishing, navigation, or other legitimate uses of the sea
- Crude oil and its wastes, refined petroleum products, residues, and mixtures containing any of these substances
- Radioactive wastes or other radioactive matter (does not apply to material containing de–minimis levels of radioactivity as defined by the International Atomic Energy Agency (IAEA) and adopted by the contracting States)
- Materials produced for chemical or biological warfare
- Incineration at sea of industrial wastes (other incineration may be performed with a special permit)
- Industrial waste (does not apply to dredged material, sewage sludge, fish waste or waste from fish processing, inert geological materials, and uncontaminated organic materials of natural origin)

Annex I also provides an exemption for substances that contain trace amounts of the first five items in this list and allows for disposal subject to the provisions of Annexes I and II. Also, an exemption is made for substances which are “rapidly rendered harmless by

2 For more information on London convention 1972, please visit “http://londonprotocol.imo.org”

physical, chemical, or biological processes in the sea provided they do not: i) make edible marine organisms unpalatable, or ii) endanger human health or that of domestic animals."

Annex II: The "Grey List"

The dumping of any item listed in Annex II is permissible, but only with a special permit. Items requiring special permits include:

A: Wastes containing significant amounts of:

- Arsenic
- Beryllium
- Chromium
- Copper
- Lead
- Nickel
- Vanadium
- Zinc
- Any compound containing one of the aforementioned elements
- Organosilicon compounds
- Cyanides
- Fluorides
- Pesticides and their by-products not covered in Annex I

B: Containers, scrap metal and other bulky wastes liable to sink to the bottom of the sea which may present a serious obstacle to fishing or navigation.

C: Incinerated substances not covered in Annex I

D: Non-toxic materials that may become harmful due to the quantity in which they are dumped.

Annex III: The White List

The dumping of all other materials that are not listed in Annex I or in Annex II is permissible, provided the State issues a general permit to the polluter. In issuing such a permit, a State must consider all of the factors set forth in Annex III. Annex III requires States to look to a) characteristics of the material being dumped, b) characteristics of the dumping site and method, and c) possible effects of dumping the material in question. More specifics about these criteria are listed below:

- Characteristics and Composition of the Matter
  - Total amount and average composition of matter being dumped (i.e. annually)
  - Form (solid, liquid, gas, or sludge)
  - Properties (physical, chemical, and biological)

  - Toxicity
  - Persistence
  - Accumulation in and effect on local organisms
  - Susceptibility to physical, chemical, and biochemical changes when left in an aquatic environment
  - Probability of damage to the marketability of resources (i.e. fish)
- Characteristics of Dumping Site and Method of Dumping
  - Location itself and location in relation to other areas
  - Rate of disposal
  - Methods of packaging and containment
  - Dilution characteristics
  - Dispersal characteristics
  - Water characteristics, oxygen demand, nitrogen and organic compound content, and bottom characteristics
  - Other materials that have been dumped in the area
- General Considerations and Conditions
  - Possible effects on usage
  - Possible effects on marine life
  - Possible effects on other uses of the sea
  - The practical availability of alternative land-based methods of disposal or of treatment to render the matter less harmful for dumping at sea.

3. The Proposed Project Design

3.1 General Description of the Proposed Plant

The proposed Project entails the construction and operation of a 2 x 660 MW gross supercritical coal-fired thermal power plant. It will utilize imported coal from Indonesia and/or South Africa. The Project will incorporate state of the art waste treatment technologies to minimize and treat gaseous emissions and liquid effluents generated from plant processes.

The Project will be located along the Arabian Sea in the southwestern part of Gadani *tehsil* in District Lasbela; in the province of Baluchistan. It will be developed on land currently owned by HUBCO. Hub Chowki or Hub, the capital city of the tehsil, is located east northeast of the proposed location of the Project, at a distance of, approximately, 25 km by road. Karachi, the capital city of the province of Sindh is located east southeast, at an aerial distance of, approximately, 38 km from the proposed Project.

Along with the proposed power plant; coal storage and handling facilities; ash handling and disposal facilities, and cooling water intake and outfall channels will also be constructed in the vicinity of the power plant. **Exhibit 3.1** illustrates the location of the Project on a map.

There are two major industries located next to the proposed Project: HUBCO residual furnace oil (RFO) fired power plant and Byco Oil Pakistan oil refinery and chemical manufacturing plant. These are located, approximately, 1.3 km and 1.7 km south southwest of the proposed Project, respectively. Churna Island, a tourist attraction for deep-sea divers, is located, approximately, 8 km west southwest of the proposed location of the Project, separated by the Arabian Sea.

The Project site is accessible by road from Karachi city via three different routes. The route used frequently by the industries located close to the Project is via the National Highway (N-25) and Pirkas Road.

Supercritical boilers typically emit gases containing NO_x, SO_x, CO and Particulate Matter (PM) which are harmful for both humans and the environment. Using emission control systems, the Project will emit these pollutants at rates which comply with the limits prescribed by the National Environmental Quality Standards (NEQS) and the International Financial Corporation’s (IFC) limits for emissions from coal-fired boilers. This will help ensure that the concentrations of these pollutants in ambient air will be within the ambient air quality levels prescribed by the NEQS.

The proposed power plant will be based on a once-through cooling system. The cooling-water requirement for the cooling system will be met by extracting water from the Arabian Sea. Water required for other plant services will also be extracted from the sea and will be used after being treated by a RO plant.

Effluents from the plant will be treated and monitored for compliance with NEQS before being discharged into the sea. All other industrial effluents such as those from the boiler make-up water treatment system; oily waste and sanitary waste will be treated to comply with NEQS and re-used as far as possible.

Water will also be used to mix with ash to form ash slurry and for washing coal. Here too, water will be treated and re-used.

3.1.1 Project Layout

A proposed layout for Project facilities is shown in **Exhibit 3.2**. A typical layout of a coal-fired power plant, which is also representative of the proposed project, is shown in **Exhibit 3.3.** The major components of the power plant include;

- Supercritical boiler;
- Coal transportation, handling and storage;
- Water supply and waste water system;
- Ash handling system;
- Emission control system;
- Flue Gas Desulfurization (FGD) system.

The major activities with regards to the operation of the plant include the following.

- Coal for the power plant will be received at the coal yard inside the plant. It will be processed before feeding into the boiler. Heat from the combustion of coal in the supercritical boilers will be used to generate steam at high pressure. The steam will then be fed into a steam turbine, where it will rotate the turbine to generate mechanical energy. The steam, after passing through the turbine, will be reheated by re-injecting into the boiler. The rotating steam turbine will operate the power generator, which will generate electricity.
- Flue gas from the boiler is normally laden with pollutants such as NO_x, PM and SO_x. The gas will be passed through a series of treatment units to remove the pollutants before being discharged into the atmosphere.
- Cooling water is required to condense the steam exiting the turbine for reuse as water into the boiler. Cooling water for the proposed Project will be obtained from the Arabian Sea.
- Bottom ash from the boiler and fly ash from the flue gas treatment system will be collected and disposed into ash yard through the ash handling system.
- The proposed Project will require several supporting systems for other plant operations. These include the RO seawater desalination system to provide water for feeding the boilers, the effluent treatment system; wastewater treatment plants and waste disposal systems for wastewater.

Exhibit 3.1: Project Location

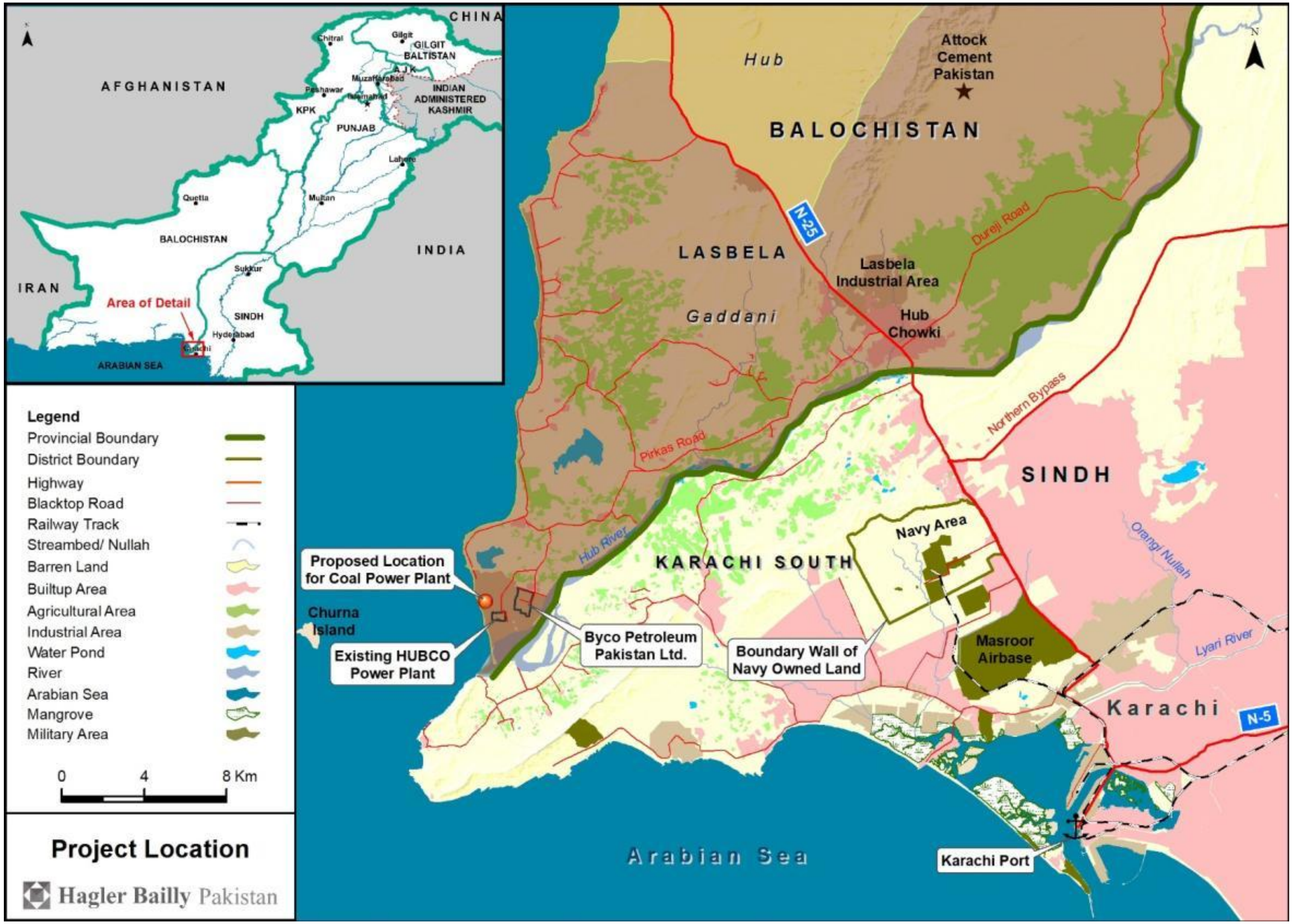


Exhibit 3.2: Proposed Project Layout

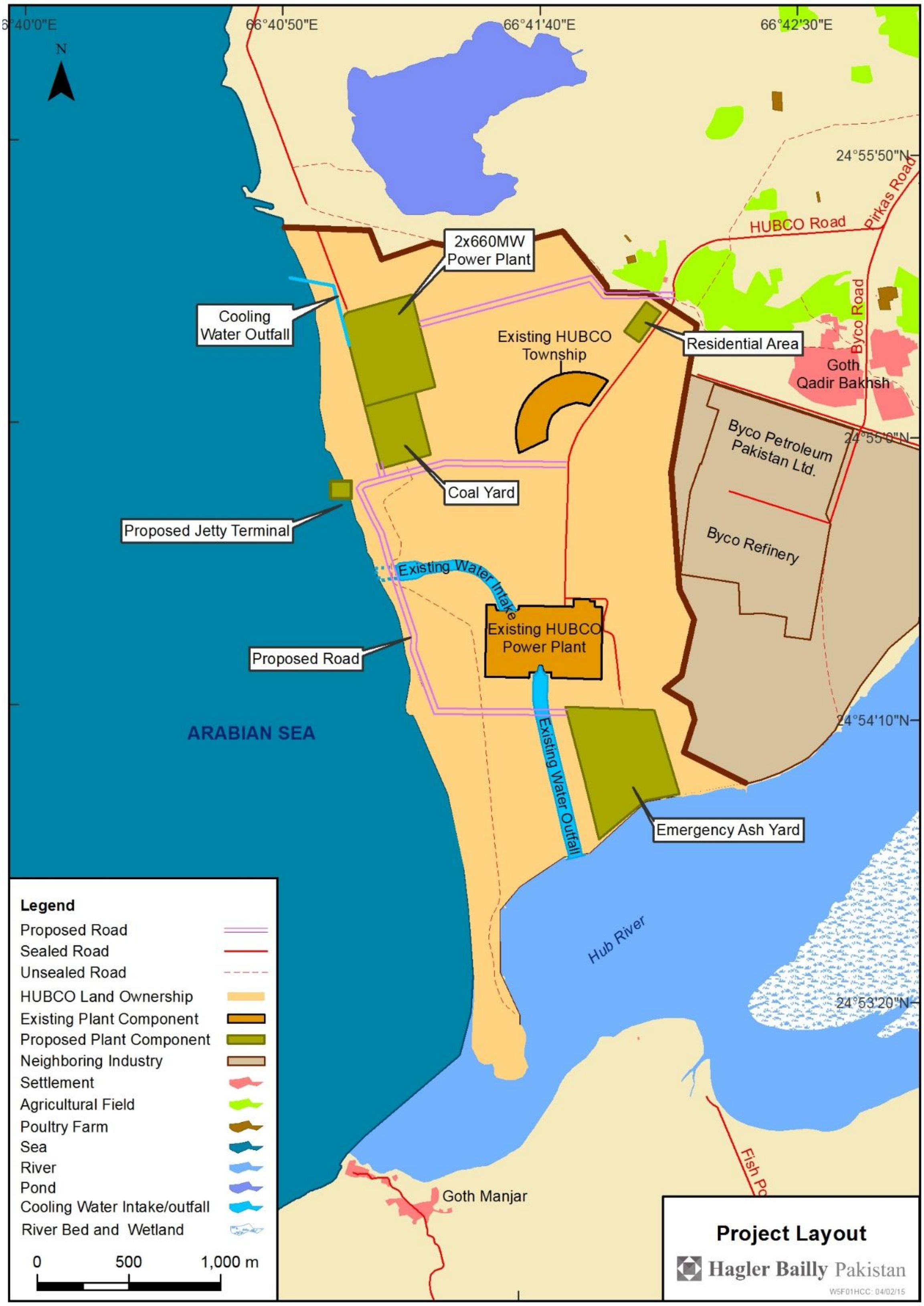
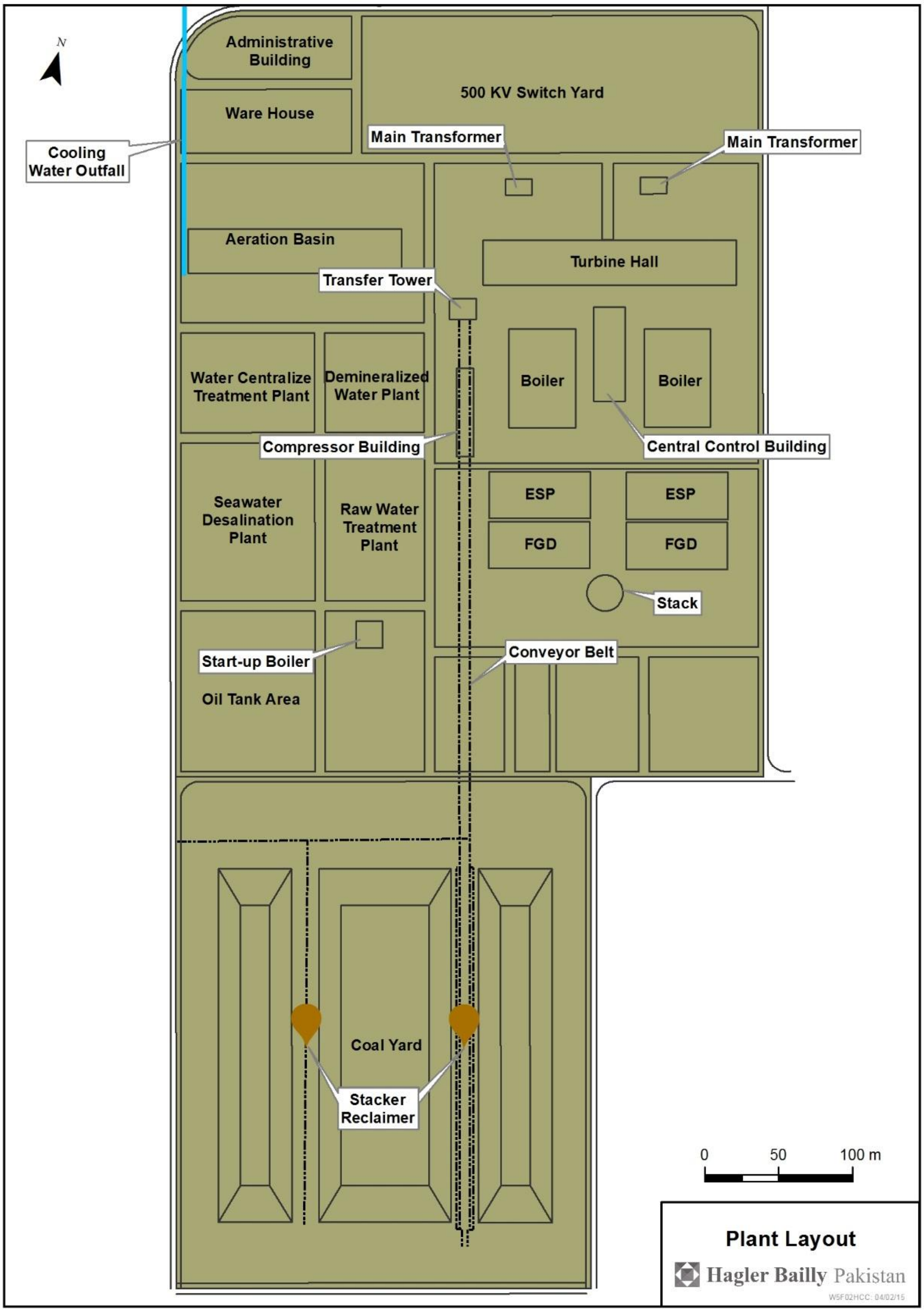


Exhibit 3.3: Proposed Coal Power Plant Layout[1]



1 HSD: High Speed Diesel

The minimum functional specifications that the proposed Project will meet are mentioned below:

Gross Capacity (ISO):	1320 MW
Power Technology	Pulverized coal firing supercritical boiler
Fuel	Sub-bituminous coal
Net Capacity:	1214 MW
Auxiliary Consumption:	106 MW (Approx)
Net thermal efficiency:	Minimum 39% on LHV basis (higher efficiency preferred)
Plant Availability Factor:	85%

3.1.2 Boiler Technology

The Project will be designed to employ a once-through supercritical boiler which consists of water/steam circuit in which all water particles get heated, evaporated and superheated in one pass. In contrast to conventional subcritical boilers, once-through boilers do not have a steam drum and require advanced automation and control systems because of their relatively small water/steam volume as well as very pure boiler feed water requirement.

The Project will be designed to use a pulverized coal boiler in which the steam generator receives coal from coal storage bunkers, which is pulverized in coal mills to a fine powder which is then conveyed by primary air to the burners for combustion in the furnace to produce steam that drives the turbine and generator. The system consists of coal silos, pulverizers, burners, furnace, back pass; heating surfaces within the furnace and back pass; air heaters, soot blowers, forced draught fans, primary air fans, and induced draught fans.

3.1.3 Coal Quality

Sub-bituminous coal for the proposed Project is intended to be imported from Indonesia or South Africa.

The design-range for design coal quality parameters for the proposed Plant are indicated in **Exhibit 3.4**.

Exhibit 3.4: Coal Quality Design Range

Parameter Test	*Design Coal*	*Check Coal*
Total Moisture*	9.27%	26%
Inner Moisture**	4.44%	18%
Ash Content**	18.5%	5%
Volatile Matter**	24.98%	38%
Net Calorific Value*	5371 Kcal/kg	4700 Kcal/kg
Sulfur**	1.09%	0.99%
IDT	1240 °C	1050 °C
HGI	53	47

*As received basis

**Air dry basis

3.2 Water Supply, Intake and Outfall System

For service water, potable water and other miscellaneous purposes desalinated seawater will be utilized. The seawater intake system will provide seawater for the power plant. Discharge from the once-through cooling water system will also be released into the outfall from the other plant processes. All the effluents will comply with NEQS standards shown in **Exhibit 3.5**.

Exhibit 3.5: Environmental Standards for Liquid Effluents.

Parameter	*Limits for Discharge to Seawater*
Temperature Increase	=< 3oC
pH value	6-9
Biochemical Oxygen Demand (BOD) 5 at 20°C (1)	80**
Chemical Oxygen Demand (COD)(')	400
Total suspended solids (TSS)	200
Total dissolved solids (TDS)	3500
Grease and oil	10
Phenolic compounds (as phenol)	0.3
Chloride(as Cl-)	SC***
Fluoride (as F-)	10
Cyanide (as CN') total	1.0
An-ionic detergents (as MBAS) . (2)	20
Sulphate (SO4 -2)	SC***
Sulphide (S -2)	1.0
Ammonia (NH3)	40
Pesticides([3])	0.15
Cadmium([4]□	0.1
Chromium (trivalent and hexavalent) [4]□	1.0
Copper ;[4]□	1.0
Lead ;[4])	0.5
Mercury;[4])	0.01
Selenium;[4])	0.5
Nickel;[4])	1.0
Silver;[4])	1.0
Total Toxic metals	2.0
Zinc	5.0
Arsenic;[4])	1.0

Parameter	*Limits for Discharge to Seawater*
Barium;[4])	1.5
Iron	8.0
Manganese	1.5
Boron;[4])	6.0
Chlorine	1.0

1. ** The value for industry is 200 mg/L
2. *** Discharge concentration at or below sea concentration (SC).

Explanations:

1. The units are in mg/L or otherwise mentioned.
2. Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. '1 : 10 dilution' means, for example, that for each cubic meter of treated effluent discharged into a receiving water body, that body should have 10 cubic meter of water for dilution of this effluent.
3. Modified Benzene Alkyl Sulphate; assuming surfactant as biodegradable.
4. Pesticides include herbicides, fungicides, and insecticides.
5. Subject to total toxic metals discharge should not exceed 2 mg/L
6. Applicable only when and where sewage treatment is operational and BOD=80 mg/L is achieved by the sewage treatment system.
7. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.

The effluent should not result in temperature increase of more than 3 °C at the edge of the zone where initial missing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the point of discharge.

Note:

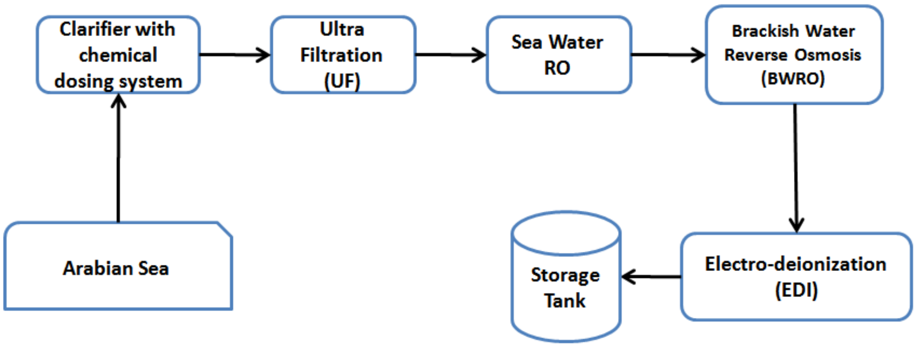
1. Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the ocean, canal or river.
2. The concentration of Pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits.

3.2.1 Desalination Plant

To meet the water requirements of the plant for cooling and miscellaneous purposes, water will be extracted from the Arabian Sea located west southwest of the proposed power plant. Saline seawater will be desalinized by a RO Demineralization (DM) Plant.

The seawater will first be taken through a clarifier with a chemical dosing system. This will be followed by taking clarified water through an ultra-filtration unit after which it will be taken into the reverse-osmosis chamber. After treatment here, the treated water will undergo electro-deionization before being stored in storage tanks. **Exhibit 3.6** provides a layout of the proposed RO DM system.

Exhibit 3.6: Schematic of Reverse Osmosis (RO) Demineralization (DM) System



3.2.2 Seawater Pre-Treatment System

The seawater pretreatment system will be installed to satisfy the makeup quality requirement for the power plant.

The seawater pretreatment scheme will be:

Water→ mixed coagulant → reaction →flocculation → sedimentation →clarified water
↓
pond →clarified water boost pumps→ seawater desalination system

The sludge generated from inclined plate/tube settlers will be collected in a common sludge pump. Sludge will be pumped from sludge pump by means of sludge disposal pumps to sludge treatment system.

A chemical house will be built to store all chemicals required for the seawater pre-treatment system and to arrange chemical dosing facilities.

Monitoring and control of all important and critical system parameters will be carried out by use of distributed control system (DCS). This system will consist of the following:

- inclined plate settlers for cooling water makeup;
- inclined plate settlers for desalination plant;
- coagulant and flocculants dosing equipment; and
- associated piping, valves, instrumentation and controls.

3.2.3 Outfall System

The discharged water will have an increased concentration of TDS and will include effluents from the wastewater treatment facilities and the discharge of the desalination system. All the effluents that will be released in the outfall system will be treated for compliance with NEQS standards given in **Exhibit 3.5.** The outfall system will discharge water into the sea through an outfall channel. The temperature of the discharged water will not be more than 3° C higher than the existing seawater temperature, at 100 m from the outfall location into the sea.

3.2.4 Potable Water System

Potable water system will provide water for general purpose washing, air conditioning make-up and other potable purposes at Jetty and plant. The system will consist of potable water tank and potable water treatment system (if required). The source of potable water will be water tankers from Hub city or desalinated water from RO plant or both.

3.2.5 A complete potable water system including potable water pumps, piping, accessories, control and instrumentation will be provided to meet the requirements. Service Water System

The service water system will supply water in adequate quantity and pressure for users. Service water will be stored and taken when required from service water tank. The source for service water will be desalinated water from RO plant.

The service water system will be designed to supply water for different services in the power plant such as coal handling/bunker dust suppression water system, flushing water for ash handling system, ash yard spraying water etc. Service water pumps and all the necessary equipment will be installed to meet the above mentioned requirements.

3.2.6 Cooling Water System

Seawater from the Arabian Sea will be used as a cooling medium and will be circulated through the tubes of a surface condenser to absorb heat from the steam. The warm water exiting the condenser will be discharged back into the sea after combining the stream with the outlet stream from the oxidizer basin. Detailed thermal plume modeling (**Section 8.9.1**) and marine impact assessment (**Section 8.10**) exercises were conducted using the outfall flow, velocity and temperature to assess the impacts of the warm water on marine life and to check whether the water temperature would be in compliance with NEQS standards. According to the thermal plume model results, the release from the power plant will comply with the NEQS guidelines with regards to the thermal gradient. NEQS allows a maximum temperature difference of 3 ºC at 100 m from the point of release. The impact on marine ecology will not be significant if NEQS guidelines are met and recommended mitigation measures are adopted.

3.2.7 Drainage Systems of the Plant

Storm Water Drainage system

Storm water associated with the Project will be discharged to the sea by a trench specially built for this purpose.

Exhibit 3.7: Sanitary Water Quality

Parameters	*Expected Concentration Before Treatment*	*Expected Concentration After Treatment*
COD	≤400mg/	≤125mg/l
BOD_5	≤200mg/l	≤25mg/l
SS	≤250mg/l	≤15mg/l
Waste Oil	≤30mg/l	≤5mg/l

3.3 Wastewater Treatment Systems

3.3.1 Industrial Wastewater Preparation System

Industrial waste water treatment system will treat the regular and intermittent waste water generated from various parts of the plant. The industrial wastewater treatment plant will consist of a frequent and non-recurring wastewater tanks, wastewater pump, pH adjusting sink, reaction sink, flocculating sink, sloping plate clarifier, gravity filter, final neutralization basin, clean water basin and re-using water pump. The slurry generated will be transferred to a slurry-thicker from where it will be disposed by licensed contractors. The industrial wastewater treatment plant will be equipped with continuous pH, flow, and suspended solids monitoring devices to monitor the quality of wastewater discharge. Wastewater composition for other contaminants will be tested by sampling method. Treated effluents will be preferably collected in re-using water tank or sump for use in coal yard dust suppression system. The excess effluents that will be discharged to the sea will be treated/managed to ensure compliance with NEQS standards.

3.3.2 Sanitary Water Treatment system

The sanitary water treatment system will be connected to sanitary drainage pipes. Sewage water from the proposed power plant will comprise of employees' bathing and washing drainage water, toilet drainage water, mess hall and dormitory drainage water.

The main indicators for sewage water quality will be Chemical Oxygen Demand (COD), Biological Oxygen Demand$_5$ (BOD_5), Suspended Solids (SS) and waste oil.

A 100% capacity sewage water treatment plant will be built. At first sewage water will flow into the sewage water adjustment basin. The impurity of sewage water will be wiped off by separator bars after which it will be pumped into the assembled sanitary sewage treatment equipment. After being treated, the clean water will be collected into the clean water basin and reused. In contrast the sludge will flow into the sludge tank and transported outside the plant through a licensed contractor.

Exhibit 3.7 provides the expected qualities of sanitary water before and after treatment.

3.3.3 Coal Wastewater Treatment System

Polluted waste water from coal-handling processes such as the dust-suppression process, will be re-pumped to the coal bunkers as spray water after filtration. The filtered out coal will be sent back to the coal yard.

3.4 Coal Transportation, Handling and Storage

3.4.1 Coal Import

It is expected that coal will be imported through shipping vessels via a coal jetty near Hub. The detailed coal importing mechanism and associated environmental impact assessment will be covered as part of a separate ESIA to be conducted for the coal jetty. For emergency purposes in case of a breakdown at coal jetty, coal is expected to be unloaded at Karachi Port and transported to the Project site via trucks.

3.4.2 Coal Storage Yard

The coal storage yard will be located on South of the proposed plant layout and will have a storage capacity of at least 60 day coal requirement of the plant. This location of coal yard will have significant advantages including less distance from trestle to the coal yard, possibility of future expansion of coal yard in either direction, more distance from the surrounding community, reason for better control of fugitive dust etc. The yard will comprise of a fully mechanized stacker/re-claimer machine system to handle and manage coal demand for 2x660 MW units. The area of coal yard will be further sub-divided into 3 yards A, B and C. Two stacker/re-claimer sets will be provided in these yards to run across the length of the yard and working either in stacking or re-claiming mode. The coal from the coal yards will be transported to crusher before transferring it to coal bunkers via conveyor system. The discharge size of coal after crushing will be around 30mm and then it will be finely powdered in pulverizers before feeding into the boiler using pneumatic flow of hot air. Coal weighing arrangement will be provided in the coal handling system along with an appropriate firefighting system.

3.4.3 Stacker/Reclaimer

A fully mechanized stacker/reclaimer will be used for coal handling in the coal yard. The stacker piles bulk material on to a stock. The reclaimer will be used to recover the coal and transfer it for further operation. Compared to manual handling, the stacker-reclaimer involves lesser human intervention and provides an efficient and cleaner way of transferring coal.

3.4.4 Coal Dust Control

The dust control system will be equipped with dust suppression sprinklers and a dust collection system. The design of the dust collection system will consist of a transfer tower, a crusher house, and coal bunkers. Wash down systems will be provided in transfer tower, crusher house, tunnels and trestles. Water spray will be provided in coal storage yard to suppress dust during coal transportation and handling. Coal Preparation and Firing

3.4.5 Raw Coal Bunker

To ensure mass flow, raw coal bunkers will be designed with very steep sides and large discharge openings. Bunkers will be lined to minimize the frictions between the coal and the walls. Raw coal will be extracted from the bunkers at variable rates according to the requirements. The boiler will be equipped with cylindrical steel coal bunkers.

3.4.6 Coal Milling and Firing

In a pulverized coal boiler, the steam generator receives coal from the coal yard, and then pulverizes it in coal mills to a fine powder which is conveyed by the primary air to the burners for combustion in the furnace to produce steam that drives the turbine and generator. The system consists of coal silos, pulverizers, burners, furnace, back pass, heating surfaces within the furnace and back pass, air heaters, soot blowers, forced draft fans, primary air fans, and induced draft fans.

Burners

For burner configuration, tangential fired boilers with burner tilts will be the preferred option. They are low NO_x burners, with high efficiency and contribute in meeting the environmental guidelines for emissions.

Pulverizer

The system will be designed based on reliable pulverizer technology with proven track record to accommodate a range of fuel specifications. All necessary safe guards will be taken for potential fire and explosions. These are expected to have a proven track record of high availability with low maintenance costs. Each pulverizer shall meet the fineness criteria and will be equipped with dynamic classifiers. The burner lines will be arranged in an equal and even distribution for proper combustion. All pulverizers will have a pyrite and tramp iron discharge outlet and safe handling system for disposal. There will be at least one spare pulverizer available at all times.

Feeders

Each pulverizer will have its own feeder, preferably gravimetric feeder, with high reliability. All controls will be provided for efficient firing and tracking of fuel consumption (with integrator readout), and individual operating hours integrator. All necessary isolation mechanisms will be provided for online maintenance. Additionally, chutes will be provided to unload coal from the silos on to trucks in case of abnormal conditions.

3.5 Boiler Equipment

3.5.1 Ignition and Combustion Supporting Oil System

The boiler will be employed with light oil ignition and combustion supporting system designed in closed circulation loop. Part of the oil will return back to the oil tank during operations. The oil gun feeding oil to the system will apply mechanical atomization.

To meet the ignition and combustion oil requirements, the plant will be equipped with vertical fuel oil storage tanks, oil feeding centrifugal pumps, oil unloading centrifugal pumps and contaminated oil treatment system in the oil pump house.

3.5.2 Primary Air Fan

All fans and motors will be designed to be direct drive, with appropriate capacity to serve the boiler design rated capacity. All dampers and drives will be designed to manage balanced draft and capable of transient conditions, include over pressurization protection. Positive shut off will be available for online maintenance if required. Enough capacity will be ensured in case of excess air leakages attributed to Air Heater leakages. As a minimum, fans will be monitored for vibrations and all motors current and RTD temperatures will be available in the control room.

3.5.3 Air Heaters

Vertical shaft air heaters will be preferred with adjustable sector plates. Design air leakage will be minimized and guaranteed for efficiencies. They will also be equipped with soot blowing air/steam and wash header, and proper monitoring will be available in the control room. These air heaters will be equipped with fire detection system as well.

3.5.4 Ceiling Fan

It is a simple device and is a part of heating, ventilation and cooling (HVAC) system commonly found in industrial and power generating units. It is used to control the temperature where it is installed. Its functioning will be controlled by a thermostat.

The boiler will be furnished with two centrifugal ceiling fans, one for operations and one as a standby. The provision of the assembly of the ceiling fan will be the responsibility of coal mill manufacturer.

3.5.5 Forced Draft Fan

A forced draft fan will provide a positive pressure to the system. Fans for boilers will force ambient air into the boiler typically through a preheater to increase overall boiler efficiency. Inlet or outlet dampers will be used to control and maintain the system pressure.

Forced draft fan technology for boilers is a tested and a widely used technology for 2 x 660 MW (gross) thermal fired power plants. The controllable rotating blade axial-flow air fans will be used in the design due to their high performance and economic efficiency especially when the load factor is lower than 70%. They are more efficient than centrifugal controllable fixed blade axial-flow air fans. The boiler will be equipped with two forced draft fans of this technology. As a fan radiates considerable levels of noise creates an adverse impact on the ambient environment; therefore, silencers will be connected with each inlet of the fan.

3.5.6 Induced Draft (ID) Fans

Fans that are used to evacuate a space or create a negative air pressure in a system are referred to as induced draft fans. A blower is used to pull air into the burner and through the combustion chamber and heat exchanger. The induced draft fan then pushes the flue gases out from the vent. Particulates add up in the air while passing through the burners which are then caught by Electrostatic Precipitators (ESP) to prevent environmental pollution.

The Project adopts the coal with low ash content. The low level of ash will eliminate the issue of abrasive resistance during fan operations. For the proposed project, two fans will be installed to serve the boiler.

3.6 Selection of Environmental Control Equipment

3.6.1 Deduster/Electrostatic Precipitator (ESP)

The steam generator will be designed to be equipped with a dry ESP to be located between the air heater outlet and the flue gas desulfurization (FGD) unit inlet. The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon) at the entrance to the FGD. The boiler will be set with two double-room 5 field ESP with efficiency more than 99.5%.

3.6.2 Stack

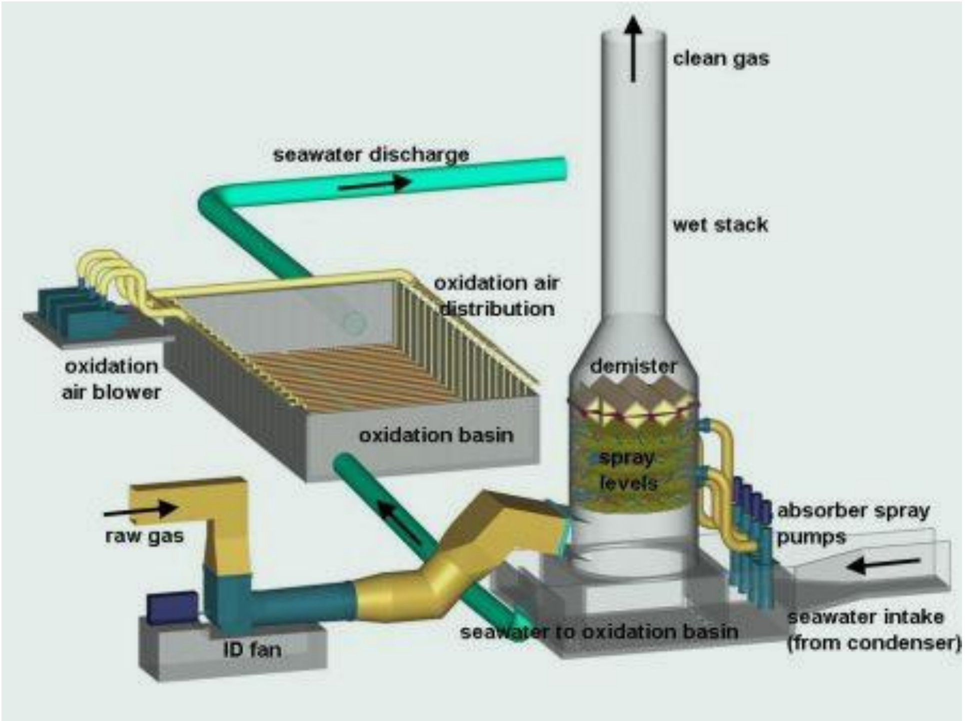
Gaseous emissions from the boilers will be emitted through a common concrete stack. The emission-dispersion-modeling exercise carried out during the ESIA process recommends a height of 210 m for the stack to ensure compliance with NEQS air quality standards.

3.6.3 Seawater Flue Gas Desulfurization System

A Seawater Flue Gas Desulfurization will be used for the Project because of economics and plant location at sea side. The seawater will be used to scrub the flue gas, taking advantage of seawater's natural alkalinity in order to neutralize the SO_2. Most manufacturers claim that up to 93.3 % of the SO_2 can be removed within the absorber. This process also removes almost 100 % of any HCl in the flue gas. At the top of the absorber, the gas will pass through a de-mister to remove suspended water droplets.

The principle of this process will be to make use of the natural alkalinity of seawater instead of a limestone solution to absorb the acidic substances in flue gas, such as SO_2. In this process, at first the SO_2 is converted into HSO_3^- in the spray tower. Then the HSO_3^- is oxidized to SO_4^{2-} in the aeration basin in order to raise the dissolved oxygen and reduce the chemical oxygen demand (COD) value. Meanwhile, the CO_2 formed by the neutralization reaction is stripped by aeration membrane and the pH value is raised as a result, thus meeting the legal requirements for emission of pollutants from the stack. A process flow diagram for this process is shown in **Exhibit 3.8**. A Gas-Gas Heater (GGH) will also be used which will increase the temperature of flue gases leaving the stack to 70 °C**.** Impact on air quality with and without GGH is compared in **Section 8.4.1 Exhibit 8.23.**

Exhibit 3.8: Seawater FGD System Concept



3.7 Ash Handling and Disposal

Coal combustion residuals generated from the boiler technology proposed for the Project will include the following:

- At the furnace bottom, as bottom ash or bed ash (about 10% of the total volume of ash produced); and
- At the ESP and Economizer, as fly ash (about 90% of the total volume of ash produced).

3.7.1 Ash Generation

Fly ash, bottom ash, and pyrites left over from combustion will be removed from their respective points of accumulation. Fly ash will be removed with the help of the ESP installed. Bottom ash will be removed from the boiler’s bottom ash hopper, and pyrites from the pulverizer’s pyrite collection hoppers. This project with 2×660MW units which discharge 707,300 tons of ashes and 18,800 tons of stone coals per year. The total volume of annual ashes and stone coals discharged from a 2 × 660 MW unit will be maximum about 726,100 m^3 with ash density of 1.0 t/m^3.

3.7.2 Ash Yard

The southern side of the site will be used as an emergency ash storage yard, with no demolition inside. The lower soil layer of the proposed ash storage yard is composed of clayey silt, silty clay, sand and gravel.

An ash dam will be built since the ash storage yard will be plain. The structure of the ash dam will be sloping seawall and dam about 6 m high. The emergency ash storage yard will cover an area of about 319,000 m^2. To prevent the dust emissions of fly ash, sprinkling of water on ash surface will be carried out to keep ash surface in wet state. Compaction of ash after spraying the surface will be carried out to avoid artificial disturbance. For long-term, when ash heaps up after reaching final level of ash height, the heap will be covered with 500 mm clay on the ash final surface for plantation. Tree planting around the dry ash yard dam slope side will be carried out to form tree forest, of approximate width about 10 to 20 m. Trees can be arbor or shrub and grass, which can provide shelter and could reduce the wind speed which will reduce the effect of fly ash.

A dedicated ash yard will be developed outside the land currently owned by HUBCO, for long term disposal of ash. A separate environmental impact assessment study will be conducted for ash yard site selection.

3.8 Decommissioning

If demanded by the Government, the Project will be decommissioned after completing, approximately, 30 years of operation. Decommissioning activities will include dismantling and demolition works. For this purpose, a detailed plan will be drafted prior to commencement of decommissioning works to ensure orderly and selective dismantling and demolition of the plant in compliance with the national environmental guidelines. The plan will require approvals from BEPA and other concerned institutions.

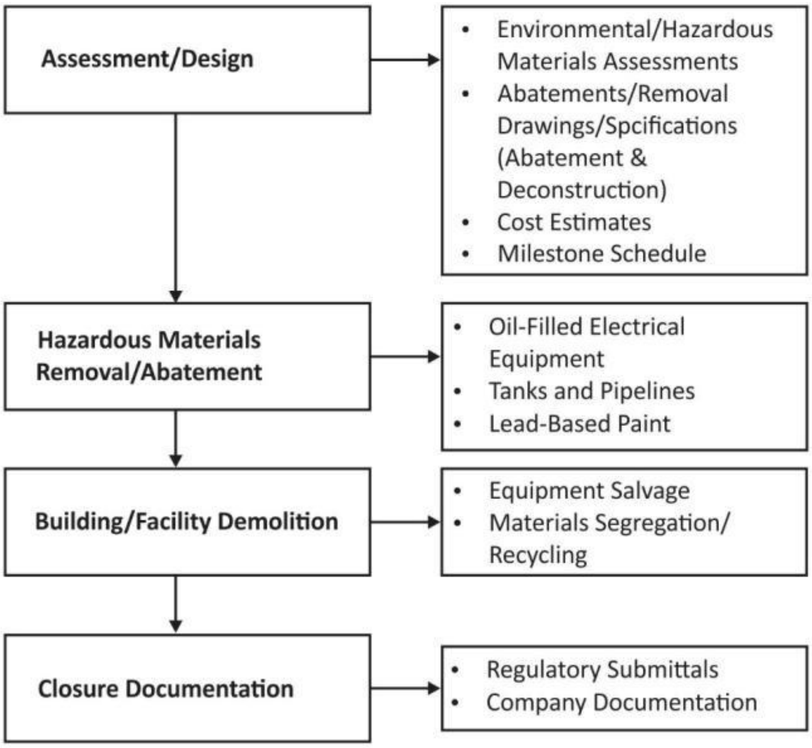
The plan will include cataloging hazardous materials and carrying out assessment and abatement works; contingency and Environmental Control Plans; ash yard rehabilitation; plant, equipment re-sale and salvage evaluations; and, construction management during the demolition and deconstruction work.

Before decommissioning, a consultant will be engaged who will work closely with the proponent to understand the layout of the power plant facilities to target environmental and hazardous materials assessments. This will minimize unexpected incidents during demolition, excavation and general construction work. Performing a comprehensive evaluation of hazardous materials and addressing compliance requirements will assure that during decommissioning, general construction workers are not exposed to hazardous materials or contaminated media and achieves compliance with applicable regulatory requirements.

Power plant equipment will be evaluated to identify items for re-sale or salvage.

A general structure of decommissioning planning is illustrated in **Exhibit 3.9**.

Exhibit 3.9: Structure for Decommissioning Proposed Coal-Fired Power Plant



4. Description of the Environment

This section describes the environmental baseline conditions in the vicinity of the Project and areas likely to be environmentally impacted due to the Project. The baseline data was collected using primary and secondary sources of information. Primary sources involved surveys, interviews and collection of samples to be later tested at laboratories. The environmental baseline data was collected for physical environment, ecological environment, marine environment and the socioeconomic environment.

4.1 Study Areas

The study areas for the baseline are split as follows:

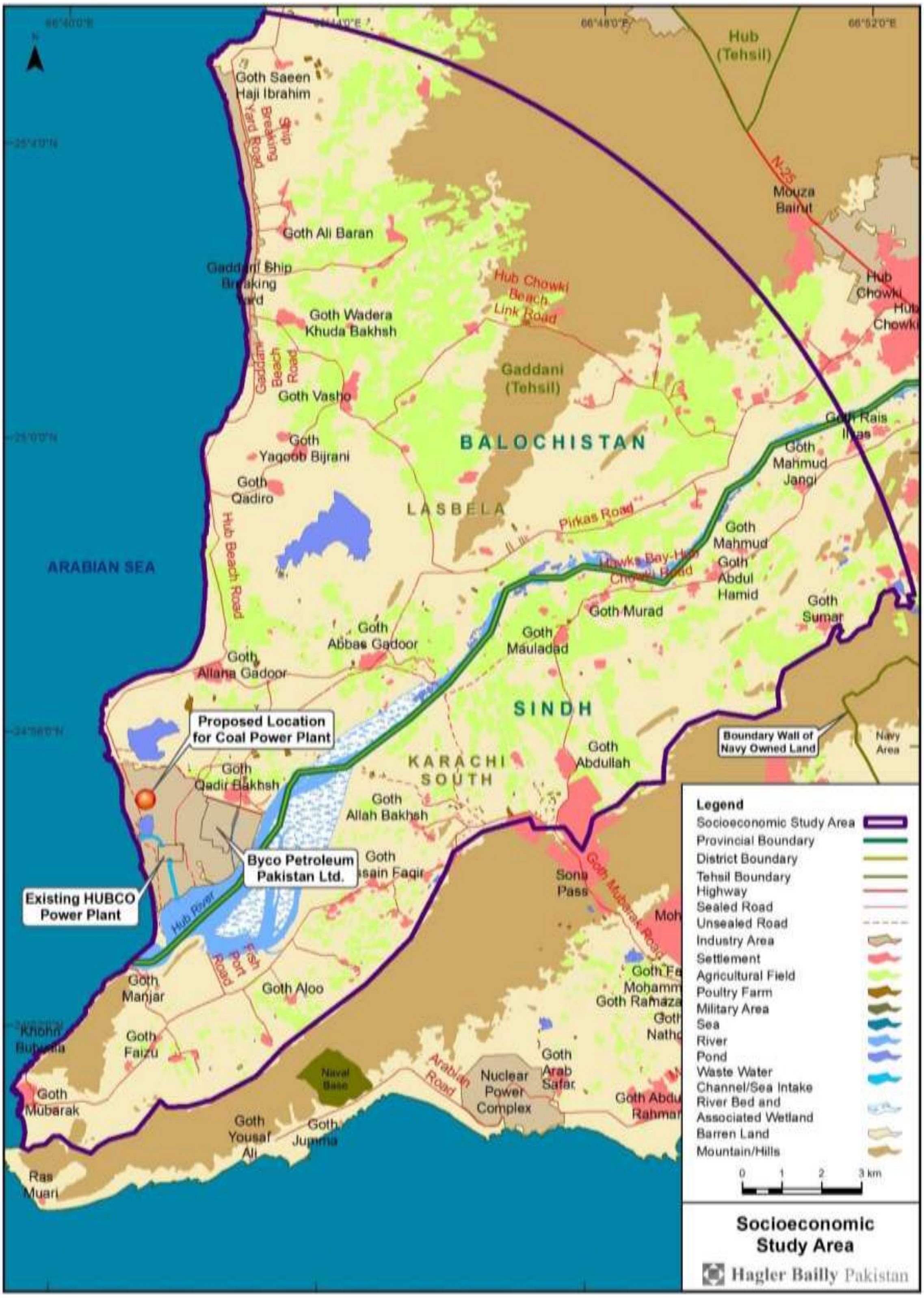
- Near-Field Physical Study Area – for noise, water, soil and ecological impacts
- Far-Field Physical Study Area – for air quality and traffic impacts
- Socioeconomic Study Area – for socioeconomic impacts.

These areas are illustrated by**Exhibit 4.1**, **Exhibit 4.2** and **Exhibit 4.3** respectively.

Exhibit 4.1: Near-Field Physical Study Area

Exhibit 4.2: Far-Field Physical Study Area

Exhibit 4.3: Socioeconomic Study Area



4.2 Physical Environment

4.2.1 Topography

The topography at the Near-Field Study Area (**Exhibit 4.1**) and the existing HUBCO industrial site is generally gentle with all areas at or below 10 m above mean sea level (m asl). The topography is related to the underlying geology. The topographical map of the Far-Field Study Area (**Exhibit 4.2**) is provided in **Exhibit 4.4**. The drainage pathway of the Hub River follows the Hub Fault. The Mor Range extends in a general northeast-southwest direction in the northwest of the Project site. The Kirthar Range trends northeast-southwest and lie in the east and southeast of the Project site. Both the Mor Range and Kirthar Range are associated with topographical highs. Immediately north of the Project site, the Porali plains extend along the Arabian Sea (**Exhibit 4.5**).

4.2.2 Geology

Geological blocks in the Far-Field Study Area are shown in **Exhibit 4.5**. The Project site lies in the southern edge of the Khuzdar Lithological Block. The Porali plain lies west of the Project site. The plain lies at the southern edge of the Bela-Waziristan Ophiolite Lithological Zone (BWZ). The BWZ indicates the uplift of the ocean floor in the region.

The lithological units within the Far-Field Study Area are shown in **Exhibit 4.6**. The Project site comprises of outcrops of Eocene and Paleocene sedimentary rocks and quaternary unconsolidated sedimentary sand, silt and gravel deposits. Review of secondary sources of information, indicates that the area is characterized largely by loamy and gravely soils[1]. The soil baseline studies carried out (**Section 4.2.5**) indicate that the upper 15 cm of the soil layer has sand as the dominant fraction. This is potentially due to aeolian deposition the coastal environment. Based on borelogs[2], the typical thickness of the soil is 5 to 10 m. Extrusive mud volcanoes are also present in the region. In some areas, particularly in the west of the HUBCO industrial site, some rock outcrops over patchy heterogeneous soil materials were identified using aerial imagery.

[1] Survey of Pakistan. “Soils Map”, Atlas of Pakistan (2012)

[2] HUBCO. “Geotechnical Borelogs” (obtained during Site Visit); some additional information from HUBCO has been requested.

Exhibit 4.4: Topography in Far-Field Study Area

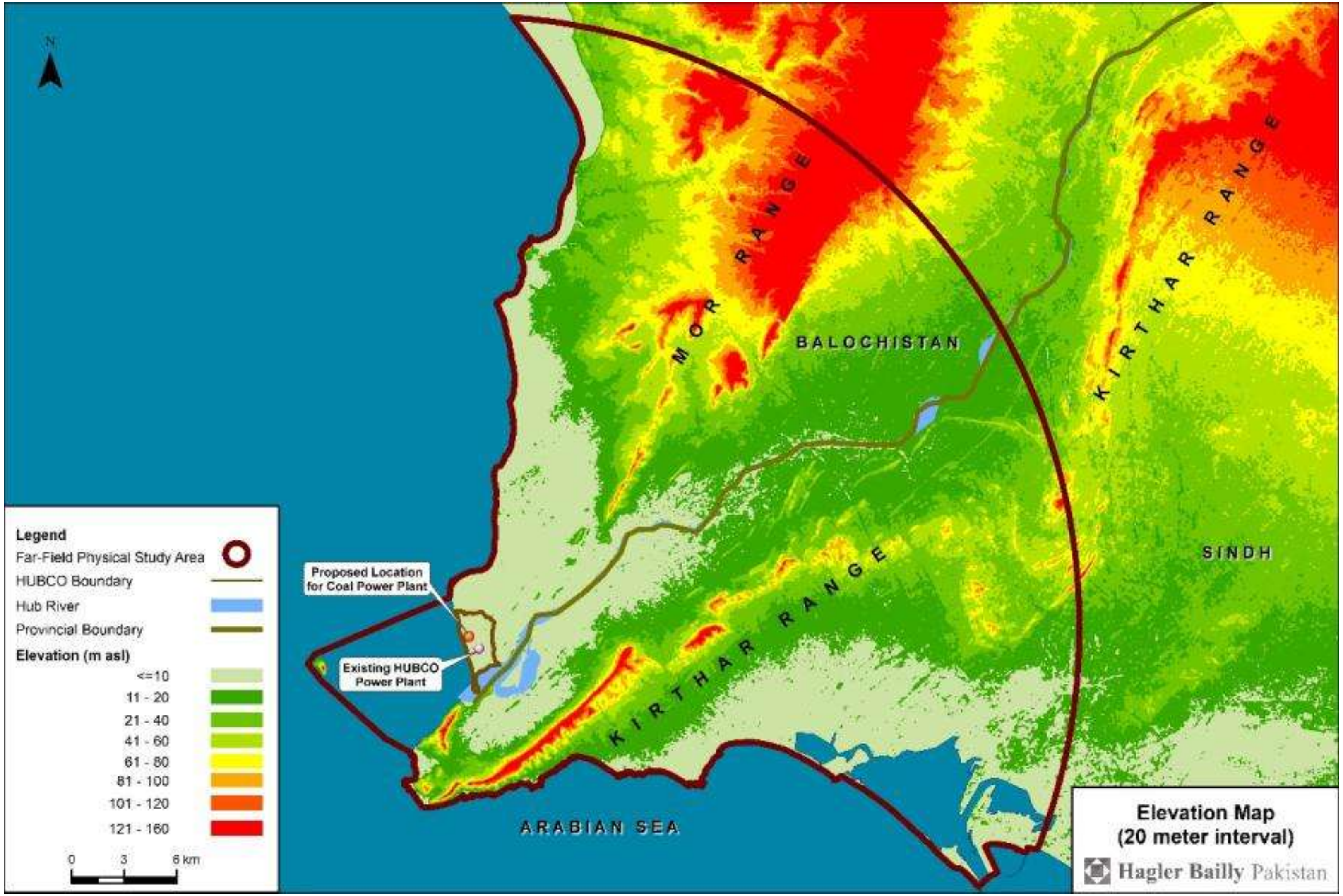


Exhibit 4.5: Major Geological Blocks

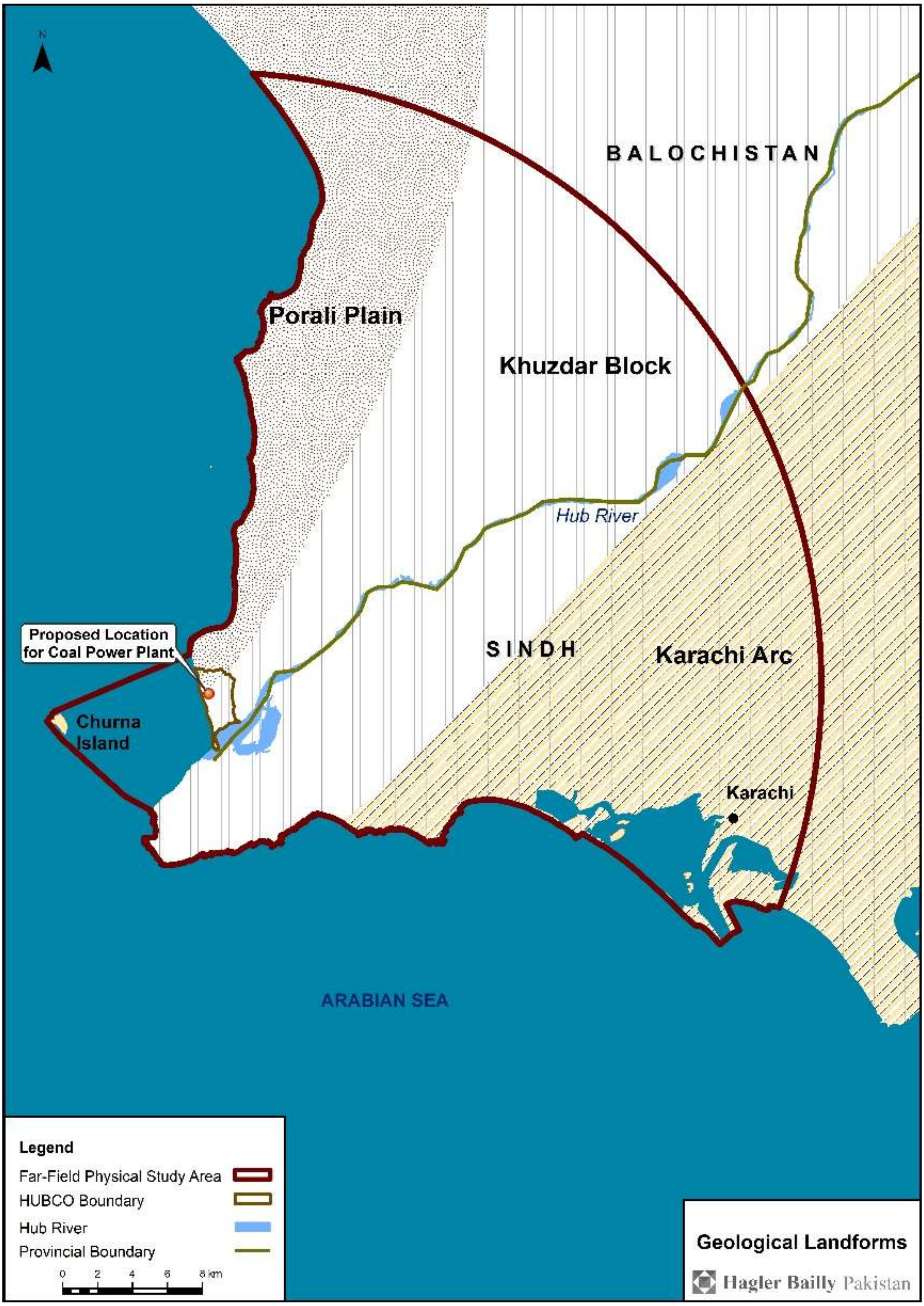
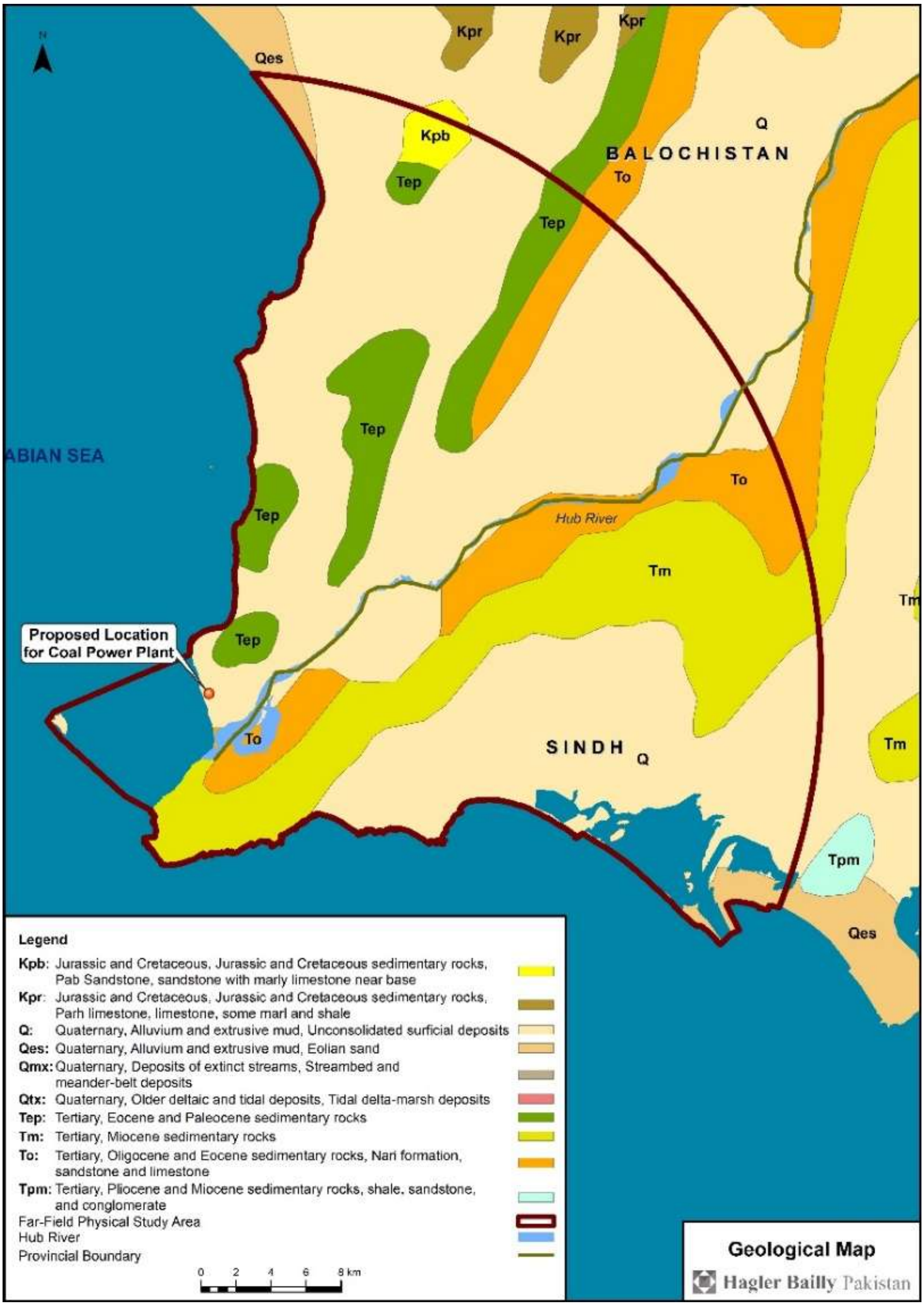


Exhibit 4.6: Lithology in Far-Field Study Area[3]

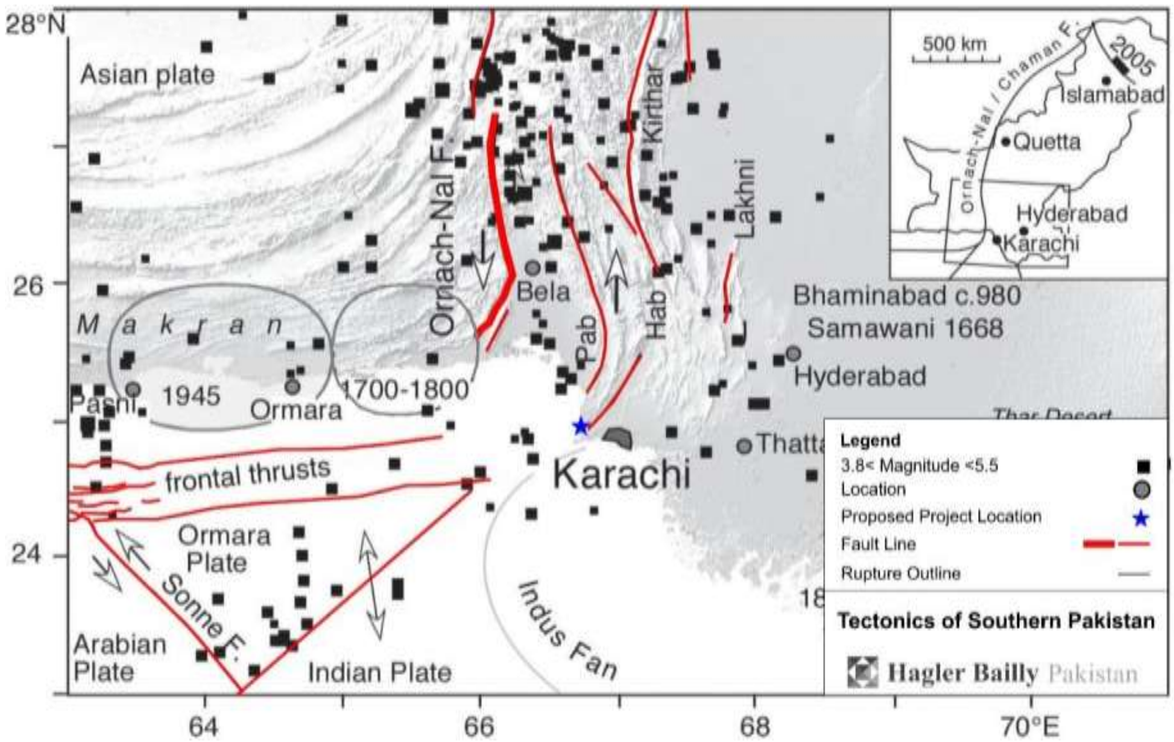


3 Geological Survey of Pakistan (GSoP) and United States Geological Survey (USGS). "Geological Map of Pakistan [Scale: 1:2,000,000]" (1964)

Earthquakes and Seismic Hazard

The Project site is located adjacent to an active tectonic setting approximately 190 km east of the triple continental junction between the Arabian, Eurasian and Indian plates. A tectonic map of southern Pakistan, with the Project site indicated, is provided in **Exhibit 4.7**. Three structures associated with major crustal movements southwest of the Project site include the strike-slip Ornach–Nal Fault, the strike-slip Sonne Fault and frontal thrusts associated with the Makran Subduction Zone (MSZ) in the Indian Ocean. Additionally, smaller intraplate faults associated with subduction are present in the vicinity of the Project site. In particular, north-south striking Hub and Pab Faults exist in the east and west of the Project site respectively.

Exhibit 4.7: Tectonics of Southern Pakistan[4]



The Study Area experiences an earthquake density of less than 1 per year (**Exhibit 4.8**). Earthquake epicenters, for magnitudes between 3.8 and 5.5 M_L[5], have been recorded along the Pab fault, Ornach–Nal fault, and the offshore areas in the south east of the Project site (**Exhibit 4.7**). Several events are located close to the Hub and Pab faults, including an mb[6] 4.6 earthquake on 8 September 1986 and an mb 4.5 earthquake on 29 September 1998. Both of these earthquakes were felt in Karachi. The Pakistan

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4 adapted from Bilham *et al.* "Seismic Hazard in Karachi, Pakistan: Uncertain Past, Uncertain Future" Seismological Research Letters 78 (2007).

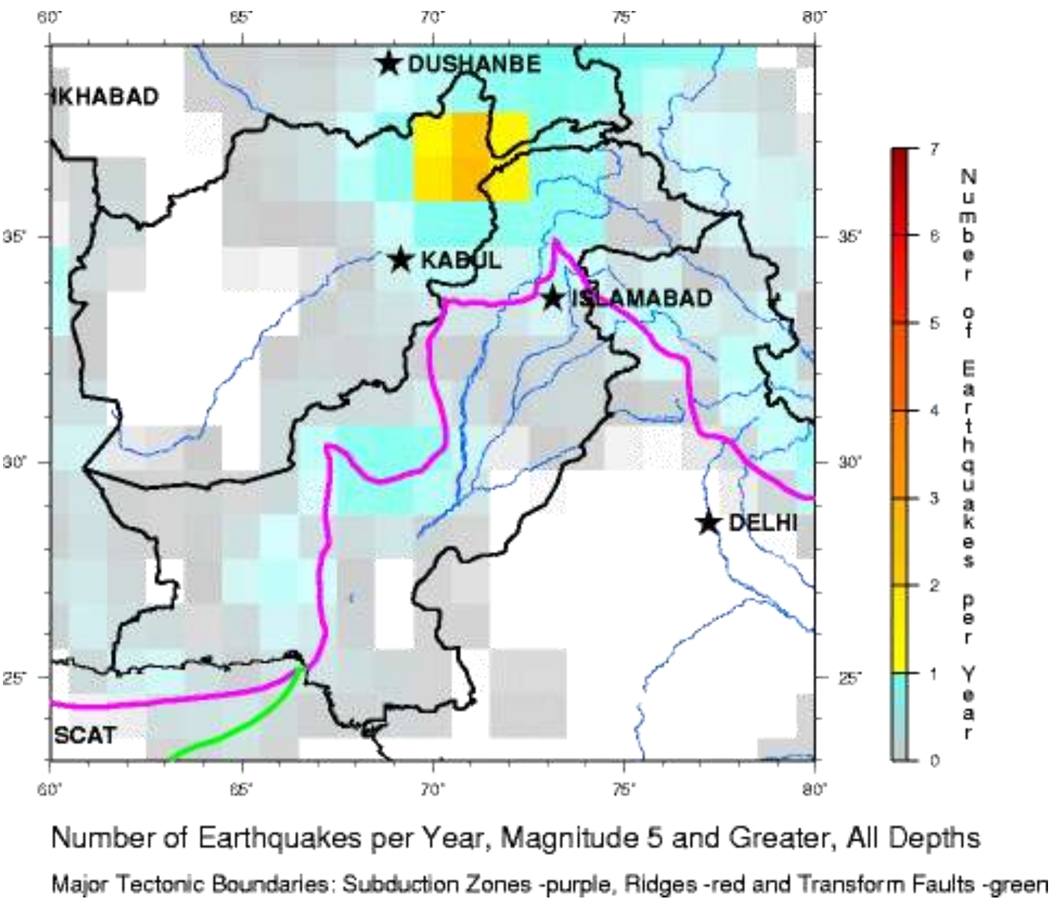
5 M_L: Richter scale

6 mb: Short duration body-wave magnitude

Meteorological Department (PMD) characterizes the zone in which the Project site lies, as a Moderate Earthquake Zone[7].

Based on the Global Seismic Hazard Map Project (GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is 1.6 m/s^2 (**Exhibit 4.9**).

Exhibit 4.8: Earthquake Density of Pakistan[8]



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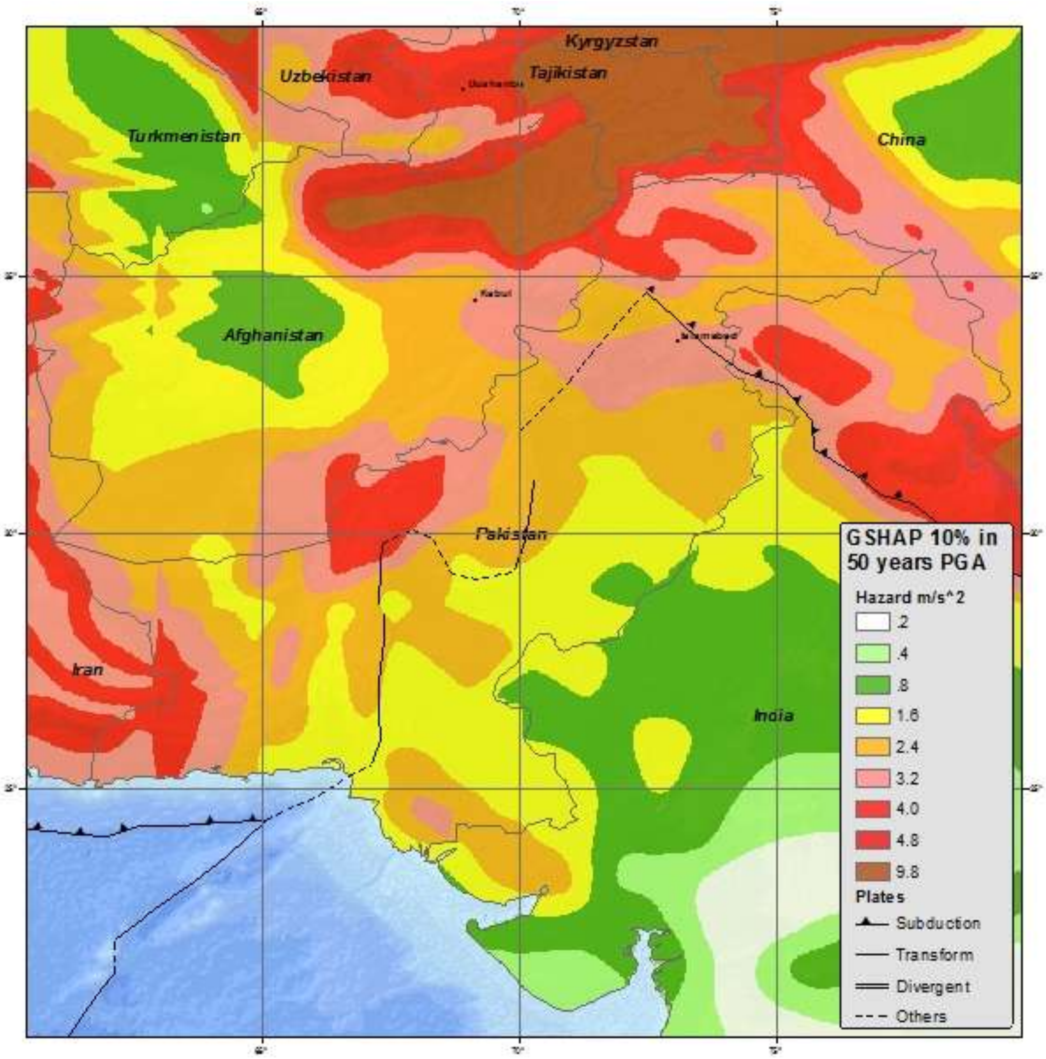
7 5 – 6.9 Magnitude on Richter scale with Seismic Factor Ground Acceleration of g/10 to g/15.

8 United States Geological Survey (USGS), "Earth Quake Density of Pakistan", accessed 15 September 2014, http://earthquake.usgs.gov/earthquakes/world/pakistan/density.php

Exhibit 4.9: Seismic Hazard Map of Pakistan[9]



Tsunamis

The Project site is in an area of potential tsunami. While large tsunamigenetic earthquakes have been relatively rare, however there is potential for a tsunami associated with the Makran Subduction Zone (MSZ) or smaller localised tsunamis associated with several smaller thrust faults around Karachi[10].

The tsunami generated along the MSZ in 1945 was responsible for loss of life (approximately 4000 deaths) and destruction along the coast of Pakistan. There is evidence that this tsunami was 1.2 m and the associated earthquake of intensity was 7.2 M_L. The earthquake was also associated with eruption of a mud volcano and forming

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9 United States Geological Survey (USGS), "Seismic Hazard Map of Pakistan" (based on GSHAP), accessed 15 September 2014, http://earthquake.usgs.gov/earthquakes/world/pakistan/density.php

10 Pararas-Carayannis. "The potential of tsunami generation along the Makran Subduction Zone in the northern Arabian Sea. Case study: the earthquake and tsunami of November 28, 1945", Science of Tsunami Hazards 24 (2006).

four islands off the Makran Coast. This also caused minor damages in Port Qasim area. The 1945 event was followed by another tsunami-related tidal wave in 1953. The tsunami of December 26, 2004 and March 28, 2005 had little impact on the coastal areas of Gadani and Sonmiani. Both these areas are west of the Project site.

4.2.3 Land Use

The land use with the Far-Field Study Area is shown in **Exhibit 4.9**. A pie chart showing the breakdown of land-use types is shown in **Exhibit 4.10**. It is noted that the Far-Field Study Area comprises largely of barren land (54.9%), agricultural land (12.3%), and built-up areas (15.2%). The remaining 17.6% of the Far-Field Study area comprised of industrial areas (4.1%), non-perennial water ponds/playa lakes (0.4%), river bed (1.5%), military areas (3.8%), mangrove area (1.0%) and the Arabian Sea (6.7%).

Exhibit 4.10: Land Use in Far-Field Study Area

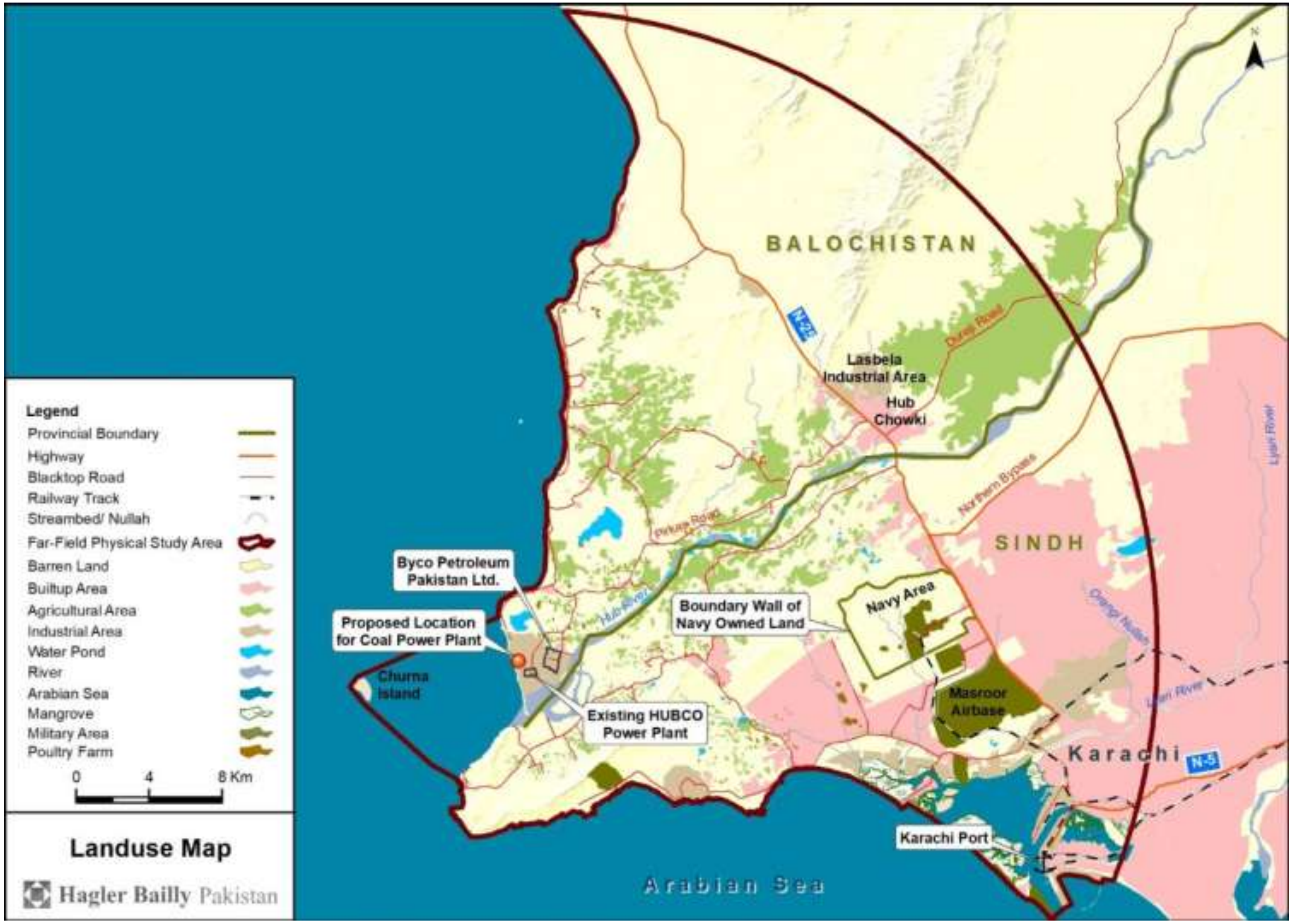
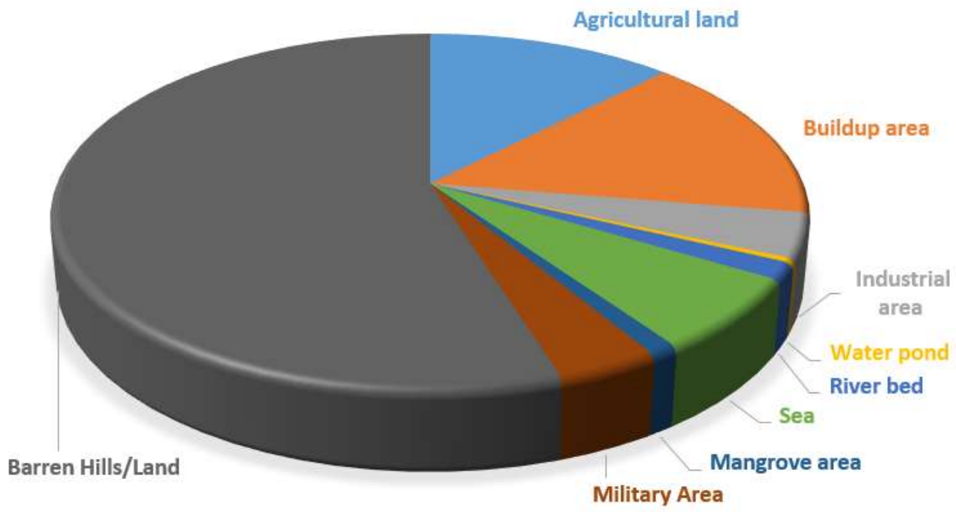


Exhibit 4.11: Land Use Break down in Far-Field Study Area



4.2.4 Climate

The climate at the Project site is characterized as hot and dry during summer, and mild during winter with heavy, sporadic, rainfall during the monsoon. The southwest monsoon prevails from April to October in the Project area and the Indian Ocean. The monsoon is characterized by a reversal in wind direction during the remaining months; and, heavy rainfall over most of the Indian Subcontinent.

There is a weather station at Karachi Airport (24°54'2.47"N 67°10'6.39"E), approximately 45 km east of the existing HUBCO plant site and proposed Project site. As part of the Baseline Study, additional and more recent synthetic climatic data from January, 2012 – December, 2013 was obtained for the Project site. This was synthesized using nearby stations and the MM5 model (**Appendix B**).

The general characteristics of the seasons based on this data is provided in **Exhibit 4.12**. **Exhibit 4.13** and **Exhibit 4.14** shows the monthly temperature and rainfall based on the long term data (1928-1990) measured at Karachi Airport Meteorological Station. The hottest months are between mid-March to June in which the maximum average monthly temperature exceeds 40 °C. The winters are mild with temperature dropping to 6 °C in January. Karachi receives approximately 217.3 mm of rain annually. Almost 80 % of the rain is concentrated in the monsoon season.

Exhibit 4.15 provides a summary of the climate (temperature, relative humidity, and wind speed and wind direction) for the Project site based on the recent data. **Exhibit 4.16** provides a wind rose based on the same date, according to which, from January, 2012 – December, 2013, more than 50 % of the time, the wind direction at the Project site blew from southwest to northeast. This corresponds with the summer season, particularly, the months from May to October. The other predominant wind direction during the sample year is from the northeast to southwest which occurred for a little over 10 % of the time. This corresponds with the winter season, especially, in the months of January, November and December. The monthly predominant direction of wind is also provided in **Exhibit 4.15.**

Exhibit 4.12: Seasonal Characteristics of the Climate of Karachi

Season	*Temperature*	*Rainfall*	*Wind*
Summer (Mid-March to mid-June)	The summers are hot with temperature increasing from March 26.2 °C rising up to 40 °C in June.	There are less frequent rain showers in summer with no more than 1 or 2 rainy days in summer. Average total amount of rain in summer is around 10 mm	The wind speed in summer is variable. It is around 2.5 m/s in March and rises upto 18 m/s in April and drops to 4 m/s for the rest of the season. The direction mostly remains towards West
Monsoon (Mid-June to mid-September)	The temperature in monsoon remains high but relatively lower than summer and oscillates around 32 °C.	Almost 80 % of the yearly rain occurs in the monsoon with July and August being the wettest month.	The wind direction in the monsoon is mostly towards East
Post-Monsoon Summer (Mid-September to November)	The average temperature post monsoon drops and average minimum temperature may reach 12 °C. in November	The post-monsoon remains mostly dry and rainfall in the November is around 1.8 mm	The wind speed in Septembers is around 3.7 m/s and drops to 1.4 m/s in November.
Winter (December to mid-March)	The winter is mild with January being the coolest month where average minimum temperature falls to 6 °C.	Like the other season except monsoon there is little occasional rainfall. The rainfall in winter is less than 50 mm	The wind speed in the winter season increase from 1.4 m/s in December to 2.6 m/s in March. The wind direction for most part winter season is towards North-East and changes its course towards West in early March

Exhibit 4.13: Mean Monthly Temperatures (°C) of Karachi Airport Meteorological Station

Month	*Mean of Monthly*		*Highest Recorded**		*Lowest Recorded**	
	Maximum	*Minimum*	*Value*	*Date*	*Value*	*Date*
Jan	29.1	6.1	32.8	16/1/1965	0	21/1/1934
Feb	32.0	7.7	35.0	29/2/1960	2	11/2/1950
Mar	36.1	12.2	39.0	26/3/1977	8	2//31939
Apr	40.1	17.7	44.0	16/4/1947	13	5/4/1940
May	41.5	22.2	48.0	9/5/1938	18	9/5/1960

Month	*Mean of Monthly*		*Highest Recorded**		*Lowest Recorded**	
	Maximum	*Minimum*	*Value*	*Date*	*Value*	*Date*
Jun	40.1	25.4	47.0	18/6/1979	22	3/6/1940
Jul	37.5	25.0	42.0	3/7/1958	22	22/7/1938
Aug	35.5	23.9	41.7	9/8/1964	23	12/8/1933
Sep	37.4	22.7	43.0	30/9/1951	18	30/9/1950
Oct	39.3	16.1	43.0	1/10/1951	10	30/10/1949
Nov	35.6	11.2	38.5	1/11/1986	6	29/11/1938
Dec	31.0	6.8	33.9	8/12/1963	2	30/12/1932
Annual	36.3	16.4	48.0	9/5/38	0	21/1/ 34

* Highest and lowest recorded temperatures are based on data collected at the Karachi meteorological station since it was established in 1928-1990

Source: Pakistan Meteorological Department

Exhibit 4.14: Rainfall measured at Karachi Airport Meteorological Station

Month	*Mean Monthly (mm)*	*Wettest Month**		*Mean Number of Rainy Days*
		Value (mm)	*Year*	
Jan	6.0	66.8	1976	0.5
Feb	9.8	96.0	1979	0.6
Mar	11.7	130.0	1967	0.4
Apr	4.4	52.8	1935	0.3
May	0.0	33.3	1933	0.0
Jun	5.5	85.9	1936	0.7
Jul	85.5	429.3	1967	2.6
Aug	67.4	359.4	1944	2.5
Sep	19.9	315.7	1959	0.7
Oct	10.0	98.0	1956	0.1
Nov	1.8	83.1	1959	0.2
Dec	4.4	63.6	1980	0.7
Annual	217.3	745.5	1944	9.4

* Based on data collected at the Karachi station since it was established in 1928-1990

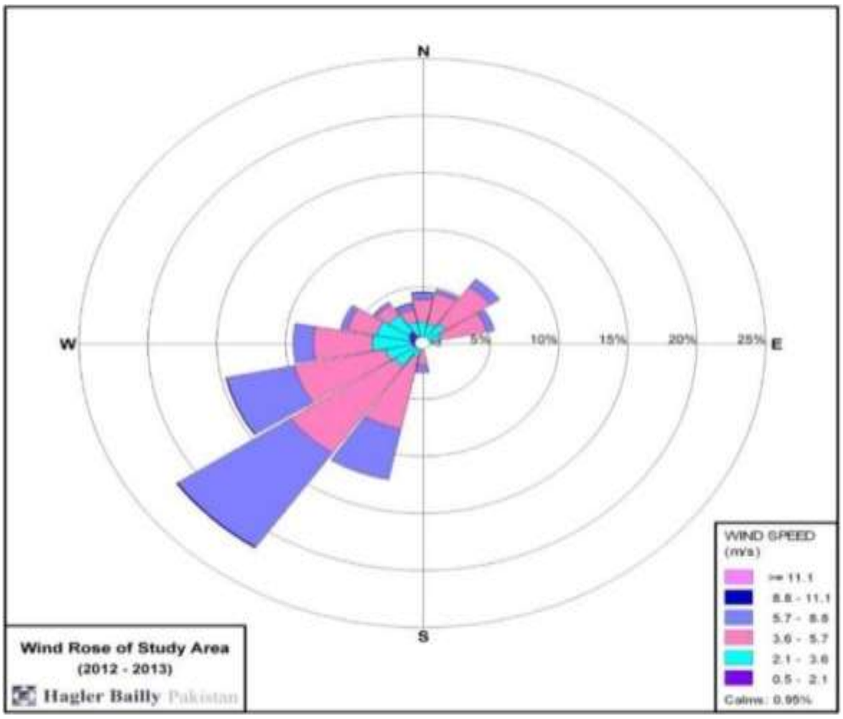
** 'Rainy day' is defined as a day on which at least 0.1 mm of rain is recorded

Source: Pakistan Meteorological Department

Exhibit 4.15: Summary of Climate of Project site[11]

Month	*Temperature*			*Relative Humidity*			*Wind Speed*			*Predominant Wind Direction*[12]
	Min.	*Average*	*Max.*	*Min.*	*Average*	*Max.*	*Min.*	*Average*	*Max.*	
Jan	10.0	17.4	25.6	17.0	47.2	100.0	0.0	3.6	8.2	NE
Feb	8.6	19.0	26.6	17.0	51.1	100.0	0.1	3.9	9.2	Variable (VRB)
Mar	14.1	23.8	31.6	15.0	62.1	100.0	0.0	4.2	13.2	W
Apr	22.8	27.8	33.8	12.0	69.2	96.0	0.1	5.0	11.1	WSW
May	25.4	29.9	35.4	9.0	74.7	100.0	0.8	5.8	9.6	SW
Jun	26.1	30.3	36.9	27.0	77.5	99.0	0.1	5.6	8.7	SWS
Jul	26.6	29.7	33.1	52.0	80.6	98.0	1.9	5.8	9.1	SWS
Aug	25.2	28.2	32.1	64.0	81.7	98.0	0.2	5.3	9.1	SWS
Sept	24.2	28.7	34.8	40.0	78.7	100.0	0.0	4.6	8.2	SW
Oct	20.1	27.2	34.6	21.0	65.5	100.0	0.0	3.3	7.4	SW
Nov	15.1	23.2	30.6	21.0	52.1	91.0	0.0	3.1	7.0	NE
Dec	6.1	18.5	25.0	18.0	50.8	100.0	0.0	3.6	11.7	NE

Exhibit 4.16: Wind Rose of the Project site[13]



[11] Based on generated synthetic data for a 50 km x 50 km area around the Project site (24.918N, 66.688E), for a period of two years from January, 2012 to December, 2013. This data was acquired from Lakes Environmental (.http://www.weblakes.com/services/met_data.html).

[12] Key: VRB: Variable, N: North, S: South, E: East, W: West

[13] See Footnote 11.

4.2.5 Soil

This section provides the baseline condition of surface soils in Near-Field Study Area (**Exhibit 4.1**).

Scope of Soil Investigation

The scope of the investigation included:

- surveying of soils in the Study Area for potential contamination;
- collecting representative soil samples;
- carrying out analysis of metals, cations and anions, hydrocarbons; and
- determining the particle size distribution or soil samples.

Soil Sampling and Parameters Analyzed

Sampling and Locations

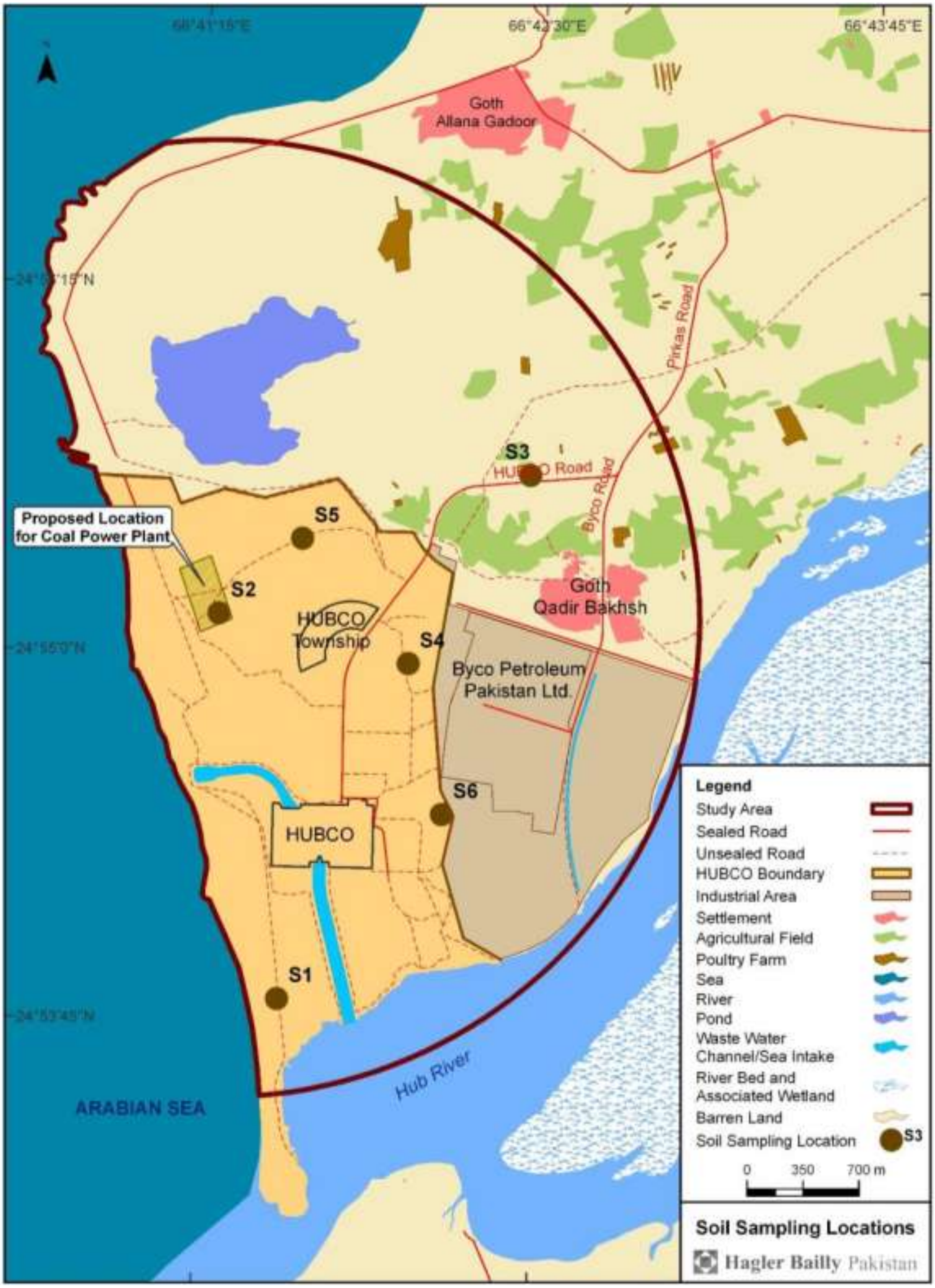
The sampling locations were chosen considering wind direction and land use. The sample collected from the agriculture land was analyzed for soil fertility characteristics.

The sampling locations are listed in **Exhibit 4.17** and indicated on a map in **Exhibit 4.18**.

Exhibit 4.17: Surface Soil Quality Sampling Locations

Sample ID	*Sample Lab ID*	*Coordinates*	*Sampling Depth (cm)*	*Location Description*	*Rationale*
S1	SHCCS1	24° 53' 49.4"N 66° 41' 33.5"E	15	barren land south of exisiting Byco and HUBCO plant and proposed Project location (upwind location)	to determine existing/baseline condition of soils in the Project area
S2	SHCCS2	24° 55' 7.7"N 66° 41' 19.2"E	15	barren land at proposed Project location	to determine existing condition of soils at the Project location
S3	SHCCS3	24° 55' 36.8"N 66° 42' 28.3"E	15	agricultural land towards the north, outside land owned by HUBCO	Existing condition of soil agricultural productivity since agricultural productivity may be affected by the Project
S4	SHCCS4	24°54'58.00"N 66°42'1.60"E	15	east of the HUBCO Township where accumulation of flood water takes place in monsoon	to determine quality of accumulated surface run off
S5	SHCCS5	24° 55' 23.2"N 66° 41' 37.6"E	15	Surface soil sample: up wind and back ground conditons	to determine baseline soil quality in the land owned by HUBCO
S6	SHCCS6	24° 54' 27.4"N 66° 42' 09.6"E	15	HUBCO landfill and hazardous waste disposal area	to determine/detect soil quality around existing infrastructure close to the proposed location of the Project

Exhibit 4.18: Sampling Locations in Near-Field Study Area



Parameters for Analysis

The soil samples were analyzed for the following parameters (**Exhibit 4.19**):

- **Total metals**: Aluminum, Arsenic, Barium, Boron, Cadmium, Copper, Lead, Mercury, Selenium, Nickel, Chromium, Iron, Manganese and Zinc
- **Major cations and anions** (in the soil samples collected from agricultural land): pH, Electrical Conductivity (EC), Organic Matter, Organic Carbon, Nitrate Nitrogen (NO_3-N), Phosphate Phosphorus (PO_4-P), Potassium (K)
- **Hydrocarbons:** oil and grease; benzene, toluene, ethyl benzene, and xylenes (BTEX); and total petroleum hydrocarbons (TPH)
- Particle size distribution (PSD)

Equipment

The following sampling equipment was used:

- shovel
- plastic spoon

Sample Collection

Surface soil samples were collected by removing 15 cm upper surface layer with a shovel (**Exhibit 4.20**). Samples were taken in a manner to minimize loss of volatile compounds, and sealed immediately in sample containers with minimal headspace.

Soil Sample Containers

For chemistry, 250 mg of soil samples were collected in glass jars and for PSD, 0.5 kg of the soil sample was collected in zip-lock plastic bag.

Sample Storage & Shipment

All samples (for chemistry) were kept chilled at approximately 4°C and sent for analysis to laboratory immediately after the field visit.

Exhibit 4.19: Parameters of Analysis in Soil Quality Samples

Parameters	*Soil Samples*					
	SHCCS1	*SHCCS2*	*SHCCS3*	*SHCCS4*	*SHCCS5*	*SHCCS6*
Total Metals	✓	✓	✓	✓	✓	✓
Major Ions			✓			
Hydrocarbon				✓		✓
Particle Size Distribution	✓	✓	✓	✓	✓	✓

Exhibit 4.20: Photographs of the Soil Sampling

Photograph 01: Soil Sample Collection for Chemical Analysis

Photograph 02: Soil Sample Collection for PSD Analysis

Results

There are no national standards for screening of soil parameters. The approach used is to compare the concentration of various parameters with the three times the corresponding value of average crustal abundance (the target value) of metals that found in the Earth's crust and published international standards.

A summary of the sample analysis against soil target values and standards is provided in **Exhibit 4.21**, while the detailed laboratory results are provided in **Appendix C**. A summary of the observations based on the sample analysis are provided in the following sub-sections.

Metals

Metals were analyzed in six samples from the Study Area. The observations are as follows:

- Selenium was detected at concentrations higher than three times its average crustal abundance in all samples (S1 to S6) but lower than other standards except for sample S1 (see **Exhibit 4.21**). The sample S1 results were also exceeded the Canadian Soil Quality Guidelines[14] (CSQ) values.
- Values of all other metals were below the reported guidelines or target values.

Hydrocarbons

Oil and Greases, BTEX and TPH were analyzed in two samples including:

- S4 since these are in drainage areas where hydrocarbons could be drained; and
- S6 since this is close to the hazardous waste disposal area.

Hydrocarbons were not detected in any of the samples.

Agricultural Productivity

One sample (S3) was collected from agricultural land in the Project vicinity and analyzed for soil agricultural productivity. The soil agricultural fertility was evaluated against the guideline values provided in **Exhibit 4.22**. The observations are as follows:

- The soil is considered vulnerable with respect to agricultural productivity based on the organic carbon and matter present within the samples. Soil with organic matter levels above 3.4% (equal to 2% organic carbon) are not considered to be vulnerable[15].
- Potassium and PO_4 (P) detected in the low range.
- pH of the soil is alkaline and EC shows high salinity.
- Nitrates fall in an adequate range in terms of agricultural productivity.

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[14] Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health for Industrial Land Use/ Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment (2007)

[15] http://www.agriculture.gov.ie/media/migration/farmingschemesandpayments/crosscompliance/soilorganicmatter/Soil%20organic%20matter%20guidelines.pdf (accessed September 16, 2014)

Based on the sample results for most of the analyzed parameters, the topsoil soil existing conditions are not suitable for agricultural purposes. However, nitrate values fall in the adequate range which may be attributed to the use of fertilizers during the cultivation of crops.

Soil Type

Soil samples were also collected and analyzed for particle size distribution (PSD) in parallel to samples for soil chemistry. PSD was analyzed in six soil samples through sieve analysis. The dominant texture was found to be sand based on the results in all samples. Laboratory provided results of sieve analysis are provided in **Appendix C**.

Quality Assurance

One sample (S7) was analyzed as quality control duplicate sample. The real identity was unknown to the testing laboratory. Upon receipt of results, relative percentage difference (RPD) was detected with the corresponding sample (S6) and found below 10% for most of the parameters, thus add confidence and reliability to the results. The goal for precision of field duplicate results is ±50 percent RPD for soil samples[16].

PSD analysis of quality control duplicate sample (S7) shows similar pattern of soil size distribution with the corresponding sample (S6) as well.

The RPD between quality control duplicate samples (S7) with corresponding sample (S6) is shown in **Exhibit 4.23**.

[16] Montana Department of Environmental Quality, Data Validation Guidelines for Evaluating Analytical Data (2010), accessed September 19, 2014

Exhibit 4.21: Summary of Soil Samples Analysis Results

Parameter	*Units*	*Level of Reporting (LOR)*	*Soil Sample Results*						*Soil Target Values and Standards*				
			SHCCS1	*SHCCS2*	*SHCCS3*	*SHCCS4*	*SHCCS5*	*SHCCS6*	*3 x Crustal Abunda nce*	*ASGWSS*[17]	*DTV*[18]	*CSQG*[19]	*SST*[20]
Aluminum	mg/kg	0.001	102.307	83.074	57.113	59.776	126.198	43.770	–	–	–	–	–
Arsenic	mg/kg	0.001	1.317	1.286	0.805	0.743	0.371	0.158	6.3	18	29	12	3.9
Barium	mg/kg	0.001	136.328	168.445	28.502	30.174	17.223	20.851	1,020	670	160	2000	–
Boron	mg/kg	0.001	2.735	5.460	0.701	0.639	1.506	0.582	26.1	120	–	–	–
Cadmium	mg/kg	0.001	0.102	0.417	0.058	0.063	0.059	0.035	0.45	1.9	0.8	22	–
Copper	mg/kg	0.001	2.376	5.622	3.774	3.840	1.808	1.475	204	300'[a], 230	36	91	–
Lead	mg/kg	0.001	1.772	7.542	4.202	3.869	1.131	0.917	30	120	85	600	400
Mercury	mg/kg	0.001	0.032	0.019	0.008	0.009	<0.001	0.094	0.201	0.29	–	50	23
Selenium	mg/kg	0.001	3.684	1.886	1.143	1.062	0.930	0.656	0.15	5.5	–	2.9	390
Nickel	mg/kg	0.001	8.076	5.427	3.622	3.478	4.337	1.451	270	340	35	50	1600
Chromium	mg/kg	0.001	6.582	8.607	4.567	4.843	5.533	7.870	420	160	100	87	300
Iron	mg/kg	0.001	4.352	4.442	3.777	6.605	1.618	4.867	189,000	–	–	–	–
Manganese	mg/kg	0.001	28.122	41.918	33.688	35.192	11.097	40.261	3,300	–	–	–	1800
Zinc	mg/kg	0.001	24.807	16.250	14.308	12.426	10.097	29.751	237	340	140	360	
Potassium	mg/kg	0.001	–	–	12.404	–	–	–	45,000	–	–	–	–
PO_4 (P)	mg/kg	0.001	–	–	0.528	–	–	–	–	–	–	–	–

17 ASGWSS: Australian Soil, Ground Water and Sediment Standards (ASGWS) for se under Use Under Part XV.1 of the Environmental Protection Act, Table 6 (Generic Site Condition Standards for Shallow Soils in a Potable Ground Water Condition): Ministry of the Environment

18 DTV: Dutch Target Values, 2000

19 CSQG: Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health for Industrial Land Use

20 SST: Soil Standards for Thailand

Parameter	*Units*	*Level of Reporting (LOR)*	*Soil Sample Results*						*Soil Target Values and Standards*				
			SHCCS1	*SHCCS2*	*SHCCS3*	*SHCCS4*	*SHCCS5*	*SHCCS6*	*3 x Crustal Abunda nce*	*ASGWSS* [17]	*DTV*[18]	*CSQG* [19]	*SST*[20]
NO_3 (N)	mg/kg	0.001	–	–	28.179	–	–	–	–	–	–	–	–
pH	–	0.1	–	–	8.10	–	–	–	–	–	–	–	–
EC	µS/cm	1.0	–	–	336	–	–	–	–	–	–	–	–
Organic Matter	%	0.1	–	–	0.45	–	–	–	–	–	–	–	–
Organic Carbon	mg/kg	0.05	–	–	0.26	–	–	–	–	–	–	–	–
BTEX													
Benzene	mg/kg	0.1	–	–	–	<0.1	–	<0.1	–	–	–	–	–
Toluene	mg/kg	0.1	–	–	–	<0.1	–	<0.1	–	–	–	–	–
Ethyl benzene	mg/kg	0.1	–	–	–	<0.1	–	<0.1	–	–	–	–	–
m&p-Xylenes	mg/kg	0.2	–	–	–	<0.2	–	<0.2	–	–	–	–	–
o-Xylenes	mg/kg	0.1	–	–	–	<0.1	–	<0.1	–	–	–	–	–
TPH													
C6-C9	mg/kg	5	–	–	–	<5	–	<5	–	–	–	–	–
C10-C14	mg/kg	50	–	–	–	<50	–	<50	–	–	–	–	–
C15-C28	mg/kg	100	–	–	–	<100	–	<100	–	–	–	–	–
C29-C36	mg/kg	100	–	–	–	<100	–	<100	–	–	–	–	–
Oil and Grease	mg/kg	5	–	–	–	<5.0	–	<5.0	–	–	–	–	–

Exhibit 4.22: Generalized Guidelines for Interpretation of Soil Analysis Data

Criteria A[21]*: Nitrate Nitrogen, Phosphate Phosphorus and Potassium*

Measurement	*Low (mg/kg)*	*Marginal (mg/kg)*	*Adequate (mg/kg)*
Nitrate (NO3-N)	< 11	11 - 20	> 20
Phosphate (PO4-P)	< 4	4 - 7	> 7
Potassium (K)	< 60	60 - 120	> 120

Criteria B[22]: pH

Denomination	*Strong acid*	*Moderate acid*	*Slightly acid*	*Neutral*	*Slightly alkaline*	*Moderatel y alkaline*	*Strongly alkaline*
pH range*	5.1–5.5	5.6–6.0	6.1–6.5	6.6–7.3	7.4–7.8	7.9–8.4	8.5–9.0

Criteria C: Salinity or Electrical Conductivity[23]

EC (mS/cm)	*Degree of salinty*	*Hazard for crop growth*	*Plant Response*	*Relative tolerance of crops within EC and salinity range*
0-2	Non-saline	Very low	Negligible	
2-4	Slightly saline	Restricted yield of sensitive crops	Restricted yield of sensitive crops	Beans, peas, corn, soybean, sunflowers, clovers and timothy
4-8	Moderately saline	Medium	Restricted yield of many crops	Canola, flax, oats, wheat, rye, barley, bromegrass, alfalfa, sweet clover and trefoil
8-16	Severly saline	High	Only a few tolerant crops yield satisfactorily	Slender and tall wheatgrass, Russian and Altai wildrye
>16	Very serverly saline	Very high	Only a few tolerant forage grasses grow satisfactorily	

21 Land Resources Research Institute National Agricultural Research Center Islamabad- Pakistan

22 http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_019157.pdf (accessed September 16, 2014)

23 http://www.gov.mb.ca/agriculture/crops/soil-fertility/soil-fertility-guide/print,soil-ph-and-salinity.html (accessed September 16, 2014)

Exhibit 4.23: Quality Control Duplicate Sample Results

Parameter	*Units*	*LOR*	*QC Duplicate: SHCCS7*	*Reference Sample: SHCCS6*	*RPD*
Aluminum	mg/kg	0.001	*46.206*	43.770	5.4%
Arsenic	mg/kg	0.001	*0.162*	0.158	2.5%
Barium	mg/kg	0.001	*22.257*	20.851	6.5%
Boron	mg/kg	0.001	*0.590*	0.582	1.4%
Cadmium	mg/kg	0.001	*0.040*	0.035	13.3%
Copper	mg/kg	0.001	*1.408*	1.475	4.7%
Lead	mg/kg	0.001	*0.892*	0.917	2.8%
Mercury	mg/kg	0.001	*0.107*	0.094	13.0%
Selenium	mg/kg	0.001	*0.683*	0.656	4.0%
Nickel	mg/kg	0.001	*1.436*	1.451	1.0%
Chromium	mg/kg	0.001	*7.996*	7.870	1.6%
Iron	mg/kg	0.001	*5.139*	4.867	5.4%
Manganese	mg/kg	0.001	*42.117*	40.261	4.5%
Zinc	mg/kg	0.001	*30.404*	29.751	2.2%
Potassium	mg/kg	0.001	–	–	–
PO_4 (P)	mg/kg	0.001	–	–	–
NO_3 (N)	mg/kg	0.001	–	–	–
pH	–	0.1	–	–	–
EC	S/cm	1.0	–	–	–
Organic Matter	%	0.1	–	–	–
Organic Carbon	mg/kg	0.05	–	–	–
BTEX					
Benzene	mg/kg	0.1	*<0.1*	<0.1	–
Toluene	mg/kg	0.1	*<0.1*	<0.1	–
Ethyl benzene	mg/kg	0.1	*<0.1*	<0.1	–
m&p-Xylenes	mg/kg	0.2	*<0.2*	<0.2	–
o-Xylenes	mg/kg	0.1	*<0.1*	<0.1	–
TPH					
C6-C9	mg/kg	5	*<5*	<5	–
C10-C14	mg/kg	50	*<50*	<50	–
C15-C28	mg/kg	100	*<50*	<100	–
C29-C36	mg/kg	100	*<100*	<100	–
Oil and Grease	mg/kg	5	*<5*	<5	–

4.2.6 Water

This section describes the baseline conditions of onshore water resources in the Near-Field Study Area (**Exhibit 4.1**). A field visit and sampling exercise was carried out from June 25, 2014 to June 27, 2014.

Scope of Water Investigation

The scope of the investigation included:

- identification of all onshore water resources in the Study Area;
- selection and sampling of the water resources; and
- characterization of sampled water resources in terms of their use, and chemical and physical properties.

General Description of Water Resources

The major water resources in the Study Area are Hub River, groundwater and Arabian Sea. In general, groundwater is not in use for potable purpose as it contains a high amount of salinity. The water resources are briefly described in the following sections.

Surface Water

The proposed Project site is bounded by the Arabian Sea in its' southeast and southwest. The Hub River is located adjacent to the HUBCO's limits in the east. Both, HUBCO and Byco use seawater as the source for cooling water and discharge the wastewater into the Hub River. The section of Hub River above the wastewater outfalls of HUBCO and Byco refinery are dry up to a *bund* (small dam) constructed by the community. The staff of HUBCO have advised that after construction of the Hub Dam (approximately 50 km upstream of Project site) the river floods occasionally in the monsoon season.

Groundwater

A census of groundwater wells was performed during the Study. A total of five (5) groundwater extraction wells were identified within the Study Area. The depth to groundwater, as measured, was varying from 3.8 to 13 meters from ground surface in the dug wells. Groundwater uses are restricted to washing and ablution due to high salinity except in Goth Qader Bukhsh village (see **Exhibit 4.24**) where the community reported that it is occasionally used for drinking. Bowser water is the source of drinking in the settlements of the Study Area.

A summary of the water resources identified in the Study Area is provided in **Exhibit 4.24**.

Exhibit 4.24: Description of the Onshore Water Resources in the Study Area

Resource	*Water Resource ID*	*Location*	*Coordinates*	*Extraction Method*	*Depth *(m)*	*Water Table Depth from Ground Level (m)*	*Owner*	*Use(s)*
Groundwater Well	WR1	Byco Bulk Oil Deport	24° 54' 02.0"N 66° 42' 30.4"E	Electric motor	30	–	Byco	Industrial
Groundwater Well	WR2	Abbas Goth	24° 57' 00.0"N 66° 44' 37.8"E	Bailing Bucket	13	12.2	Community	Cleaning and sanitary
Groundwater Well	WR3	Goth Qader Bukhsh	24° 55' 16.6"N 66° 42' 20.8"E	Bailing Bucket	8.5	8.3	Community	Cleaning and sanitary, occasional drinking
Groundwater Well	WR4	Goth Qader Bukhsh	24° 55' 18.3"N 66° 42' 18.1"E	Bailing Bucket	8.5	8.3	Community	Cleaning and sanitary
Groundwater Well	WR5	HUBCO Plant Area	24° 54' 27.5"N 66° 42' 8.3"E	Bailing Bucket	4	3.8	HUBCO	Groundwater testing and monitoring
River Water	WR6	Hub River	24° 53' 55.2"N 66° 42' 21.8"E	–	0.3-0.5	Not applicable	Not applicable	There is no fresh water in the Hub River. The Hub River bed receives cooling water from HUBCO and Byco. In the upstream areas of the Hub River, groundwater orginating from seepage at the Hub Dam is used for agricultural purposes.

* Depth refers to depth of well below ground level in the case of groundwater well and depth of water body in the case of river water

Water Sampling and Parameters Analyzed

A total of ten (10) water samples were collected in the Study Area. Additionally, one sampling location (W6) could not be sampled since there was no water and an additional sample (W11) was a field duplicate.

Selection of Sampling Locations

Sampling locations were chosen to ensure sampling of key water resources and wastewater streams identified in the Study Area, including:

- Hub River upstream of existing Byco and HUBCO plants (W2)
- Hub River downstream of existing Byco and HUBCO plants (W1, W3, W8)
- Seawater (W9)
- Groundwater (W5, W10, W13 and W14)

The sampling locations are listed in **Exhibit 4.25** and shown in **Exhibit 4.26**. It is important to note that one identified location could not be sampled as it was dry (W6).

Exhibit 4.25: Location and Rationale on Water Quality Sampling Points

Sample ID	*Water Resource ID*	*Coordinates*	*Location and Justification*
W1	–	24° 53' 55.2"N 66° 42' 21.8"E	Upstream of the existing HUBCO wastewater outfall into Hub River, to obtain information of water conditions in Hub River prior to the effect of existing industries on the river
W2	WR6	24° 56' 41.9"N 66° 45' 42.2"E	Upstream section of Hub River in east northeast of the plant to provide background conditions of Hub River before mixing of existing Byco and HUBCO industrial effluents
W3	–	24° 53' 17.7"N 66° 41' 38.6"E	In the Hub River, downstream of the existing Byco and HUBCO plants to obtain information on water conditions in the river after the effect of the existing industries on the river
W5	WR3	24° 55' 16.6"N 66° 42' 20.8"E	Groundwater extracting well in settlement (Goth Qader Bukhsh) in north of the plant to provide information on the conditions of groundwater in nearest settlement to the proposed Project location
W6	–	24°55'52.91"N 66°41'16.78"E	Accumulated water pond/playa lake north of HUBCO industrial site. The pond/playa lake was dry during the field visit. Locals informed that the accumulation of flood waters take place in the monsoon.
W8	–	24° 53' 45.1"N 66° 41' 48.6"E	In the Hub River, downstream of the existing Byco and HUBCO plants to obtain information on water conditions in the river after the effect of the existing industries on the river.

Sample ID	*Water Resource ID*	*Coordinates*	*Location and Justification*
W9	–	24° 54' 35.8"N 66° 41' 19.8"E	At the Arabian Sea to provide information on ambient seawater quality to be able to assess any water quality impacts on it from proposed Project activities.
W10	WR1	24° 54' 02.0"N 66° 42' 30.4"E	Deep groundwater well adjacent to the existing HUBCO and Byco industrial site to provide information on deep groundwater resources and potential contamination.
W12	WR5	24° 54' 27.5"N 66° 42' 8.3"E	Pit at HUBCO's hazardous waste handling and landfill area to provide information on the shallow aquifer located there.
W13	WR2	24° 57' 00.0"N 66° 44' 37.8"E	Dug well in the settlement (Abbas Goth) in the northeast of the HUBCO industrial site to provide information on baseline water-quality available to the settlements.
W14	WR4	24° 55' 18.3"N 66° 42' 18.1"E	Dug well in settlement (Goth Qader Bukhsh) in the north of the HUBCO industrial site to provide information on baseline groundwater quality to the nearest settlement there.
W11	–	24° 53' 17.7"N 66° 41' 38.6"E	QC Sample - duplicate of W3.

Parameters for Analysis

Laboratory analysis carried out for the parameters indicated in **Exhibit 4.27**. All samples were analyzed for physical parameters and major ions. Four samples were analyzed for Total Petroleum Hydrocarbons (TPH). Four samples were analyzed for Benzene, Toluene, Ethyl Benzene, and Xylenes (BTEX) to check any potential contamination from nearby oil handling, storage and refining facilities in the Study Area. Two samples (W5 and W14) were analyzed for pesticides as these were collected from dug groundwater wells close to agricultural land.

Exhibit 4.26: Sampling Locations in Near-Field Study Area

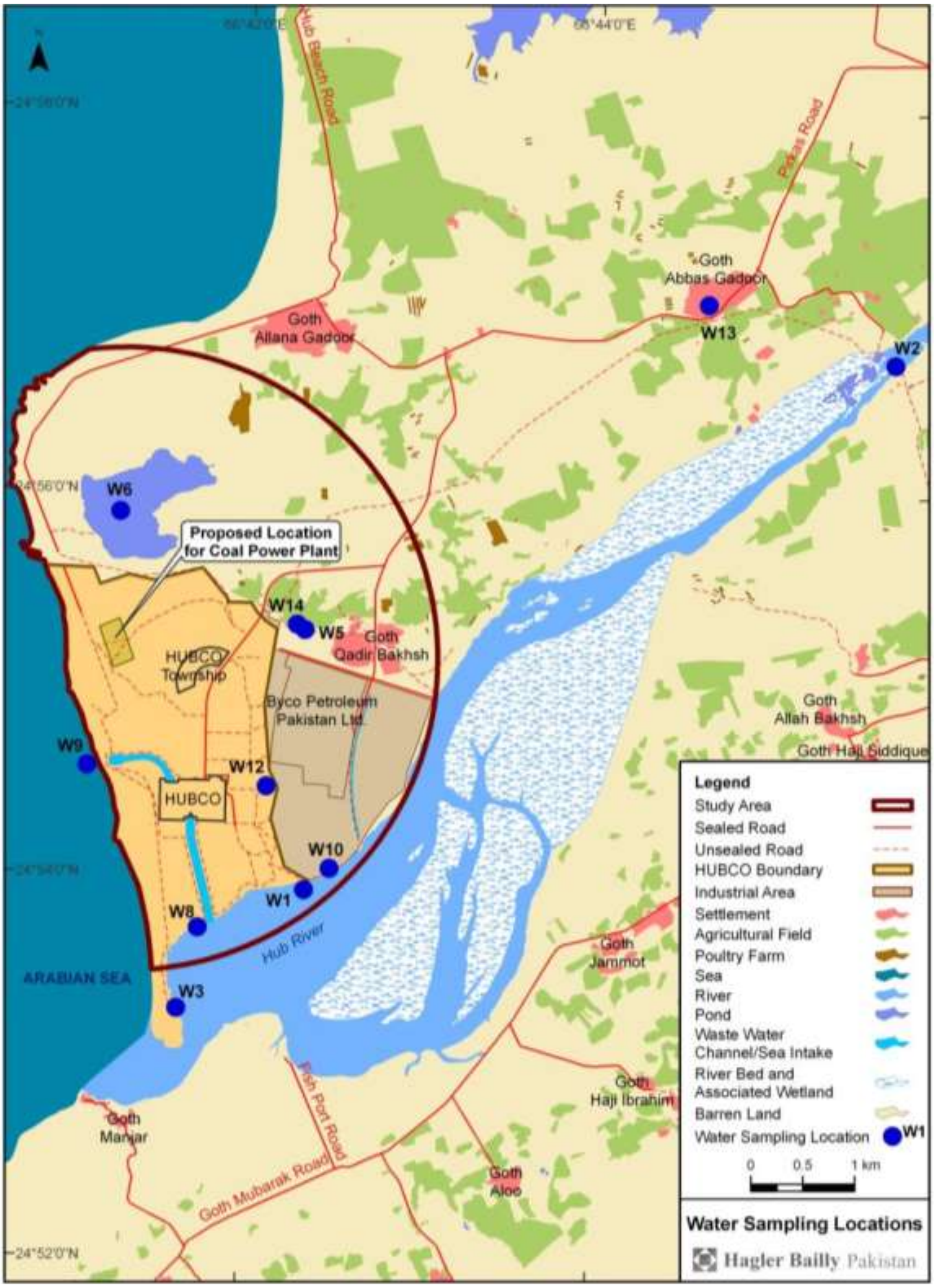


Exhibit 4.27: Parameters for Laboratory Analysis

Sample ID	*Physical and Major Ions*	*Total Metals*	*BOD_5 and COD*	*Total Petroleum Hydrocarbons (TPH)*	*BTEX*	*Bacteriolo gical*	*Pesticides*
W1	✓	✓	✓				
W2	✓	✓	✓			✓	
W3	✓	✓	✓	✓	✓		
W5	✓	✓	✓				✓
W8	✓	✓	✓	✓	✓		
W9	✓	✓	✓				
W10	✓	✓	✓	✓	✓	✓	
W12	✓	✓	✓	✓	✓		
W13	✓	✓	✓				
W14	✓	✓	✓			✓	✓

Sampling Methodology

Collection Method

The following method was used for collection:

- Water samples were collected directly from the river or through bailing bucket in case of dug well or nearest tap to the pumping motor in case electrical motor installed.
- Water samples were collected in containers appropriate for the parameter analyzed. The various containers that need to be filled with water from each depth are shown in **Exhibit 4.28**.
- Physical parameters including pH, DO, temperature, specific conductivity, TDS, salinity and turbidity were recorded in the field during the sampling
- All sample containers were rinsed with water from the sampler except for those which contained preservative.
- The containers were filled to the top to eliminate air space. These were left open only for the minimum amount of time needed to rinse and fill them.
- The capped bottles were placed in lean plastic bags, which were placed in coolers with plenty of ice packs. Photographs of the sampling are shown in (**Exhibit 4.29**).
- Water quality sample ID was given in the form of: WHCCW1, where:
  - W indicates it is a water sample;
  - HCC indicates the project ID; and

  - W1 indicates the unique number of the sample.
- Sample labels were used and included the following:
  - sample ID
  - collection date and time
  - sample type Groundwater or freshwater
  - parameter group *e.g*. metals, nutrients, physical + major ions, *etc*.
  - preservative if any was added
- In addition to the above, the field notes were recorded GPS coordinates, well depth, and photograph.
- Powder-free disposable gloves were worn at all times when transferring water from the sampler to the container.

Sample Collection and Handling

Sample collection and handling employed the following:

Sample Storage & Shipment

All samples were kept chilled at approximately 4°C and sent for analysis to laboratory immediately after the field visit. All containers were contained required preservatives according to **Exhibit 4.28**.

Exhibit 4.28: Bottles and Preservatives for Parameter

Parameter Type	*Bottle*	*Preservative*
Common Ions	1 L plastic or glass	None –cool to 4^{o}C
Hydrocarbons (Oil and Grease and TPH) and Pesticides	1 L amber glass	None –cool to 4^{o}C
BTEX	40 ml glass vial	HCl, –cool to 4^{o}C
Bacteriological	0.5 L plastic	Sodium thiosulfate, –cool to 4^{o}C
Total Metals	125 ml plastic, acid washed	HNO_3, –cool to 4^{o}C,

Exhibit 4.29: Water Sampling Photographs

Photograph 01: Field physical parameters testing during sample collection

Photograph 02: Collection of seawater from the Arabian Sea at intake channel

Photograph 03: View of measuring of well depth and groundwater level in a well near the proposed Project

Photograph 04: Collection of Sample from Hub River before mixing to Arabian sea

Quality Control Duplicate

A duplicate sample (W11) was collected. The duplicate sample was handled with the same protocols as other samples. The real identity of the quality control sample was unknown to the testing laboratory. After analysis the relative percentage difference (RPD) of the results was analyzed with the results of corresponding sample. The goal for precision of field duplicate results is ±30 percent RPD for water samples[24].

Results

A total of ten waters samples were collected and analyzed. The summary of sample analysis results is presented in **Exhibit 4.30** and laboratory provided results are provided in **Appendix D**.

24 Montana Department of Environmental Quality, Data Validation Guidelines for Evaluating Analytical Data (2010), accessed September 19, 2014

Physical and Major Ions

Physical parameters were analyzed in all samples including temperature, pH, DO, TDS, TSS, color, odor, turbidity and total hardness. Of these parameters, TDS levels were exceeding the national environmental quality standard (NEQS).

Major ions were analyzed in all samples including chloride, fluoride, sulfate, sulfide, chlorine, nitrate, and nitrite. Of these parameters, chloride and sulfate levels in all samples were exceeding NEQS.

BOD_5 and COD

Biological oxygen demand (BOD) was analyzed in all samples. Samples W1, W3 and W12 have BOD above the NEQS standard. BOD levels of other samples were within the NEQS limit. The same result was found for chemical oxygen demand (COD) in the samples W1, W3 and W12.

Cyanide and Ammonia

Cyanide and ammonia were analyzed in all samples. None of the samples had any detectable cyanide or ammonia.

Total Metals

Total metals were analyzed in all samples. Key observations are:

- Cr levels in all samples were above the NEQS.
- Ni levels was above the NEQS in W1, W2, W3, W5, W8, W9 and W10.
- The levels of other metals are within NEQS in all samples.

Hydrocarbons

No BTEX and TPH was found in the four samples analyzed (W3, W8, W10 and W12). Only W1 had traces of oil and grease but below the NEQS and other samples did not show any traces.

Pesticides

Analysis for pesticides was carried out in two samples (W5 and W14). No pesticides were detected in the samples.

Bacteriological Analysis

Analysis for bacteriological contamination was carried out in three samples (W2, W10 and W14). Bacteriological contamination was found in sample W2 and W14. Both of these samples were collected from the nearest settlement (Goth Qader Bukhsh) in the north of the existing HUBCO industrial site. The sample (W10) analyzed from the deeper groundwater well was not contaminated.

Quality Assurance

One sample (W11) was analyzed as quality control duplicate sample. Upon receipt of results, relative percentage difference (RPD) was detected with the corresponding sample (W3) and found below 10% for most of the parameters. The RPD between quality control duplicate samples (W11) with corresponding sample (W3) is shown in **Exhibit 4.31**.

Key Observations

Key observations are the following:

- Groundwater in the area is saline and based on the results of TDS, BOD, COD and bacteriological tests, the groundwater is not for potable use.
- No hydrocarbon contamination was found in any sample.
- No pesticides were detected in the analyzed samples.
- Salinity is pervasive within the area, including ground and surface water resources. The surface water is fresher, while the groundwater is more saline indicating either connection of the groundwater aquifer to the sea or that the groundwater is relatively slow moving and old.

Exhibit 4.30: Summary of Analysis Results for Water Samples

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW1*	*WHCCW2*	*WHCCW3*	*WHCCW5*	*WHCCW8*
Temperature	oC	1	40 ± 3oC	–	34.40	31.10	32.50	31.00	36.10
DO	mg/l	1	–	–	5.60	4.90	6.46	3.90	6.18
TDS	mg/l	10	3,500	1,000	39,776.00	9,196.00	39,704.00	6,706.00	39,464.00
pH		0.1	6.5 – 9.0	6.5 – 9.0	7.81	8.40	7.88	7.90	7.81
TSS	mg/l	4	200	–	44.67	11.67	42.00	41.00	27.00
Color	TCU	1	15[a]	<15	–	–	–	–	–
Odor	TON	1	–	–	–	–	–	Acceptable	–
Turbidity	NTU	0	<5[a]	5	–	–	–	10.00	–
Total Hardness	mg/l	1	<500[a]	–	–	–	–	1,828.00	–
Oil and Grease	mg/l	5	10	10	7.20	<5	<5	<5	<5
Phenol	mg/l	0.05	0.1	0.1	<.05	<.05	<.05	<.05	<.05
Chloride	mg/l	5	1000	<250	22,510.75	5,246.60	21,390.38	3,540.57	21,491.56
Fluoride	mg/l	0.1	20	1.5	0.50	0.25	0.50	<0.1	0.25
Sulfate	mg/l	10	600	600	38,641.81	1,692.91	3,412.98	818.06	3,798.14
Sulfide	mg/l	0.5	1	1	<0.5	<0.5	<0.5	<0.5	<0.5
Ammonia	mg/l	0.5	40	40	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide	mg/l	0.1	2	2	<0.1	<0.1	<0.1	<0.1	<0.1
MBAS	mg/l	0.1	20	20	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorine	mg/l	0.1	1	1	<0.1	<0.1	<0.1	<0.1	<0.1

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW1*	*WHCCW2*	*WHCCW3*	*WHCCW5*	*WHCCW8*
Nitrate	mg/l	0.1	<50[a]	50	–	–	–	0.46	–
Nitrite	mg/l	0.01	<3[a]	3	–	–	–	<0.01	–
Residual Chlorine	mg/l	0.1	–	0.2 – 0.5	–	–	–	<.1	–
BOD5	mg/l	5	80	80	128.03	5.12	199.02	<5	<5
COD	mg/l	4	150	150	444.44	12.35	600.82	<4	<4
Total Metals									
Cadmium, Cd	mg/l	0.001	0.1	0.01	0.0049	0.0010	0.0013	0.0010	0.0023
Copper, Cu	mg/l	0.001	1	–	0.733	0.1250	0.6870	0.1170	0.8020
Lead, Pb	mg/l	0.001	0.5	0.05	0.0055	0.0012	0.0014	0.0038	0.0025
Chromium, Cr	mg/l	0.001	1	0.05	1.356	0.2000	1.0030	0.2060	1.4970
Mercury, HG	mg/l	0.001	0.01	0.001	0.0089	<0.01	0.0015	<0.01	0.0047
Selenium, Se	mg/l	0.001	0.5	0.01	0.0047	<0.01	0.0031	0.0090	0.0042
Nickel, Ni	mg/l	0.001	1	0.02	2.677	0.3900	2.2020	0.0690	2.8830
Silver, Ag	mg/l	0.001	1	–	0.164	0.0240	0.1250	0.0200	0.0940
Zinc, Zn	mg/l	0.001	5	5	0.413	0.1650	0.5390	0.1910	0.6690
Arsenic, As	mg/l	0.001	1	0.05	0.747	0.0310	0.8630	0.1940	0.7210
Barium, Ba	mg/l	0.001	1.5	0.7	0.186	0.6210	0.1310	0.1850	0.1380
Iron, Fe	mg/l	0.001	8	–	1.618	0.1060	0.3650	0.1660	0.1270
Manganese, Mn	mg/l	0.001	1.5	0.5	0.729	0.1400	0.6240	0.5070	0.7220
Boron, B	mg/l	0.001	6	0.3	0.497	0.0290	0.5110	0.0410	0.3290
Aluminum, Al	mg/l		–	–				0.2940	–

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW1*	*WHCCW2*	*WHCCW3*	*WHCCW5*	*WHCCW8*
Antimony, Sb	mg/l		–	–				0.0010	–
BTEX									–
Toluene	ug/l	1	–	–	–	–	<1	–	<1
Ethyl benzene	ug/l	1	–	–	–	–	<1	–	<1
m&p–Xylenes	ug/l	2	–	–	–	–	<2	–	<2
o–Xylenes	ug/l	1	–	–	–	–	<1	–	<1
TPH									
C6–C9	ug/l	50	–	–	–	–	<50	–	<50
C10–C14	ug/l	50	–	–	–	–	<100	–	<100
C15–C28	ug/l	100	–	–	–	–	<50	–	<50
C29–C36	ug/l	50	–	–	–	–	<50	–	<50
Organo-chlorine Pesticides		–	150	–					
Alpha–BHC	ug/l	5	–	–	–	–	–	<5	–
Beta & gamma–BHC	ug/l	10	–	–	–	–	–	<10	–
Delta–BHC	ug/l	5	–	–	–	–	–	<5	–
Heptachlor	ug/l	5	–	–	–	–	–	<5	–
Aldrin	ug/l	5	–	–	–	–	–	<5	–
Heptachlor epoxide	ug/l	5	–	–	–	–	–	<5	–
Endosulfan 1	ug/l	5	–	–	–	–	–	<5	–

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW1*	*WHCCW2*	*WHCCW3*	*WHCCW5*	*WHCCW8*
4,4–DDE	ug/l	5	–	–	–	–	–	<5	–
Dieldrin	ug/l	5	–	–	–	–	–	<5	–
Endrin	ug/l	5	–	–	–	–	–	<5	–
Endosulfan 2	ug/l	5	–	–	–	–	–	<5	–
4,4'–DDD	ug/l	5	–	–	–	–	–	<5	–
Endosulfan Sulfate	ug/l	5	–	–	–	–	–	<5	–
4,4'–DDT	ug/l	5	–	–	–	–	–	<5	–
Endrin Ketone	ug/l	5	–	–	–	–	–	<5	–
Methoxychlor	ug/l	5	–	–	–	–	–	<5	–
Organo-phosphorus Pesticides			150						
Dichlorvos	ug/l	5	–	–	–	–	–	<5	–
Dimethoate	ug/l	5	–	–	–	–	–	<5	–
Diazinon	ug/l	5	–	–	–	–	–	<5	–
Chlorpyrifos methyl	ug/l	5	–	–	–	–	–	<5	–
Malathion	ug/l	5	–	–	–	–	–	<5	–
Fenthion	ug/l	5	–	–	–	–	–	<5	–
Chloropyrifos	ug/l	5	–	–	–	–	–	<5	–
Pirimiphos ethyl	ug/l	5	–	–	–	–	–	<5	–
Chlorfenvinphos	ug/l	5	–	–	–	–	–	<5	–

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW1*	*WHCCW2*	*WHCCW3*	*WHCCW5*	*WHCCW8*
–E									
Chlorfenvinphos –Z	ug/l	5	–	–	–	–	–	<5	–
Prothiofos	ug/l	5	–	–	–	–	–	<5	–
Ethion	ug/l	5	–	–	–	–	–	<5	–
Bacteriological Analysis									
Total Colony Count	Cfu/ml	1	–	<500[b]		1200	–	–	–
Total Coliforms	/100 ml	1	–	absence		Numerous	–	–	–
Fecal E.Coli	/100 ml	1	–	absence		<1	–	–	–
Fecal Entrococci	/100 ml	1	–	absence		<1	–	–	–

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW9*	*WHCCW 10*	*WHCCW 12*	*WHCCW 13*	*WHCCW 14*
Temperature	^{o}C	1	40 ± 3^{o}C	–	33.10	–	33.20	30.20	30.10
DO	mg/l	1	–	–	6.46	–	2.91	4.89	3.89
TDS	mg/l	10	3,500	1,000	39,180.00	42,232.00	22,216.00	9,768.00	3,960.00
pH		0.1	6.5 – 9.0	6.5 – 9.0	7.86	7.90	7.83	7.72	7.90
TSS	mg/l	4	200	–	29.67	BDL	13.00	4.33	9.67
Color	TCU	1	15[a]	<15		–	–	–	–
Odor	TON	1	–	–	–	Acceptable	–	Acceptable	Acceptable
Turbidity	NTU	0	<5[a]	5	–	5.00	–	3.00	2.00
Total Hardness	mg/l	1	<500[a]	–	–	8,080.00	–	2,920.00	1,060.00
Oil and Grease	mg/l	5	10	10	<5	<5	<5	<5	<5
Phenol	mg/l	0.05	0.1	0.1	<.05	<.05	<.05	<.05	<.05
Chloride	mg/l	5	1000	<250	21,934.69	27,030.63	12,230.25	5,060.49	2,346.79
Fluoride	mg/l	0.1	20	1.5	0.25	0.25	0.25	<0.1	<0.1
Sulfate	mg/l	10	600	600	3,405.57	3,745.47	1,910.18	2,048.44	495.45
Sulfide	mg/l	0.5	1	1	<0.5	<0.5	<0.5	<0.5	<0.5
Ammonia	mg/l	0.5	40	40	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide	mg/l	0.1	2	2	<0.1	<0.1	<0.1	<0.1	<0.1
MBAS	mg/l	0.1	20	20	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorine	mg/l	0.1	1	1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate	mg/l	0.1	<50[a]	50	–	0.58	–	0.39	0.21

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW9*	*WHCCW 10*	*WHCCW 12*	*WHCCW 13*	*WHCCW 14*
Nitrite	mg/l	0.01	<3[a]	3	–	<0.01	–	<0.01	<0.01
Residual Chlorine	mg/l	0.1	–	0.2 – 0.5	–	<.1		<.1	<0.1
BOD5	mg/l	5	80	80	17.36	40.92	85.56	<5	<5
COD	mg/l	4	150	150	57.61	133.74	263.37	<4	<4
Total Metals									
Cadmium, Cd	mg/l	0.001	0.1	0.01	0.0018	0.0020	0.0015	0.0010	<0.1
Copper, Cu	mg/l	0.001	1	2	0.5980	0.8260	0.3980	0.1240	0.0350
Lead, Pb	mg/l	0.001	0.5	0.05	0.0033	0.0150	0.0037	0.0035	0.0041
Chromium, Cr	mg/l	0.001	1	0.05	1.3130	0.6960	0.3150	0.2140	0.0270
Mercury, HG	mg/l	0.001	0.01	0.001	0.0010	<0.01	0.0020	<0.01	<0.01
Selenium, Se	mg/l	0.001	0.5	0.01	0.0038	0.0250	0.0020	0.0080	<0.001
Nickel, Ni	mg/l	0.001	1	0.02	1.1820	1.8150	0.2840	0.0740	0.0160
Silver, Ag	mg/l	0.001	1	–	0.1320	0.1250	0.0320	0.0220	0.0060
Zinc, Zn	mg/l	0.001	5	5.0	0.8080	0.9270	0.6220	0.0201	0.2050
Arsenic, As	mg/l	0.001	1	0.05	0.8760	0.8030	0.3760	0.2020	0.0100
Barium, Ba	mg/l	0.001	1.5	0.7	0.1280	0.4700	0.4060	0.1910	0.2910
Iron, Fe	mg/l	0.001	8	–	0.4230	0.6560	0.4360	0.7300	0.0900
Manganese, Mn	mg/l	0.001	1.5	0.5	0.6550	0.9380	0.7580	0.4800	0.3520
Boron, B	mg/l	0.001	6	0.3	0.4560	0.3990	0.1510	0.0400	0.0190
Aluminum, Al	mg/l	0.001	–	–		1.9920	0.7940	0.3080	0.1170
Antimony, Sb	mg/l	0.001	–	–		0.0050	0.0018	0.0011	<0.01

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW9*	*WHCCW 10*	*WHCCW 12*	*WHCCW 13*	*WHCCW 14*
BTEX									
Toluene	ug/l	1	–	–	–	<1	<1	–	–
Ethyl benzene	ug/l	1	–	–	–	<1	<1	–	–
m&p–Xylenes	ug/l	2	–	–	–	<2	<2	–	–
o–Xylenes	ug/l	1	–	–	–	<1	<1	–	–
TPH									
C6–C9	ug/l	50	–	–	–	<50	<50	–	–
C10–C14	ug/l	50	–	–	–	<100	<100	–	–
C15–C28	ug/l	100	–	–	–	<50	<50	–	–
C29–C36	ug/l	50	–	–	–	<50	<50	–	–
Organo-chlorine Pesticides			**150**	**–**					
Alpha–BHC	ug/l	5	–	–	–	–	–	–	<5
Beta & gamma–BHC	ug/l	10	–	–	–	–	–	–	<10
Delta–BHC	ug/l	5	–	–	–	–	–	–	<5
Heptachlor	ug/l	5	–	–	–	–	–	–	<5
Aldrin	ug/l	5	–	–	–	–	–	–	<5
Heptachlor epoxide	ug/l	5	–	–	–	–	–	–	<5
Endosulfan 1	ug/l	5	–	–	–	–	–	–	<5
4,4–DDE	ug/l	5	–	–	–	–	–	–	<5

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW9*	*WHCCW 10*	*WHCCW 12*	*WHCCW 13*	*WHCCW 14*
Dieldrin	ug/l	5	–	–	–	–	–	–	<5
Endrin	ug/l	5	–	–	–	–	–	–	<5
Endosulfan 2	ug/l	5	–	–	–	–	–	–	<5
4,4'–DDD	ug/l	5	–	–	–	–	–	–	<5
Endosulfan Sulfate	ug/l	5	–	–	–	–	–	–	<5
4,4'–DDT	ug/l	5	–	–	–	–	–	–	<5
Endrin Ketone	ug/l	5	–	–	–	–	–	–	<5
Methoxychlor	ug/l	5	–	–	–	–	–	–	<5
Organo-phosphorus Pesticides			**150**						
Dichlorvos	ug/l	5	–	–	–	–	–	–	<5
Dimethoate	ug/l	5	–	–	–	–	–	–	<5
Diazinon	ug/l	5	–	–	–	–	–	–	<5
Chlorpyrifos methyl	ug/l	5	–	–	–	–	–	–	<5
Malathion	ug/l	5	–	–	–	–	–	–	<5
Fenthion	ug/l	5	–	–	–	–	–	–	<5
Chloropyrifos	ug/l	5	–	–	–	–	–	–	<5
Pirimiphos ethyl	ug/l	5	–	–	–	–	–	–	<5
Chlorfenvinphos –E	ug/l	5	–	–	–	–	–	–	<5

Parameter	*Unit*	*Level of Reporting, LOR*	*NEQS Guideline Values for Waste Water*	*NEQS Guideline Values for Drinking Water*	*WHCCW9*	*WHCCW 10*	*WHCCW 12*	*WHCCW 13*	*WHCCW 14*
Chlorfenvinphos –Z	ug/l	5	–	–	–	–	–	–	<5
Prothiofos	ug/l	5	–	–	–	–	–	–	<5
Ethion	ug/l	5	–	–	–	–	–	–	<5
Bacteriological Analysis									
Total Colony Count	Cfu/ml	1	–	<500[b]	–	40	–	–	5,700
Total Coliforms	/100 ml	1	–	absence	–	<1	–	–	Numerous
Fecal E.Coli	/100 ml	1	–	absence	–	<1	–	–	<1
Fecal Entrococci	/100 ml	1	–	absence	–	<1	–	–	<1

[a]: PSQCA: Pakistan Standards and Quality Control Authority Standards

[b]: Aga Khan University Hospital recommended values

Dash '–'means parameter not analyzed or information not available

Exhibit 4.31: Quality Control Duplicate Sample Results

Parameter	*Unit*	*WHCCW3*	*WHCCW11*	*RPD*
TDS	mg/l	39,704.00	39,434.00	1%
pH		7.88	7.88	0%
TSS	mg/l	42.00	38.67	8%
BOD5	mg/l	199.02	195.30	2%
COD	mg/l	600.82	592.59	1%
Oil and Grease	mg/l	<5	<5	–
Phenol	mg/l	<.05	<.05	–
Chloride	mg/l	21,390.38	21,934.69	3%
Fluoride	mg/l	0.50	0.25	67%
Sulfate	mg/l	3,412.98	3,391.81	1%
Sulfide	mg/l	<0.5	<0.5	–
Ammonia	mg/l	<0.5	<0.5	–
Cyanide	mg/l	<0.1	<0.1	–
MBAS	mg/l	<0.1	<0.1	–
Chlorine	mg/l	<0.1	<0.1	–
Total Metals				
Cadmium, Cd	mg/l	0.0013	0.0016	21%
Copper, Cu	mg/l	0.6870	0.5880	16%
Lead, Pb	mg/l	0.0014	0.0030	73%
Chromium, Cr	mg/l	1.0030	1.3910	32%
Mercury, HG	mg/l	0.0015	0.0011	31%
Selenium, Se	mg/l	0.0031	0.0036	15%
Nickel, Ni	mg/l	2.2020	1.1900	60%
Silver, Ag	mg/l	0.1250	0.1390	11%
Zinc, Zn	mg/l	0.5390	0.8430	44%
Arsenic, As	mg/l	0.8630	0.8520	1%
Barium, Ba	mg/l	0.1310	0.1350	3%
Iron, Fe	mg/l	0.3650	0.4590	23%
Manganese, Mn	mg/l	0.6240	0.6480	4%
Boron, B	mg/l	0.5110	0.4480	13%

4.2.7 Noise

A noise survey was conducted at HUBCO township residential area in the existing plant premises. This survey was conducted to establish baseline ambient noise levels in the region around the plant. As there are no other major sound sources in the area, only one location was sampled and it was assumed that noise levels at this point were representative of general noise levels in the region. Sampling along the transport routes was not carried out due to low traffic in the area. Also, the traffic noise contribution to ambient noise level is minimum because traffic noise occurs in peaks which results in overall average incremental affect in the ambient noise level to be insignificant. No major noise receptors were present in the area around the Project site. The noise survey was conducted on September 11th -12th, 2014. It was a 24 hour survey conducted in three 8-hour shifts. **Exhibit 4.32** lists the geographical coordinates of the noise survey location and states the duration for which the surveys lasted. **Exhibit 4.33** displays the noise survey location on a map.

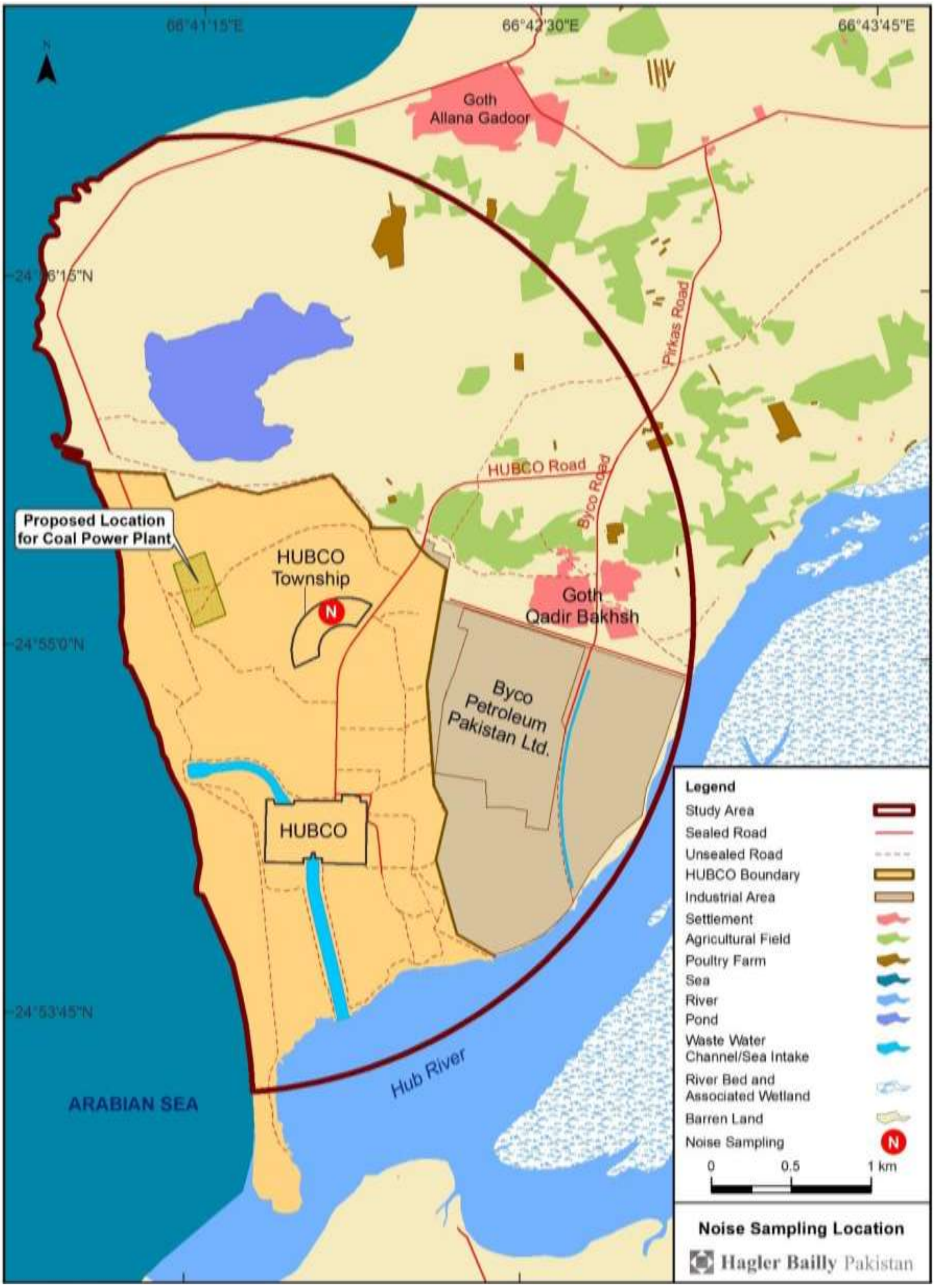
The equipment used for recording noise measurements was a Cirrus Optimus Red Sound Level Meter (G061412, CR: 1720) and the measurements were expressed in Decibels (dB) and recorded using *A-Weighting* frequency weighting (dBA).[25]

Exhibit 4.32: Noise Survey Locations and Durations.

Survey Shift	*Survey Location*	*Northing*	*Easting*	*Date*	*Time Duration (Hours)*
N1	Township	24.55 7.56°	66.41 45.8°	Sep 11, 2014	1435 to 2241 hours
N2	Township	24.55 7.56°	66.41 45.8°	Sep 11, 2014	2304 to 0711 hours
N3	Township	24.55 7.56°	66.41 45.8°	Sep 12, 2014	0724 to 1538 hours

[25] The most common weighting that is used in noise measurement is A-Weighting. This effectively cuts off the lower and higher frequencies that the average person cannot hear. [http://www.noisemeters.co.uk/help/faq/frequency-weighting]

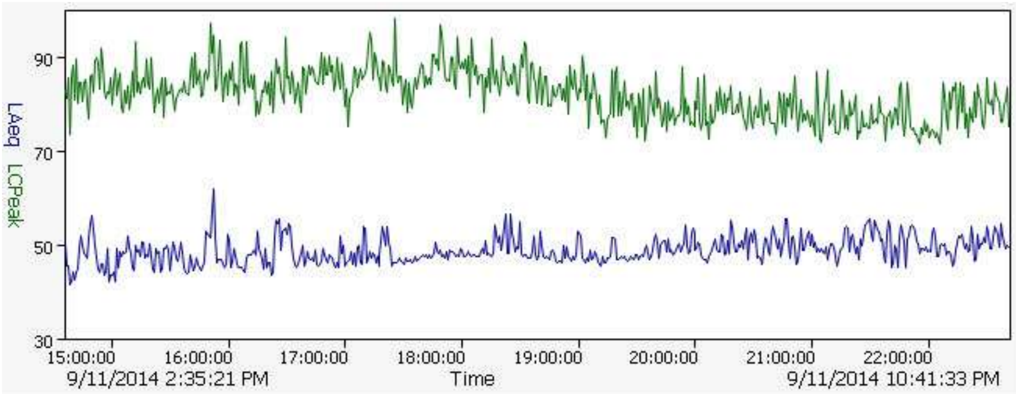
Exhibit 4.33: Noise Sampling Location



The key observations of the noise survey were:

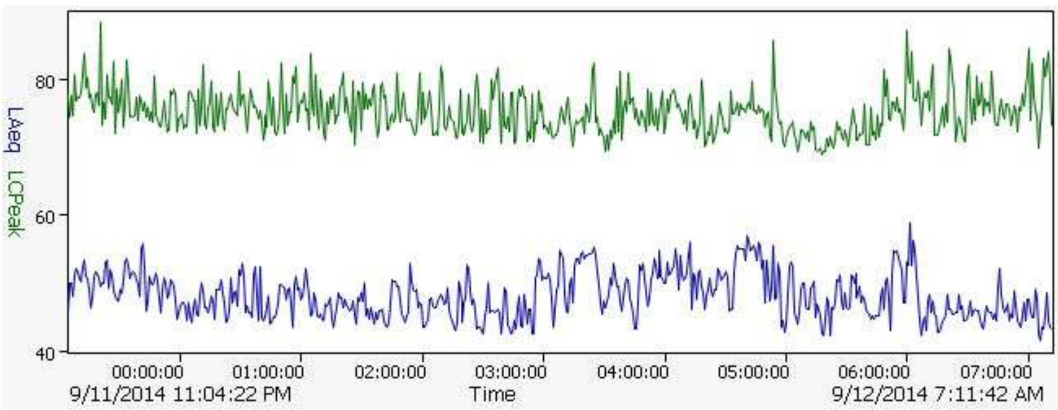
1. For shift N1, daytime maximum recorded level was about 60 dBA, and the average level was 49.8 dBA. The average recorded level was within the range of NEQS ambient daytime noise quality limit of 55 dBA. **Exhibit 4.34** provides a summary of the LAeq sound measurements during survey shift N1. The peak noise level was recorded at a single instance during 15:45 to 16:00 hours.

Exhibit 4.34: Chart Displaying LAeq Sound Measurements during Noise Survey Shift N1.



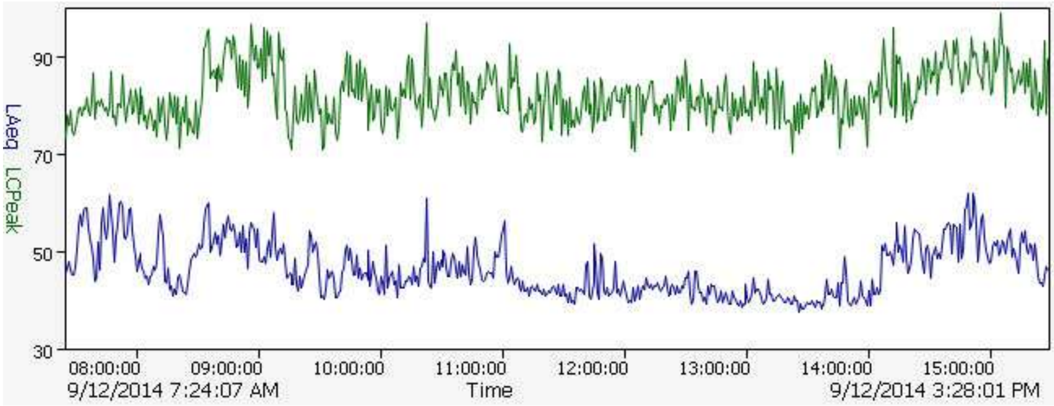
2. For shift N2, nighttime maximum recorded level was about 58 dBA, and the average level was 49.7 dBA. The average recorded level exceeded the range of ambient nighttime noise quality limit imposed by NEQS of 45 dBA. **Exhibit 4.35** provides a summary of the LAeq sound measurements at noise survey location N2. High wind conditions were observed which led to high variation in the noise levels during the survey duration. No other major noise source was detected during this time. The noise levels in this shift are true representation of the noise generated from the existing power plant and wind factors. The noise survey shifts N1 and N3 incorporate noise due to movement of people and other activities.

Exhibit 4.35: Chart Displaying LAeq Sound Measurements during Noise Survey Shift N2.



3. For shift N3, daytime maximum recorded level was about 65 dBA at 07:30 hrs due to start of office timings and 62 dBA at 1445 hours which is higher than of the NEQS. The average recorded level recorded was 50.1 dBA which was within the range of ambient daytime noise quality limit imposed by NEQS of 55 dBA. Relatively low noise levels were observed between 10.00 and 14.00 hours due to low activity outdoors. The noise level increases again in the afternoon and evening possibly due to close of business. **Exhibit 4.36** provides a summary of the LAeq sound measurement at noise survey shift N3.

Exhibit 4.36: Chart Displaying LAeq Sound Measurements during Noise Survey Shift N3.



4.2.8 Air Quality

Since the proposed Projects impact airshed may extend up to Karachi city, a radial span of 35 km extending east and northeast of the Project site, *i.e.* the Far-Field Study area, was selected for monitoring **(Exhibit 4.2**).

This section provides the current average concentration of nitrogen oxides (NO_x), sulfur dioxide (SO_2) and particulate matter (PM) at different locations in the Far-Field Study Area.

The information reported in this section is based on the following:

- primary short-term ambient air monitoring data collected by HBP and SUPARCO (August 12, 2014 to August 14, 2014 and September 11, 2014 to September 16, 2014)
- primary long-term ambient air monitoring data collected by HUBCO (1996 to 2013)
- secondary data from literature

Applicable Standards

The proposed Project is located in Baluchistan; however the Study area, shown in **Exhibit 4.2**, is extended to some areas of Sindh. The NEQS are applicable in Baluchistan, whereas SEQS in Sindh for ambient air quality. The standards applicable to the Project are shown in **Exhibit 4.37**.

Exhibit 4.37: Applicable Standards for Ambient Air Quality for the Pollutant of Concern

Pollutants	*Time–weighted Average*[26]	*NEQS*[27] *(μg/m3)*	*SEQS*[28] *(μg/m3)*
Sulfur Dioxide (SO_2)	Annual Average	80	80
	24 hours	120	120
Nitric Oxide (NO)	Annual Average	40	40
	24 hours	40	40
Nitrogen Dioxide (NO_2)	Annual Average	40	40
	24 hours	80	80
All Oxides of Nitrogen[29] (NO & NO_2) as NO_2	Annual Average	101.2	101.2
	24 hours	141.2	141.2
Respirable Particulate Matter (PM_{10})	Annual Average	120	120
	24 hours	150	150
Particulate Matter ($PM_{2.5}$)	Annual Average	15	40[30]
	24 hours	35	75
	1 hour	15	–

Some of the major stationary sources of air pollution in the vicinity of the Project site are listed in **Exhibit 4.38.** Emissions from these sources are expected to consist of SO_x, NO_x and PM.

Exhibit 4.38: Major Sources of Air Emissions in Vicinity of the Project Site

Source	*Approximate Distance from Project site (km)*	*Expected Emission*	*Direction from Project Site*
Existing HUBCO Power plant	1.5	PM, SO_x, NO_x	South
Byco Petroleum Pakistan Ltd	1.5	PM, SO_x, NO_x	Southeast
Settlements (Goth Qadir Bakhsh)	2	PM	East
Settlements (Goth Allana Gadpor)	3.5	PM	Northeast
Poultry Farms	> 2	PM, NO_x	Northeast

26 For annual average. the annual arithmetic mean of minimum 104 instruments in a year taken twice a week 24 hourly at uniform interval and for 24 hourly/8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

27 Effective from January 1, 2012

28 Effective from July 1, 2014

29 The combined limit for NO_x as NO_2 was calculated using a 1.53 conversion factor assuming that all NO is converted into NO_2.

30 Annual average limit of 40 (μg/m^3) or background annual average concentration plus allowable allowance of 9 (μg/m^3), whichever is low

Data from Secondary Sources

Data from a study carried out by the World Bank was used to define the baseline conditions in urban areas of Karachi[31]. The study report presents air quality data from 2007 to 2010 for $PM_{2.5}$ and SO_2, and for NO_2 for a 48-hour monitoring period. **Exhibit 4.39** lists the data provided in the report. The study concludes that road traffic is likely to be the major source of fine particles in Karachi; however other sources including industries and natural dust also contribute.

Exhibit 4.39: Ambient Air Quality in Karachi

Pollutant	*Concentration in Air (µg/m^3)*		*Based on*
	Average	*Maximum*	
PM2.5	68	201	Available data from 2007 to 2010
SO2	34	173	Available data from 2007 to 2010
NO2	46	122	48-hour data

HUBCO Monitoring Data

Monitoring of SO_2 and NO_2 has been carried out by HUBCO since January 1996. The monitoring employed passive diffusion tubes. While the trends could be used to calculate expected values for 2018 when the proposed Project is expected to be online, the average values measured during the year 2012 were used for the baseline as this was the most recent data. The receptor locations and the average concentration of NO_2 and SO_2 measured for the year 2012 are provided in **Exhibit 4.40**. A map showing locations of the monitoring points are provided in **Exhibit 4.42**.

Exhibit 4.40: Concentration NO_2 of and SO_2 at HUBCO's Monitoring Points (MP)[32]

MP ID	*MP Name*	*MP Location*		*Concentration of Pollutants (µg/m^3)*[33]	
		Latitude (N)	*Longitude (E)*	*NO_2*	*SO_2*
1	Ghulam Goth	24° 54' 44.5"	66° 41' 50.0"	25.96	41.13
2	Allana Goth	24° 56' 58.2"	66° 42' 31.9"	11.48	20.70
3	Abbas Goth	24° 56' 57.0"	66° 44' 21.9"	13.36	28.30
4	Al Madina Poultry Farm	24° 58' 48.8"	66° 46' 40.5"	10.91	50.30
5	Old Stone Factory	24° 58' 47.7"	66° 48' 31.3"	9.78	28.30
6	Sherwani Farms	24° 59' 58.4"	66° 49' 44.8"	11.29	25.68
7	Wali Mohd Goth	25° 0' 58.5"	66° 45' 5.3"	6.21	18.34
8	Gaddani PSO Solar Station	24° 56' 11.2"	66° 46' 31.8"	13.92	33.01

31 Ernesto Sánchez-Triana. "Cleaning Pakistan's Air: Policy Options to Address the Cost of Outdoor Air Pollution". Washington DC: The World Bank (2014)

32 R.D.Wright. (2013). Air Quality Around HUB Power Station, 2012. HUBCO.

33 The concentrations have been converted from ppb to µg/m^3 using formula: Amount in µg/m^3 = Amount in ppb × (Molar mass of pollutant/24.45)

MP ID	*MP Name*	*MP Location*		*Concentration of Pollutants (µg/m³)*[33]	
		Latitude (N)	*Longitude (E)*	*NO_2*	*SO_2*
9	Zulfiqar Poultry Farm	24° 54' 40.3"	66° 47' 41.1"	9.60	54.23
10	Café Al Amin Moosa Goth	24° 52' 27.5"	66° 44' 40.9"	10.54	35.89
11	Mubarak Village	24° 51' 6.2"	66° 40' 2.8"	10.72	25.94
12	HUBCO Township	24° 55' 6.2"	66° 41' 45.1"	7.34	21.48
17	North East Ghulam Goth	24° 55' 0.5"	66° 43' 6.3"	18.25	29.87
18	Pir Ibrahim	24° 55' 40.7"	66° 43' 3.0"	10.91	24.63

Monitoring Methodology

The air quality sampling was conducted in two phases (Air Quality Monitoring Phase I and Phase II). The sampling locations and their rationale for selection for Phase I and Phase II are provided in **Exhibit 4.62**, and **Exhibit 4.42** shows these locations on a map.

Air Quality Monitoring Phase I

Location A1 was selected for air quality sampling in Phase I of the baseline survey. The location was selected taking into account wind direction and the location of other emission sources close to the Project. During this phase, SO_x and NO_x were monitored at A1 using diffusion tubes. Diffusion tubes were exposed to ambient air of the location A1 from July 26, 2014 to August 25, 2014. Meanwhile, SUPRCO was deployed to monitor SO_2 and NO_x for 48 hours and PM_{10}, and $PM_{2.5}$ for 24 hours. Due to accessibility issues, SUPRCO undertook monitoring approximately 1 km west of A1. This monitoring was done during August 12, 2014 to August 14, 2014. Since the location of SUPRCO’s monitoring is different from location of A1, therefore this point is discussed as monitoring point A2 in this report.

Air Quality Monitoring Phase II

The second phase of monitoring was carried out from September 11, 2014 to September 16, 2014. HBP monitored PM_{10} and $PM_{2.5}$ at six locations (SPM1 through SPM6) around the Project Site. A MiniVol Sampler was used to measure the concentration of PM_{10} and $PM_{2.5}$ at each sampling location. Both, PM_{10}, and $PM_{2.5}$ were monitored for a period of 8 hours at the six locations. The monitoring was carried out for 8-hours period because no temporal variation in the concentration of PM_{10} and $PM_{2.5}$ was expected and the 8-hour concentration would reflect a good average of the ambient air concentration of PM in the area, except for survey points SPM2 and SPM5, which are located upwind of settlements where the concentration of PM_{10} and $PM_{2.5}$ may vary with time depending on the activity in the settlements.

Location and Rationale of Sampling Points

A1 and A2 were located at 2 km and 3.5 km northeast of the Project Site, respectively. This is the general wind-direction in the Project area and these locations were selected to assess the ambient air quality upwind of the Project Site.

SPM1 and SPM4 were located 2.4 km north and 10 km upwind (northeast) of the Project site, respectively. Both these locations had no source in the downwind direction and selected to assess the background concentration of pollutants in the Project area.

SPM2 was located upwind (northeast) of "Goth Abbas Gadoor" a relative large settlement and SPM5 was located upwind (North-East) of "Goth Allana Gadoor". These locations were selected to assess the concentration of pollutants in upwind direction of the settlements.

SPM3 and SPM6 were located at 1.8 km and 4.5 km upwind (northeast) of the existing HUBCO power plant, respectively. These locations were selected to assess the ambient air quality upwind of the existing plant.

Monitoring Methodology

Diffusion tubes were exposed to ambient air of location A1 for 726 hours from July 26, 2014 to August 8, 2014. Two sets of diffusion tubes were installed at same location for quality assurance. After this period the tubes were sent to Gradko International Limited, United Kingdom (UK) for analysis. The diffusion tubes were analyzed according to the standard method applicable in the UK[34] and the results were sent back to HBP. These are tabulated in **Exhibit 4.45**.

SUPARCO's mobile air-monitoring vehicle collected air-quality data of criteria pollutants including NO_x (as sum of NO and NO_2), SO_2, PM_{10} and $PM_{2.5}$ at sampling location A2. The air quality parameters were measured based on USEPA and ASTM methods. Meteorological parameters such as wind speed, wind direction, temperature and relative humidity were also measured onsite (**Appendix E**). Atmospheric concentrations of NO_2 were measured indirectly by photometrically measuring the light intensity at wavelengths greater than 600 nanometers, resulting from the chemi-luminescent reaction of NO with ozone (O_3). SO_2 was measured using the SO_2 analyzer which is based on the principle of fluorescence technique in which a molecule of sulfur dioxide is radiated with particular wavelengths of ultraviolet light. The details of these procedures are widely available on internet.

A MiniVol Sampler was used to monitor concentrations of PM_{10} and $PM_{2.5}$ at the locations from SPM1 through SPM6. The samples were analyzed at HBP's laboratory on September 18, 2014.

Exhibit 4.43 shows the exposure time and the monitoring equipment for each monitored location. **Exhibit 4.44** shows the photographs of activities undertaken during the monitoring.

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[34] AEA Energy and Environment. "Diffusion Tubes for Ambient NO2 Monitoring: Practical Guidance" (2008, Feb). http://laqm.defra.gov.uk/documents/0802141004_NO2_WG_PracticalGuidance_Issue1a.pdf, Retrieved September 20, 2014.

Exhibit 4.41: Description of Ambient Air Quality Sampling Sites

Site ID	*Location Description*	*Coordinates*		*Rationale for Selection*	*Monitoring by*
		Latitude (N)	*Longitude (E)*		
A1	3 km northest of the Project site	24°55'40.40"	66°43'06.40"	To assess the ambient air quality upwind of the Project site.	HBP using Diffusion tubes
A2	2 km northeast of the Project Site	24°55'41.70"	66°42'21.70"	To assess the ambient air quality upwind of the Project site.	SUPARCO
SPM1	2.4 km north of the Project Site	24°56'22.60"	66°41'42.40"	To assess the background concentration of pollutants. No source in the downwind direction.	HBP using MiniVol sampler
SPM2	Upwind of “Goth Abbas Gadoor” a relative large settlement	24°57'08.40"	66°44'47.60"	To assess the concentration of pollutants in upwind direction from a settlement.	HBP using MiniVol sampler
SPM3	1.8 km upwind (North-East) of the existing HUBCO and Byco plants	24°54'51.50"	66°42'02.40"	To assess the ambient air quality upwind of the existing HUBCO and Byco plants.	HBP using MiniVol sampler
SPM4	10 km upwind (North-East) of the existing HUBCO and Byco plants.	24°58'54.40"	66°45'29.90"	To assess the background concentration of pollutants. No source in the downwind direction up to 4 km.	HBP using MiniVol sampler
SPM5	Upwind (North-East) of “Goth Allana Gadoor”.	24°56'52.16	66°42'27.10"	To assess the concentration of pollutants in upwind direction of the settlement.	HBP using MiniVol sampler
SPM6	4.5 km upwind (North-East) of existing HUBCO and Byco plants	24°56'21.70"	66°43'36.20"	To assess the ambient air quality upwind of the existing plant.	HBP using MiniVol sampler

Exhibit 4.42: Location of Ambient Air Quality Sampling Sites

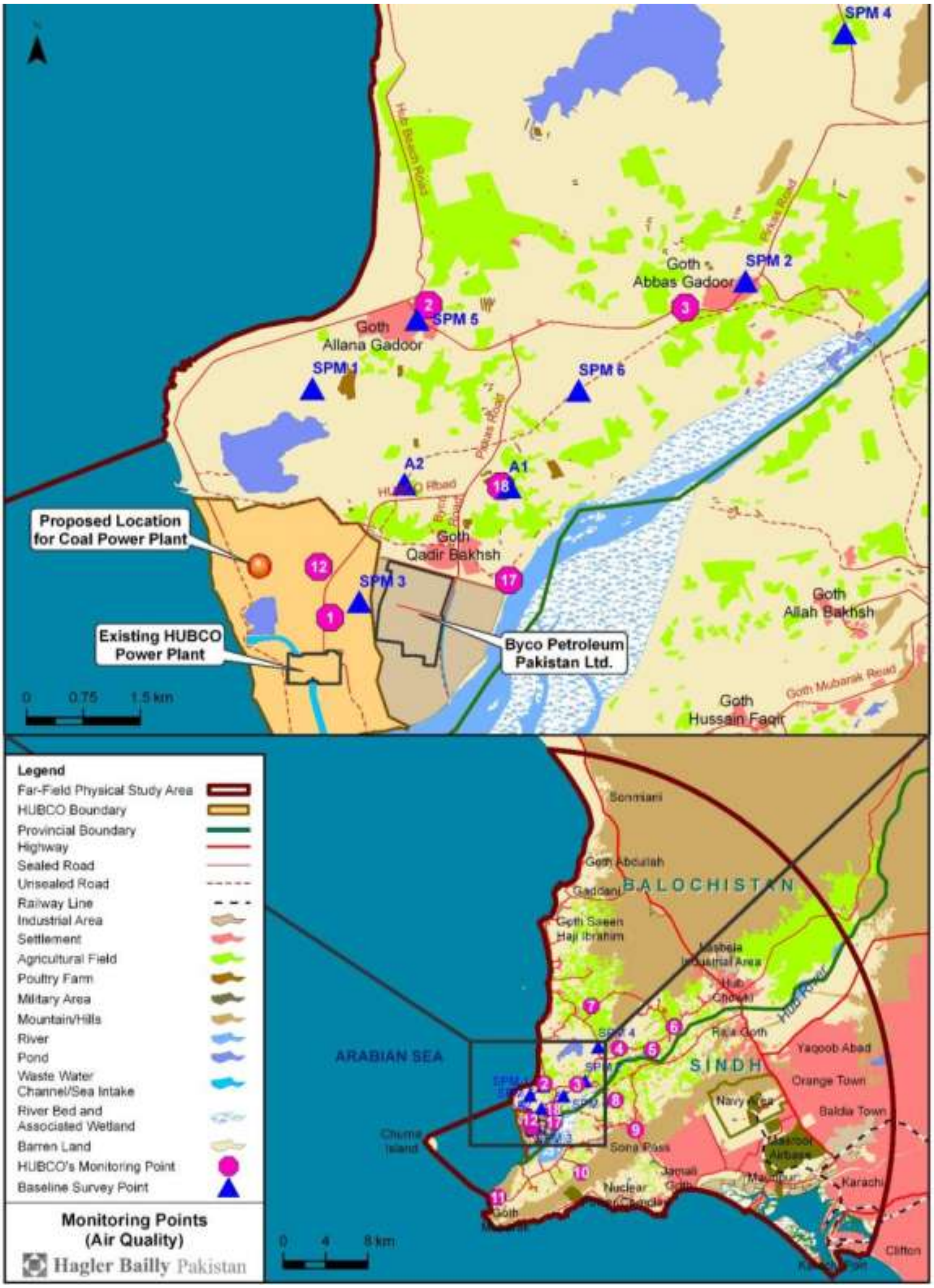


Exhibit 4.43: Exposure time for each of the sampling locations

Sample ID	*Parameters*	*Monitoring*			*Monitoring Equipment*
		From	*To*	*Period (hours)*	
A1	SO_2, NO_x (NO and NO_2)	Jul 26, 2014	Aug 25, 2014	726	Diffusion Tubes
A2	SO_2, $PM_{2.5}$, PM_{10}, NO_x (NO and NO_2)	Aug 12, 2014	Aug 14, 2014	48 (SO_x & NO_x) 24 ($PM_{2.5}$ & PM_{10})	Mobile air-monitoring vehicle
SPM 1	$PM_{2.5}$ and PM_{10}	Sep 13, 2014 8:50	Sep 13, 2014 17:05	8	MiniVol Sampler
SPM 2	$PM_{2.5}$ and PM_{10}	Sep 12, 2014	Sep 12, 2014	8	MiniVol Sampler
	$PM_{2.5}$ and PM_{10}	Sep 26, 2014	Sep 27, 2014	24	Mobile air-monitoring vehicle
SPM 3	$PM_{2.5}$ and PM_{10}	Sep 11, 2014	Sep 11, 2014	8	MiniVol Sampler
SPM 4	$PM_{2.5}$ and PM_{10}	Sep 14, 2014	Sep 14, 2014	8	MiniVol Sampler
SPM 5	$PM_{2.5}$ and PM_{10}	Sep 15, 2014	Sep 15, 2014	8	MiniVol Sampler
SPM 6	$PM_{2.5}$ and PM_{10}	Sep 16, 2014	Sep 16, 2014	8	MiniVol Sampler

Exhibit 4.44: Air Quality Baseline Monitoring Activities at the Sample Locations


Deployment of the equipment at the location

Snapshot showing the MiniVol Sampler


Mobile air-monitoring vehicle used by SUPARCO


Monitoring equipment installed in the vicinity of a settlement

Quality Assurance

Since a relatively higher 8-hour concentration of PM_{10} and $PM_{2.5}$ was measured at locations near settlements by HBP, SUPRACO was deployed to monitor PM_{10} and $PM_{2.5}$ for a 24-hour duration at location SPM2 for quality assurance. The average concentration over 24 hour monitoring period was consistent with the 8 hour concentration measured at other locations.

Results and Discussion

A summary of the ambient air condition in the Study Area is discussed in this section. The air-monitoring survey results are provided in **Exhibit 4.45**. The complete set of results ambient air monitoring can be found in **Appendix E**.

A summary of the ambient air quality is as follows:

- Based on the available data from 2007 to 2010, the average concentration of SO_2, NO_2, and $PM_{2.5}$ in the Karachi city is reported to be 34 µg/m^3, 46 µg/m^3, and 68 µg/m^3 respectively.[35] The concentration of SO_2 is within the limits prescribed by the SEQS for 24-hour as well as the annual ambient air quality concentrations. The concentration of NO_2 exceeds the annual limit but is under the 24-hour limit. However, the concentrations of $PM_{2.5}$ are higher than the annual limits prescribed by the SEQS.
- Based on the ambient air monitoring data provided by HUBCO, the average concentration of NO_2 ranges from 6.2 µg/m^3 to 25.9 µg/m^3, and from 18.3 µg/m^3 to 54.2 µg/m^3 for SO_2. The concentration of these pollutants in the vicinity of the Project Site is within the ambient air concentration limits prescribed by the NEQS as well as SEQS.
- the average ambient air concentrations of SO_2, NO_2, and NO at A1 were 3.2 µg/m^3, 2.23 µg/m^3 and 10.5 µg/m^3 respectively. All the pollutants are well below the ambient air concentration limits prescribed by the NEQS. The concentration of NO_2 was measured to be very small and only just above the levels usually seen on blank tubes; also the value was inconsistent compared to other sampling locations, therefore this value for NO_2 was not used in the impact assessment section (**Section 8**).
- the average concentration of SO_2, NO and NO_2 was at A1 was 4.2 µg/m^3, 5.9 µg/m^3 and 15.8 µg/m^3 respectively. Whereas the average concentration of PM_{10} and $PM_{2.5}$ for a 24 hour period were measured to be 625 µg/m^3 and 416 µg/m^3, respectively. The concentration of SO_2, NO and NO_2 is within the ambient air concentration limits prescribed by the NEQS and SEQS. The concentration of PM_{10} and $PM_{2.5}$ were measured to be higher than the limit prescribed by NEQS as well as SEQS. The concentration of PM_{10} and $PM_{2.5}$ recorded at this location was also considerably higher than the concentration at other sampling locations. This may have been due to proximity to an unpaved and

35 Ernesto Sánchez-Triana, Pakistan's Air: Policy Options to Address the Cost of E. (2014). Cleaning . .Outdoor Air Pollution Washington DC: The World Bank.

the sample is, therefore, considered biased and excluded from subsequent analysis in impact assessment section (**Section 8**).

- The concentration of PM_{10} at SPM1, SPM2 SPM3, SPM4, SPM5, and SPM6 was 138.8 µg/m^3, 185.1 µg/m^3, 83.3 µg/m^3, 138.8 µg/m^3, 231.4 µg/m^3, and 138.8 µg/m^3, respectively. Since sampling locations SPM2 and SPM5 were located upwind of settlements, the concentration of PM_{10} at these locations w higher than other locations. The concentration of PM10 at SPM3 is under the limits prescribed by NEQS; however, the concentration of PM10 at SPM1, SPM2, SPM4, SPM6 exceeds the annual limit of the NEQS. The concentration of PM_{10} at SMP5, which is located upwind of Goth Allana Gadoor, exceeds the annual and 24-hour limits prescribed by NEQS.
- The concentration of $PM_{2.5}$ at SPM1, SPM2 SPM3, SPM4, SPM5, and SPM6 was 92.6 µg/m3, 115.7 µg/m^3, 46.3 µg/m^3, 46.3 µg/m^3, 92.59 µg/m^3, and 69.44 µg/m^3, respectively. The concentration of $PM_{2.5}$ at all the monitoring location exceeds both, annual as well as 24-hour limits, prescribe by the NEQS. The explanation for the high values of $PM_{2.5}$ in Pakistan is included in the air quality impact assessment section (**Section 8**) of this report.

Conclusion

The monitoring results show that the concentration of SO_2 and NO_x in the vicinity of Project is under all the limits prescribed by NEQS as well as SEQS; however near Karachi the concentration of NO_2 may exceed the annual limit. The concentration of PM_{10} in most of the areas is under the 24-hour limits prescribed by NEQS and SEQS, however, it exceeds annual limit in most of the areas. The concentration of $PM_{2.5}$ in all areas exceed the annual and 24-hour NEQS limits; however it is under the limit prescribed by SEQS in all areas.

Exhibit 4.45: Results of Ambient Air Quality Monitoring in the Study Area

Location ID	*Monitoring Period*	*Monitoring Methodology*	*Sulfur Dioxide (SO_2)*	*Nitrogen Dioxide (NO_2)*	*Nitrogen Oxide (NO)*	*Particulate Matter*	
						PM_{10}	*$PM_{2.5}$*
			µg/m³	*µg/m³*	*µg/m³*	*µg/m³*	*µg/m³*
A1	1 month	Diffusion Tubes	3.2	2.23	10.5	–	–
A2	48 hours (SO_x & NO_x) 24 hours ($PM_{2.5}$ & PM_{10})	Mobile air-monitoring vehicle	4.2	15.8	5.9	416	625
SPM 1	8 hours	MiniVol Sampler	–	–	–	138.9	92.6
SPM 2	8 hours	MiniVol Sampler	–	–	–	185.2	115.7
	24 hour[36]	Mobile air-monitoring vehicle	–	–	–	115.5	28.1
SPM 3	8 hours	MiniVol Sampler	–	–	–	83.3	46.3
SPM 4	8 hours	MiniVol Sampler	–	–	–	138.9	46.3
SPM 5	8 hours	MiniVol Sampler	–	–	–	231.8	92.9
SPM 6	8 hours	MiniVol Sampler	–	–	–	138.9	69.4
1	1 year	Diffusion Tubes	41.1	26.0	–	–	–
2	1 year	Diffusion Tubes	20.7	11.4	–	–	–
3	1 year	Diffusion Tubes	28.3	13.5	–	–	–
4	1 year	Diffusion Tubes	50.3	10.9	–	–	–
5	1 year	Diffusion Tubes	28.3	9.8	–	–	–
6	1 year	Diffusion Tubes	25.7	11.3	–	–	–
7	1 year	Diffusion Tubes	18.3	6.2	–	–	–

[36] The purpose of this 24 hour monitoring was quality assurance.

Location ID	*Monitoring Period*	*Monitoring Methodology*	*Sulfur Dioxide (SO_2)*	*Nitrogen Dioxide (NO_2)*	*Nitrogen Oxide (NO)*	*Particulate Matter*	
						PM_{10}	*$PM_{2.5}$*
			µg/m^3	*µg/m^3*	*µg/m^3*	*µg/m^3*	*µg/m^3*
8	1 year	Diffusion Tubes	33.0	13.9	–	–	–
9	1 year	Diffusion Tubes	54.2	9.6	–	–	–
10	1 year	Diffusion Tubes	35.9	10.5	–	–	–
11	1 year	Diffusion Tubes	25.9	10.7	–	–	–
12	1 year	Diffusion Tubes	21.5	7.3	–	–	–
17	1 year	Diffusion Tubes	29.9	18.2	–	–	–
18	1 year	Diffusion Tubes	24.6	10.9	–	–	–
NEQS	24-hour (98 percentile)		120	80	40	150	35
	Annual arithmetic mean		80	40	40	120	15

4.2.9 Traffic

The objective of traffic survey was data collection and development of traffic baseline necessary for assessment of impacts due to traffic generated during construction and operation of the new power plant.

The impacts on the environment are expected to be in two phases, construction and operation phase. The potential impacts during different phases are listed below:

- Air quality impact on communities,
- Noise level impact on communities,
- Traffic congestion impact on road users, and
- Road safety impact on communities and road users.

Scope

According to the Project design, the most important route that will be used during the construction and operation of this Project will be the road connecting Karachi Port and HUBCO plant site. This route is divided in three different segments on the basis of their road use type. These segments are shown in **Exhibit 4.47.**

- Segment A: From Karachi port to within Karachi city limits.
- Segment B: From Karachi city to Pirkas Road intersection via National Highway (N-25).
- Segment C: From Pirkas Road intersection to Project site via Pirkas Road.

It is expected that due to the Project activities, different segments on the route connecting Karachi Port and Project Site will have different environmental impacts. It is important to understand the different road use type and road users on each segment to assess impacts that will be expected on the environment due to the traffic that will be generated by the Project.

During the construction phase of the Project, as most of the equipment will be imported on Karachi Port and movement of large machinery and equipment will be expected on all three segments of the route identified. Due to the added traffic, impacts on air quality, noise, traffic congestion and road safety will be expected. Potential impacts on each segment of the route and their respective data requirements are identified in **Exhibit 4.46**.

Exhibit 4.46: Data Requirements for Traffic Survey

Environmental Impact	*Segment A*	*Segment B*	*Segment C*
Air quality	Not required	Not required	Not required
Noise levels	Not required	Not required	Not required
Traffic congestion and safety	Secondary	Secondary	Primary

Air Quality and Noise Levels

For assessment of impacts on air quality and ambient noise levels, primary or secondary data collection will not be required. The route from Karachi Port to Project location has existing roads which is already heavily used by vehicular traffic. The NO_x, SO_x and particulate matter concentrations along this route are expected to be high and therefore the incremental impact due to Project related traffic will be small in proportion.

The incremental impact of noise generated from vehicular traffic generated is not expected to significantly affect the ambient noise levels along the route. This is because the vehicular noise will be in the form of peaks at intervals, generated when a vehicle travels from Karachi Port to the Project location. The average effect of such peaks will be minimum and the effect on the ambient noise level is expected to be insignificant.

Traffic congestion and safety

The transport route, which connects Karachi Port to the Project location, is divided in three segments. For measuring traffic congestion, count data and vehicle type data have to be recorded. Segment A (within Karachi city) and Segment B (National Highway) are commonly used roads by industries and Karachi road users therefore number of road users is dynamic and varies significantly. Segment A, the road which connects KPT to N-25 is a wide road which is already being used by heavy traffic 24 hours. A photograph of this road is shown in **Exhibit 4.48 a**. Also, on Segment B, two roads follow this route parallel to each other. One of the roads is dedicated to heavy traffic single carriageway (**Exhibit 4.49 b and c)**. Another road that follows the same route is a dual carriageway which is being used by local and public transport. It is expected that due to this provision of extra road, the impact on traffic congestion will not be significant on this segment. Segment B connects to Segment C in the settlement of Hub Chowki which is densely populated and congested with traffic (**Exhibit 4.48 d**). For Segment C (Pirkas Road), primary data collection in the form of 24-hour count data collection was carried out. For this, number or vehicles passing through this road and the category of each vehicle was surveyed. The photographs of this route are shown in **Exhibit 4.48 e and f**. The count data and associated analysis is given in **Section Count Data.**

Exhibit 4.47: Traffic Sampling Locations

Exhibit 4.48: Photographs of Proposed Transportation Route

a. *Segment A, Road in Karachi from KPT towards N-25*

b. *Segment B, N-25 from KPT towards Hub Chowki*

c. *Segment B, one single carriageway and one dual carriageway from KPT to HUBCO*

d. *Segment B, the settlement of Hub Chowki*

e. *Segment C, Pirkas Road (Traffic Survey Location 1)*

f. *Segment C, Pirkas Road (Traffic Survey Location 2)*

Count Data

The traffic count data was collected for 24 hour periods during which data on number of vehicles and type of vehicles passing through a particular sampling points were surveyed. Two traffic-sampling points were chosen T1 and T2, shown in **Exhibit 4.47**. The first point, T1 was chosen to survey traffic joining the Pirkas Road from the National Highway. The second traffic sampling point T2 was selected to differentiate between the traffic related to HUBCO and Byco plants and the traffic attracted by and generated from the few settlements and farms on Pirkas Road. The coordinates of the traffic survey points are given in **Exhibit 4.49.**

Exhibit 4.49: Summary of Traffic Survey Details

Survey Point	*Survey Location*	*Northing*	*Easting*	*Date*	*Time Duration (Hours)*
T1	Pirkas Road intersection with N-25	25 01 57.13 N	66 52 18. 72 E	26th Jul 2013	24 hours
T2	Pirkas Road	25 00 38.22 N	66 50 41.66 E	22nd Jul 2013	24 hours

Passenger Car Unit (PCU)

Passenger Car Equivalent (PCE) or Passenger Car Unit (PCU) is a metric unit used to assess traffic-flow rate.[37] PCU, is a measure of the relative space requirement of a vehicle compared to that of a passenger car under a specified set of roadway, traffic and other conditions. The value assigned to each of the classification of the vehicles may depend on a number of factors such as:

- dimensions, power, speed, acceleration and braking characteristics of the vehicle;
- road characteristics such as geometrics including gradients, curves, access controls, type of road: rural or urban, presence and the type of intersections;
- transverse and longitudinal clearances between vehicles moving on road, which in turn depends upon the speeds, driver characteristics and the classes of other moving vehicles;
- environmental and climatic conditions and;
- Traffic control methods, speed limits, and barriers.

The PCU for different classes of vehicles are not defined universally, however, the values used for the ESIA of this Project are typical for Pakistani road conditions. The PCU values used for analysis of baseline traffic data are given in **Exhibit 4.50**.

Exhibit 4.50: Vehicle Classification

Class	*Types Included*	*PCU*
Cars	Sedans, coupes, and station wagons primarily used for carrying passengers. Includes both privately owned cars and taxis	1
Pickups	Two-axle, 4-wheeled vehicles, other than passenger cars	2
Bikes	Two wheeled vehicles	0.5
Rickshaws	A three-wheeled motorized cabin cycle with seating space for up to three passengers.	0.86
Buses	Vehicles manufactured as traditional passenger-carrying buses with two axles and six wheels. Includes conventional buses as well as minibuses with seating capacity of 30 or more passengers	2

[37] Ahuja, Amanpreet Singh (2004). *Development of passenger car equivalents for freeway merging section*

Class	*Types Included*	*PCU*
Trucks	Vehicles on a single frame, having two to six axles , used for carrying goods (each axle type was separtely counted)	3
Tractor	Tractors and tractor lorries	3
Other	Three wheeled vehicles and animal drawn carts	0.5

Location 1

The first survey was conducted on Pirkas Road just after the intersection with N-25. The survey was for 24 hours and data was collected for traffic in both directions. Survey data collected consisted of count data and vehicle type data that passed the survey location. This route is open to heavy traffic for 24 hours. The count data collected at Location 1 for traffic towards the Project site is given in **Exhibit 4.51** whereas for traffic towards Hub Chowki is given in **Exhibit 4.52**.

The count data for light vehicles, heavy vehicles and PCU has been plotted for both the directions separately in **Exhibit 4.53** and **Exhibit 4.54.**

For traffic in the direction towards HUBCO, the number of light vehicles is low during nighttime from 23.00 – 07.00 hours which shows low activity at this location. However, the number of light vehicles start increasing after that due to light vehicles heading to offices for work. The busiest time for light vehicles is 08.00-11.00 hours. Heavy traffic on this route seemed to be low during the peak usage of light vehicles which shows that heavy vehicles avoid this route when it is used most by light vehicles. Heavy vehicle count declines at night time following a similar trend to light vehicles. Overall, if the trend in PCU is analyzed, the score remains high during the day with a dip between 12.00-14.00 hours representing lunch and prayer break.

For traffic in the direction towards Hub Chowki, the number of vehicles decrease significantly after 19.00 hours and decreases further after 23.00 hours. Number of heavy vehicles travelling from HUBCO towards Hub Chowki seemed to be lesser in number than heavy vehicles travelling towards HUBCO. This was due to large amount of traffic, such as oil tankers attracted by the Byco refinery which is on the similar route as HUBCO. Light traffic travelling towards Hub Chowki were higher in number than travelling towards HUBCO.

Exhibit 4.51: Traffic towards HUBCO at Location 1

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/9/2014	07:00 to 08:00	39	6	5	2	7	1	2	8	15	5	**90**	154	40
9/9/2014	08:00 to 09:00	83	12	13	7	6	2	–	5	5	2	**135**	154	27
9/9/2014	09:00 to 10:00	93	32	22	16	4	1	–	–	2	4	**174**	188	27
9/9/2014	10:00 to 11:00	76	25	16	13	10	4	1	–	2	3	**150**	181	33
9/9/2014	11:00 to 12:00	75	23	18	10	9	4	4	–	2	4	**149**	186	33
9/9/2014	12:00 to 13:00	56	15	12	7	8	2	4	–	–	2	**106**	129	23
9/9/2014	13:00 to 14:00	46	11	7	4	6	5	1	1	–	3	**84**	104	20
9/9/2014	14:00 to 15:00	48	26	21	4	8	8	5	1	3	3	**127**	184	32
9/9/2014	15:00 to 16:00	39	8	12	5	16	3	2	–	2	4	**91**	143	32
9/9/2014	16:00 to 17:00	62	13	10	5	9	6	5	1	1	3	**115**	149	30
9/9/2014	17:00 to 18:00	59	8	10	11	11	17	6	3	–	5	**130**	206	53
9/9/2014	18:00 to 19:00	57	10	18	6	11	6	9	3	1	2	**123**	183	38
9/9/2014	19:00 to 20:00	55	8	22	2	9	10	8	2	5	2	**123**	192	38
9/9/2014	20:00 to 21:00	34	5	5	9	6	10	5	3	4	–	**81**	134	37
9/9/2014	21:00 to 22:00	19	4	4	5	9	13	4	6	1	2	**67**	137	40
9/9/2014	22:00 to 23:00	21	5	3	3	4	11	4	4	2	–	**57**	103	28
9/9/2014	23:00 to 00:00	4	1	–	–	5	8	8	–	–	–	**26**	66	21
9/10/2014	00:00 to 01:00	–	–	–	–	3	–	–	–	–	–	**3**	9	3
9/10/2014	01:00 to 02:00	–	1	2	4	1	–	–	1	–	–	**9**	19	6

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/10/2014	02:00 to 03:00	–	–	–	1	–	2	–	–	–	–	**3**	8	3
9/10/2014	03:00 to 04:00	–	–	–	1	–	2	1	–	–	–	**4**	11	4
9/10/2014	04:00 to 05:00	–	–	1	–	6	2	–	–	–	–	**9**	26	8
9/10/2014	05:00 to 06:00	10	1	1	3	5	–	–	–	–	–	**20**	29	8
9/10/2014	06:00 to 07:00	24	2	10	2	6	8	–	–	–	2	**54**	86	18
	24hrs	**900**	**216**	**212**	**120**	**159**	**125**	**69**	**38**	**45**	**46**	**1,930**		

Exhibit 4.52: Traffic towards Hub Chowki at Location 1

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/9/2014	07:00 to 08:00	44	7	5	2	4	9	8	7	2	5	**93**	148	37
9/9/2014	08:00 to 09:00	69	13	13	3	6	9	9	3	7	4	**136**	194	41
9/9/2014	09:00 to 10:00	91	25	10	2	11	9	1	2	1	3	**155**	176	29
9/9/2014	10:00 to 11:00	78	16	3	1	5	2	1	0	0	5	**111**	102	14
9/9/2014	11:00 to 12:00	78	29	15	0	10	11	1	0	1	5	**150**	182	28
9/9/2014	12:00 to 13:00	65	22	7	0	7	4	3	3	0	1	**112**	123	18
9/9/2014	13:00 to 14:00	40	10	6	1	8	2	2	1	0	2	**72**	89	16
9/9/2014	14:00 to 15:00	37	24	14	0	8	10	1	1	0	5	**100**	146	25
9/9/2014	15:00 to 16:00	53	18	8	8	11	8	1	2	14	0	**123**	185	44
9/9/2014	16:00 to 17:00	77	24	12	2	8	9	7	2	1	5	**147**	187	34
9/9/2014	17:00 to 18:00	67	18	10	17	7	9	4	1	4	9	**146**	208	51
9/9/2014	18:00 to 19:00	36	10	14	0	4	5	1	0	2	1	**73**	95	13
9/9/2014	19:00 to 20:00	47	7	7	1	2	9	1	1	1	1	**77**	92	16
9/9/2014	20:00 to 21:00	24	1	6	5	2	9	2	3	4	1	**57**	98	26
9/9/2014	21:00 to 22:00	23	15	11	0	1	7	6	1	0	0	**64**	94	15
9/9/2014	22:00 to 23:00	7	2	2	4	3	5	7	5	0	0	**35**	78	24
9/9/2014	23:00 to 00:00	2	1	0	0	0	3	0	0	0	0	**6**	11	3
9/10/2014	00:00 to 01:00	0	0	0	0	0	1	2	0	0	0	**3**	9	3
9/10/2014	01:00 to 02:00	0	0	0	0	0	2	1	1	0	0	**4**	12	4

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/10/2014	02:00 to 03:00	0	0	0	0	0	0	2	0	0	0	**2**	6	2
9/10/2014	03:00 to 04:00	0	0	0	0	0	5	0	0	0	0	**5**	15	5
9/10/2014	04:00 to 05:00	1	0	1	0	3	4	1	0	0	0	**10**	27	8
9/10/2014	05:00 to 06:00	6	2	2	0	2	3	7	9	0	0	**31**	72	21
9/10/2014	06:00 to 07:00	14	5	2	5	2	5	5	2	4	3	**47**	89	26
24hrs		**859**	**249**	**148**	**51**	**104**	**140**	**73**	**44**	**41**	**50**	**1759**		

Exhibit 4.53: Data for Traffic towards HUBCO at Location 1

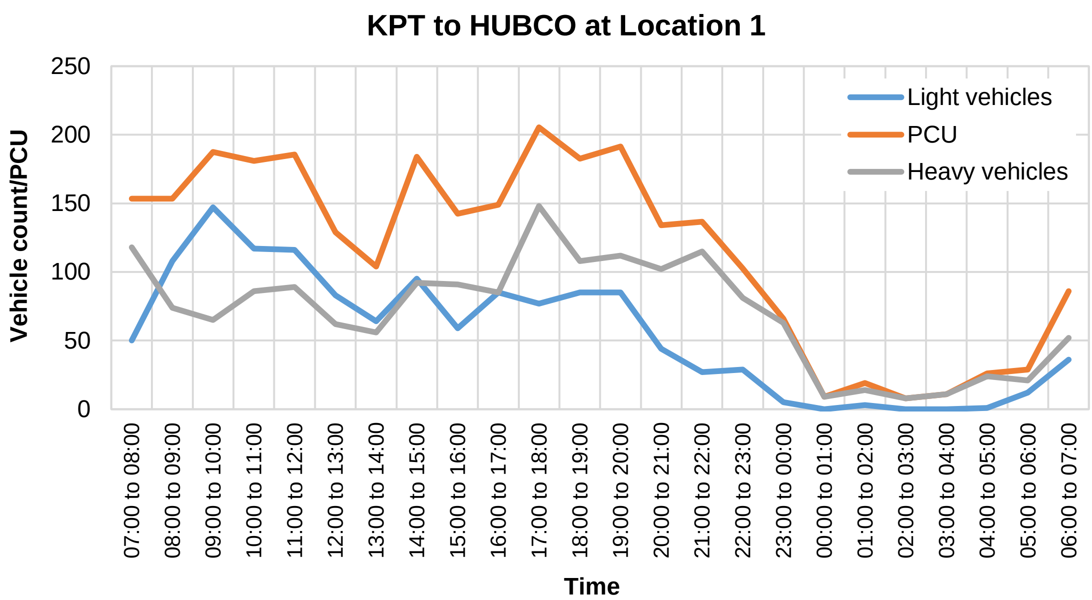
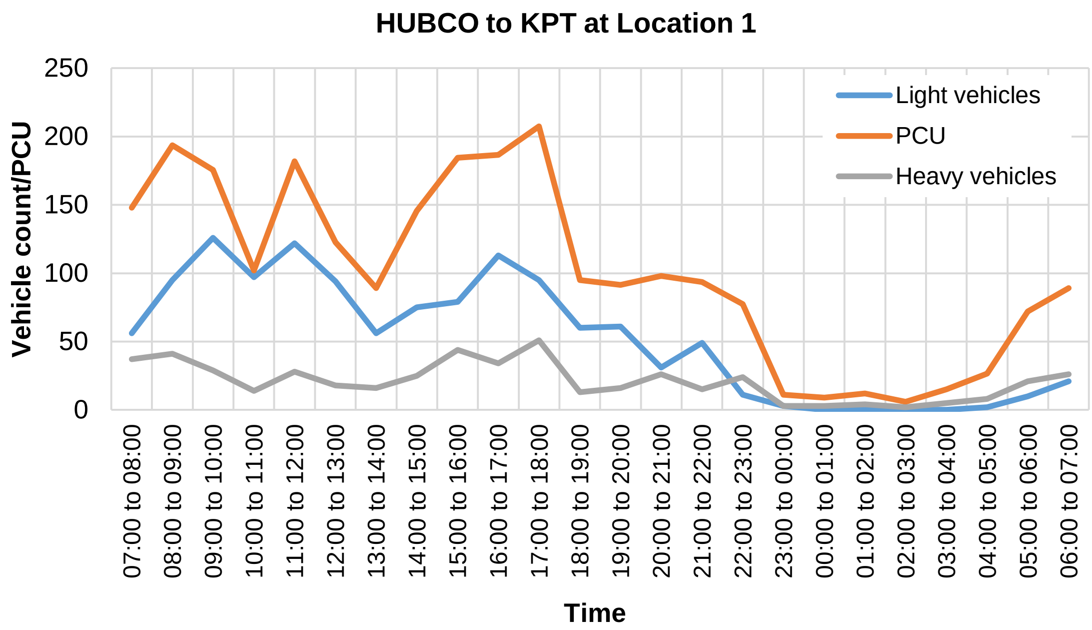


Exhibit 4.54: Data for Traffic towards Hub Chowki/KPT at Location 1



Location 2

The second point chosen for the survey was on Pirkas Road after the few farms and small settlements. The count data and vehicle type data was collected for traffic in both directions for 24 hours passing through this point. This route is open to heavy traffic for 24 hours. The count data collected at Location 2 for traffic towards the Project site is given in **Exhibit 4.55** whereas for traffic towards Hub Chowki is given in **Exhibit 4.56**.

The count data for light vehicles, heavy vehicles and PCU has been plotted for both the directions separately in **Exhibit 4.57** and **Exhibit 4.58.**

Overall, the traffic count data recorded at Location 2 was lesser than recorded at Location 1. This was because at this point, mainly traffic travelling to and from HUBCO and Byco refinery were recorded. Traffic at Location 1 also involved vehicles attracted by the few farms, communities, side roads and Siddiqsons Industries on this route. The location of the second survey was chosen in order to analyze the effect of this traffic.

At this location, both the heavy and light vehicles followed a similar trend. For traffic in the direction towards HUBCO, the number of vehicles was low during nighttime from 23.00 – 07.00 hours which shows low activity at this location. However, the number of light vehicles started increasing after that due to light vehicles heading to offices for work. The busiest time for light vehicles was 08.00-10.00 hours. Overall, if the trend in PCU is analyzed, the score remains high during early morning and during evening.

For traffic in the direction towards Hub Chowki, a similar trend according to the traffic in opposite direction was followed with traffic peaking at early morning and during evenings. However, the peaks are higher for light vehicles in the evening in this direction and in morning in the opposite direction. This shows light vehicles cross this route to and from office. Heavy vehicular traffic was generally low at this point in the direction towards Hub Chowki.

Exhibit 4.55: Traffic towards HUBCO at Location 2

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/9/2014	07:00 to 08:00	4	73	2	3	6	4	0	4	4	1	**101**	142	22
9/9/2014	08:00 to 09:00	12	50	5	5	3	5	1	6	2	1	**90**	130	23
9/9/2014	09:00 to 10:00	16	6	5	5	1	0	0	2	0	0	**35**	43	8
9/9/2014	10:00 to 11:00	6	10	1	6	3	4	1	0	0	0	**31**	51	14
9/9/2014	11:00 to 12:00	15	2	2	7	3	4	5	0	0	0	**38**	64	19
9/9/2014	12:00 to 13:00	11	5	2	3	4	6	2	0	0	0	**33**	57	15
9/9/2014	13:00 to 14:00	14	9	5	7	4	7	3	1	0	0	**50**	85	22
9/9/2014	14:00 to 15:00	14	3	3	1	2	6	6	0	2	0	**37**	66	17
9/9/2014	15:00 to 16:00	9	2	6	4	6	8	1	0	0	0	**36**	72	19
9/9/2014	16:00 to 17:00	17	3	6	0	3	3	3	1	0	0	**36**	54	10
9/9/2014	17:00 to 18:00	15	4	2	3	3	13	7	1	0	0	**48**	94	27
9/9/2014	18:00 to 19:00	17	8	5	4	10	12	6	0	0	0	**62**	119	32
9/9/2014	19:00 to 20:00	10	21	5	2	4	3	10	3	0	0	**58**	100	22
9/9/2014	20:00 to 21:00	9	7	5	2	2	7	8	7	0	0	**47**	98	26
9/9/2014	21:00 to 22:00	3	7	4	3	1	6	4	3	0	0	**31**	65	17
9/9/2014	22:00 to 23:00	4	1	0	2	1	2	5	2	2	1	**20**	46	15
9/9/2014	23:00 to 00:00	4	2	1	0	1	2	3	2	0	0	**15**	30	8
9/10/2014	00:00 to 01:00	0	0	0	0	1	4	5	1	0	0	**11**	33	11
9/10/2014	01:00 to 02:00	1	0	1	3	0	1	1	0	0	0	**7**	15	5

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	0.5	1	2	2	3	3	3	3	3	3			
9/10/2014	02:00 to 03:00	3	1	1	0	0	0	0	0	0	0	**5**	5	0
9/10/2014	03:00 to 04:00	1	1	2	0	0	0	0	0	0	0	**4**	6	0
9/10/2014	04:00 to 05:00	2	0	1	2	2	0	0	0	0	0	**7**	13	4
9/10/2014	05:00 to 06:00	2	0	0	1	1	2	0	0	0	0	**6**	12	4
9/10/2014	06:00 to 07:00	2	3	1	4	6	2	0	0	0	0	**18**	38	12
	24hrs	**191**	**218**	**65**	**67**	**67**	**101**	**71**	**33**	**10**	**3**	**826**		

Exhibit 4.56: Traffic towards Hub Chowki at Location 2

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	*0.5*	*1*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*			
9/9/2014	07:00 to 08:00	4	2	4	4	4	8	7	0	1	0	**34**	80	24
9/9/2014	08:00 to 09:00	14	19	10	5	8	6	10	3	0	0	**75**	137	32
9/9/2014	09:00 to 10:00	20	9	7	5	2	0	0	6	1	0	**50**	70	14
9/9/2014	10:00 to 11:00	18	6	5	2	1	0	0	0	0	0	**32**	32	3
9/9/2014	11:00 to 12:00	16	4	6	6	4	0	1	0	0	0	**37**	51	11
9/9/2014	12:00 to 13:00	10	3	3	4	1	4	0	0	0	0	**25**	37	9
9/9/2014	13:00 to 14:00	14	6	4	4	1	2	0	0	1	0	**32**	41	8
9/9/2014	14:00 to 15:00	12	6	5	6	4	0	2	7	1	0	**43**	76	20
9/9/2014	15:00 to 16:00	12	11	4	9	1	1	2	0	0	1	**41**	58	14
9/9/2014	16:00 to 17:00	7	71	6	4	3	6	0	1	2	0	**100**	131	16
9/9/2014	17:00 to 18:00	13	11	2	1	2	0	0	2	0	0	**31**	36	5
9/9/2014	18:00 to 19:00	15	7	5	0	2	3	2	2	0	0	**36**	52	9
9/9/2014	19:00 to 20:00	10	4	3	1	0	3	5	4	0	0	**30**	53	13
9/9/2014	20:00 to 21:00	5	1	3	0	2	7	6	0	0	0	**24**	55	15
9/9/2014	21:00 to 22:00	4	21	2	0	1	0	0	0	0	0	**28**	30	1
9/9/2014	22:00 to 23:00	4	1	0	2	0	1	0	0	0	0	**8**	10	3
9/9/2014	23:00 to 00:00	2	1	0	0	0	0	0	0	0	0	**3**	2	0
9/10/2014	00:00 to 01:00	2	0	0	0	0	0	0	0	0	0	**2**	1	0
9/10/2014	01:00 to 02:00	1	1	0	0	0	1	0	0	0	0	**3**	5	1

Date	*Time*	*Bikes*	*Cars*	*Pickups*	*Truck (2X)*	*Truck (3X)*	*Truck (4X)*	*Truck (5X)*	*Truck (6X)*	*Buses*	*Trailer/ Tractor*	***Total***	*PCU*	*Heavy No.*
	PCU	*0.5*	*1*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*			
9/10/2014	02:00 to 03:00	2	1	0	0	0	0	0	0	0	0	**3**	2	0
9/10/2014	03:00 to 04:00	0	0	1	0	5	0	0	0	0	0	**6**	17	5
9/10/2014	04:00 to 05:00	0	0	0	5	0	0	1	0	0	0	**6**	13	6
9/10/2014	05:00 to 06:00	1	0	0	0	6	12	9	2	0	0	**30**	88	29
9/10/2014	06:00 to 07:00	2	3	1	3	7	2	15	3	1	0	**37**	96	31
	24hrs	**188**	**188**	**71**	**61**	**54**	**56**	**60**	**30**	**7**	**1**	**716**		

Exhibit 4.57: Data for Traffic towards HUBCO at Location 2

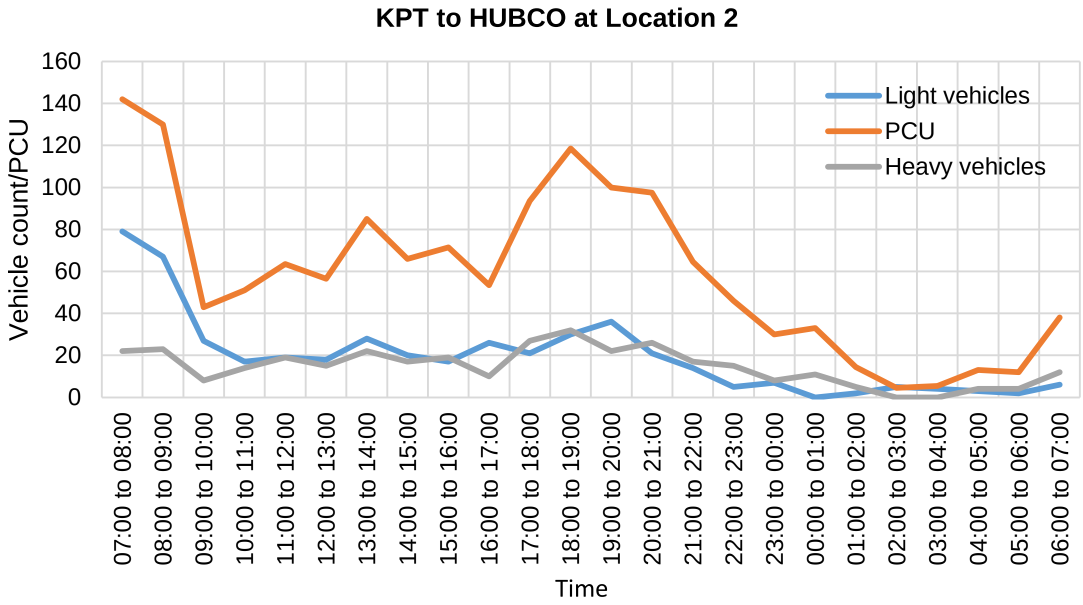
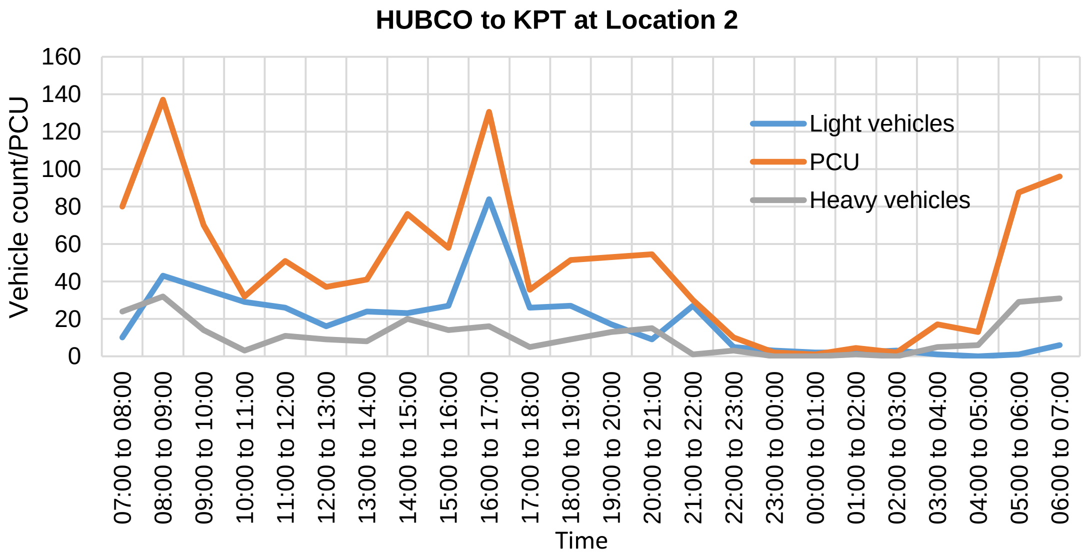


Exhibit 4.58: Data for Traffic towards Hub Chowki/KPT at Location 2



4.3 Ecological Baseline

A two day ecology field survey was conducted on 19th and 20th of September 2014 (September 2014 survey). The objective of the study was to establish marine and terrestrial ecological baseline of the Project site and vicinity. In addition to the field survey, a review of available literature as well as interviews with members of the local communities were also carried out to verify the information collected.

4.3.1 Marine ecological baseline

The scope of the marine ecology survey was to determine the baseline conditions in the Project site and vicinity of the following marine ecological resources:

- Marine epifaunal invertebrate communities
- Fish
- Marine mammals
- Marine turtles
- Mangroves

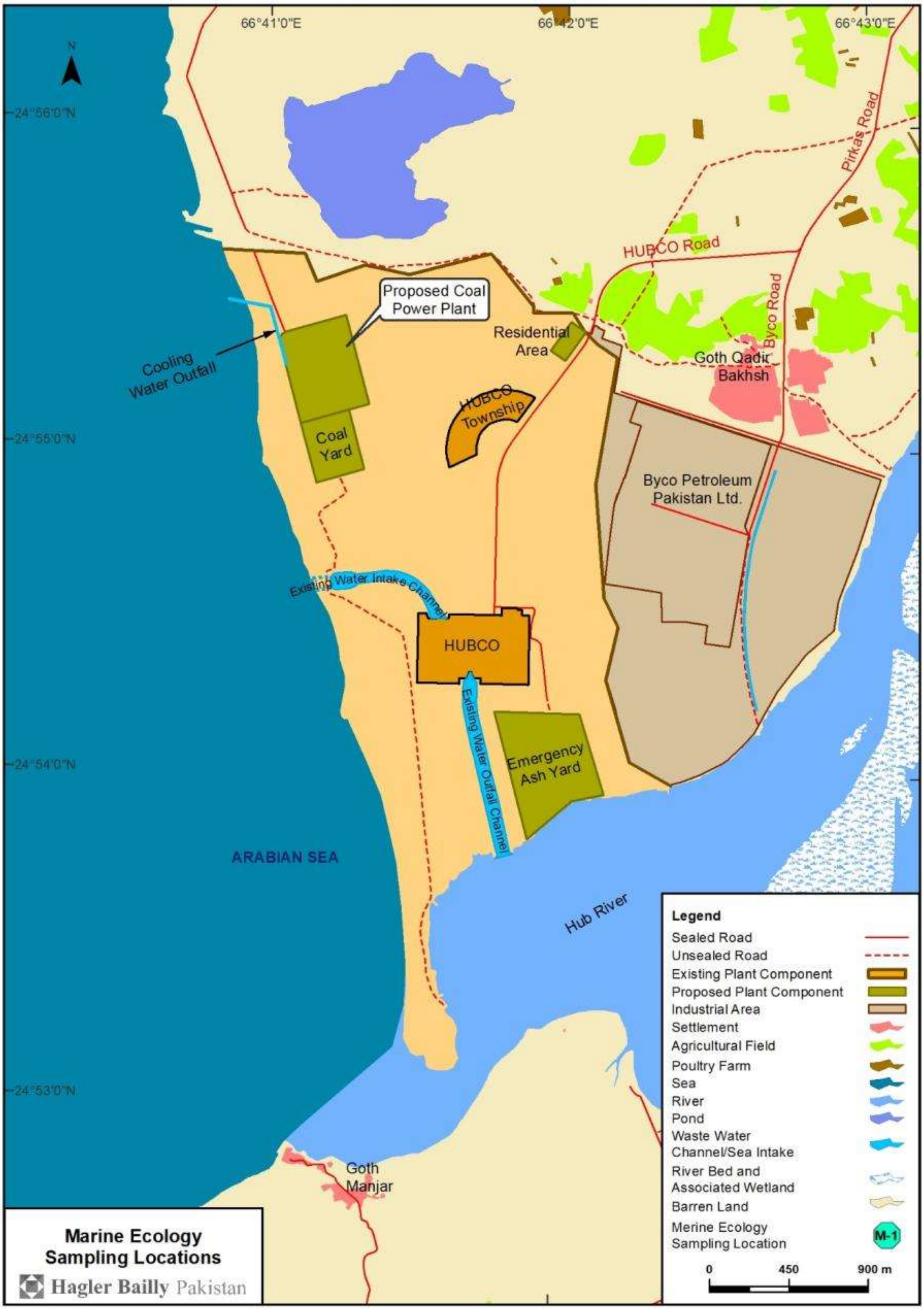
Sampling Plan and Methodology

A total of five locations were selected for sampling. Four sampling points (M-1, M-2 M-3 and M-4) were located in coastal areas while sampling site M-5 was located at the mouth of the Hub Estuary. The co-ordinates of the sampling points are shown in the **Exhibit 4.59** and a map of the marine ecological sampling locations is given in the **Exhibit 4.60.** Details of the survey techniques and data collection are provided below.

Exhibit 4.59: Coordinates of Marine Ecological Sampling Locations. Survey Conducted September 2014

Sampling Point	*Latitude*	*Longitude*	*Substrate Type*	*Tidal height (m)*
M-1	24° 55' 14.211" N	66° 40' 58.524" E	Rocky/coarse sand	0.01 m Low tide
M-2	24° 54' 55.814" N	66° 41' 0.180" E	Rocky/shingle/ coarse sand	0.01 m Low tide
M-3	24° 54' 45.651" N	66° 41' 5.256" E	Rocky/shingle/ coarse sand	0.01 m Low tide
M-4	24° 53' 54.945" N	66° 41' 24.870" E	Coarse Sand	0.01 m Low tide
M-5	24° 53' 46.956" N	66° 41' 54.477" E	Fine sand and muddy	3.0 m high water

Exhibit 4.60: Marine Ecology Sampling Locations Survey Conducted September 2014



Sampling for the marine ecological resources was carried out at low tide using linear transects. (200 m by 20 m) A hand held GPS was used to mark the co-ordinates of the locations sampled.

Habitats observed at the sampling locations included coastal rocky habitat, coarse sandy beach, shingle beach and some tidal lagoons **Exhibit 4.61.**

Exhibit 4.61: Coastal Habitats Observed Surveys Conducted September 2014

Coarse Sandy Beach at High tide

Shingle Beach at High tide

Rocky Beach at Low tide

Tidal Lagoons

Marine epifaunal invertebrate communities

Epifaunal communities are invertebrate faunal species that may attach themselves to rocky surfaces or move freely over them, as by crawling or swimming. Some examples include gastropods, mussels, sea slugs, crabs, etc.

Descriptive Statistics

The descriptive statistics of the marine epifaunal invertebrate communities are given in **Exhibit 4.62**. The highest number of species (18) was recorded at sampling locations M-1 and M-2. These locations were located in the rocky part of the beach. Epifauna were observed and counted in the exposed habitats at low tidal position (0.01 m). Station M-4 was located in sandy beach and five (5) faunal species were observed here. Seven species (7) were observed at Sampling Point M-5 that had a predominately muddy substrate with fine sand.

Exhibit 4.62. Descriptive Statistics of Epifaunal Invertebrate Communities

Sampling Location	*Mean Individuals*	*Variance*	*Standard Deviation*	*Standard Error*	*Total Individuals*	*Total Species*	*Min*	*Max*	*Mean Confidence Interval*
M-1	0.217	0.013	0.112	0.024	4.782	18	0	0.403	0.005
M-2	0.218	0.013	0.112	0.024	4.789	18	0	0.403	0.005
M-3	0.196	0.012	0.111	0.024	4.309	17	0	0.271	0.005
M-4	0.053	0.01	0.102	0.022	1.163	5	0	0.323	0.004
M-5	0.089	0.02	0.143	0.03	1.969	7	0	0.403	0.008

Distribution pattern of epifaunal species

The results of epifauna species distribution pattern at the observed sampled stations (M-1, M-2, M-3, M-4, and M-5) showed that between high and low high water mark, Amphitrite spp (Barnacles) and Graphide Crabs dominated the epifauna. Both species showed a random distribution pattern while Clams and Cockles exhibited aggregate distribution. Most of the other invertebrate species exhibited random distribution pattern. A histogram showing abundance of epifaunal species is given in **Exhibit 4.63** while their distribution pattern is shown in **Exhibit 4.64**. Some photographs of the epifauna observed during the September 2014 survey are shown in **Exhibit 4.65.**

Exhibit 4.63. Histogram showing Abundance of Epifaunal Species

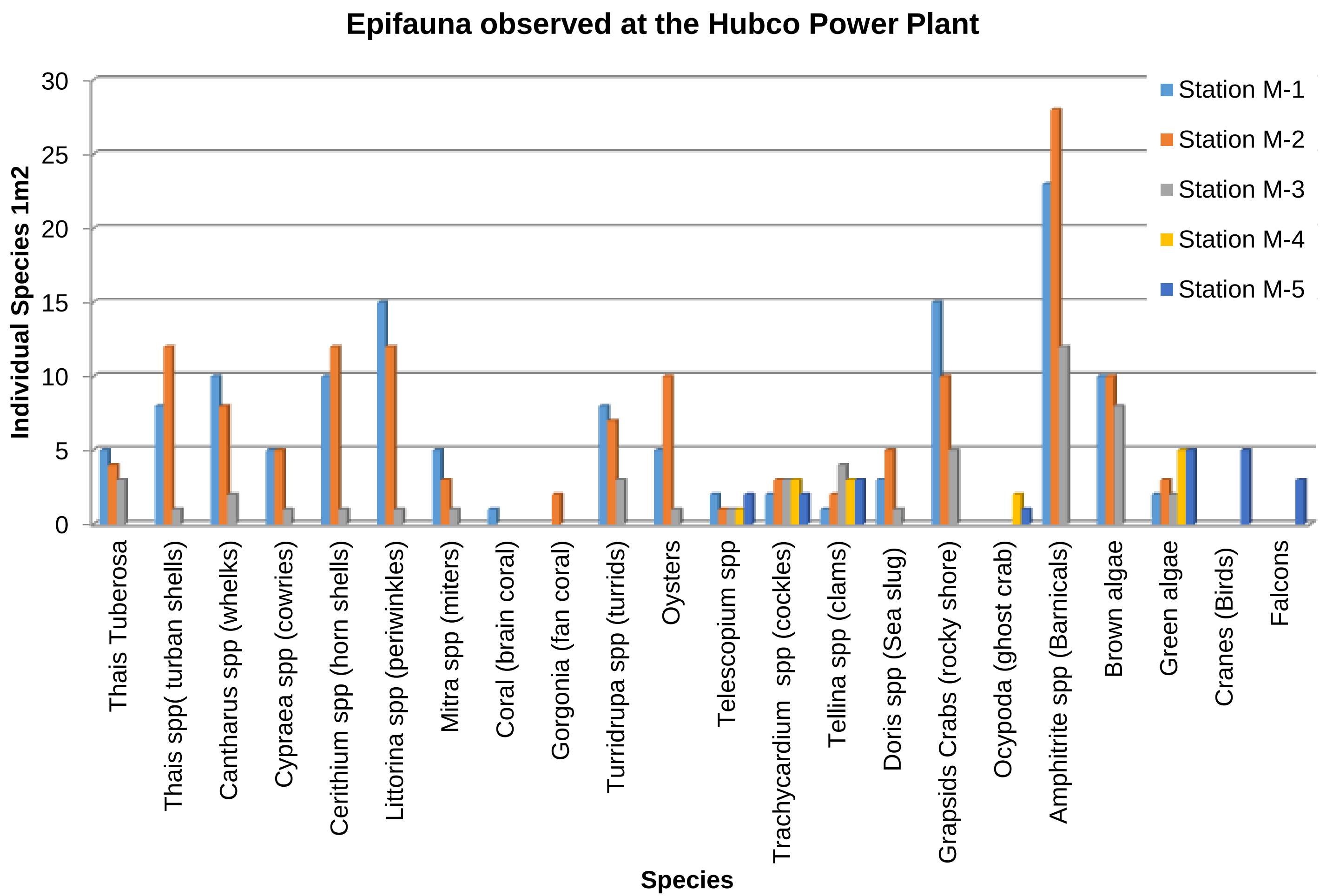


Exhibit 4.64: Distribution Pattern of the Epifaunal Communities Surveys Conducted September 2014

Species	*Variance*	*Mean*	*Chi-sq*	*d.f.*	*Distribution*
Thais Tuberosa	0.0221	0.1627	0.5423	4	Random
Thais spp(turban shells)	0.0221	0.1626	0.5426	4	Random
Cantharus spp (whelks)	0.0221	0.1627	0.5424	4	Random
Cypraea spp (cowries)	0.0221	0.1627	0.5425	4	Random
Cerithium spp (horn shells)	0.0221	0.1626	0.5426	4	Random
Littorina spp (periwinkles)	0.0221	0.1626	0.5426	4	Random
Mitra spp (miters)	0.0221	0.1627	0.5425	4	Random
Coral spp	0.0324	0.0805	1.6104	4	Random
Gorgonia (fan coral)	0.0324	0.0805	1.6104	4	Random
Turridrupa spp (turrids)	0.0221	0.1627	0.5423	4	Random
Oysters	0.0221	0.1627	0.5425	4	Random
Telescopium spp	0	0.2093	0.0002	4	Aggregate
Trachycardium spp (cockles)	0	0.2093	0	4	Aggregate
Tellina spp (clams)	0	0.2092	0.0004	4	Aggregate
Doris (Sea slug)	0.0221	0.1627	0.5425	4	Random
Graphide Crabs (rocky shore)	0.0221	0.1627	0.5423	4	Random
Ocypoda (ghost crab)	0.0309	0.1285	0.9635	4	Random
Amphitrite spp (Barnacles)	0.0221	0.1627	0.5423	4	Random
Brown algae	0.0221	0.1627	0.5423	4	Random
Green algae	0	0.2093	0.0001	4	Aggregate

Note:

Variance: Measure of how far a set of numbers is spread out

Mean: Average of numbers

Chi-sq: The chi-squared distribution (also chi-square or χ^2-distribution) with *k* degrees of freedom is the distribution of a sum of the squares of *k* independent standard normal random variables.

d.f: Degree of Freedom

Exhibit 4.65: Photographs of Epifaunal Invertebrate Communities Observed Surveys Conducted September 2014

Thais spp

Thais spp (turban shells)

Cerithium spp (horn shells)

Cypraea spp (cowries)

Amphitrite spp (Barnacles)

Acorn Barnicles spp

Graphide spp (Shore crab)

Ocypoda (ghost crab)

Gorgonia (fan coral) & Coral Spp

Oyster Pinna spp (fan oyster)

Green Algae

Brown Algae

Doris spp (Sea slug)

Doris spp (Ventral side)

Shannon-Weiner Species Diversity

Species Diversity includes both species richness (number of epifaunal species) and evenness (relative abundance of the different faunal species). Communities with a large number of species that are evenly distributed are the most diverse and communities with few species that are represented by one species and fewer individuals are the least diverse. H is maximized when all species have the same number of species. The Shannon Weiner Biodiversity Index observed for epifaunal species during the September 2014 survey is shown **Exhibit 4.66.** The H max biodiversity values for the faunal species ranged from 1.25 at Sampling Points M-1, M-2, and M-3, to 0.691-0.826 at Sampling Points M-4 and M-5. Diversity ranged from 0.1 to 3. The Evenness Value J' was high and ranged from 0.99 to 0.977 (J values are an index ratio and range from 0-1).

Exhibit 4.66: Shannon Weiner Biodiversity Index for Epifaunal Invertebrate Species Surveys conducted September 2014

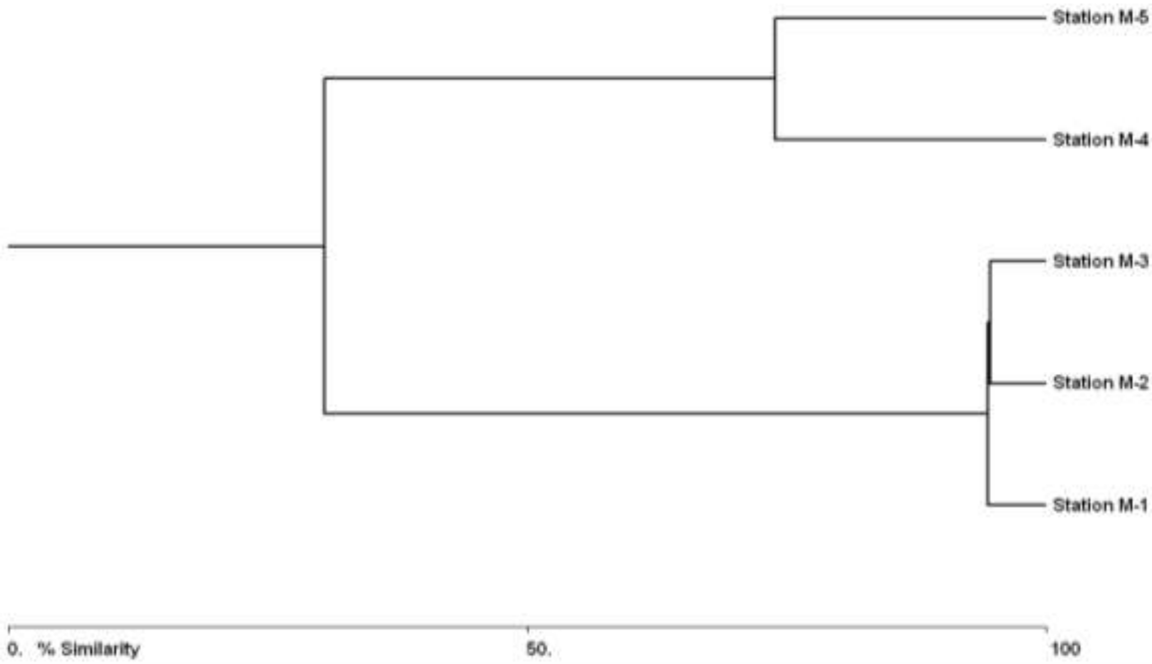
Index	*Sampling Locations*				
	M-1	*M-2*	*M-3*	*M-4*	*M-5*
Shannon H' Log Base 10.	1.25	1.25	1.228	0.691	0.826
Shannon Hmax Log Base 10.	1.255	1.255	1.23	0.699	0.845
Shannon J'	0.996	0.996	0.998	0.989	0.977

Cluster Analysis

In ecology and biology, the Bray–Curtis dissimilarity, named after J. Roger Bray and John T. Curtis, is a statistic used to quantify the compositional dissimilarity between two different sites, based on counts at each site. It is used for classifying information from a large set of data into manageable meaningful groups. It involves grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). The Bray–Curtis dissimilarity is bound between 0 and 1, where 1 means the two sites have the same composition (that is they share all the species), and 0 means the two sites do not share any species.

The epifaunal data collected from different sampling locations in the Study Area was analyzed statistically using Bray and Curtis Cluster Analysis to assess similarities in the epifauna at the different sampling locations during the September 2014 survey. This is given in the form of a dendrogram (**Exhibit 4.67**). Sampling Points M-1, M-2 & M-3 showed similarity in the epifaunal communities and were grouped together while Sampling Points M-4 & M-5 show similarities and were grouped together.

Exhibit 4.67: Bray and Curtis Cluster Analysis of Epifaunal Communities Survey Conducted September 2014



Conservation and Protection Status

None of the marine epifauna invertebrate species observed or reported from the Project site and vicinity are included in the IUCN Red List 2014[38].

Fish

Coastal and offshore areas of Baluchistan contain a wide variety of fish fauna. Fishing grounds for large pelagic species such as Tuna (Family Scombridae),, Mackerel (Family Scombridae), Sharks (Class Chondrichthyes) are located in the offshore waters and support the fishing industry of the province. Species such as Mullet (Order Mugiliformes), Silver whiting (Order Perciformes) and other small sized fishes, especially juveniles of large commercially important estuarine fish, are harvested from shallow waters in the coastal areas, small rivers as well as from enclosed and semi-enclosed bays throughout the coast line.

Fishing grounds of demersal fish (bottom living) and pelagic fish (surface dwellers) are located mostly in shallow waters. Sharks and some other species are fished in comparatively deeper waters. Important fishing grounds are located in shallower areas all along the coast where fishing is done with bottom set gill nets and submerged drift gill nets. These include Sonmiani, Astola Island, and the offshore areas of Hub River (**Exhibit 4.69**).

[38] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014

The fishing grounds along the Hub River, along the Hub coast (where Project site is located) and Churna Island (about 8 km from Project site) are the most heavily exploited. The competition for fish catch continues to increase and intensify resulting in the rapid depletion of fish resources, destruction of fish habitats and coastal ecosystems, as well as diminishing economic returns.

Large pelagic fisheries

One of the important fishing activities along the Hub coast (where Project site is located) is gillnetting for the large pelagic fish such as Tuna (Family Scombridae), Sailfish (Order Perciformes), Marlins (Order Perciformes), Mackerels (Family Scombridae), Seer fishes, and Sharks. Artisanal fishing boats called *'rachins* or *churpuk'* and some larger *`yakdars'* are employed for fishing. Sharks are also caught using drift gill nets throughout the year with a peak in May to September when their contribution to total catch may be as high as 75 per cent.

Small pelagic fisheries

The small pelagic fish consist mainly of Sardinella *Sardinella longiceps,* Thryssa *Thryssa spp,* Scad *Decapterus russelii* and Indian Mackerel *Rasteralger kanagurta.* These species are harvested with the help of cast nets along the coast of Hub and Churna Island.

Demersal fisheries

Demersal fish along the coast of Hub, Baluchistan coast are harvested with the help of bottom set gill nets, Small quantities of demersal fish are also caught with beach seine, and cast nets in shallow waters especially near the mouth of the Hub River. The catch generally consists of Mullets, Silver Whiting and juveniles of other commercially important species. The catch is mostly utilized for subsistence purposes. However a small quantity of catch from such gears is transported to inland population centers in wet salted form for commercial use.

During the September 2014 survey, the local fishermen interviewed reported that many fish species have disappeared from coastal waters. Some of these fish were of commercial importance and have been over-exploited, while others have suffered decline due to various environmental factors. The ‘Pallah’ fish (*Tenualosa ilisha*), for instance, is a popular food fish. It has a migratory behavior, which is triggered by the flow of fresh water from the inland rivers. With an increase in drought and associated decline in fresh water from the Hub river flow to the sea, the habitat for Pallah has been significantly altered, resulting in fast decline of this species in the inland coastal waters of Baluchistan.

Conservation and Protection Status

None of the fish species reported from the coastal waters near Project site are included in IUCN Red List 2014[39].

[39] Ibid

Corals

The reefs off the coast of Baluchistan have not yet been fully documented. However, corals have been observed around the island of Churna located about 8 km from the Project site. Other locations in Baluchistan where corals are present include the Astola Island (off Pasni) and Gwadar[40] (**Exhibit 4.69).** Coral reefs have not been observed in the coastal areas along the Hub coast or near the Project site and vicinity.

Corals provide habitat to a variety of marine flora and fauna. Some commercially important species including fish, prawns and crabs have been observed near coral reefs. Other marine species found in the vicinity of coral reefs include Sea Weeds, Sea Anemones (Order Actiniaria), Sea Urchins (Class Echinoidea), Gastorpods (Class Gastropoda), Oysters (Phylum Mollusca), turtles as well as demersal and pelagic fish species such as Catfish (Order Siluriformes), Mullets (Family Mugilidae), Croakers (Class Actinopterygii), Pomfret (Family Bramidae), Sardinella (Family Clupeidae) Tuna (Family Scombridae) etc.

The surveys conducted by Pakistan Wetlands Program in 2010[41] reported a recent increase in deep sea coral species including *Leptastrea pruinosa* (Spotted coral), *Favites flexuosa* (Stony coral) and H*ydnophora microconos*. This has been attributed to the slight increase in warm water currents, which bring more nutrition and offer optimum growth conditions. However any further increase in seawater temperature is most likely to have a detrimental impact on the coral population off the coast of Baluchistan.

Conservation and Protection Status

Among the coral species reported from the area Stony Coral *Favites flexuosa* and H*ydnophora microconos* are listed as Near Threatened in the IUCN Red List 2014[42]. Both these species as well as the Spotted Coral *Leptastrea pruinosa* are also included in Appendix II of the CITES Species List.[43]

Marine Mammals

Some species of dolphins, porpoises, and whales have been reported from the Arabian Sea off the coast of Baluchistan. However there is insufficient information regarding their abundance and distribution in this region.

The marine mammals reported to be found off the coast of Baluchistan include Finless Porpoise *Neophocaena phocaenoides*, Indo-Pacific Hump-Backed Dolphin *Sousa chinensis*, Bottlenose Dolphin *Tursiops aduncus*, Spinner Dolphin *Stenella longirostris*, Striped Dolphin *Stenella coeruleoalba*, Common Dolphin Delphinus delphis, Melon-Headed Whale *Peponocephala electra*, Dwarf Sperm Whale, Bryde’s Whale *Balaenoptera edeni*, and Humpback Whale *Megaptera novaeangliae* (Roberts T. J.

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[40] Reefs off the coast of Gwadar Bay, 2011, Pakistan Wetlands Programme.

[41] Ibid

[42] The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 30 September 2014

[43] UNEP-WCMC. 30 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

1997)[44]. Most of the information reported about the presence of marine mammals is based on sightings by fishermen or stranding data.

Marine mammals prefer the deep waters of the ocean and are very rarely seen in the shallow waters of coastal areas. No marine mammals were observed during the September 2014 survey.

Conservation and Protection Status

Among the marine mammals reported from the area, Indo-Pacific Hump-Backed Dolphin *Sousa chinensis* and Finless Porpoise *Neophocaena phocaenoides* are listed as Near Threatened and Vulnerable in the IUCN Red List respectively[45]. Both of the species are included in the Appendix I of the CITES Species List[46]. Humpback Whale *Megaptera novaeangliae* is included in Appendix I of the CITES Species List while Bottlenose Dolphin *Tursiops aduncus*, Spinner Dolphin *Stenella longirostris*, Striped Dolphin *Stenella coeruleoalba*, Common Dolphin *Delphinus delphis*, Melon-Headed Whale *Peponocephala electra*, Dwarf Sperm Whale *Kogia sima* and Bryde's Whale *Balaenoptera edeni* are all included in the Appendix II of the CITES Species List[47].

Marine Turtles

Two turtle species have been reported from the marine waters off the coast of Sindh and Baluchistan. The Olive Ridley Turtle *Lepidochelys olivalea* and Green Turtle *Chelonia mydas* visit the sandy beaches of Sindh and Baluchistan for breeding and nesting. Olive Ridley Turtle *Lepidochelys olivalea* is listed as Vulnerable in the IUCN Red List[48] and included in Appendix I of the CITES Species List[49] while the Green Turtle *Chelonia mydas* is listed as Endangered in the IUCN Red List 2014, and included in the Appendix I of the CITES Species List.

Literature sources report turtle nesting at Sandspit, Hawks Bay, Jiwani (Daran), Haft Talar (Astola Island), Ganz, Ormara and the Sonmiani. Extensive nesting is also recorded on the beach at the foot of the Kamgar Hills on the eastern side of Ormara West Bay, with sparse nests along the northern margin of the same bay. There are small sandy coves and inlets at eight kilometers beyond Hawks Bay where green turtles are occasionally found (Firdous 1988).[50]

Marine turtles spend, almost their entire life cycle at sea in areas where they prey upon slow drifting marine organisms, such as jelly fish or dead benthic animals. They also feed on seaweed and algae. Due to their food and respiration requirements, marine turtles usually remain in shallow coastal waters. Turtles nest on beaches and mate in inshore coastal water near their nesting places. Nesting and hatching of green turtles takes place

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44 Roberts, T.J., The Mammals of Pakistan, 1997, Oxford University Press

45 The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 30 September 2014

46 UNEP-WCMC. 30 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

47 Ibid

48 IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014

49 UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

50 Fehmida Firdous, 1988. Conservation of Turtles at Hawkes Bay and Sandspit Beaches, Karachi

throughout the year, with peak season being the post monsoon (September to December).[51]

Both the Olive Ridley Turtle *Lepidochelys olivalea* and Green Turtle *Chelonia mydas* are found in the marine waters near the Project site. However, they do not use the beaches near the Project site for nesting and according to information provided by the locals, are very rarely seen in the Project site and vicinity. A dead Olive Ridley Turtle *Lepidochelys olivalea* was observed by the survey team during the September 2014 survey near Sampling Point M-4 (observed at 24°54'14.01"N 66°41'19.55"E) (**Exhibit 4.68**).

In addition to turtles, 14 species of sea snakes have been recorded from Pakistan coast. These species are mostly present in tidal creeks, rocky coast and sandy beaches.

Exhibit 4.68. Dead Specimen of Olive Ridley Survey conducted September 2014

Olive Ridley Turtle Lepidochelys olivalea

[51] Ibid

Exhibit 4.69: Marine Ecologically Sensitive Locations

Mangroves

In Baluchistan, mangroves have been reported from the areas of Sonmiani Bay, Kalmat, Miani Hor, Jiwani and Gwadar Bay in Baluchistan (Qureshi., 2005)[52] (**Exhibit 4.69).** Beside their ecological importance, mangroves play a significant role in the lives of coastal communities. People who live along the coast utilize this resource for fuel, construction of houses and fodder. Mangroves have a great economic and ecological significance. They provide habitat for a diverse community of organisms ranging from bacteria and fungi to fish, shrimps, birds, reptiles and mammals (WWF, 2005)[53]. They also provide important products and services for the livelihood of coastal communities.

No mangrove species were observed in the Project site and vicinity during the September 2014 survey

4.3.2 Terrestrial Ecology

A two day ecological field survey was carried out on 12th and 13th of September, 2014 (September 2014 survey). The objective of this study was to establish ecological baseline information on the terrestrial flora and fauna in the Study Area during the Monsoon season (mid-July – mid-September).

Study Area

The Study Area for sampling the ecological resources consists of the entire area owned by HUBCO including the proposed Coal Power Plant and the proposed Ash Disposal sites.

Scope

The specific tasks covered under this ecological baseline study include:

- A review of the available literature on the biodiversity of the Study Area.
- Field surveys including:
  - Qualitative and quantitative assessment of flora, mammals, reptiles and birds
  - Identification of key species, their population and their conservation status in the country and worldwide.
  - Reports of wildlife sightings in the Study Area by the resident communities.
- Analysis was also carried out to further develop the basis for evaluating the potential impacts of Project related activities on the biodiversity, specifically seeking any potential critical habitat and ecosystem services in the Study Area.

Methodology and Sampling Plan

The methodology for the ecological surveys has been compiled to meet the requirements of the ESIA for the Project and provides a means to obtain objective data, and to determine the baseline conditions for assessment of the resulting impacts of the Project.

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[52] Qureshi, M.T. (2005) Mangroves of Pakistan: Status and Management. IUCN, Pakistan.

[53] WWF (2005).Sonmiani Village Development Plan. World Wide Fund for Nature and Commission of the European Union.

A total of seven sampling points were selected for terrestrial sampling of vegetation, mammals, reptiles and birds. Two of the sampling points E-1 and E-2 were located at the proposed Ash Pond sites, while E-6 was located at potential Land Fill Plot for Ash. Sampling Point E-2 and E-3 were located at the proposed water intake and water outfall channels while Sampling Point E-5 was located at the Coal Yard. A map showing the sampling locations is given in **Exhibit 4.70.** The location and coordinates of sampling points and field data collected during the survey is included in **Appendix F -** Ecology Field Data.

Details on survey techniques and data collection are provided below.

The conservation status of the species identified were determined using criteria set by the IUCN Red List of Threatened Species (IUCN Red List, 2014)[54] and the Convention on International Trade in Endangered Species (CITES) appendices[55]. The status of mammals in the Pakistan's Mammals National Red List 2006[56] was also noted.

The presence of critical habitat was determined in accordance with IFC Performance Standards definitions[57].

Vegetation

The area was sampled by the quadrat method, taking 3 quadrates of 10m x 10m at each sampling site. Abundant vegetation species observed in the quadrats were noted. Cover, relative cover, density, relative density, frequency, relative frequency percentages, and Importance Value Index (IVI) for each species was calculated by using appropriate formulae. Plants collected were identified following the nomenclature from Flora of Pakistan (Nasir and Ali 1972-1994[58], Ali and Qaiser, 1995-to date[59]).

Mammals

Line Transects of 200m by 20m were placed at each sampling location to record the sightings and signs of mammal species (foot marks, droppings, dens, pug marks). Transects were started as early as possible in the day and covered all possible habitat types in order to avoid bias of stratification. GPS co-ordinates for all those locations were noted. The specimens were identified with the help of the most recent key available in the literature (Roberts 1997)[60].

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[54] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014.

[55] UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species.

[56] Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan. This list is not officially recognized by the Government of Pakistan and is referenced in this report to provide an indication of species that may be assigned a conservation status subject to further research, and evaluation by the Government of Pakistan.

[57] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

[58] S. I. and Nasir. 1972-1994. Flora of Pakistan Fascicles. Islamabad

[59] Ali, S. I. and Qaiser, M. 1995 to date. Flora of Pakistan Fascicles. Karachi

[60] Roberts, T.J. 1997. The Mammals of Pakistan. Oxford University Press Karachi. 525 pp

In addition, incidental sightings of all mammals were recorded and number of individuals, location and habitat type were recorded for each sighting. Anecdotal information regarding incidental sightings of specific mammals were also collected by consulting local people and relevant literature was consulted.

Reptiles

Line transects of 200 m by 20m were placed at each sampling location and reptiles were surveyed by active searching during the day. In addition to the sightings of individuals, any signs of their presence (burrows, tracks etc.) were also recorded. The coordinates and elevations were recorded using GPS, and other features of interest like habitat type were documented. The specimens were identified with the help of the most recent keys available in literature (Khan, 2006)[61].

Birds

Line transects of 200 m by 20 were placed at each sampling location to record all birds observed. Transects were started as early as possible in the morning and in late afternoon. The coordinates of the starting point were recorded. The birds were identified using the most recent keys available in literature (Grimmett 2008)[62].

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61 Muhammad Sharif Khan. 2006. *Amphibians and Reptiles of Pakistan*. Krieger Publishing Company, Malabar, Florida, pp. 311.

62 Grimmett, R., Roberts, T., and Inskipp, T. 2008. *Birds of Pakistan*, Yale University Press.

Exhibit 4.70: Terrestrial Ecology Sampling Locations

Vegetation

There are four phytogeographical regions in Pakistan. The Study Area falls into the Saharo-Sindian region. This region is considered poor in vegetative diversity; despite its large size, only 9.1% of the known 5,738 floral species of Pakistan are found in this region (Rafiq and Nasir 1995)[63].

Major tree species found in Lasbella District include Pelu (*Salvadora oleoides*), Kandi (*Prosopis cineraria*), Ber (*Zizyphus nummularia*), Date Palm (*Phoenix dactylifera*), Gaz (*Tamarix sp*.), Kikar (*Acacia jacquemontii*), and II (*Cadaba ferinosa*). The mangrove species are *Avicenia marina*, *Rhizophora mucronata* and *Ceriops I*. Main shrubs are *Euphorbia I, Haloxylon sp*., *Calligonum polygonoides,* Gugul (*Commiphora mukal*), Merin (*Heliotropium sp*.), Gujo (*Aerva javanica*), Aak (*Callotropis procera*), and Mazri (*Nannorrhops ritchieana*). The ground is covered with grasses like *Eliosine sp*., *Lasiurus sp*., *Chrysopogon sp*., Aristidasp and *Cymbopogon sp.*[64]

Based on geomorphology and soil characteristics, Plains is the predominant habitat constituting 95 % of the habitats in the Study Area (including 4% of the existing plant area). In addition, vegetation clusters (micro-habitat) are present at certain locations. Photographs of the habitats observed in the Study Area are provided in **Exhibit 4.71.**

Field Survey Results

During the September 2014 survey, the vegetation and floral diversity observed in the Plains was relatively sparse and vegetation was degraded. The species diversity observed was 2.25 species per sampling point **(Exhibit 4.72).** The dominant plant species observed in this habitat as reflected by the Importance Value Index are *Zygophylum simplex* 51.91, *Blapharis scindicus* 6.87, *Ochthochloa compressa* 21.82, *Asparagus sp*. 5.83 and *Calotropis procera* 4.16 (**Exhibit 4.73**).

Some vegetation clusters were observed in depressions in the Plains and were labeled as a micro-habitat. In this micro-habitat, the vegetation cover was comparatively higher. The natural vegetation in the area has mostly been replaced by mesquite vegetation (exotic plant species). However, some natural vegetation in the form of herbs and grasses were also observed. The range of vegetation cover in this habitat was from 0.01% to 3.45%. The species diversity of this habitat was 2.0 species per sampling point (**Exhibit 4.72).** The dominant plant species in this habitat as reflected by the Importance Value Index were *Prosopis juliflora* 42.26, *Ochthochloa compressa 31.98* and *Tamarix dioica* 9.99 **(Exhibit 4.73).**

Conservation and Protection Status

No threatened or endemic plant species were observed in the Study Area during the survey nor reported from the literature survey.

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63 Rafiq, Rubina A., and Nasir, Yasin J. 1995. Wild Flowers of Pakistan, Oxford University Press.

64 District Development Profile Lasbella, 2011, Planning & Development Department, Government of Baluchistan, Quetta in collaboration with United Nations Children's Fund Provincial Office Baluchistan, Quetta.

Determination: No threatened or endemic plant species are present in the Study Area. None of the plant species observed were endemic, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Exhibit 4.71: Photographs of Habitats in the Study Area

a. Plains North of Power Plant

b. Plains South of Power Plant

c. Vegetation Cluster in Plains

d. Vegetation Cluster in Plains

Exhibit 4.72: Vegetation Cover, Species Count and Species Diversity by Habitat Types

Habitats	*Vegetation Cover*			*Plant Count*			*Species Diversity*
	Average	*Maximum*	*Minimum*	*Average*	*Maximum*	*Minimum*	
Plains	0.77%	2.16%	0.01%	73	122	21	2.25
Plains (Vegetation Cluster)	2.43%	3.45%	0.01%	43	94	4	2.00

Exhibit 4.73: Phytosociological Attributes of Plant Communities in Habitats

Habitat	*Scientific Names*	*D1*	*D3*	*C3*	*F1*	*F3*	*IVI*
Plains	*Asparagus sp.*	*1.58*	*6.51*	*0.63*	*0.25*	*10.34*	*5.83*
	Blapharis scindicus	*4.17*	*17.12*	*0.05*	*0.08*	*3.45*	*6.87*
	Calotropis procera	*0.08*	*0.34*	*8.68*	*0.08*	*3.45*	*4.16*
	Commiphora wightii	*0.17*	*0.68*	*1.69*	*0.17*	*6.90*	*3.09*
	Fagonia indica	*1.50*	*6.16*	*0.35*	*0.08*	*3.45*	*3.32*
	Heliotropium sp.	*0.08*	*0.34*	*0.13*	*0.08*	*3.45*	*1.31*
	Ochthochloa compressa	*9.67*	*39.73*	*1.59*	*0.58*	*24.14*	*21.82*
	Prosopis juliflora	*0.08*	*0.34*	*1.28*	*0.08*	*3.45*	*1.69*
	Zygophylum simplex	*7.00*	*28.77*	*85.60*	*1.00*	*41.38*	*51.91*
Plains (Vegetation Cluster)	*Heliotropium sp.*	*0.23*	*2.34*	*0.17*	*0.08*	*7.69*	*3.40*
	Indegofera oblongifolia	*1.00*	*10.16*	*7.19*	*0.08*	*7.69*	*8.35*
	Ochthochloa compressa	*7.15*	*72.66*	*0.20*	*0.23*	*23.08*	*31.98*
	Prosopis juliflora	*0.85*	*8.59*	*79.73*	*0.38*	*38.46*	*42.26*
	Tamarix dioica	*0.23*	*2.34*	*12.23*	*0.15*	*15.38*	*9.99*
	Zygophylum simplex	*0.38*	*3.91*	*0.48*	*0.08*	*7.69*	*4.02*

D1: Density
The number of individual of a species counted on a unit area.

D3: Relative density
The proportion of a density of a species to that of a stand as a whole.

C3: Relative cover
The proportion of the total frequency of a species to sum of the frequency of all the species in area.

F1: Frequency
Percentage of sampling plots in which a given species occurs.

F3: Relative frequency
The proportion of the total of a species to the sum of the cover of all the plants of all species in the area.

IVI: Importance value index
It can be obtained by adding the values of relative density, relative cover and relative frequency and dividing it by three will give the importance value IVI of the species

Mammals

A total of 90 mammalian species have been reported from Baluchistan belonging to nine orders and twenty seven families. A total of twenty four mammalian species belonging to 5 orders and 10 families have been reported from the Hub Dam located about 55 km away from our Study Area[65]. Common mammal species reported from District Lasbella include Caracal *Felis caracal*, Honey Badger *Mellivora capensis*, Chinkara *Gazella bennettii*, Ibex *Capra aegagrus*, Urial *Ovis vignei cycloceros*, Wolf *Canis lupus*, Bengal

[65] Abeda Begum et.al 2013 Current Status of Mammals and Reptiles at Hub Dam Area, Sindh/Baluchistan, Pakistan, Current World Environment, Vol. 8(3), 395-402

Fox *Vulpes bengalensis*, Asiatic Jackal *Canis aureus*, Stripped Hyaena *Hyaena hyaena*, Cape Hare *Lepus capensis* and Porcupine *Hystrix indica*.[66]

Field survey results

No mammals were sighted during the September 2014 survey. However, a total of 17 signs belonging to four (4) species were seen. These included signs of the Asiatic Jackal *Canis aureus,* Indian Crested Porcupine *Hystrix indica*, Cape Hare *Lapus capensis* and signs of a fox species *Vulpes sp*. that could not be identified on the basis of signs alone. The maximum number of signs observed belonged to Cape Hare *Lapus capensis* and Asiatic Jackal *Canis aureus*. The maximum abundance and diversity was observed at Sampling Point E-7. A small mammal species Baluchistan Gabril *Gerbillus nanus* was sighted at Sampling Point E-7. According to information provided by locals, Wild Boars *Sus scrofa* are often seen in the Study Area and surroundings.

Conservation and Protection Status

Among mammals reported from Study Area, Ibex *Capra aegagrus*, Urial *Ovis vignei cycloceros* are listed as Vulnerable while Stripped Hyaena *Hyaena hyaena* is listed as Near Threatened in the IUCN Red List 2014. [67] None of these species were observed during the September 2014 survey. The Asiatic Jackal *Canis aureus* and Bengal Fox *Vulpes bengalensis* are included in Appendix III of the CITES Species List[68] and listed as Near Threatened in Pakistan’s Mammals National Red List 2006[69]. The signs of Asiatic Jackal were observed at Sampling Points E-4, E-1, E-6 and E-7 during September 2014 survey while signs of a fox species were observed at Sampling Points E-4, E-6, E-7 and E-5. Indian Crested Porcupine *Hystrix indica* is listed as Near Threatened in Pakistan’s Mammals National Red List 2006. Signs of this species were seen in the Study Area at Sampling Points E-3, E-5 and E-7 (**Exhibit 4.74)**

Determination:

No Endangered or Critically Endangered mammal (in IUCN Red List 2014)[70] has been reported or observed in the Study Area. Even though some mammals are included in the IUCN Red List, Pakistan’s Mammals National Red List 2006[71] and CITES Species List[72], none of the mammal species is endemic, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

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[66] District Development Profile Lasbella, 2011, Planning & Development Department, Government of Baluchistan, Quetta in collaboration with United Nations Children’s Fund Provincial Office Baluchistan, Quetta.

[67] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. ‘www.iucnredlist.org’. Downloaded on 16 September 2014.

[68] UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

[69] Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

[70] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. ‘www.iucnredlist.org’. Downloaded on 16 September 2014

[71] Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

[72] UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

Exhibit 4.74: Photographs of Mammal Signs in Study Area
Surveys Conducted September 2014

a. Scats of Asiatic Jackal

b. Droppings of Cape Hare

c. Porcupine Needle

d. Footprint of Fox

Reptiles

A total of 37 species of lizards, 35 species of snakes, 1 species of crocodile and 2 species of Chelonia have been reported from Baluchistan.[73] Common reptile species of the Lasbela District include Marsh Crocodiles *Crocodylus palustris*, Spiny tail Lizard *Saara hardwickii*, Black Rock Agama *Laudakia melanura*, Brilliant Ground Agama *Trapelus agilis* and Monitor Lizard *Varanus varius.* Among snakes, the Common Krait *Bungarus caeruleus*, Common Cobra *Naja naja* Brown or Oxus Cobra *Naja oxiana* and Vipers such as Saw scaled Sand Viper (*Echis carinatus sochureki*) and Horned Viper (*Pseudo Cerastus Persicus*) have been reported from the district. Occasional sightings of Green Turtle *Chelonia mydas* and Olive Ridley Turtles *Lepidochelys olivacea* have been reported from the coastal areas. [74]Some common reported reptile species of the Study Area are shown in **Exhibit 4.75.**

[73] Muhammad Ali *et.al* 2012, HERPETOFAUNA IN THE PROVINCE OF BALOCHISTAN, PAKISTAN, Sci.Int.(Lahore),24(1),59-62

[74] District Development Profile Lasbella, 2011, Planning & Development Department, Government of Baluchistan, Quetta in collaboration with United Nations Children’s Fund Provincial Office Baluchistan, Quetta.

Field survey results

A total of 8 reptile individuals belonging to two species were sighted in the Study Area during the field survey. These were the Blue Tail Lizard *Acanthodactylus cantoris* and Sand Swimmer *Ophiomorus raithmai*. Blue Tail Lizard was seen at Sampling Point E-1, E-2, E-3, E-7 and E-5 during the September 2014 survey while Sand Swimmer *Ophiomorus raithmai* was sighted at Sampling Point E-5. In addition, burrows of the Spiny-tailed Ground Lizard *Saara hardwicki* were observed at Sampling Point E-1, E-2, E-7 and E-5. High reptile abundance was observed at Sampling Point E-2 where a Blue Tail Lizard *Acanthodactylus cantoris* was observed and seven burrows of Spiny-tailed ground Lizard *Saara hardwicki* were seen. A dead turtle, Olive Ridley Turtles *Lepidochelys olivacea* was found on the shore near Sampling Point E-7.

Conservation and Protection Status

Of the terrestrial reptiles, Spiny-tailed Ground Lizard *Saara hardwicki*, Monitor Lizard *Varanus varius*, Common Cobra *Naja naja* and Brown or Oxus Cobra *Naja oxiana* are included in the Appendix II of CITES Species List. The only reptile species of conservation importance observed in the Study Area during the September 2014 survey was the Spiny-tailed Ground Lizard *Saara hardwicki* that was not sighted but signs were observed at four sampling points.

Determination

Some reptilian species reported from the Study Area are included in the IUCN Red List[75] and CITES Species List[76], but none of them are endemic. Moreover, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Exhibit 4.75: Photographs of Reptile Species Reported from the Study Area

a. Spiny-tailed Ground Lizard *Saara hardwickii*

b. Saw-scaled viper *Echis carinatus sochureki*

[75] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014

[76] UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

c. Brilliant Ground Agama *Trapelus agilis*

d. Blue Tailed Lizard *Acanthodactylus cantoris*

Birds

Terrestrial bird species reported from District Lasbela include Common Babblers (Family Sylviidae), Larks (Family Alaudidae), Sand Grouses (Family Pteroclidae), Partridges (Family Phasianidae), Houbara Bustard (Family Otididae), Shrikes (Family Laniidae), Buntings (Subfamily Emberizinae), Bee- eaters (Family Meropidae), Hoopoes (Family Upupidae), Pigeons and Doves (Family Columbidae), White -eared Bulbuls (Family Pycnonotidae), Brown-headed Raven (Family Corvidae), Owls (Family Strigidae) , and birds of prey such as Eagles, Vultures, Hawks, Buzzards (Family Accipitridae), Falcons (Family Falconidae) etc. Common birds found along coast line are seagulls (Family Laridae), Terns (Family Laridae), Pelicans (Family Pelecanidae), Flamingos (Family Phoenicopteridae), Herons (Family Ardeidae), Egrets (Family Ardeidae), Plovers (Family Charadriidae), Lapwings (Family Charadriidae), Stints (Family Scolopacidae), Sandpipers (Family Scolopacidae), Godwits (Family Scolopacidae), Shanks (Family Scolopacidae), Coots (Family Rallidae), Curlews (Family Scolopacidae), King Fishers (Family Alcedinidae), Osprey (Fanily Accipitridae), etc.

Some of the resident bird species that are reported from the area include Black Kite *Milvus migrans*, Bay-backed Shrike *Lanius vittatus*, Common Wood Shrike *Tephrodornis pondicerianus*, Indian Robin *Saxicoloides fulicatus*, and Common Myna *Eremopterix nigriceps*. The winter visitors include Macqueen’s Bustard *Chlamydotis macqueenii*, Common Hoopoe *Upupa epops*, Northern Shoveler *Spatula clypeata*, Common Teal *Anas crecca*, Gadwall *Mareca strepera*, Mallard *Anas platyrhynchos*, Common Coot *Fulica atra*, Spotted Sand Grouse *Pterocles senegallus*, Bar-tailed Godwit *Limosa lapponica*, Common Sandpiper *Actitis hypoleucos*, Green Sandpiper *Tringa ochropus*, Greater Sand plover *Charadrius leschenaultii*, Caspian Gull *Larus cachinnans*,, Eurasian Griffon *Gyps fulvus* and Cinereous Vulture *Aegypius monachus*.[77]

Field survey results

A total of 223 bird individuals belonging to twenty four (24) bird species were observed in the Study Area during the September 2014 survey. The most abundant species were the House Sparrow *Pycnonotus leucotis* with 30 individual observed, followed by Red-

[77] Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

Wetted Lapwing *Cercotrichas Galactotes*, Common Myna *Eremopterix nigriceps* and Black Drango *Alauda gulgula* with 25, 20 and 16 individuals observed respectively.

The highest bird abundance was seen at Sampling Point E-4 where 69 bird individual were observed. Common Myna *Eremopterix nigriceps* was the most abundant species at this sampling point with 12 individual observed. Maximum diversity was also seen at sampling Point E-4 where 13 bird species were observed during the September 2014 survey.

Conservation and Protection Status

Among the species reported from the Study Area, Macqueen's Bustard *Chlamydotis macqueenii* is listed as Vulnerable in the IUCN Red List 2014[78] and is also included in the Appendix I of CITES Species List[79]. Cinereous Vulture *Aegypius monachus* is listed as Near Threatened in the IUCN Red List 2014 and included in the Appendix II of the CITES Species List. These species were not seen in the Study Area during the September 2014 survey. Black Kite a resident bird species which is included in the Appendix II of CITES Species List and was observed at Sampling Point E-3, E-1, E-7 and E-4 during the September 2014 survey.

Determination

A few bird species reported from the Study Area are included in the IUCN Red List[80] and CITES Species List[81]. However, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Importance of Study Area for Migratory Birds

Pakistan gets a large number of guest birds from Europe, Central Asian States and India every year. These birds that originally reside in the northern states spend winters in various wetlands and deserts of Pakistan from the high Himalayas to coastal mangroves and mud flats in the Indus delta. After the winter season, they go back to their native habitats.

This famous route from Siberia to various destinations in Pakistan over Karakorum, Hindu Kush, and Suleiman Ranges along Indus River down to the delta is known as International Migratory Bird Route Number 4. It is also called the Green Route or more commonly the Indus Flyway, one of the important migratory routes in the Central Asian - Indian Flyway[82] (**Exhibit 4.76**). The birds start on this route in November. February is the peak time and by March they start flying back home. These periods may vary depending upon weather conditions in Siberia and/or Pakistan. As per an estimate based

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78 IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014

79 UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

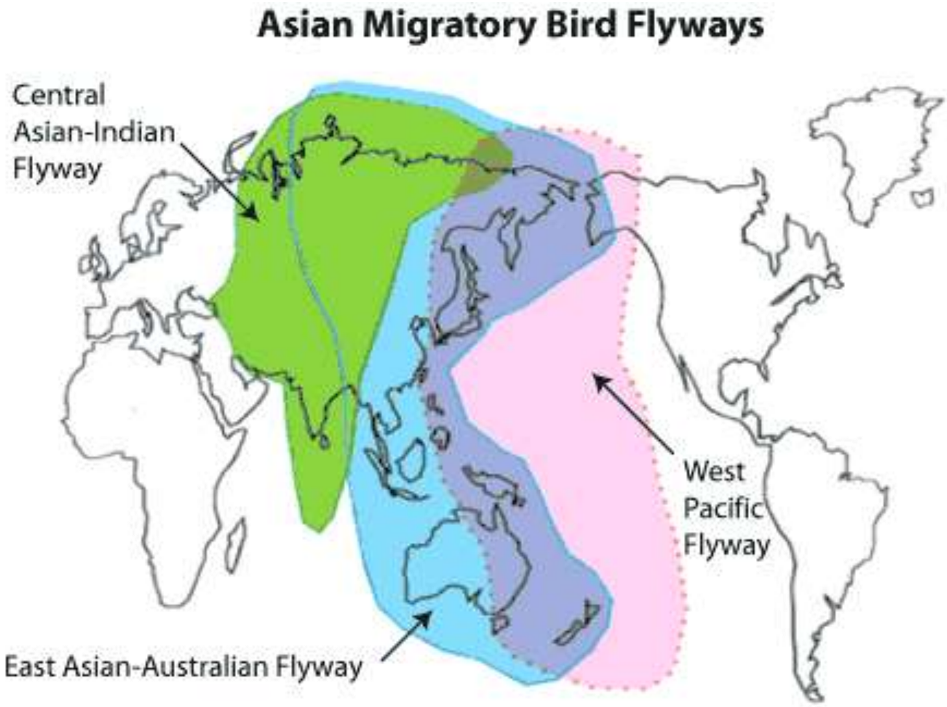
80 IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. 'www.iucnredlist.org'. Downloaded on 16 September 2014

81 UNEP-WCMC. 16 September 2014. UNEP-WCMC Species Database: CITES-Listed Species

82 Convention on the Conservation of Migratory Species. 1 February 2006. Central Asian Flyway Action Plan for the Conservation of Migratory Waterbirds and their Habitats. New Delhi, 10-12 June 2005: UNEP/CMS Secretariat.

on regular counts at different Pakistani wetlands, between 700,000 and 1,200,000 birds arrive in Pakistan through Indus Flyway every year.[83] Some of these birds stay in the lakes but majority migrate to coastal areas.

Exhibit 4.76: Asian Migratory Bird Flyways



Source: http://alaska.fws.gov/media/avian_influenza/ak-flyway2.gif U.S. Fish and Wildlife Service/Alaska] |Author=U.S. Fish and Wildlife Service |Date=2008

A number of migratory birds have been reported from the Study Area and its vicinity. According to the Baluchistan Conservation Strategy, the deserts of Lasbela, Hub River (**Exhibit 4.70**) and Hub Dam (located about 55 km from the Study Area) are important staging areas for migratory birds in Pakistan.[84] These include Macqueen’s Bustard *Chlamydotis macqueenii*, Houbara Bustard *Chlamydotis undulate,* Falcons (Family Falconidae) and Cranes (Family Gruidae). Other winter visitors to the Study Area include Northern Shoveler *Spatula clypeata*, Common Teal *Anas crecca*, Gadwall *Mareca strepera*, Mallard *Anas platyrhynchos*, Common Coot *Fulica atra*, Spotted Sand Grouse *Pterocles senegallus*, Bar-tailed Godwit *Limosa lapponica*, Common Sandpiper *Actitis hypoleucos*, Green Sandpiper *Tringa ochropus*, Greater Sand plover *Charadrius leschenaultii*, Caspian Gull *Larus cachinnans*, Eurasian Griffon *Gyps fulvus* and Cinereous Vulture *Aegypius monachus*.[85]

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83 Pakistan Wetlands Programme. 2012. Migratory Birds Census Report.

84 IUCN Pakistan and Government of Baluchistan (2000) The Baluchistan Conservation Strategy. Pakistan. 354 pp.

85 Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

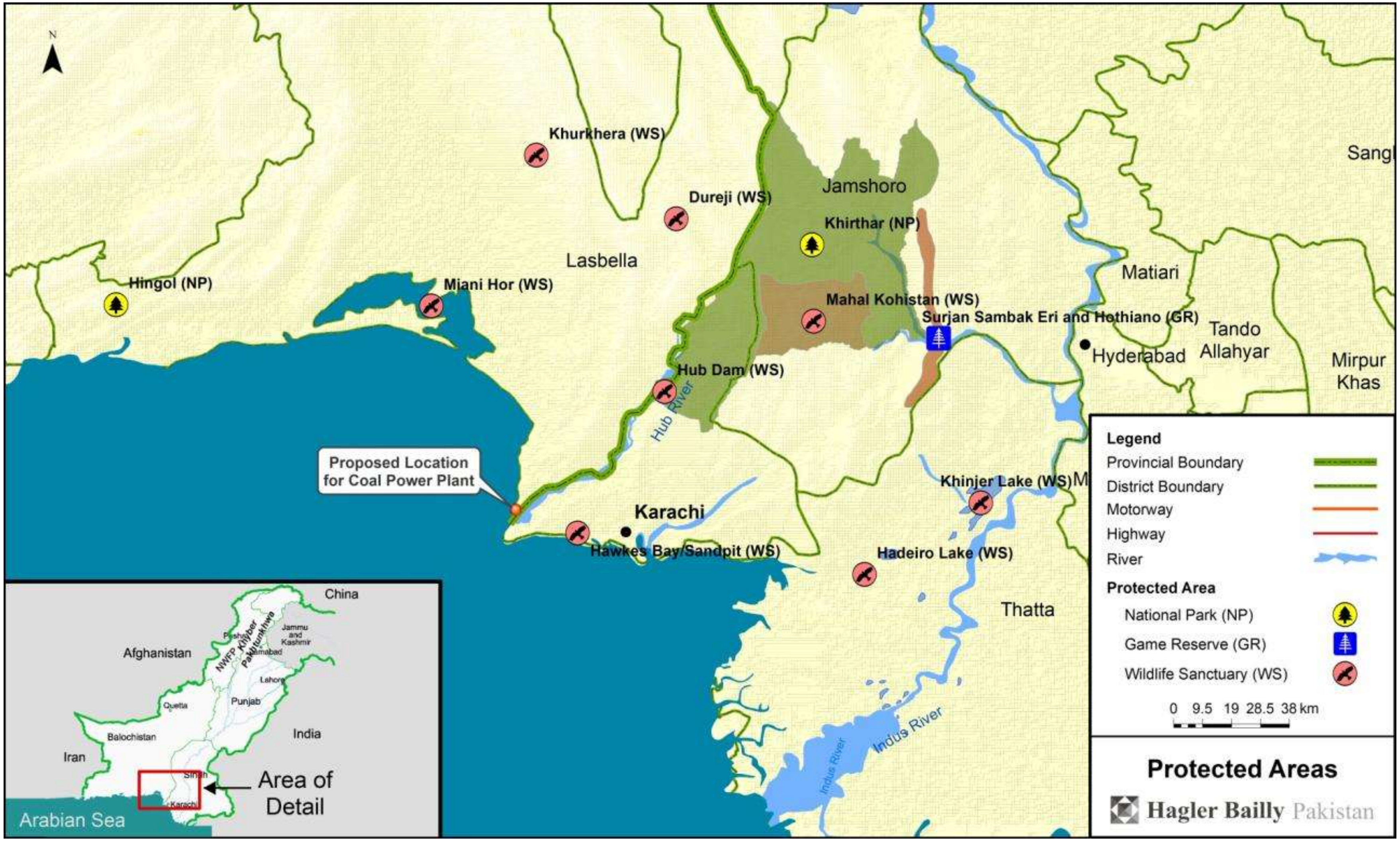
The Study Area is not declared as a protected wetland Ramsaar site.[86] It is also not part of a game sanctuary or game reserve. However, some migratory birds use the coastal areas and Hub River in the vicinity of the Study Area as a staging ground.

Protected Areas

The Protected Areas in the vicinity of the Study Area are shown in **Exhibit 4.77**. The Project site is not included in any protected area (Wildlife Sanctuary, National Park, Game Reserve etc.). The closest protected area is the Hawkes Bay/Sandspit Wildlife Sanctuary located about 20 km from the Study Area and the Hub Dam Wildlife Sanctuary located 55 km away.

[86] The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Exhibit 4.77: Protected Areas



Critical Habitat Assessment

Critical Habitat is designated by the International Finance Corporation (IFC) Performance Standards[87] and Asian Development Bank's SR1, SPS [88] as follows:

Critical habitat is described as having a high biodiversity value, as defined by:

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);[89]
- wetlands of international importance (according to the Ramsar Convention);[90]
- important bird areas (defined by Birdlife International);[91] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[92]

The Study Area does not meet the criteria of any of these determinations.

The following additional characteristics are used in the Critical Habitat Assessment.

Habitat of significant importance to Critically Endangered and/or Endangered species: The Green Turtle *Chelonia mydas* is listed as Endangered in the IUCN Red List 2014. It is a marine mammal found in the waters off the coast of the Study Area. However, these turtles do not use the beaches in the Study Area and vicinity for nesting and are rarely observed in the area. Thus the Study Area is not critical to the survival of this endangered marine reptile.

Habitat of significant importance to endemic and/or restricted-range species: The habitats found on Study Area are homogenous and widespread. They hold no significance for the survival of endemic or restricted range species; or

Habitat supporting globally significant concentrations of migratory species and/or congregatory species: Some migratory birds have been reported from the Study Area and vicinity. However, majority of these birds use the Hub River Wildlife Sanctuary, located about 55 km away as a staging ground. Moreover, no mammal species depends on the area for its migration. No significant concentration of congregatory species is present in the Study Area.

Highly threatened and/or unique ecosystems: The ecosystems found in the Study Area are typically those found in coastal areas. There are no threatened or unique ecosystems in the Study Area.

Areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services. This situation is not present in the Study Area. While all species are functioning components of ecosystems, there are

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87 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

88 Asian Development Bank, ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment,

89 IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

90 Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

91 Birdlife International, UK

92 Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

no unique assemblages of species or association of key evolutionary processes in the Study Area; or

Areas having biodiversity of significant social, economic or cultural importance to local communities. Although the area is of importance to locals in terms of ecosystem services, it has no unique biodiversity value of social, economic or cultural importance to the community.

Determination: There is no critical habitat present on the Study Area.

4.4 Socioeconomic Environment

This section provides a description of the existing socioeconomic conditions around the site of the proposed Project. A socioeconomic study area was defined and consequently surveyed to collect baseline socioeconomic data with a particular focus on those aspects which may be affected by Project activities.

The primary socioeconomic data collected included information on the following:

- Occupational Profile of the surveyed settlements,
- Ethnic groups residing in the village,
- Status of health and education,
- Health and education infrastructure,
- Existing infrastructure including roads, telephone, post offices, police stations and connectivity to the black top roads,
- Cropping pattern,
- Migration pattern, and
- Socio-cultural characteristics.

4.4.1 Socioeconomic Study Area

The spread of the Socioeconomic Study Area was based on the locations of the settlements around the proposed Project located on both sides of the Hub River. The river acts as a boundary between the provinces of Balochistan and Sindh. The settlements extend up to Goth Saeen Haji Ibrahim in Balochistan, located 20 km north of the proposed Project; and, Goth Mubarak in Sindh, 7.5 km south of the proposed Project. The Socioeconomic Study Area is shown in **Exhibit 4.78**.

In terms of administrative boundaries, the settlements within the Socioeconomic Study Area located north of the Hub River fall under the *tehsils*[93] Gadani and Hub in District Lasbela, in Balochistan. The settlements located south of the Hub River fall under District Karachi South, in Sindh. **Exhibit 4.79** illustrates the administrative boundaries around the Socioeconomic Study Area.

There are two major industries located in the Socioeconomic Study Area: HUBCO Power Plant and Byco Oil Pakistan’s oil refinery. Churna Island, located, approximately, 6 km west of the Mubarak Village, is the only major tourist attraction in the Socioeconomic Study Area and is well-known for attracting deep-sea-divers.

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[93] A tehsil, also known as Taluka (or taluq/taluk) or mandal, is an administrative division of Pakistan. It is an area of land with a city or town that serves as its headquarters, with possible additional towns, and usually a number of villages (http://en.wikipedia.org/wiki/Tehsil) accessed on September 19, 2014.

Exhibit 4.78: Socioeconomic Study Area

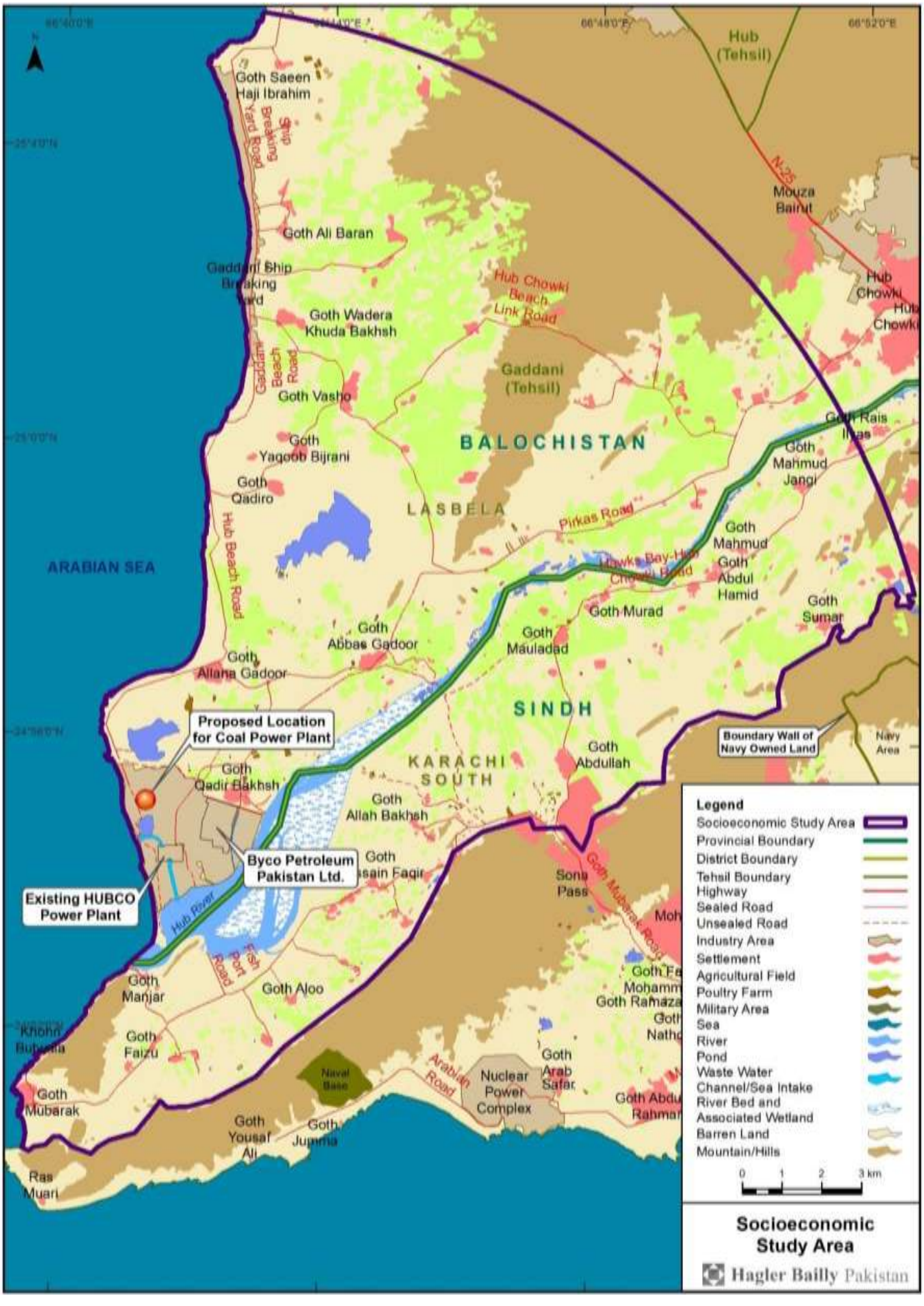

Exhibit 4.79: Administrative Boundaries around the Socioeconomic Study Area

District Lasbela, Baluchistan

Area-wise, District Lasbela is the seventh largest district of Baluchistan and has an area of 15,153 square kilometres (km^2). It is located at the southern-eastern edge of Baluchistan and shares its boundary with the Province of Sindh. The name originates from '*Las'*, which means a plain and '*Bela'*, which means a jungle. The district is located south of Quetta City, the provincial capital of Baluchistan. Lasbela comprises of five *tehsils* and twenty two union councils. **Exhibit 4.80** provides the list of tehsils with their union councils.[94] The Socioeconomic Study Area falls within *tehsils* Gadani and Hub in District Lasbela.

Exhibit 4.80: Tehsil and Union Councils of District Lasbela

Tehsil	*Union Council*
Bela	Kathore, Welpat Janubi, Welpat Shumali, Bela, Gadore
Dureji	Dureji, Lohi
Gaddani	Gadani, Hubco
Hub	Kanraj, Allahabad, Sakran, Sonmiani, Winder, Baroot, Pathra
Uthal	Khenwari, Wayara, Lakhra, Sheh, Uthal, Liari

(Local Government, Baluchistan, 2005)

District Karachi South, Sindh

Karachi is the provincial capital of Sindh and is the largest city of Pakistan. In 1948, the Federal Capital Territory of Pakistan was created comprising, approximately, 2,103 km^2 (812 square miles) of Karachi and surrounding areas with a municipal corporation to provide basic services including water, transportation, health, education and policing services to the residents of the city.

This territory, however, lost its status as Federal Capital Territory in 1961 when the capital was shifted to Islamabad. The municipal corporation, however, remained in existence and in 1976 became a metropolitan corporation, followed by the creation of zonal municipal committees, which lasted until 1994. Two years later Karachi was divided into five districts, each with its own municipal corporation, with a common City District Government. The City Government had the same role as of the metropolitan corporation. [95]

In 2011, City District Government of Karachi was de-merged into five constituent districts namely Karachi West, Karachi East, Karachi Central, Karachi South and District Malir. These five districts form the Karachi Division now.[96]

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94 Planning and Development Department, Government of Baluchistan in collaboration with UNICEF *District Development Profile Lasbela* (Quetta, 2011)

95 Karachi Metropolitan Corporation, *About Karachi* http://www.kmc.gos.pk/ (accessed on September 8, 2014)

96 Ibid

On, November 5, 2013, after the issuance of a notification from the Sindh Board of Revenue for a new district, Karachi city is now divided into six districts.[97] The name of the districts along with the areas included in each district is provided in **Exhibit 4.81**.

Recently, the name of the two districts has been shuffled. District Karachi West has now changed to District Karachi South and vice versa. No notification or record of this change of districts could be found. Telephonic conversation with Mr M Rasees, Municipal Commissioner Karachi South confirmed that the Socioeconomic Study Area comes under the jurisdiction of Commissioner, Karachi South.

The Socioeconomic Study Area is included in District Karachi South.

Exhibit 4.81: List of Karachi Districts with Areas

District	*Areas*
Karachi Central District	Liaqatabad, Gulberg, Nazimabad, North Nazimabad, New Karachi
Karachi East District	Ferozabad, Jamshaid Quarter, Gulshan-e-Iqbal, Gulzar Hijri
Karachi South District	Saddar, Araam Bagh, Civil Lines, Garden, Liyari, Kimari, Maripur
Karachi West District	Orangi Town, Mominabad, SITE, Baldia, Mangho Pir
Karachi Malir District	Bin Qasim, Ibrahim Haidri, Shah Mureed, Gadaap, Airport, Cantonment
Karachi Korangi District (added in November 5, 2013)	Shah Faisal Colony, Model Colony, Korangi, Landhi

(Sindh Board of Revenue, Karachi, 2014)

4.4.2 Methodology and Sampling Framework

Information on the socioeconomic conditions prevailing within the Study Area was collected through a combination of settlement level surveys and focus group interviews. The socioeconomic survey was conducted from August 22 to 27, 2014. The information was obtained from key informants: literate people, knowledgeable of the socioeconomic conditions of their communities. Data collection for settlement surveys was carried out using standardized questionnaires which is given in **Appendix G**. The responses were recorded on the questionnaires by a consultation specialist from HBP's socioeconomic team.

The main objective of the socioeconomic baseline Settlement Survey was to document the existing socioeconomic conditions of the communities including demography, livelihoods and access to social services. Principal areas covered in the village questionnaire are listed below:

- Demographic variables included (i) population, (ii) size of household,
- Socioeconomic variables included (i) literacy and access to educational facilities, (ii) access to health services, (iii) water supply and (iv) occupations.

[97] Paki Mag, Karachi Divided into Six Districts with Korangi New One (Tahir, November 5, 2013) www.pakimag.com/politics) accessed on September 9, 2014.

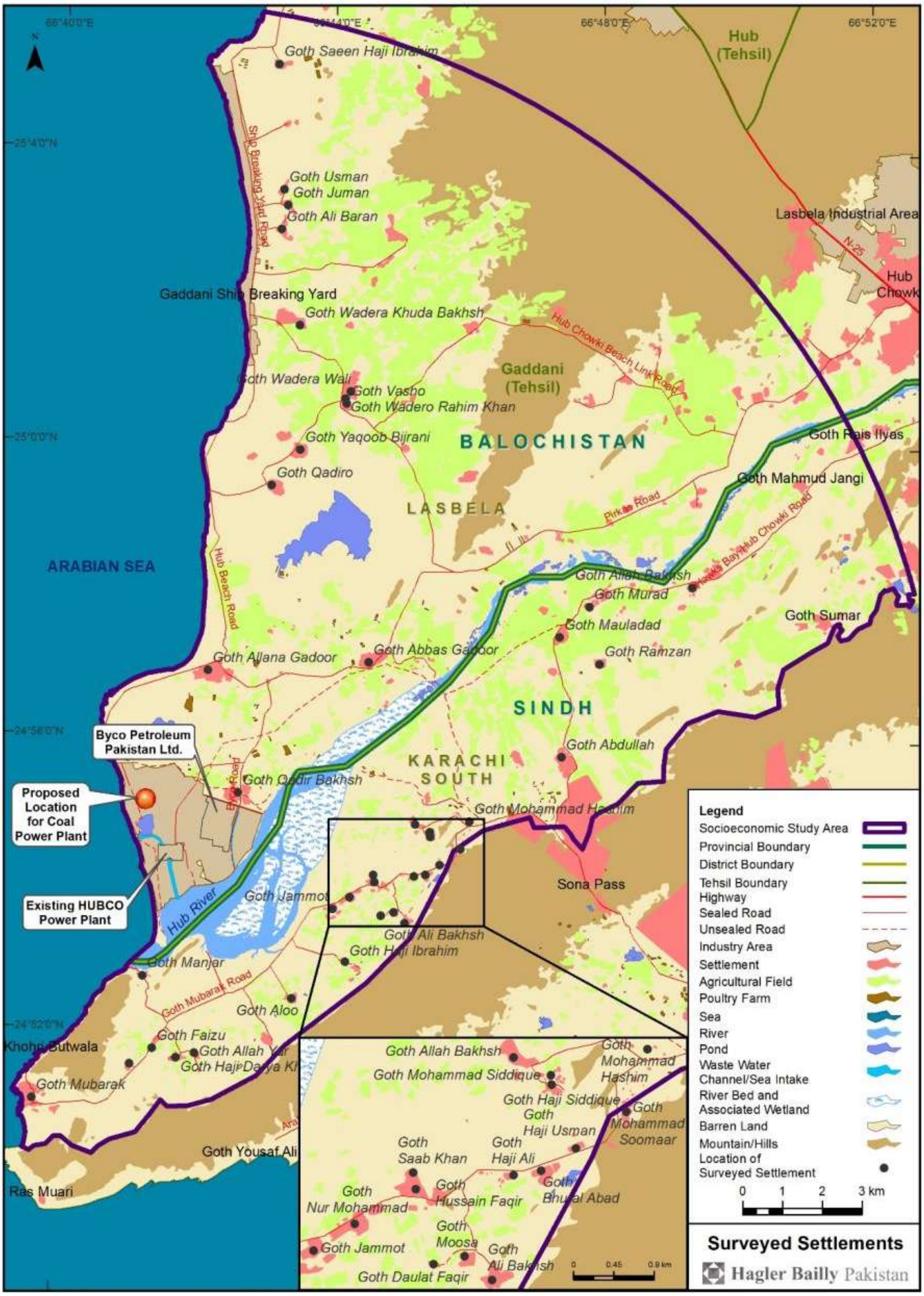
List of surveyed settlements along with geographical coordinates and dates of survey is provided in **Exhibit 4.82**. The locations of the settlements surveyed are shown on a map in **Exhibit 4.83**.

Exhibit 4.82: Surveyed Settlements with Geographical Coordinates and Date of Survey

Location	*District*	*Province*	*Coordinates*		*Consulted Date*
Goth Qadir Bukhsh	Lasbela	Balochistan	24°54' 53.921" N	66°42' 44.265" E	Aug 22, 2014
Goth Abbas Gadoor	Lasbela	Balochistan	24°57' 0.850" N	66°44' 37.748" E	Aug 22, 2014
Goth Allana Gadoor	Lasbela	Balochistan	24°56' 52.394" N	66°42' 14.024" E	Aug 22, 2014
Goth Qadiro	Lasbela	Balochistan	24°59' 24.223" N	66°43' 8.317" E	Aug 23, 2014
Goth Yaqoob Bijrani	Lasbela	Balochistan	24°59' 53.647" N	66°43' 33.530" E	Aug 23, 2014
Goth Wadera Wali	Lasbela	Balochistan	25°0' 41.771" N	66°44' 17.786" E	Aug 23, 2014
Goth Wadero Rahim Khan	Lasbela	Balochistan	25°0' 35.846" N	66°44' 13.317" E	Aug 23, 2014
Goth Vasho	Lasbela	Balochistan	25°0' 31.877" N	66°44' 14.298" E	Aug 23, 2014
Goth Muhammad Soomaar	Karachi Southt	Sindh	24°54' 29.356" N	66°46' 2.513" E	Aug 23, 2014
Goth Muhammad Hashim	Karachi South	Sindh	24°54' 51.983" N	66°46' 10.182" E	Aug 23, 2014
Goth Muhammad Siddique	Karachi South	Sindh	24°54' 42.614" N	66°45' 35.056" E	Aug 23, 2014
Goth Haji Usman	Karachi South	Sindh	24°54' 16.029" N	66°45' 44.148" E	Aug 25, 2014
Goth Moosa	Karachi South	Sindh	24°53' 36.831" N	66°45' 3.694" E	Aug 24, 2014
Goth Allah Bukhsh	Karachi South	Sindh	24°54' 48.990" N	66°45' 21.572" E	Aug 24, 2014
Goth Daulat Faqir	Karachi South	Sindh	24°53' 33.962" N	66°44' 52.466" E	Aug 24, 2014
Goth Bhural Abad	Karachi South	Sindh	24°54' 7.917" N	66°45' 31.485" E	Aug 24, 2014
Goth Haji Ali	Karachi South	Sindh	24°54' 6.311" N	66°45' 21.535" E	Aug 24, 2014
Goth Ali Bukhsh	Karachi South	Sindh	24°53' 28.206" N	66°45' 13.684" E	Aug 24, 2014
Goth Mauladad	Karachi South	Sindh	24°57' 23.684" N	66°47' 28.404" E	Aug 24, 2014
Goth Abdullah	Karachi South	Sindh	24°55' 45.665" N	66°47' 31.703" E	Aug 24, 2014
Goth Wadera Khuda Bukhsh	Lasbela	Balochistan	25°1' 35.248" N	66°43' 31.328" E	Aug 25, 2014
Goth Ali Baran	Lasbela	Balochistan	25°2' 53.646" N	66°43' 13.471" E	Aug 25, 2014
Goth Juman	Lasbela	Balochistan	25°3' 13.300" N	66°43' 18.800" E	Aug 25, 2014

Location	*District*	*Province*	*Coordinates*		*Consulted Date*
Goth Hussain Faqir	Karachi South	Sindh	24°54' 1.210" N	66°44' 46.065" E	Aug 25, 2014
Goth Saab Khan	Karachi South	Sindh	24°54' 7.244" N	66°44' 45.099" E	Aug 25, 2014
Goth Nur Muhammad	Karachi South	Sindh	24°53' 48.638" N	66°44' 23.849" E	Aug 25, 2014
Goth Haji Siddique	Karachi South	Sindh	24°54' 39.100" N	66°45' 35.400" E	Aug 25, 2014
Goth Usman	Lasbela	Balochistan	25°3' 25.957" N	66°43' 15.283" E	Aug 25, 2014
Goth Saeen Haji Ibrahim	Lasbela	Balochistan	25°5' 8.364" N	66°43' 9.021" E	Aug, 26, 2014
Goth Haji Ibrahim	Karachi South	Sindh	24°52' 55.962" N	66°44' 20.879" E	Aug 26, 2014
Goth Aloo	Karachi South	Sindh	24°52' 25.120" N	66°43' 33.502" E	Aug 26, 2014
Goth Jammot	Karachi South	Sindh	24°53' 38.920" N	66°44' 8.831" E	Aug 26, 2014
Goth Ramzan	Karachi South	Sindh	24°57' 2.188" N	66°48' 4.635" E	Aug, 26, 2014
Goth Murad	Karachi South	Sindh	24°57' 48.900" N	66°47' 54.600" E	Aug, 26, 2014
Goth Allah Bukhsh	Karachi South	Sindh	24°58' 5.965" N	66°49' 26.650" E	Aug, 26, 2014
Goth Mubarak	Karachi South	Sindh	24°51' 1.149" N	66°39' 42.184" E	Aug 27, 2014
Goth Haji Jummo Khan	Karachi South	Sindh	24°51' 30.093" N	66°41' 9.368" E	Aug 27, 2014
Goth Faizu	Karachi South	Sindh	24°51' 42.951" N	66°41' 29.118" E	Aug 27, 2014
Goth Haji Darya Khan	Karachi South	Sindh	24°51' 35.530" N	66°41' 50.649" E	Aug 27, 2014
Goth Allah Yar	Karachi South	Sindh	24°51' 39.512" N	66°42' 7.121" E	Aug 27, 2014
Goth Manjhar	Karachi South	Sindh	24°52' 42.119" N	66°41' 19.600" E	Aug 27, 2014

Exhibit 4.83: Locations of the Surveyed Settlements



4.4.3 Economic Setting

Economic infrastructure includes the type of occupations, their share in employed occupation and other income generating activities in the Socioeconomic Study Area.

Occupation

To obtain the most accurate statistics about occupations, data from men and women representatives are obtained. The percentage share of the occupations existing in the Socioeconomic Study Area is listed in **Exhibit 4.84**. **Exhibit 4.85** and **Exhibit 4.86** provide a pie chart illustration of the occupational structure of the earning household members in the surveyed villages in both Lasbela and Karachi South districts. The ship-breaking industry is the largest source of employment for the inhabitants of Lasbela district. The Gadani ship-breaking yard is the third largest ship breaking yard in the world consisting 132 ship-breaking plots. They are employed on both daily wages and in the form of contractual labour. Employment from the ship-breaking industry had a share of 30% in the total available employment opportunities in the Socioeconomic Study Area. Fish labour—fish labour refers to the individuals who do not own their own fishing boats, but are employed by the boat owners to help them in catching fish—constitutes 53% of Karachi South and 24% of Lasbela's employed personnel in the surveyed settlements.

According to the statistics, obtained from women, art and craft is the largest source of their earning, contributing 31% in Lasbela and 67% in Karachi South District. The women made embroidery are sold in the markets.

Industrial Setup

The existing HUBCO Residual Furnace Oil (RFO) fired power plant and Byco's oil refining and chemical manufacturing plant are the two major industrial units found in the Socioeconomic Study Area. Linkages of the livelihoods of people residing in the surveyed communities with these industries were found to be minimal. This can be ascribed to the low literacy rate prevailing in the Socioeconomic Study Area.

HUBCO

The HUBCO power company owns a 1,200 MW net capacity, RFO fired power plant in District Lasbela of Baluchistan. The plant is located at a geodesic distance of 60 km from Karachi in Hub. The RDO is supplied to the power plant by a 78 km long pipeline from Pakistan State Oil (HUBCO, 1999b)[98].

During the socioeconomic survey, only four people were reported to be working at HUBCO power plant as contract employees.

Byco

Byco Oil Pakistan Limited (BOPL) was incorporated as a company in Pakistan on April 6, 2014 with the portfolio of oil refining and chemical manufacturing business. Byco installed its first oil refinery with a refining capacity of 30,000 barrels a day at Mouza Kund, Hub Baluchistan and started its commercial production from July 1, 2004 with various saleable components including Liquefied Petroleum Gas, Light Naphtha,

[98] http://www.freewebs.com/pak-desalination/ (accessed on September 15, 2014)

Heavy Naphtha, High Octane Blending Component, Motor Gasoline, Kerosene, Jet Fuels, High Speed Diesel and Furnace Oil.[99]

In Dec 2012, Byco successfully installed a new refinery in the vicinity of the existing refinery with a refining capacity of 120,000 barrels a day. The new refinery is the largest refinery in the country.[100]

Exhibit 4.84: Percentage Share of Occupations among the Employed Population of the Study Area

Occupation	*Percentage (Data obtained from Men)*	*Percentage (Data obtained from Women)*
District Lasbela		
Art and Craft	-	31
Agriculture/Farm Labor	8	11
Farming (Self Employed)	2	22
Fish Labor	24	-
Fishing (Self Employed)	11	-
Government Service	0	-
HUBCO Employee	5	-
Livestock Farming	0	13
Other Wage Labor	20	23
Ship Breaking Industry	30	-
District Karachi South		
Art and Craft	-	67
Agriculture/Farm Labor	7	1
Farming (Self Employed)	6	13
Fish Labor	53	-
Fishing (Self Employed)	6	-
Government Service	2	1
HUBCO Employee	0	-
Livestock Farming	1	4
Other Wage Labor	19	2
Private Service	0	1
Small Boat Owners	0	-
Trade/Business	6	11

99 http://www.byco.com.pk (accessed on September 15, 2014)
100 Ibid

Exhibit 4.85: Occupational Profile of Lasbela

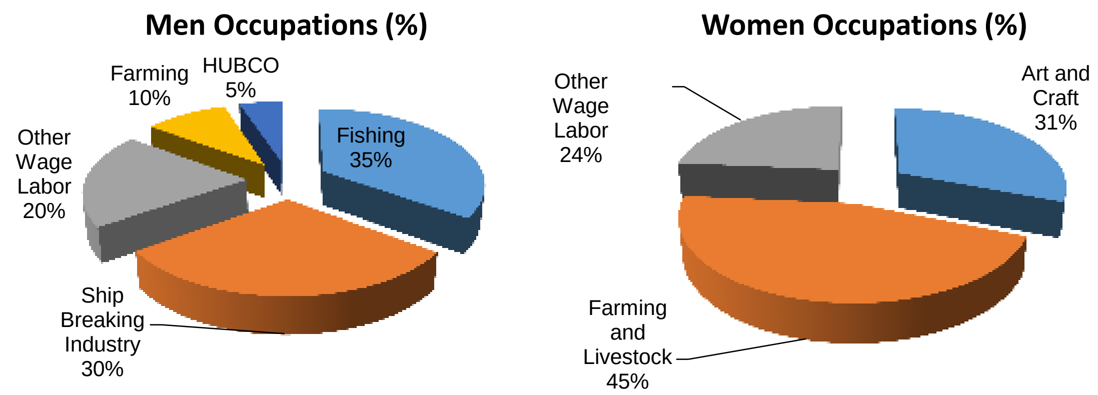
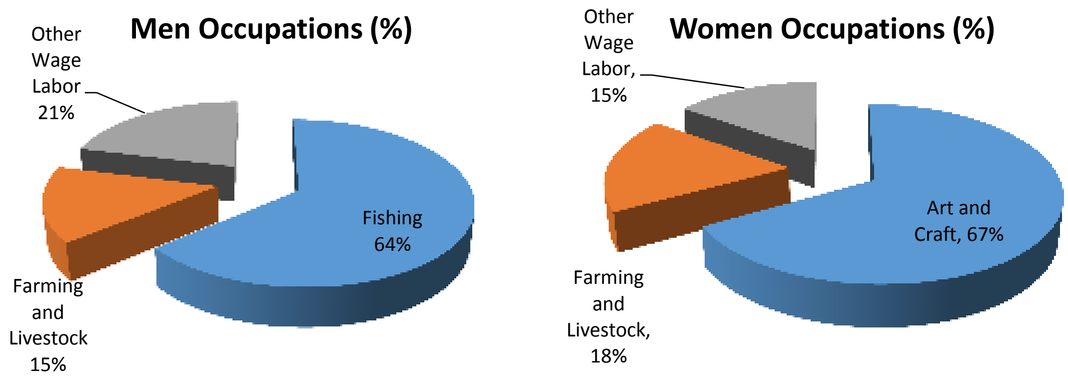


Exhibit 4.86: Occupational Profile of Karachi South



Agriculture

Although agriculture contributes only 10% and 14% share in Lasbela and Karachi South respectively, the occupational profile of the respondents, nearly whole of the village engages in farming if the area receives adequate rainfall. The agricultural yield of the area is dependent upon the rainfall. The common rain-fed crops sown in the area, as reported by the respondents, include vegetables, Jawar (Sorghum), Guar (Cluster Bean) and Water Melon. **Exhibit 4.87** provides the list of crops along with percentage sown in each district.

Exhibit 4.87: Main Crops Reported in the Surveyed Settlements

Crop	*%age of the settlements sowing the crop*	
	Lasbela	*Karachi South*
Guar	2	44
Jawar	5	10
Vegatables	22	54
Watermelon	10	2
Wheat	2	0

Communication Network

The communication network includes roads, telephone and mobile networks, post offices and available modes of transportation. 93% of the surveyed settlements reported to have access to mobile networks including services provided by Mobilink, Telenor and Zong. 80% of the respondents reported to have access to public transport. The main source of public transport in the surveyed settlements was a village individual's owned Datsun pick-up vehicles which provides pick and drop to the villages to and from the Hub Chowki and Marripur. 90% of the surveyed settlements are linked with blacktop roads. Only one out of forty-one settlements reported to have landline telephone network. There are no post offices located in the surveyed settlements. People have to approach post offices located in Hub Chowki and Marripur at the time of need.

Water Supply and Sanitation

Water supply is one of the major problems faced by inhabitants living in the Study Area. Most of the underground water is brackish and saline. The main source of drinking water for the communities residing on the both sides of the Hub River is the river itself. Due to a lack of financial resources, the residents are unable to develop sufficient dug wells near the river to meet their daily water requirements. Women have to walk for several hours to fetch water from the river or nearby dug wells. Mostly, the water for drinking and washing purposes is obtained through water tankers and bowsers. These tankers and bowsers are filled with water from the Hub River through motors at facilities located in Hub Chowki. Small tanker charges Rs 1,500 to 2,000 depending upon the distance, while a large three compartment tanker charges Rs 6,000 per trip to the settlement. Two to three households contribute for a single tanker. The water is stored in underground storage tanks and is reported to be sufficient to meet the requirements of the contributors.

There is no proper water sanitation and waste disposal system reported in the surveyed settlements. The municipal waste water is drained to an open storage pond through open drainage lines where it is evaporated by the sun. A few households reported to have a waste water storage pit where water is left open to get evaporated.

None of the surveyed settlements reported to have a waste management system. The municipal waste is disposed in open disposal pits located at various places in a settlement. **Exhibit 4.88** shows some photographs of the water sources, supply, sanitation and waste disposal system existing in the surveyed settlements.

Exhibit 4.88: Water Supply, Sanitation and Waste Disposal

A view of the Hub River

Water Supply Tanker

Underground water storage tank

Donkey carts used to fetch water from the Hub River and nearby dug wells

Dried-up water well

Women fetching water from a functioning water well

Municipal waste disposal pit

Water drainage system

Power Supply and Fuel Consumption

The two only fuel sources reported by the respondents of the surveyed communities include electricity and fuel wood. Seven out of forty one surveyed settlements have no electricity connection. Twenty five surveyed settlements reported to have electricity supply lines which are outdated and not functional. Only nine settlements are connected to functional electricity distribution lines.

Most of the people use wood as a main source of fuel for cooking and water heating purposes. The wood is either purchased from market or is cut by the males from the forest. The average price of the wood varies from rupees 120 to 150 per mann (1 mann in Urdu is equal to 40 kg).

4.4.4 Social Setting

Social infrastructure comprises of the health and educational infrastructure, prevailing diseases and services provisions in the Socioeconomic Study Area.

Demography and Household Characteristics

As shown in **Exhibit 4.89**, the surveyed area comprised of an estimated population of 27,982 with a population of 12,480 in District Lasbela and 15,502 in District Karachi South.

The estimated number of households[101] in the surveyed settlements is 4,569. The average household size of the surveyed settlements is 5.9 and varies from 9 persons per households in Goth Mubarak and smallest of 3.8 persons per household in Goth Wadero Rahim Khan. The names of the surveyed settlements along with the estimated number of households and total estimated population in each settlement are provided in **Exhibit 4.90.**

Exhibit 4.89: Size of Surveyed Settlements

	District Lasbela	*District Karachi South*
Coverage of the Settlement Survey		
Total Number of Settlements in Socioeconomic Study Area	13	28
Total Population	12,480 (44.6% of the total estimated population of the surveyed settlements)	15,502 (55.4% of the total estimated population of the surveyed settlements)
Number of Households	2,129 (46.5% households of the surveyed settlements)	2,440 (53.5% households of the surveyed settlements)

[101] A household can be defined as: “A domestic unit consisting of the members of a family who live together along with nonrelatives such as servants”, or, “A person or group of people occupying a single dwelling”.

Exhibit 4.90: Surveyed Settlements with Number of Households and Estimated Population

Location	*District*	*Province*	*Number of Households*	*Estimated Populations*
Goth Qadir Bukhsh	Lasbela	Balochistan	170	1,360
Goth Abbas Gadoor	Lasbela	Balochistan	300	1,500
Goth Allana Gadoor	Lasbela	Balochistan	350	1,800
Goth Qadiro	Lasbela	Balochistan	70	560
Goth Yaqoob Bijrani	Lasbela	Balochistan	350	1,800
Goth Wadera Wali	Lasbela	Balochistan	200	800
Goth Wadero Rahim Khan	Lasbela	Balochistan	34	130
Goth Vasho	Lasbela	Balochistan	80	500
Goth Muhammad Soomaar	Karachi South	Sindh	40	320
Goth Muhammad Hashim	Karachi South	Sindh	20	150
Goth Muhammad Siddique	Karachi South	Sindh	36	200
Goth Haji Usman	Karachi South	Sindh	12	72
Goth Moosa	Karachi South	Sindh	40	350
Goth Allah Bukhsh	Karachi South	Sindh	40	320
Goth Daulat Faqir	Karachi South	Sindh	14	70
Goth Bhural Abad	Karachi South	Sindh	30	150
Goth Haji Ali	Karachi South	Sindh	25	150
Goth Ali Bukhsh	Karachi South	Sindh	30	150
Goth Mauladad	Karachi South	Sindh	250	1,100
Goth Abdullah	Karachi South	Sindh	300	1,500
Goth Wadera Khuda Bukhsh	Lasbela	Balochistan	250	2,200
Goth Ali Baran	Lasbela	Balochistan	150	750
Goth Juman	Lasbela	Balochistan	60	420
Goth Hussain Faqir	Karachi South	Sindh	52	300
Goth Saab Khan	Karachi South	Sindh	30	170
Goth Nur Muhammad	Karachi South	Sindh	250	1,200
Goth Haji Siddique	Karachi South	Sindh	39	200
Goth Usman	Lasbela	Balochistan	30	150
Goth Saeen Haji Ibrahim	Lasbela	Balochistan	85	510
Goth Haji Ibrahim	Karachi South	Sindh	25	150

Location	*District*	*Province*	*Number of Households*	*Estimated Populations*
Goth Aloo	Karachi South	Sindh	150	900
Goth Jammot	Karachi South	Sindh	50	250
Goth Ramzan	Karachi South	Sindh	30	130
Goth Murad	Karachi South	Sindh	76	380
Goth Allah Bukhsh	Karachi South	Sindh	50	250
Goth Mubarak	Karachi South	Sindh	600	5,500
Goth Haji Jummo Khan	Karachi South	Sindh	45	270
Goth Faizu	Karachi South	Sindh	30	150
Goth Haji Darya Khan	Karachi South	Sindh	85	590
Goth Allah Yar	Karachi South	Sindh	18	100
Goth Manjhar	Karachi South	Sindh	73	430
Total			**4,569**	**27,982**

Ethnicity and Religion

All of the population of the surveyed villages in both districts is Muslim. The influence of spiritual leaders and the practice of venerating saints were not found to be strong in the Socioeconomic Study Area. However, tribal leaders exert influence on the communities in matters of politics, land-related conflicts and employment. During the field survey, a number of mosques were spotted in both districts. Some of these are shown in **Exhibit 4.91**.

Nearly, 7 ethnic castes were reported in District Lasbela and 10 in District Karachi South. The largest caste in the Socioeconomic Study Area is Bhand Baloch which accounts for 46.7% of the total estimated population in both the Districts.

The largest District-wise caste in terms of population is Bazenjo with the share of 41% in District Lasbela and Bhand Baloch with the share of 67% in Karachi South District. There was no evidence of tensions between the ethnic groups residing in the Socioeconomic Study Area.

Inter-caste marriages and other social exchanges amongst the castes were common. Castes by district are provided in **Exhibit 4.92**.

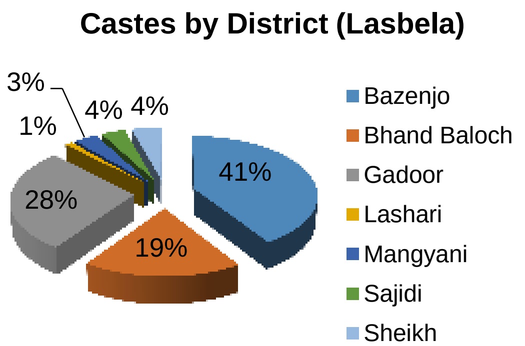
The major languages spoken in the Socioeconomic Study Area are Balochi, Sindhi and Lassi; the last being a dialect of Sindhi. The percentage distribution of languages spoken in each district is provided in **Exhibit 4.93**.

Exhibit 4.91: Mosques in the Socioeconomic Study Area

Mosque in Goth Muhammad Hashim

Mosque in Goth Allana Gadoor

Exhibit 4.92: Distribution of Castes by District



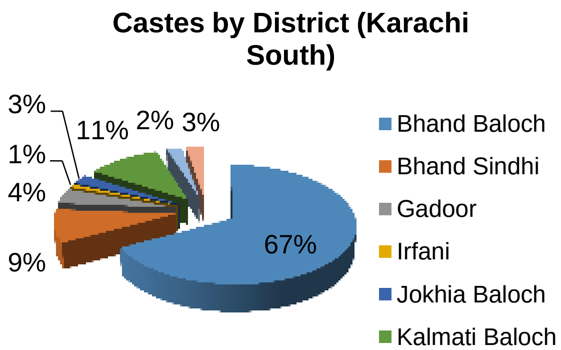
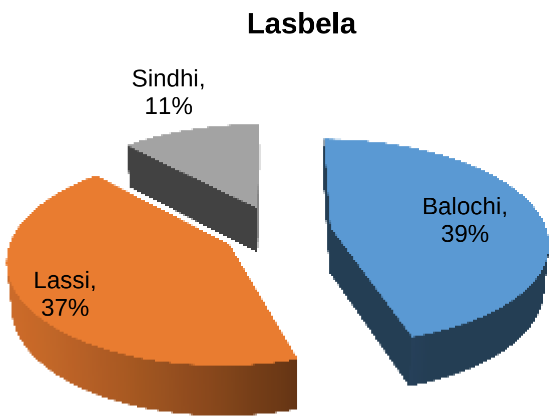
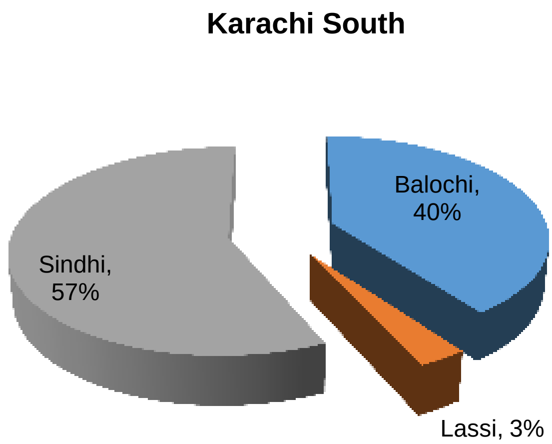


Exhibit 4.93: Distribution of Languages Spoken in both Districts





Health

The respondents of the surveyed settlements located in Lasbela district reported to have three dispensaries and two health units while, the respondents from Karachi South reported access to only one health center located in Goth Mauladad. However, according to the respondents, the latter had been in a non-functional state for more than a year. Instead, they have to go to a dispensary located at Hub Chowki.

Eleven out of thirteen surveyed settlements in Lasbela and twenty three out of twenty eight surveyed settlements of Karachi South recorded regular visits in their communities by polio-immunization teams. Twelve untrained and two trained midwives were providing services in surveyed settlements of Karachi South, while none were reported in the settlements located in Lasbela.

According to the respondents, a team from HUBCO periodically visits the settlements located in the Lasbela district with a frequency between one to three months. During these visits medicines are distributed among villagers. The medicines are used to treat seasonal cold, cough, fever and relieve pain. The villagers also reported that HUBCO management periodically arranges a medical camp for free eye-checkups in the villages located in Lasbela. Similar activities by HUBCO were not reported by the respondents from District Karachi South.

Respondents of Goth Allah Bakhsh, located in Karachi South reported that a NGO named Indus Earth used to distribute medicines among the residents of the villagers. However, they had not visited the area during the last one year.

Private and government hospitals are located in Hub Chowki and Karachi city. Due to the distance, residents of the surveyed communities on both sides on the Hub River head to these hospitals only during emergencies or for severe injuries and health issues.

Health facilities located in the surveyed settlements are shown in **Exhibit 4.94**.

Exhibit 4.94: Health Facilities in Surveyed Settlements

Basic Health Center in Goth Allana Gadoor

Health Center in Goth Mauladad

Ailments

Common ailments identified in the surveyed communities along with the percentage of incidence are given in **Exhibit 4.95**. Cold and flu, skin problems and breathing problems are the major ailments reported by the male members of the surveyed communities while females reported sufferings from jaundice and stomach diseases in addition to the ailments identified by the males.

Marginalized Individuals

Out of 12,480 and 15,502 estimated population of surveyed settlements located in districts Lasbela and Karachi South respectively, the respondents reported only 2% people to be marginalized including physically and mentally challenged individuals and widows. **Exhibit 4.96** provides the quantitative data of the marginalized individuals reported by the respondents of the surveyed communities.

Exhibit 4.95: Percentage Occurrence of Common Health Problems reported by Males and Females

Common Diseases	*Men*	*Women*
Tuberculosis	3	2
Diarrhea	2	7
Breathing problems	10	9
Jaundice	2	11
Skin diseases	14	15
Cold and flu	35	23
Stomach diseases	3	14
Joint aches	4	9
Tetanus	0	2
Paralysis	0	0
Diabetes	9	6
Cancer	1	0
Heart problems	6	3
Hepatitis	5	0
Eye problem	5	0

Exhibit 4.96: District-Wise Marginalized Individuals

District	*Estimated Population of the Surveyed Settlements*	*Mentally Challenged people*	*Physically Challenged People*	*Widows*	*Total*	*Percentage in Total Surveyed Population*
Lasbela	12,480	43	69	171	283	2%
Karachi South	15,502	38	57	169	264	2%

Education

Education in the surveyed settlements is provided by government primary schools. There is only one, The Citizen Foundation (TCF) high school functioning near Goth Abbas in District Lasbela. The school is funded by HUBCO and International Power GDF Suez[102]—operators of HUBCO Power Plant at Hub. HUBCO Power Company also provides transportation to the students attending the TCF high school.

Nearly all the schools are co-educational. Most of the children in Lasbela and Karachi South who wish to study beyond primary level attend school in Hub Chowki and Marripur respectively.

Literacy rate—the literacy rate refers to the ability of the population aged 10 years and above to read and write a simple message—for both males and females is reported to be very low in the surveyed settlements. **Exhibit 4.97** shows photographs of some of the educational facilities located in the Study Area.

Crime and Security Conditions

There were almost no reported cases of conflicts, feuds, thefts, land disputes or other serious crimes. The elders of the community are usually approached to resolve all disputes and conflicts. The formal mechanisms, such as, police are only approached if the elders are unable to resolve an issue.

Exhibit 4.97: Educational Facilities in the Study Area

Primary School, Goth Yaqoob Bijrani

Government Primary School, Goth Mauladad

[102] International Power is the largest single shareholder of Hubco and also the O&M Contractor. The O&M Agreement was initially for a period of 12 years from Commercial Operation Date and now have been extended for a further 12 years period (source: http://www.hubpower.com/our-business/business-partnerships/) accessed on September 26, 2014.

TCF School, Pirkas Road

Bus provided by International Power to the TCF students

Migration Pattern

Migration pattern is the movement of people from one place to another for a variety of reasons including environmental, political, economic and cultural. Migration affects population pattern and characteristics, social and cultural patterns and processes, economies, and physical environments.[103]

The respondents from the surveyed communities located in Lasbela reported zero migration in the last twenty years, while two out of twenty eight settlements from Karachi South reported out-migration and one settlement reported in-migration in the last one decade.

Housing

The majority of the surveyed households are *Katcha* (adobe) houses. *Katcha* (adobe) houses, made of mud, account for 64% of the dwellings, while 36% of the houses are *Pakka* (masonry), made of bricks and concrete (**Exhibit 4.98** and **Exhibit 4.99**, respectively). Photographs of the types of dwellings in rural households are shown in **Exhibit 4.100**.

Exhibit 4.98: Percentage of Types of Houses Existing in the Surveyed Settlements

District	*Type of Houses (in %age)*	
	Masonry	*Adobe*
Lasbela	30.7	69.3
Karachi South	47.3	52.7

[103] International Organization for Migration (IOM) http://www.iom.int/ (accessed on September 16, 2014)

Exhibit 4.99: Percentage Distribution of Masonry and Adobe Households (in both districts)

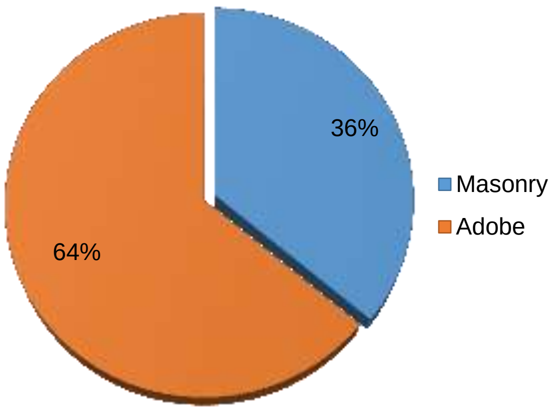


Exhibit 4.100: Commonly-found Masonry and Adobe Households in the Study Area

Adobe Household in Goth Muhammad Soomar

Masonry Household in Goth Haji Ibrahim,

4.4.5 Role of Women in Surveyed Communities

The women residing in the surveyed communities reported to have no restriction in moving around in the villages. They actively participate in the cultural activities of the village. Women along with the children fetch water from the nearby dug wells and collect wood from the jungle. They are also reported to participate in agriculture and livestock farming along with the male members of the community.

4.4.6 Fishing

Fishing is a major source of income reported by the respondents from Karachi South. Respondents from 22 out of the 28 surveyed settlements recorded to be engaged in fishing activities, while respondents from 7 out of 13 surveyed villages in Lasbela reported to work as fish labor. Fishing labor exists in nearly all the surveyed villages of

Karachi South except Goth Mubarak and Goth Manjhar, as the inhabitants own their fishing boars there. While in villages of Lasbela, three fishing communities Goth Allana Gadoor, Goth Qadir Bukhsh and Goth Abbas Gadoor are located within ten kilometers radius of the HUBCO Power Plant. Goth Allana hosts a relatively large fishing community with over 300 home. Bottom gill set net is the major fishing gear used to catch the fish (**Exhibit 4.101**). Along with Bottom gill set net, fishermen also use hook to catch fish. Most of the fishing is carried out along the coast line to save cost. During calm winds, fishermen sail to 12 nautical miles and beyond for fishing. The number of trips made for fishing depends upon the fish catch. A longer trip made to the deep sea (12 nautical miles and beyond) lasts for 10 to 30 days to catch fish. These trips hold a major share in the earnings of the fishermen. The fishermen fish for small, large pelagic, and demersal fish in the off shore areas using bottom gill set nets (**Exhibit 4.101**).

Exhibit 4.101: Bottom Grill Set Net and Fish Catch

Wooden fishing boats on the beach with bottom gill set nets

Small pelagic fish

Fishing, Recreation and Churna Island

Churna Island is a small uninhabited island located in the Arabian Sea, about 9 km west of the mouth of the Hub river at the boundary between the provinces of Baluchistan and Sindh. Churna is approximately 1.2 km long and 0.5 km wide. It is 6 km away from Mubarak Village. Fishermen of Mubarak Village go for fishing near the Churna Island as the island acts as a barrier between fishing boats and high speed sea winds. There are many species of fish, crabs and lobsters which exist near Churna Island.

Anglers rent boats to go to the island from Mubarak Village. Mubarak Village, even after being the second largest fishermen locality in Karachi, lacks basic facilities including education, health, jetty, ownership rights and communication.[104]

Churna is mostly used as a firing range by the Pakistan Navy and for scuba diving, cliff diving and snorkeling by tourists. Thus, the island becomes a major source of income for the boat owners residing in Mubarak. **Exhibit 4.102** provides a map to show location of Churna Island with respect to HUBCO Power Plant and Mubarak Village.[105]

[104] http://www.diversreefkarachi.com (accessed on September 17, 2014)
[105] http://www.en.wikipedia.org/wiki/Churna_Island (accessed on September 17, 2014)

Exhibit 4.102: Location of Churna Island

4.4.7 HUBCO CSR Activities

CSR or corporate social responsibility includes provision of services by the companies which take responsibility and compensate the communities located in their impact zone for the adverse environmental and social impact caused by their project. CSR activities include initiatives that benefit the community and promote sustainable development of affected communities' in an area. CSR activities may include human resource management, environmental protection, health and safety of the community, community development and involvement at various phases of the project, etc.

HUBCO CSR activities in its surrounding areas (please see **Exhibit 4.83**) mainly focus on education, health, CPI and livelihood. The CSR targets are achieved by scholarships, sponsors and donations. Highlights of some of the CSR activities carried out by HBCO in the surrounding areas of its power plant located near Hub are provided below.

Scholarships

- Provision of scholarships to 50 female students of Sardar Bahadur Khan Women University (SBKWU) Quetta belonging to the Province of Baluchistan. Each scholarship covers stipend and semester fees; and
- Payment of complete hostel charges for 10 female students at SBKWU.

Sponsorships

- Sponsoring a number of local football and cricket clubs to support healthy activities by providing sports gears.
- Assistance and sponsors to government schools and colleges for arranging study tours.
- A free eye camp is organized every year at Hub. 1,545 OPDs and 159 ophthalmology related procedures operations were conducted in 2014.
- Distribution of essential medicines like pain killers, anti-inflammatory drugs, cold and flu prevention drugs, etc. are distributed on quarterly basis to government hospital in Hub and four government dispensaries in the surrounding areas.
- Free eye screening camp is established for approximately 1,100 students of TCF and government primary schools every year.
- Management of health centers in three neighboring villages by trained LHVs
- Mobile medical unit covering 25 nearby villages by a lady doctor and a dispenser providing free medical advice and medicines
- General medical and skin camps are arranged on regular basis to cover masses.
- Installation of solar street lights in three villages located around the HUBCO power plant near Hub.
- Provision of fully funded TCF School educating approximately 500 students of Hub and Gaddani.
- Provision of free transportation services to the students of TCF School.

- Provision of free school bags, uniforms and books to the students of TCF School.
- Sponsors to 18 local government primary schools in District Lasbela by providing free books, school bags and furniture.
- Supply of clean drinking water to schools of eight villages located around the Hub power plant.
- Apprentice training center providing two years technical training in power plant operation and maintenance works to 14 male members of the neighboring communities

Donations

- The company had donated a Laser Photo Coagulator and Yag Laser machine to LRBT Quetta
- Rupees one Million is donated to the Kidney Centre Karachi each year
- Donation of seven ambulances to Edhi Center.
- Donation of wheel chairs as and when required by health centers and hospital in Hub.
- Financial donation to disaster/natural calamity hit families at Gadani & Hub

5. Information Disclosure, Consultation and Participation

Stakeholder engagement is an integral part of the (ESIA) process. Stakeholders are groups and individuals that can be affected by or can affect the outcome of the project.[1] Engaging with stakeholders helps ensure their suggestions and concerns regarding a proposed project are taken into account during the project's design-phase. Effective stakeholder consultations involve informing the stakeholders about the project plans, development activities, its potential consequences on the environment and the proposed plans to mitigate the impacts. As a result, confidence is established amongst the stakeholders that the project is being developed in a responsible manner. The consultation process should last through the life of the project, providing a continuous platform for stakeholders to voice any concerns.

As part of the ESIA of the Project, stakeholder consultations with communities were held from August 22 to 27, 2014, whereas institutional stakeholders were consulted in two phases. The first phase of institutional consultation was held from Sep 18 to 22, 2014, and the second phase of consultations was held from Dec 23, 2014 to Jan 1, 2015.

The community consultations were conducted in settlements located on both sides of the Hub River extending up to Goth Saeen Haji Ibrahim in Baluchistan province located to the North and Goth Mubarak in the Sindh province located to the South of the proposed power plant location. During these consultations, the stakeholders shared their concerns and expectations regarding the Project, which were documented in **Appendix H**.

5.1 Objectives of Stakeholder Consultations

The objectives of stakeholder consultations during an ESIA include the following:

- Ensure involvement of the affected and interested public into the project planning and the ESIA decision making processes;
- Inform stakeholders of the proposed activities and its consequences;
- Gather data and information from the stakeholders about their human and biophysical environment, as well as about the relations they have with their environment; and
- Seek input from key stakeholders regarding the planned activities to increase its positive outcomes and avoid or mitigate any negative impacts.

The views, interests and concerns of stakeholders were taken into account on the following aspects of the Project:

- Planning, design and implementation of the Project;

[1] This definition for *Stakeholders* is consistent with the definition adopted by the World Bank Group. See *Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*, International Finance Corporation, 2007.

- The assessment of the potential impacts of the Project and the identification of appropriate mitigation measures;
- The decisions by the regulatory authorities on whether to approve the project and determination of corresponding conditions of approval.

5.2 National Regulations and International Practice for Stakeholder Consultations

The Project will adhere to the applicable national laws and international guidelines for the ESIA process in accordance to the legal framework for stakeholder consultations explained below.

5.2.1 Pakistan Environmental Law

Public consultation is mandated under the Pakistan environmental law. The Federal Agency, under Regulation 6 of the IEE-EIA Regulations 2000,[2] has issued a set of guidelines of general applicability and sectoral guidelines indicating specific assessment requirements. This includes Guidelines for Public Consultation, 1997 (the 'Guidelines'). Key extracts that represent the underlying theme of the Guidelines are given below:

- *Objectives of consultations*: "To inform stakeholders about the proposed project, to provide an opportunity for those otherwise unrepresented to present their views and values, providing better transparency and accountability in decision making, creating a sense of ownership with the stakeholders";
- *Stakeholders*: "people who may be directly or indirectly affected by a proposal will clearly be the focus of public involvement. Those who are directly affected may be project beneficiaries, those likely to be adversely affected, or other stakeholders. The identification of those indirectly affected is more difficult, and to some extent it will be a subjective judgment. For this reason it is good practice to have a very wide definition of who should be involved and to include any person or group who thinks that they have an interest. Sometimes it may be necessary to consult with a representative from a particular interest group. In such cases the choice of representative should be left to the group itself. Consultation should include not only those likely to be affected, positively or negatively, by the outcome of a proposal, but should also include those who can affect the outcome of a proposal."
- *Mechanism for consultations:* "provide sufficient relevant information in a form that is easily understood by non-experts (without being simplistic or insulting), allow sufficient time for stakeholders to read, discuss, consider the information and its implications and to present their views, responses should be provided to issues and problems raised or comments made by stakeholders, selection of venues and timings of events should encourage maximum attendance";

[2] Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000

- *Timing and frequency:* "Ideally, the public involvement program should commence at the screening stage of a proposal and continue throughout the ESIA process."
- *Consultation tools:* some specific consultation tools outlined in the Guidelines that can be used for conducting consultations include; focus group meetings, needs assessment, semi-structured interviews; village meetings and workshops.
- *Other important considerations:* "The development of a public involvement program would typically involve consideration of the following issues; objectives of the proposal and the study; identification of stakeholders; identification of appropriate techniques to consult with the stakeholders; identification of approaches to ensure feedback to involved stakeholders; and mechanisms to ensure stakeholders' consideration are taken into account".

5.2.2 International Practice

International guidelines, such as the Performance Standards by International Finance Corporation (IFC-PS) and World Bank (WB) policies for environmental assessment, layout the objective and approach for stakeholder consultations. Consultations are required for all development initiatives that lead to environmental and social impacts. Some of the main principles laid out for consultations include: [3,4,5,6]

- *Stakeholder identification:* Stakeholders include individuals and/or groups that can be affected by or are interested in the development initiative. Consultations should engage all types stakeholders, which can include potentially affected communities, local government authorities, NGOs, academia and other civil society bodies;
- *Selection of consultation techniques:* Sufficient information should be shared with the stakeholders in a timely and effective manner, with consideration for stakeholder interests, linguistic and educational backgrounds, and socio-cultural setting;
- *Arrangements for consultations:* Venue and timing for consultation meetings should be chosen in a manner that encourages maximum participation on behalf of stakeholders;
- *Stages of consultation:* Consultations should be conducted during the early cycle of project development (scoping stage), so that the results and outcomes of the consultations can contribute to the design process. Following this, stakeholders

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[3] International Finance Corporation "Performance Standard 1", World Bank Group, Washington, D.C. United States of America, January 2012.

[4] Shelton H. Davis and Nightingale Rukuba–Ngaiza, based on the World Bank's Operational Directive 4.01 on Environmental Assessments "Meaningful Consultations in Environmental Assessment", September 1998.

[5] International Finance Corporation "Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets" World Bank Group, Washington, D.C. United States of America May 2007.

[6] The World Bank Operational Manual "Operational Directive OD 4.20", World Bank Group Washington, D.C. United States of America, September 1991.

should be provided feedback before finalization of the project's environmental design (feedback stage) on how their concerns, raised at the scoping stage, were addressed through suitable mitigation or design changes;

- *Stakeholder feedback and use of results:* The views of stakeholders should be documented and then analyzed for use in more effective decision-making.

5.2.3 Good Practice Principles

The good practice principles that were adhered to during the consultations are listed below:

- *Cultural sensitivity*: this requires understanding and appreciation of the social institutions, values, and culture of the communities in the project area and respect for the historical, cultural, environmental, political and social backgrounds of the communities which are affected by a proposal;
- *Interactive approach*: consultation should not be limited to one–way dissemination of information. Stakeholder comments should feed into the EIA process and proposed project design;
- *Open, transparent and informative*: People who are affected by the Project and are interested in participating should have access to relevant information, in a simple and understandable format;
- *Inclusive and equitable*: Ensure that all stakeholder groups are represented, including less represented groups such as women, children, elderly and poor people;
- *Appropriateness and flexibility*: Consultation methodologies must be appropriate to the specific phase of the EIA process and the stakeholder groups identified. The consultation should also be adjusted according to the resources available;
- *Capacity building*: Capacity building should be a part of consultation interaction wherever appropriate and practicable.

5.3 Stakeholder Identification and Analysis

As stated earlier, stakeholders are defined as groups and individuals that can take affect or can affect the outcome of a project. Stakeholders that can be affected by the construction and operation activities of the proposed Project were identified during the scoping phase and include all groups and individuals that can take affect or can be affected by its outcomes.

The identified communities and institutions were consulted through their representatives during the consultations.

Groups and individuals that hold interest in the Project and can influence the outcome of the Project (latter part of the definition of stakeholders) include:

- Government and regulatory authorities directly or indirectly connected to or responsible for overseeing the activities of the Project;

- Industries or non-governmental organizations (NGOs) working in areas that can be affected by the Project;
- Academia that can be interested in transfer of skill and knowledge aspect of the Project.

The stakeholders were identified on the basis of the most recent information and understanding of the Project and its surrounding environment. This understanding changes during the course of the ESIA, as more information is gathered. In addition, both stakeholders and their interests can change over the life of the Project. Therefore, stakeholder identification and analysis is understood to be a dynamic process which is continued through the course of the ESIA and the life of the Project.

On the basis of the potential impacts, the following groups were identified as those which may have an interest in the Project or may be impacted by Project activities.

- Communities near the coast which are dependent on the ecological resources (especially fish) present in and around the location of the proposed power plant.
- Communities present in and around the location of the proposed power plant which are likely to be the source of local labor for the project.
- Communities located within 20 km of the proposed site.
- Key institutional stakeholders (businesses and industries) located within 6 km of the site of the proposed plant.
- Karachi Port Trust (KPT), as the shipping area comes under the jurisdiction of KPT
- Government and regulatory authorities directly or indirectly connected to or overseeing the activities of the Project.
- NGOs working in areas that can be affected by the Project.
- Academia that can be interested in transfer of skill and knowledge aspect of the Project;

A different consultation approach was adopted for each target group to suit their varying backgrounds, as described ahead.

5.4 Consultation Methodology

The methodology adopted for stakeholder consultations is summarized below:

5.4.1 Consultation Material

The main document for distribution to stakeholders during the consultations was the Background Information Document (BID). The BID contained information on the Project and the ESIA process. The BID developed for the Project is given in **Appendix I**. The BID was made available to stakeholders in Urdu, Sindhi and English, to accommodate their language preferences.

5.4.2 Consultation Mechanism for Institutional Consultations

Letters to inform the institutional and industrial stakeholders about the objectives of the consultation process and to set up meetings with them were dispatched in the third week of Sep, 2014 and in the last week of Dec, 2014 for the first and second phase of consultations respectively. A copy of the BID was enclosed with the letters which contained information regarding the Project design. The list of the institutional stakeholders, consulted in the first phase is provided in **Exhibit 5.1**. The meetings progressed in the following manner:

- The main points of the BID and Project design were described to the stakeholders. Through the BID, an overview of the Project and ESIA process was provided.
- Stakeholders were given the opportunity to raise queries or concerns regarding the Project. Queries were responded to and concerns were documented.

Exhibit 5.1: List of Institutions and Industries Consulted with Location and Date

Stakeholder	*Location*	*Consulted Date during First Phase*	*Consulted Date during Second Phase*
Balochistan Fisheries Department[7]	Hub	Sep 18, 2014	Jan 01, 2014
Byco Petroleum Pakistan Limited	Hub	Sep 22, 2014	Dec 31, 2014
Deputy Commissioner Office	Uthal	Sep 19, 2014	Dec 23, 2014
International Union for Conservation of Nature (IUCN)	Karachi	Not available for consultation.	Dec 26, 2014
Karachi Port Trust (KPT)	Karachi	Sep 20, 2014	Dec 27, 2014
Lasbela Chamber of Commerce and Industry	Hub	Sep 19, 2014	Dec 31, 2014
Lasbela University of Agriculture, Water and Marine Sciences (LUAWMS)	Uthal	Sep 19, 2014	Dec 23, 2014
Pakistan Fisherfolk Forum (PFF)[8]	Karachi	Sep 19, 2014	–
The Forest and Wildlife Department	Hub	Sep 18, 2014	Dec 23, 2014
World Wildlife Fund (WWF)	Karachi	Sep 19, 2014	Dec 26, 2014

Exhibit 5.2 shows the locations where the consultation sessions were conducted. **Exhibit 5.3** and **Exhibit 5.4** shows a few photographs of first and second phase institutional stakeholder consultations, respectively. Photographs at few locations were not allowed.

[7] Consulted Mr Ehsanullah Baloch, Director Marine Fisheries Department, Baluchistan, over telephone.

[8] The consultation with PFF was not conducted during the second phase as they disengaged from the consultation process.

Exhibit 5.2: Institutional Stakeholder Consultation Locations

Exhibit 5.3: Photographs of the First Phase of Institutional Stakeholder Consultations

Consultation with Deputy Commissioner, Lasbela

Consultation with Lasbela University of Agriculture, Water and Marine Sciences

Consultation with Baluchistan Forest and Wildlife Department

Consultation with Karachi port trust (KPT)

Consultation With Byco Petroleum Pakistan Limited

Consultation with Lasbela Chamber of Commerce and Industry

Exhibit 5.4: Photographs of the Second Phase Institutional Stakeholder Consultations

Consultation with Deputy Commissioner, Lasbela

Consultation with Lasbela University of Agriculture, Water and Marine Sciences

Consultation with Baluchistan Forest and Wildlife Department

Consultation with Karachi port trust (KPT)

Consultation With Byco Petroleum Pakistan Limited

Consultation with Lasbela Chamber of Commerce and Industry

Consultation with World Wildlife Fund (WWF)

Consultation with International Union for Conservation of Nature (IUCN)

5.4.3 Consultation Mechanism for Community Consultations

Community consultations were conducted between August 22 and 27, 2014. To ensure maximum stakeholder participation, a local field assistant was sent to extend invitations to the communities a day in advance of the arrival of the HBP Consultations Team. Separate consultation sessions were conducted with community women by female team members. The community consultations were conducted with the community members within their settlements to encourage and facilitate their participation.

The list of communities consulted along with the geographical coordinates and dates when the consultations took place are shown in **Exhibit 5.5**. The locations of the communities are shown on a map in **Exhibit 5.6**. Photographic records of the consultations with men from the communities are presented in **Exhibit 5.7**, whereas, photographs of consultations with women of the community are not presented in consideration of local customs and traditions. The meetings progressed in the following manner:

- Stakeholders were introduced to the HBP team and briefed about the consultation process and its objectives;
- The main points of the BID were read out to the stakeholders in Urdu and Sindhi, depending on their language preference. Through the BID an overview of the Project and ESIA process was provided;
- Stakeholders were given the opportunity to raise queries or concerns regarding the Project. Queries were responded to and concerns were documented.

Exhibit 5.5: List of Communities Consulted in Chronological Order with the Geographical Coordinates of the Consultation Locations

Location	*District*	*Province*	*Coordinates*		*Date Consulted*
Goth Qadir Bukhsh	Lasbela	Balochistan	24°54' 53.921" N	66°42' 44.265" E	Aug 22, 2014
Goth Abbas Gadoor	Lasbela	Balochistan	24°57' 0.850" N	66°44' 37.748" E	Aug 22, 2014
Goth Allana Gadoor	Lasbela	Balochistan	24°56' 52.394" N	66°42' 14.024" E	Aug 22, 2014
Goth Qadiro	Lasbela	Balochistan	24°59' 24.223" N	66°43' 8.317" E	Aug 23, 2014
Goth Yaqoob Bijrani	Lasbela	Balochistan	24°59' 53.647" N	66°43' 33.530" E	Aug 23, 2014
Goth Wadera Wali	Lasbela	Balochistan	25°0' 41.771" N	66°44' 17.786" E	Aug 23, 2014
Goth Wadero Rahim Khan	Lasbela	Balochistan	25°0' 35.846" N	66°44' 13.317" E	Aug 23, 2014
Goth Vasho	Lasbela	Balochistan	25°0' 31.877" N	66°44' 14.298" E	Aug 23, 2014
Goth Muhammad Soomaar	Karachi South	Sindh	24°54' 29.356" N	66°46' 2.513" E	Aug 23, 2014
Goth Muhammad Hashim	Karachi South	Sindh	24°54' 51.983" N	66°46' 10.182" E	Aug 23, 2014

Location	*District*	*Province*	*Coordinates*		*Date Consulted*
Goth Muhammad Siddique	Karachi South	Sindh	24°54' 42.614" N	66°45' 35.056" E	Aug 23, 2014
Goth Haji Usman	Karachi South	Sindh	24°54' 16.029" N	66°45' 44.148" E	Aug 25, 2014
Goth Moosa	Karachi South	Sindh	24°53' 36.831" N	66°45' 3.694" E	Aug 24, 2014
Goth Allah Bukhsh	Karachi South	Sindh	24°54' 48.990" N	66°45' 21.572" E	Aug 24, 2014
Goth Daulat Faqir	Karachi South	Sindh	24°53' 33.962" N	66°44' 52.466" E	Aug 24, 2014
Goth Bhural Abad	Karachi South	Sindh	24°54' 7.917" N	66°45' 31.485" E	Aug 24, 2014
Goth Haji Ali	Karachi South	Sindh	24°54' 6.311" N	66°45' 21.535" E	Aug 24, 2014
Goth Ali Bukhsh	Karachi South	Sindh	24°53' 28.206" N	66°45' 13.684" E	Aug 24, 2014
Goth Mauladad	Karachi South	Sindh	24°57' 23.684" N	66°47' 28.404" E	Aug 24, 2014
Goth Abdullah	Karachi South	Sindh	24°55' 45.665" N	66°47' 31.703" E	Aug 24, 2014
Goth Wadera Khuda Bukhsh	Lasbela	Balochistan	25°1' 35.248" N	66°43' 31.328" E	Aug 25, 2014
Goth Ali Baran	Lasbela	Balochistan	25°2' 53.646" N	66°43' 13.471" E	Aug 25, 2014
Goth Juman	Lasbela	Balochistan	25°3' 13.300" N	66°43' 18.800" E	Aug 25, 2014
Goth Hussain Faqir	Karachi South	Sindh	24°54' 1.210" N	66°44' 46.065" E	Aug 25, 2014
Goth Saab Khan	Karachi South	Sindh	24°54' 7.244" N	66°44' 45.099" E	Aug 25, 2014
Goth Nur Muhammad	Karachi South	Sindh	24°53' 48.638" N	66°44' 23.849" E	Aug 25, 2014
Goth Haji Siddique	Karachi South	Sindh	24°54' 39.100" N	66°45' 35.400" E	Aug 25, 2014
Goth Usman	Lasbela	Balochistan	25°3' 25.957" N	66°43' 15.283" E	Aug 25, 2014
Goth Saeen Haji Ibrahim	Lasbela	Balochistan	25°5' 8.364" N	66°43' 9.021" E	Aug, 26, 2014
Goth Haji Ibrahim	Karachi South	Sindh	24°52' 55.962" N	66°44' 20.879" E	Aug 26, 2014
Goth Aloo	Karachi South	Sindh	24°52' 25.120" N	66°43' 33.502" E	Aug 26, 2014
Goth Jammot	Karachi South	Sindh	24°53' 38.920" N	66°44' 8.831" E	Aug 26, 2014
Goth Ramzan	Karachi South	Sindh	24°57' 2.188" N	66°48' 4.635" E	Aug, 26, 2014
Goth Murad	Karachi South	Sindh	24°57' 48.900" N	66°47' 54.600" E	Aug, 26, 2014
Goth Allah Bukhsh	Karachi South	Sindh	24°58' 5.965" N	66°49' 26.650" E	Aug, 26, 2014
Goth Mubarak	Karachi South	Sindh	24°51' 1.149" N	66°39' 42.184" E	Aug 27, 2014
Goth Haji Jummo Khan	Karachi South	Sindh	24°51' 30.093" N	66°41' 9.368" E	Aug 27, 2014
Goth Faizu	Karachi South	Sindh	24°51' 42.951" N	66°41' 29.118" E	Aug 27, 2014
Goth Haji Darya Khan	Karachi South	Sindh	24°51' 35.530" N	66°41' 50.649" E	Aug 27, 2014
Goth Allah Yar	Karachi South	Sindh	24°51' 39.512" N	66°42' 7.121" E	Aug 27, 2014
Goth Manjhar	Karachi South	Sindh	24°52' 42.119" N	66°41' 19.600" E	Aug 27, 2014

Exhibit 5.6: Locations of Community Consultations

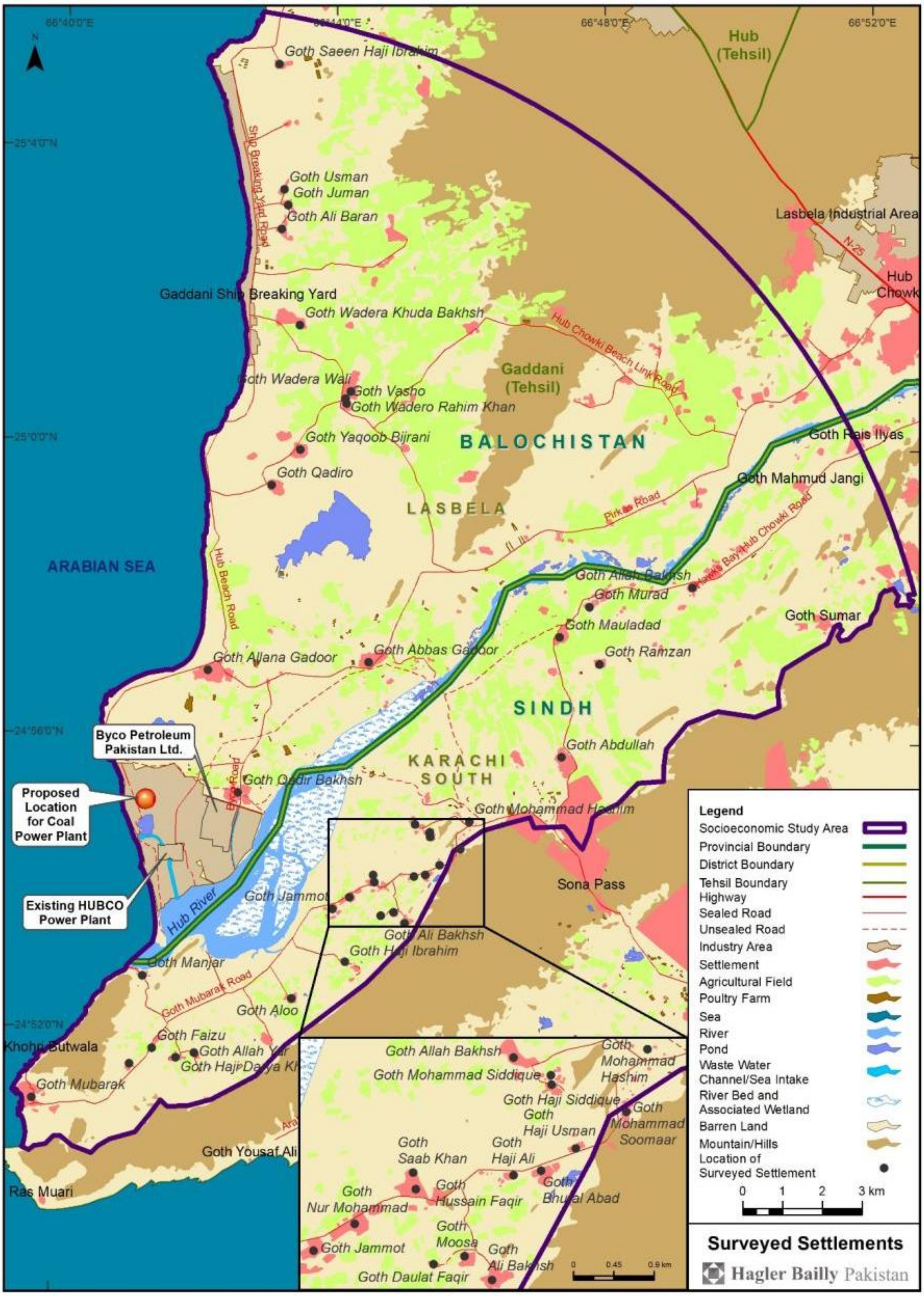


Exhibit 5.7: Photographs of Community Consultations


Consultations with members of the Goth Qadir Bukhsh community

Consultation with members of the Goth Abbas Gadoor Community.

Consultation with members of the Goth Allana Gadoor Communiy

Consultation with members of the Goth Abdullah

Consultation with members of the Goth Saeen Haji Ibrahim

Consultation with member of the Goth Vasho

Consultation with members of the Goth Wadero Rahim Khan

Consultation with members of the Goth Faizu

Consultation with members of the Goth Haji Usman

Consultation with members of the Goth Muhammad Soomaar

Consultation with members of the Goth Muhammad Hashim

Consultation with members of the Goth Muhammad Siddique

Consultation with members of the Goth Moosa

Consultation with members of the Goth Allah Bukhsh

Consultation with members of the Goth Juman

Consultation with members of the Goth Bhural Abad

Consultation with members of the Goth Mubarak

Consultation with members of the Goth Ali Bukhsh

Consultation with members of the Goth Manjar

5.4.4 Documentation and Reporting

The HBP team recorded all discussions which have been documented in this ESIA report in the form of a detailed log provided in **Appendix H**. **Exhibit 5.8** contains a summary of the concerns expressed by the community stakeholders and provides brief descriptions of the relevant measures Owner will take to address them**. Exhibit 5.9** contains a summary of the concerns raised by institutions during the first phase consultation sessions and provides relevant measures Owner will take to address them, whereas **Exhibit 5.10** contains additional concerns raised by the Institutions during the second phase and provides relevant measures Owner will take to address them.

Exhibit 5.8: Summary of Concerns Raised by Communities

	Comments/Issues raised	*Relevant Measures Taken by Owner to address the Concerns*
Air Quality	The impact of air emissions from the existing power plants in Hub and from the proposed coal-fired power plant should be mitigated and minimized.	To reduce the impact of air emissions from the proposed coal-fired power plant, emission control systems will be installed, which includes; ▶ Low NO_X burners to meet the stack emission criteria for NO_X; ▶ Seawater-based flue gas de-sulfurization (FGD) system to reduce generation of SO_2; and ▶ Electrostatic precipitators (ESP) to remove particulate matter from the exhaust gases.
	The release of gases from the existing HUBCO power plant and Byco refinery causes eyes-irritation and respiratory illnesses among inhabitants of the villages in the area.	The new Project will be coal based unlike the existing HUBCO and Byco plants. The proposed plant will also be equipped with latest technology and equipment to ensure compliance with national and international environmental standards on emission limits.
	Agriculture fields have been ruined due to the gaseous emissions from the Byco refinery and the existing HUBCO power plant.	
	Emissions from the existing power plants are contaminating vegetation that serves as livestock feed, which, in turn, is adversely affecting the health of the livestock.	
Ash Production	Ash and coal dust emitted from coal-fired power plants have deteriorated the environment in China and India. Why is such technology being employed by Pakistan when it has been proved as hazardous for both environment and human health?	Around 53% of India's and 69% of China's energy mix is dependent on coal. The state of the art technology employed in a coal-fired power plant ensures to prevent emission of dust and sulfur into the atmosphere. The proposed Project will employ Electrostatic Precipitator (ESP) and Flue Gas Desulfurization (FGD) system to prevent dust and sulfur emission and ensure that the power plant operated within NEQS for ambient air quality.
Coal Transport	The transportation of coal directly to the proposed Project site by sea and the possible construction of a coal jetty along the coast near the proposed Project will adversely affect fishing activities and tourism in the area.	A separate ESIA will be conducted for the coal jetty; and, the shipping schedule and route will be kept in a way to ensure minimum impact on the existing fishing and tourism business prevailing in the area.

	Comments/Issues raised	*Relevant Measures Taken by Owner to address the Concerns*
Effluent Discharge	Wastewater discharges into the Hub River from the existing power plants in Hub are adversely affecting the river's water-quality. The deterioration in water-quality has adversely affected aquatic life in the river which is a source of livelihood for the fishermen. The livelihood of fishermen dependent on the Hub River has thus been adversely affected by the industrial outfall into the Hub River. Between June and August, fishermen become strictly dependent on the Hub River for fishing. This is because strong winds and heavy rainfall during this time make the sea too turbulent and dangerous for fishing there.	In the new Project, seawater will be the primary source of water and wastewater will be discharged into the sea after being treated for compliance with NEQS standards.
	Discharged wastewater should be treated before discharging it into the Hub River.	In the new Project, wastewater will be treated by effluent treatment facility in order to meet the NEQS and will be discharged in Sea.
Employment	The villagers have no permanent and reliable source of income. The villagers did not obtain employment in the previously constructed 1,292 MW power plant. The management of existing power plant did not fulfill its promise of providing employment to the local community members. It is therefore reasonable for the villagers to expect that they will be meted out the same treatment with construction of the new power plant project. Furthermore, supervisor at the power plant hire people from their respective native areas.	Recruitment from local settlements will be encouraged. Locally available labor will be used where demanded skills match the skills in the local area.
Social	Educational facilities and quality education should be provided to the villagers. There is a Scarcity of potable water is a major problem in the villages. The inhabitants are bound to buy water tankers which are expensive and beyond the means of the inhabitants. Potable water should be provided to the villagers by the project proponent to the villagers.	Owner has a Corporate Social Responsibility Plan (CSR) for the welfare of local communities. HUBCO funded activities involve TCF school, solar street lights and Hepatitis C vaccination drives. A separate ESIA will be conducted for the coal jetty; and, the shipping schedule and route will be kept in a way to ensure minimum impact on the existing fishing and tourism business prevailing in the area.
	Healthcare infrastructure in the area is lacking. Hepatitis B, C and respiratory diseases are common in the area. Health facilities or such as medical camps should be set up for the locals and ambulances should be arranged for the villagers.	

	Comments/Issues raised	*Relevant Measures Taken by Owner to address the Concerns*
	Churna Island, located about geodesic distance of approximately eight 8 km away from Mubarak village, is a famous tourist spot for deep- sea -diving spot for tourists. The boat owners of Mubarak village provide tourism services to the visitors. The coal transportation via Supramax vessels will affect the tourism adversely and thus the livelihood of the villagers.	
	Existing power plant is not beneficial for the community since generated electricity is not provided to the locals.	Provision of electricity to specific communities is not under the jurisdiction of Owner.

Exhibit 5.9: Summary of Concerns Raised by Institutions during the First Phase

Issues raised	*Addressed in the ESIA*
Marine life may be affected due to the release of warm water from the outtake. The marine study should cover this.	Marine ecology impact assessment due to the outfall from the power plant is given in **Section 8.9.**
The NEQS requirement of maximum 3ºC temperature rise from ambient sea temperature at 100 m from the outtake should be met.	According to the Thermal Plume modeling exercise in **Section 8.9.1** conducted for this Project, the outfall from the plant will comply with NEQS standards.
Dumping of ash near the coast may be a problem. ESIA should consider this potential impact	Ash will be dumped in dedicated ash ponds which will be constructed on HUBCO's owned land near the Project site. Mitigation measures that will be adopted are given in **Section 8.6.**
Emissions from the coal yard and air quality impacts should be mitigated and kept below the NEQS standards.	Impact assessment on air quality and mitigation measures are given in **Section 8.4.**
No solid or liquid waste should be dumped in the sea from the power plant.	All the effluents from the Project will comply with NEQS standards. The impact assessment on water resources and marine life are covered in **Section 8.2** and **Section 8.9.2** respectively.
Coal transportation route is of serious concern because the current road infrastructure near Hub Chowki will not be able to accommodate such traffic.	Assessment if impacts due to coal transport and mitigation measures are given in **Section 8.5.**
What will be Owner's contribution for the improvement of lives of locals?	HUBCO will plan and implement a Corporate Social Responsibility Plan (CSR) for the welfare of local communities affected by the Project.
Renewable energy sources should be considered rather than energy from coal.	Discussion of available options for power production is given in **Section 7** Analysis of Alternatives.
Air pollution will be an issue of grave concern for the local area and the city of Karachi.	Impact assessment on air quality and mitigation measures are given in **Section 8.4.** The NEQS standards for ambient air quality will be complied and International Finance Corporation (IFC) standards for stack emissions will be complied.
Special sea weeds are found near the project site which are a source of food for some fish species. Warm water from the outtake will cause damage to their survival.	Impacts on marine ecology are covered in **Section 8.9.2.**

Issues raised	*Addressed in the ESIA*
What is the type of coal that will be used for this project? What will be the percentage of ash in that coal?	Details of coal quality and percentage of ash is given in **Section 3.**
It is important to consider migratory patterns of birds from Siberia to establish if they will be affected in any way from this project.	Routes of migratory birds and impact due to the Project is covered in **Section 8.7** and **Section 8.9.2.**
It is important to conduct community consultations to consider the problems and issues that the local people in that area face.	Community consultation were conducted and their concerns are summarized in **Exhibit 5.8.**
What are other project alternatives and per unit power generation cost from coal?	Alternatives to the Project and per unit power generation cost from coal is provided in **Section 7.**
A permanent structure should be constructed to control spread of particulate matter at the coal storage yard.	Coal storage yard will have nets constructed for shielding affect from the wind. The details are provided in **Section 3.**
Excess silt on marine bed damages corals. It is important that no ash or any other particulate matter is dumped in the sea.	Assessment of impacts due to disposal of ash and mitigation measures are given in **Section 8.6.**
Byco's cooling towers and air intake will be affected because we are located in the downwind direction of the proposed plant's stack.	Air dispersion modeling (**Section 8.4**) was conduction for spread of emissions to ensure compliance with NEQS standards.
Traffic congestion is of important concern because we use the same transport route for our oil tankers.	Assessment of impact due to traffic is covered in **Section 8.5.**
NEQS limits should be complied to for water from RO.	All effluents from the Project will comply with NEQS standards.
Locals should get maximum benefit from the plant. Facilities such as education, clean water and medical facilities should be provided to the locals by Owner.	Owner will plan and implement a Corporate Social Responsibility Plan (CSR) for the welfare of local communities affected by the Project.
Some farms are also present on Hub road where local people grow cheeku, coconut and other vegetables. The impact on these trees from the plant will have to be assessed.	Assessment of socioeconomic impacts is covered in **Section 8.8.** This is assessment was conducted on the basis of socioeconomic baseline data (**Section 4.5**) collected for this Project.
We have planned residential colony in the downwind direction of the new stack. Emissions may have a socioeconomic impact on our housing.	Emissions generating from the plant were modeled using air dispersion modeling. The analysis and results are provided in **Section 8.4.**

Exhibit 5.10: Summary of Additional Concerns Raised by Institutions during the Second Phase

Issues raised	*Addressed in the ESIA*
The 2×660 MW project will, in general, potentially double the emissions and effluents and hence increase the magnitude of the impacts predicted for the 660 MW project.	Impact assessment on air quality and mitigation measures are given in **Section 8.4.**
The thermal load on Hub River or the Arabian Sea as a result of effluent discharge, will increase, which will adversely impact marine ecology in those water resources.	Marine ecology impact assessment due to the outfall from the power plant is given in **Section 8.9.**
The construction and operation of the coal jetty will result in significant impacts to marine ecology. The damage caused will be a result of both direct physical damage from construction activities such as dredging and piling, and, during operation, from the resulting changes in sediment flow and other oceanographic changes which would have an impact on the coast line and the ecology it supports.	All environmental impacts associated with the import of coal will be covered as part of a separate ESIA study
Fugitive dust emissions from ash- and coal-handling processes can fly out and settle on land and water nearby and damage biodiversity where it settles.	The impact on air quality due to coal handling and ash disposal and handling are discussed in **Section 8.4.2** and **Section 8.6** respectively
If the Hub River is used to discharge the effluents from the project, marine biodiversity would also be destroyed. The effluents should be discharged into the sea.	Impacts on marine ecology are covered in **Section 8.9.2.**
The coal dust particles have the physical properties to adsorb the air moisture which may enhance the corrosion process. Owner should ensure to protect its infrastructure also its residential area from similar effects along with neighboring industries infrastructure.	The coal storage yard and other areas with coal handling facilities will be employed with coal dust suppression system. The impact of fugitive dust from coal on the ambient air quality are further detailed in **Section 8.4.2** along with appropriate mitigation measures which will be taken to prevent damage to nearby communities and industries.
Dolphins have been reported in the coastal area where the new plant will be developed. Traffic movement of coal-carrying vessels may harm these dolphins.	Please see **Section 8.9** for detailed information on marine ecology impacts and mitigation measures .All environmental impacts associated with the import of coal will be covered as part of a separate ESIA study.
How will Owner handle accidental oil spills?	Detailed Spill Management Plan is provided in **Section 9.13.**

Issues raised	*Addressed in the ESIA*
As the air quality of the local area will be degraded by Owner, locals should receive benefit by planting trees.	The proposed ash yard already has plantation of trees for rehabilitation of site. The feasibility of planting further trees will be considered as part of Social Responsibility Plan.
Feasibility of usage of local coal should be explored rather than using imported coal.	Different coal options are analyzed in **Section 7.4** Analysis of Alternatives.
Emissions during soot blowing should also be taken into account for assessment of impacts on air quality.	The stack emissions will comply NEQS guidelines.
How will be the marine environment impacted by the construction of coal jetty?	Please see **Section 8.9** for detailed information on marine ecology impacts and mitigation measures.

6. Environmental Screening

A development project can have adverse as well as beneficial environmental impacts. The extent of the impacts depends on the nature and magnitude of the proposed activities, and the type and sensitivity of the host environment. The depth of the environmental assessment to be carried out for the proposed project also depends on these factors. A detailed environmental assessment, usually called an environmental and social impact assessment (ESIA), needs to be carried out if the project has one or more of the following attributes:

- Direct pollutant discharges that are large enough to cause degradation of air, water or soil;
- Large-scale physical disturbance of the site and/or its surroundings;
- Extraction, consumption, and/or conversion of substantial amounts of forest and other natural resources;
- measurable modification of the prevalent hydrological cycle;
- Hazardous material in more than incidental quantities; and
- Involuntary displacement of people and other significant social impacts.

An integral part of the environmental assessment is the identification of those impacts that are potentially significant and, thus, merit an in-depth assessment. In this way, impacts that are not significant and need not be addressed in detail are screened out. Having described the details of the Project; existing environmental and social conditions at the proposed location of the Project; and, the results of stakeholder consultations earlier in the report; this section consists of a screening process to identify environmental impacts of significance from the proposed coal-fired Project.

6.1 Screening Methodology

The environmental screening process is conducted using a systematic approach to assess all possible impacts of the various phases of the proposed project. Quite a few alternative techniques are used for this purpose; each having its specific advantages and disadvantages. For this Project, the matrix methodology has been employed, which is the most widely used technique.

Matrices are particularly useful for environmental assessments, as they reflect the fact that impacts result from the interaction of development activities and the environment. It is a simple but effective method, and covers all possible environmental parameters and all of the proposed project activities. The matrix is formed by listing environmental parameters along one axis, and project activities along the other. The magnitude and significance of the impact of a proposed activity on a particular environmental element is indicated in the corresponding cell using a convenient scale. This approach facilitates the linking of specific project activities with specific types of impacts, and is particularly useful for identifying significant impacts.

6.2 Development of Screening Matrix

The screening matrix for the proposed Project has been developed considering the Project activities discussed in **Section 3** and evaluating their possible impacts on the environmental parameters discussed in **Section 4** and **Section 5**. The development procedure is outlined below.

- *Objective*: To evaluate the likely impacts of the proposed Project and the associated facilities on the environment and identify issues that are potentially significant and merit in-depth assessment and thus screen out issues that are unimportant or irrelevant.
- *Participants*: The environmental assessment team of HBP
- *Methodology*: Group discussion on every aspect of the development plan and their impacts on environmental parameters.
- *Preparation*: Initial site visit, preliminary interview of community representatives, and review of background information provided by Owner.

The screening matrix thus developed is shown in **Exhibit 6.1**. The main issues that were identified are:

- Impacts of liquid effluents and cooling water system outfall by the Project on sea and marine life.
- Impact of gaseous and dust emissions from the Project on the ambient air quality.
- Traffic congestion impact due to transportation of coal from KPT.

Since these parameters have been identified as having potentially significant impacts, they are discussed in separate sections of this report.

For other issues, discussed in this section, it was concluded that the impacts were not significant enough to merit in-depth assessments. However, brief impact assessments for these were carried out and necessary mitigation measures were recommended. These impacts include:

- Soil, topography, land use and drainage pattern.
- Ash Disposal.
- Increased noise levels generated by the plant operation.
- Biological resources.

6.3 Summary of Project Impacts

The potential impacts of the Project on the surrounding physical, ecological and socioeconomic environments from the gaseous emissions and effluents are expected to reduce with the increased distance from the Project facilities.

Pakistan is suffering from an acute energy crisis. The unreliable power supply is affecting the productive end uses of power due to which the direct and multiplier benefits of productive activities are foregone and the economy incurs a loss. Due to the Project, approximately 1214 MW will be added to the system. The power generated by the Project would be supplied to various sectors that are currently impacted by the power shortages and bridge part of the energy shortfall facing the country. This, in turn, will have a positive impact on the country's economy through increase in gross domestic product (GDP). The impact will last through the life of the Project and thus, be of a long duration

6.3.1 Impacts on Air Quality

Emissions from the boiler and the combustion of fuel (such as coal) results in the emission of various types of pollutants from the plant stack. The main pollutants are oxides of nitrogen (NO_x), oxides of sulfur (SO_x) and particulate matter (PM). The release of such gases from the proposed power plant may cause eyes-irritation and respiratory illnesses among the inhabitants of nearby communities. Emissions from the Project may ruin the agriculture fields and also contaminate vegetation that serves as livestock feed, which, in turn, will adversely affect the health of the livestock.

The Project will be equipped with the following systems and equipment to ensure compliance with national environmental standards and emission limits:

- Supercritical boiler technology employing low NO_x burners for emissions compliance, which will result in reduced generation of Nitrogen Oxides (NO_x).
- Flue Gas De–sulfurization (FGD) system for removal of Sulfur Oxides (SO_x).
- Electrostatic Precipitators (ESP) as a collecting device to remove dust particles from the exhaust gases resulting from coal combustion.
- Continuous Emission Monitoring system at emission ducts.

6.3.2 Soil, Topography, Land Use and Drainage Pattern

There will be no major impact on land use as the Project land will be located on industrial land owned by HUBCO. No additional land will be acquired for the power plant or for any facilities of power plant. The land where the Project will be constructed is barren land and, thus, there will be no loss of vegetation or damage caused to any environmentally sensitive land. The only potential impact to soil quality is the disposal of ash during emergency. For this Project, if required during emergency, ash will be disposed in an emergency ash yard which will be lined with clay-lining to ensure that the leachate from ash yard does not contaminate the soil around the Project site.

6.3.3 Ash Disposal

Fly and bottom ash will be produced from the boiler island of the power plant in 85:15 ratio respectively; both ashes will be handled via dry systems and transferred to an ash yard by fully enclosed trucks after humidification. An emergency ash yard will be located in the vicinity of the Project. The ash yard will be installed with an impermeable layer at the bottom to prevent soil quality and ground water contamination. As the ash will be disposed, continuous water spraying system to suppress the ash will reduce the impact of spreading particulate matter significantly. Similar protection measures will be adopted at a permanent long term ash disposal yard outside the Project premises. A separate environmental impact assessment study will be conducted for the ash yard site selection.

6.3.4 Noise Pollution

Noise generated from the power plant will be minimal and will have no major impact as there are no sensitive receptors near the Project site. However, some communities are settled on the route that is expected to be used to transport coal from KPT to the Project site in cases of emergency. The NEQS guidelines for noise levels are applicable on single vehicles and on ambient noise levels. Noise impact due to traffic will be assessed as part of traffic impact assessment in this report.

6.3.5 Biological Resources

The habitats in the vicinity of the Project site consist largely of barren plains with scattered vegetation clusters. The vegetation species observed were grasses, shrubs and invasive mesquite species that are common in the area. No threatened terrestrial floral and faunal species have reported from the area and the population of the migratory birds near the Project site is small (the major staging grounds for these birds is the Hub Dam located approximately 55 km from the Project site). However, the quality of the stack emissions and change in air quality is likely to impact the ecological resources particularly the resident and migratory birds.

There are no threatened marine fish and marine epifaunal invertebrate communities in the Project site and vicinity. The marine turtles including Green Turtle and Olive Ridley do not use the beaches near the Project site as nesting sites and the marine mammals prefer deep waters of the ocean. There are no mangroves in the area and the corals are located at least 10 – 12 km from the Project site at Churna Island. However, the temperature and quality of the water from the Project outfall channel is likely to have an impact on the marine ecological resources and requires an assessment of impacts. Thermal plume modeling (**Section 8.9.1**) has been carried out to assess the spread of heat from the outfall location towards the sea and consequent impact on marine life.

Exhibit 6.1: Environmental Screening Matrix

Environmental Parameters	*Air Quality*	*Groundwater Quality/Quantity*	*Soil Quality*	*Marine Water Quality/Life*	*Vegetation*	*Wildlife/Birds*	*Noise and Vibration*	*Landform*	*Land Use*	*Road Traffic*	*Employment*	*Relocation*	*Loss of Livelihood*	*Access to Transport*	*Access to Services*	*Safety of Surrounding Population*	*Female Mobility*	*Cultural Resources*
Project Activities																		
Project Design & Location																		
Plant Location	–	0	–	-1	0	0	–	–	–	-1	+2	–	–	–	–	–	–	–
Ash Disposal Site Location	-1	0	0	-1	0	0	–	0	0	–	–	–	–	–	–	–	–	–
Construction Phase																		
Site Preparation	0	–	–	–	0	0	–	–	–	-1	+1	–	–	–	–	0	–	–
Transportation of Equipment, Material, Staff	-1	–	–	–	–	–	-1	0	–	-1	+1	–	–	–	–	0	0	–
Civil Works	0	–	–	–	0	0	-1	0	–	-1	+2	–	–	–	–	0	–	–
Installation Works	-1	–	–	–	–	–	-1	0	–	-1	+2	–	–	–	–	0	–	–
Waste Disposal	0	0	0	–	0	0	–	–	–	-1	–	–	–	–	–	0	–	–
Operation Phase																		
Plant Operations	-2	–	–	-1	-1	-1	0	–	–	0	+2	–	–	–	–	0	–	–
Power Generation	-1	0	–	–	0	0	0	–	–	–	+1	–	–	–	–	–	–	–
Coal Handling	-1	0	0	0	0	-1	0	–	–	-1	+2	–	–	–	–	–	–	–
Ash Disposal Transport	0	–	0	–	–	–	0	–	–	–	0	–	–	–	–	–	–	–
Waste Disposal	0	0	0	–	0	0	–	–	–	0	+1	–	–	–	–	0	–	–

Legend:

-2: Major adverse impact   -1: Minor adverse impact   0: Negligible impact, if any

+2: Major favorable impact   +1: Minor favorable impact   –: No impact, whatsoever

7. Analysis of Alternatives

The purpose of this section is to provide an analysis of the different alternatives available with regards to key aspects of the Project. It also considers a No-Project Alternative. The different aspects analyzed range from the alternatives for the selection of boiler technology to the different transport routes for coal-carrying trucks travelling from the port to the Project-site. The comparison of alternatives considers factors related to cost and technological-reliability; and, environmental impacts and consequences of the alternatives. In this manner, the objective of this section is to inform decision-makers, stakeholders and the public regarding key aspects of the Project and how they compare, environmentally and technologically, with other similar projects in the country and around the world.

The focus of the analysis of alternatives for the Project in this section is on the design-aspects related to the following environmental concerns:

- Impact on Air Quality,
- Impact on Water Quality,
- Impact on Traffic on the route used by coal-carrying trucks from Karachi Port to the Project,
- Impact on the socioeconomic environment around the Project.

These were identified as potentially significant issues based on the scoping phase of the ESIA[1], stakeholder consultations (**Section 5**) and an environmental-impacts-screening exercise (**Section 6**).

This section begins by highlighting the salient features of the existing Project design related to the environmental impacts listed above. The discussion on the analysis of alternatives which follows is organized in the following sequence:

- No-Project alternative
- Site selection for the Project
- Selection of coal-type
- Transportation of coal to the via ships and trucks
- Boiler technology
- Particulate matter emission controls
- SO_2 treatment options
- NO_x treatment options
- Cooling-water system
- Ash handling and disposal

[1] Hagler Bailly Pakistan. *"Inception Report: Coal–Fired Power Plant at Hub."* Islamabad: Hagler Bailly Pakistan, July 15, 2014.

7.1 The Proposed Project

This section provides a summarized description of the main Project features which are related to the identified significant environmental and socioeconomic impacts. A detailed description of the Project can be found in **Section 3**.

Project Capacity, Location, and Employment

HUBCO planned to install a new 2 x 660 MW coal-fired power plant in the vicinity of its existing 1,292 MW oil-fired Hub Power Station located in Hub, Baluchistan. Both the existing plant and the proposed Project are located on the same land owned by HUBCO, west of the Hub River. The Project will be located about 1.5 km north of the existing power plant, at an aerial distance of about 35 km west of Karachi city. The location of the Project is shown in **Exhibit 7.1**. The project is expected to generate between 3000 and 4000 jobs during the construction phase; and, approximately, 250 jobs once it is operational. **Exhibit 7.2** provides a map indicating the locations of the Project's main components.

Exhibit 7.1: Project Location

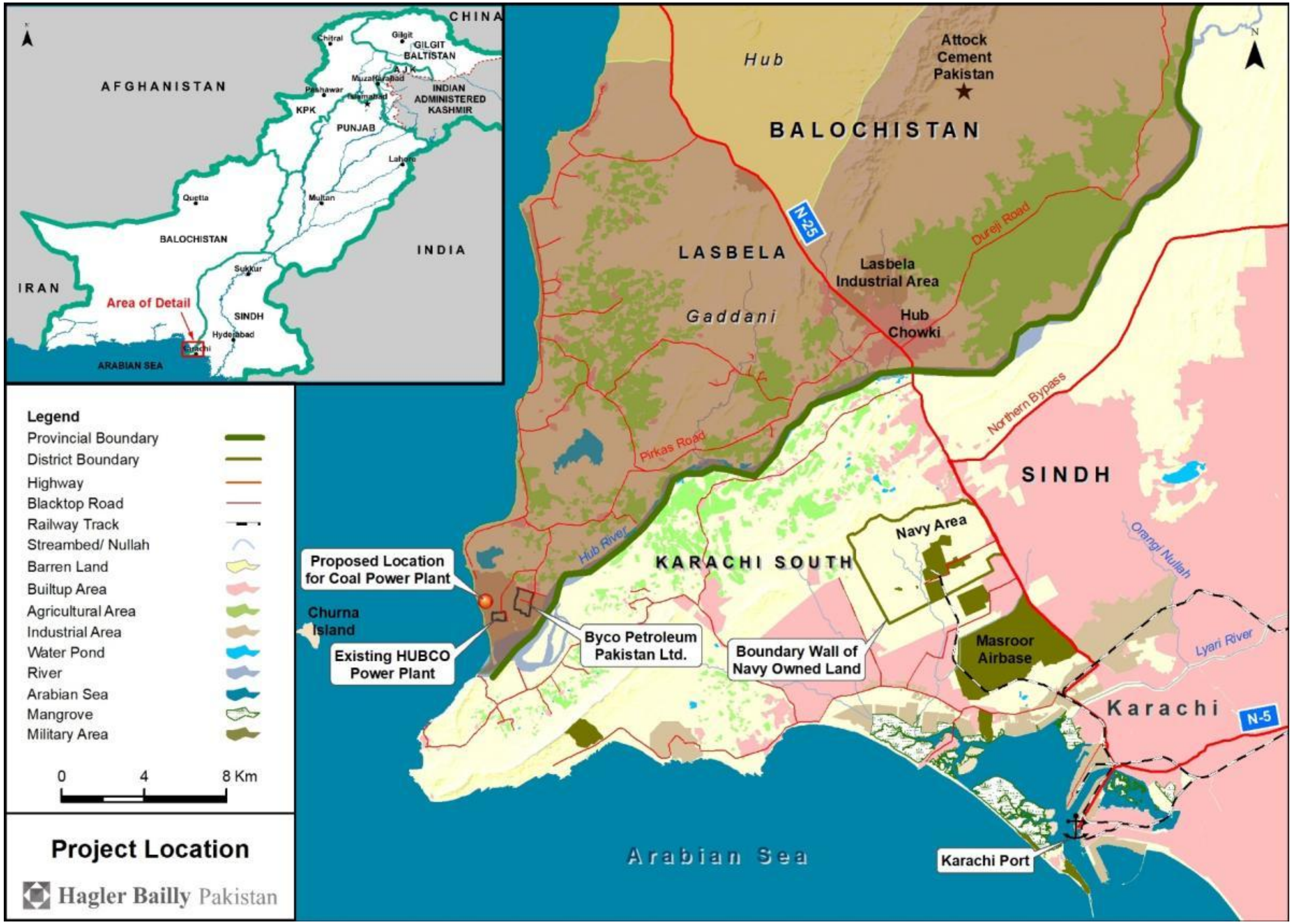
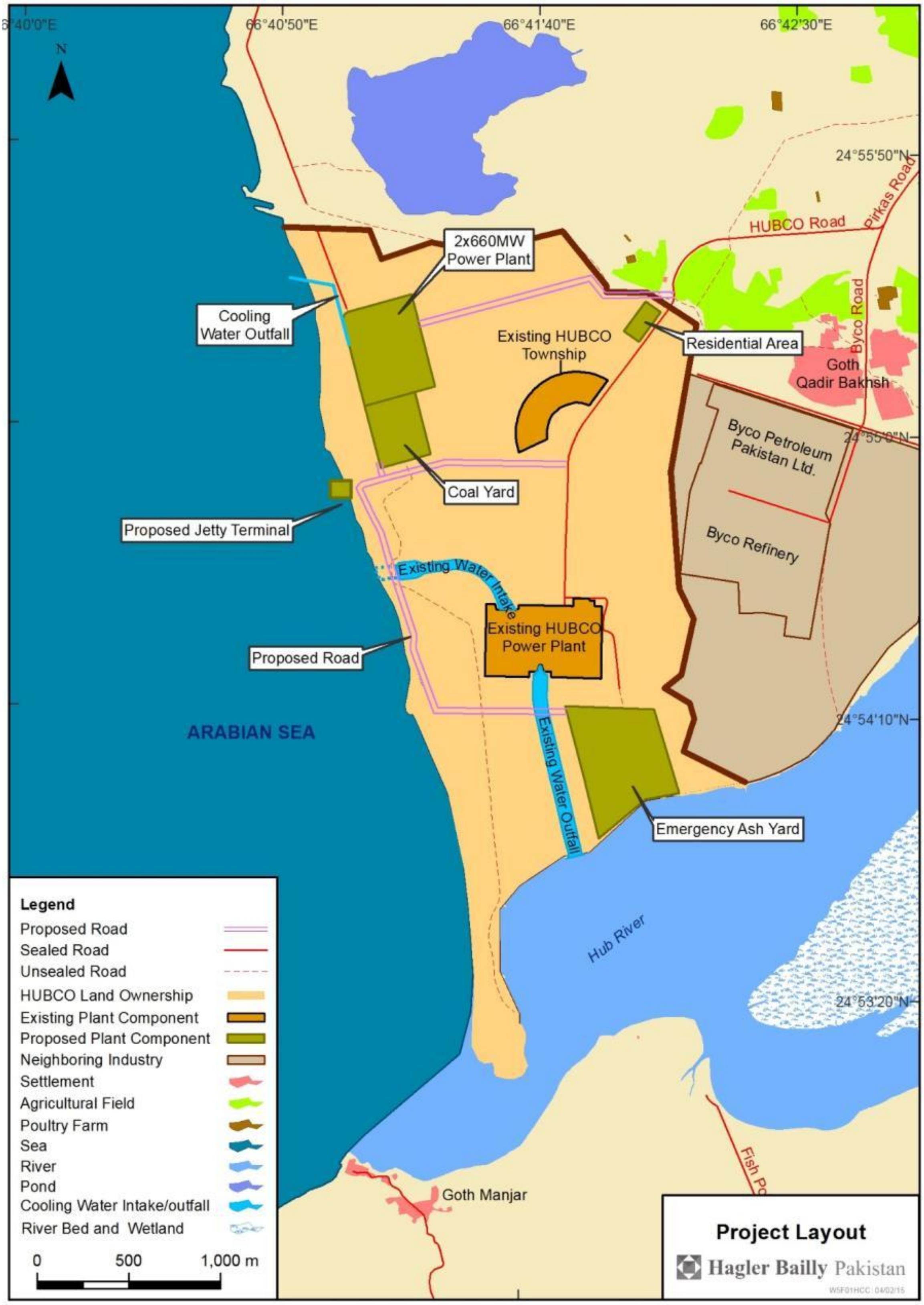


Exhibit 7.2: Locations of Main Components of the Proposed Power Plant



Boiler Technology, Coal Specifications and Coal Transport Route

The Project will comprise of two 660 MW supercritical boilers to electric power to feed to the national grid. Coal for firing the boilers will be imported either from Indonesia or South Africa. The performance-coal specifications on which the proposed plant was designed, calorific value, ash content and sulfur content are 5,500 (as-received basis[2]), 23 % (as-received basis), and 1.0 % (as-received basis), respectively.

A coal storage facility will be built near the proposed plant, within the land owned by HUBCO. Coal transportation will involve import of coal at a coal jetty near the Project and its subsequent transportation to the Project site by barges or trestle.

Environmental Control Technologies

Flue gases from the plant will be discharged into the atmosphere through a 210 m high stack. The emissions from the chimney stack of the proposed Project will contain nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM). As these are potential air pollutants, emission control systems will be installed to reduce the emissions to acceptable levels. Emission controls include:

- Low NO_x burners to reduce the amount of NO_x emissions;
- Seawater-based flue gas de-sulfurization (FGD) system to reduce generation of SO_2 and;
- Electrostatic precipitators (ESP) to remove PM from the exhaust gases.

Online analyzers for CO, SO_2, NO_x, and PM measurement will be installed in the boiler stack to continuously monitor gaseous emission.

Cooling Water System

The Project will use a once-through cooling water system. Intake water will be supplied from the sea; it will circulate through the tubes of surface condenser to absorb heat from the steam. The warmer water will be returned into the sea with an increase in temperature at the point of outfall. Plume modeling results indicate the temperature will increase no more than 3°C within 100 m of the outfall, complying with NEQS regulations.

7.2 'No-Project' Option

Pakistan is going through an acute power shortage and the existing gap between supply and demand is estimated to be up to 5,000 MW. The proposed Project represents nearly 14 % of the current gap. Thus in the absence of this project, the gap in power supply and demand will continue to grow.

However, due to the government's interest in promoting power-sector investment and changing the country's energy mix to rely on cheaper fuel sources such as coal; other proponents of coal-fired power plants will develop their projects while HUBCO will

[2] **As received basis (ar)**: Analytic data calculated to the moisture condition of sample as it arrived at the laboratory and before any processing or conditioning. If sample has been maintained in a sealed state, so there has been no gain or loss, the as received basis is equivalent to the moisture basis as sampled.

continue to generate electricity through its existing plants including the 1,292 MW oil-fired Hub Power Station.

7.3 Alternatives to the Proposed Project

The alternatives to the proposed Project include power generation from LNG/imported natural gas based combined cycle gas turbines (CCGTs), and fuel oil based diesel engines or steam plants. In addition, green field thermal projects and other options such as nuclear, run-of-the-river (RoR) hydropower, or wind and solar based renewable energy power plants at other suitable locations can also be considered. An analysis of the life cycle average cost of generation from the competing technologies was carried out to assess the least cost generation alternative of the project.

Exhibit 7.3 illustrates the calculation of life cycle average cost for the competing alternatives for power generation in Pakistan. The analysis was carried out at the delivered prices of US$ 696 per ton for fuel oil[3] and US$120/ton for imported coal. The price of LNG/imported natural gas was also worked out with reference to the Brent crude oil price. The cost data of alternatives for thermal power generation were taken from recent industry experience in Pakistan.

Exhibit 7.4 provides a comparison of cost of generation from various project alternatives. The column 'New Imported Coal Fired Steam' indicates the economics of the proposed 2 x 660 MW capacity under the Project.

The cost of generation from run-of-the-river hydropower (ROR) projects works out to be lower than the proposed Project. However, the cost of ROR must be dealt with caution as it is based on average cost and hydrology data of a basket of ROR projects in Pakistan. The actual capital cost and plant factors of any specific ROR project could vary significantly from project to project. In addition, the ROR potential lies in the northern region of the country and these projects may require additional investment in transmission interconnections to supply the generated power to the Southern and mid-country markets. The power generated by ROR plants also varies seasonally, and is reduced to about 25% of the peak capacity in winters. Given the mix of available power generation capacity in Pakistan, the shortfalls in power supply in winter attributable to ROR plants have to be met by operation of thermal power generation units such as the one proposed under the Project. Given these constraints and considerations, the Project may be thought of being at least as competitive as the low-cost RORs if not cheaper. Other than RORs, it is the least cost option among other available alternatives.

[3] Corresponding to Brent Crude oil price of US$102/bbl

Exhibit 7.3: Life Cycle Average Cost of Power Generation from the Project Alternatives

Cost Parameters	*Cost Units*	*New Imported Coal Fired Steam at Hub*	*CCGT-LNG/ Imported Gas*	*Diesel Engine- Fuel Oil*	*New Steam- Fuel Oil*	*Hydel RoR*	*Wind*
Project Life	Years	30	30	25	30	30	20
Plant Factor		85%	85%	85%	85%	55%	30%
Plant Efficiency		39.5%	48%	44%	38%	0%	0%
Average Cost of Generation	PKR/kWh	7.6 [1]	> 10.0 [2]	23.0 [3]	17.0 [3]	6.5 [4]	15.5 [1]

Sources:

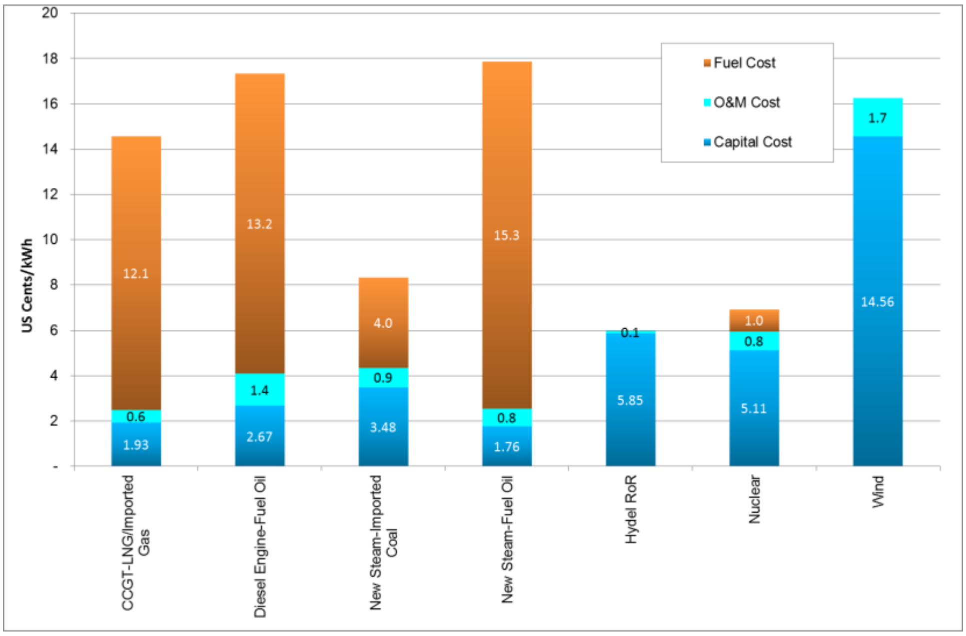
[1] NEPRA Up-front tariff;

[2] Fuel cost will take Rs. 10/kWh with an estimation of gas price as 11 USD/MMBTU;

[3] National Power Policy 2013;

[4] National Power System Expansion Plan 2011-2030 Main Report

Exhibit 7.4: Comparison of Cost of Power Generation from the Project Alternatives



7.4 Selection of Imported Coal for the Project

Pakistan is currently embarking on diversifying its fuel mix for power generation. One of the proposed strategies is to import coal for new coal-fired plants. Owner placed a preference on Indonesian coals due to the relatively cheaper cost, shorter transportation distance and large options of low sulfur varieties. This section will discuss the coal supply from Indonesia, covering the available sources and supplies, and the cost for Owner's proposed coal-fired power plant. Other similar coal is available in South Africa and Australia. **Exhibit 7.5** presents the properties of sub-bituminous coal from Australia, Indonesia, and South Africa. The Project will not use local coal, however, properties of Thar coal are also provided for reference.

Exhibit 7.5: Comparisons of Coal Properties

Coal Properties	*Sub-bituminous Coal*		*Lignite Coal*	
	*Australia**	*Indonesia**	*South Africa**	*Thar***
Total Moisture (as-received basis, arb, wt. %)	15.0 max	15-28	12.0 max	45.7
Coal Ash Content (arb, wt. %)	15.0 max	10-15	15.0 max	9.69
Volatile Matter (arb, wt. %)	24-35	36-45	22.0 min	25.0
Sulfur Content (arb, wt. %)	0.75 max	1.0 max	1.0 max	1.38
Coal Net Calorific Value (kcal/kg)	5,800-6,000	4,600-6,000	5,800-6,000	2,630

* Global Coal: https://www.globalcoal.com/Brochureware/standardTradingContract/specifications/

** Hagler Bailly Pakistan. "Environmental and Social Baseline." ESIA of Thar Coal Block II Mining Project. Karachi: Sindh Engro Coal Mining Company, 2012. 3-18

Indonesian coal has been selected for its large quantity of coal reserves spread out over most of its country. According to the World Energy Council[4], Indonesia has 6.1 billion tons of recoverable coal, located primarily in Sumatra and East and South Kalimantan. Government and industry estimates suggest that the resource base may be considerably higher than this amount.

Indonesian coal is, by large, sub-bituminous, with low ash, low sulfur, high volatilities and average Gross Calorific Value. Coal pricing is a factor of quality. The price index governing Indonesian Coal is known as Harga Acuan Batubara (HAB). The price is derived based on a marker coal price with the quality presented in **Exhibit 7.6**.

Exhibit 7.6: Quality of Coal for Marker Coal Price

Gross Calorific Value (GCV arb)	*6,322 kcal/kg*
Total Moisture (% arb)	8%
Total Sulfur (% arb)	0.8%
Ash (% arb)	15%

Most large coal mines in Indonesia have an established logistics network between the mines and the sea port. One of the deciding factors for Indonesian coal import is the distance from the source to the ports in Pakistan in comparison to that for South Africa and Australia, which will reduce the transport cost significantly.

Current production of coal in Pakistan is 3.5 million tons/year, of which 39 % is in Baluchistan, 18 % in Punjab, and 32 % in Sindh. Production is confined to small deposits scattered throughout the country, and fulfills about 45 % of the demand for coal in the country which exceeds 8.4 million tons/year[5]. The production is mainly utilized in the brick kiln and the cement industry. The quality of coal produced in the country is highly variable[6], with sulfur content ranging from 3% to 5%, and ash content ranging from 5% to 20%. Coal from the existing mines cannot be considered for utilization at the Project in view of limited availability, poor quality, and a high level of variation in quality as there is no single mine in the country that can meet the requirements of the Project, estimated at 2.5 million tons/year. Therefore, the Project will rely solely on imported coal throughout its operational life.

7.5 Alternatives Sites for the Proposed Project

The main selection criteria for the site for coal-based power plant are the following:

- Proximity to source of coal, in this case the ports;

[4] U.S. Department of Energy. "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Indonesia. http://www.eia.gov/countries/cab.cfm?fips=id (accessed September 29, 2014).

[5] U.S. Department of Energy. "*U.S. Energy Information Administration - EIA - Independent Statistics and Analysis.*" Pakistan. http://www.eia.gov/countries/country-data.cfm?fips=PK (accessed September 29, 2014).

[6] Pakistan Coal Power Generation Potential, Private Power Infrastructure Board, June 2004.

- Availability of cooling water;
- Proximity to transmission network for evacuation of power;
- Proximity to road network for transportation of equipment;
- Connection with the rail network for the transportation of coal;
- Availability of sufficient land;
- Sufficient distance from population centers; and
- Safe distance from ecologically sensitive areas.

Reviewing the map of southern Baluchistan in light of the above criteria, it is evident that there are not many choices and also the advantages proposed site can be appreciated. An evaluation of the potential sites based on these criteria is presented in **Exhibit 7.7**.

The industrial land owned by HUBCO southwest of Hub City stands out to be a natural choice. It is well connected with the road network; a year-round source of water is available in the form of the Arabian Sea, the transmission line network is available at the site of HUBCO's existing oil-fired power plant in the vicinity; it is located at a suitable distance from the Karachi Port; there is sufficient land available; it is at a reasonable distance from population center; and it is not close to any ecologically sensitive area.

7.6 Port Handling and Transportation of Coal

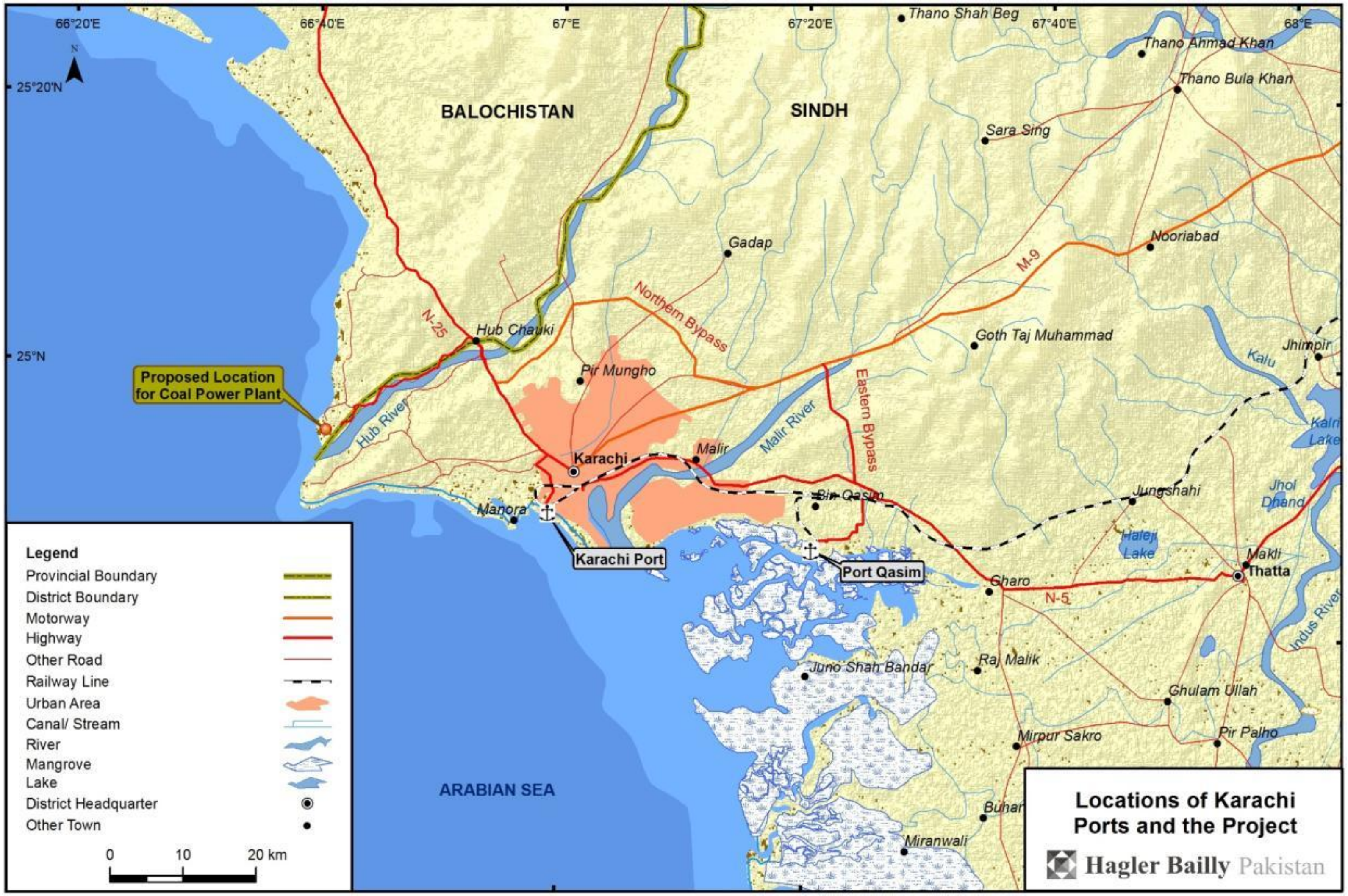
For this Project, coal is expected to be transported to the plant site through ships. It is expected that ships will be anchored at a distance from the power plant and coal will be transported to the plant either through mother vessel jetty. The detailed transport mechanism and associated environmental impacts are covered in a separate study titled ESIA of Coal Jetty.

For emergency purposes in case of a breakdown at coal jetty, coal is expected to be unloaded at Karachi Port and transported to the Project site via trucks. Analysis of different options for road transport is discussed in the following section.

Exhibit 7.7: Selection of Site for the Power Plant

Criteria	*Areas that meet the criteria*
Proximity to source of coal, in this case the ports	Given that the port of import for the coal (Karachi Port) is in southern Sindh, the transportation cost will be minimized by locating the plant either in or close to southern Sindh. Further, given that imported coal will be the main source of coal supply, in order to optimize transportation cost, the site should be close to the port or close to sites where there is a potential for future dedicated coal-handling jetties/ports to be developed such as Gadani in southern Baluchistan. **Suitable area:** Area in southern Sindh or Baluchistan, below 26° N and between Gadani in Baluchistan and Karachi Port.
Availability of cooling water	Potential sources of cooling water are the sea or Hub River. The flow in the Hub River is not guaranteed to meet cooling water requirements for the plant throughout the year. There are no ground water resources or irrigation canals near the proposed location of the Project. **Suitable areas:** Coastal zone, where the seawater may be available in sufficient quantity.
Proximity to transmission network for evacuation of power	The present circuit of 500 kV transmission line, the backbone of the transmission system, in the southern Sindh consists of a grid station at HUBCO which is west of Karachi and at the location where the proposed Project is being planned. There is also one location in Jamshoro and a 500 kV line connecting these that generally follows M-9 (Super Highway). The secondary 220kV network is found in areas around Hyderabad and along the M-9. **Suitable area:** Areas north of the latitude of 25° N preferably the existing HUBCO site.
Proximity to road network for transportation of equipment	The main highways which can be used for the transport of the equipment are the N-5 and the M-10. **Suitable area:** Areas within a short distance (say 10 km) of the N-5, or M-10.
Availability of sufficient land	There is sufficient land available throughout the region and this criterion does not limit the choice. However, west of Hub River there are settled areas, industries and the Hub City. Here land is both expensive and conversion to industrial purpose may not be preferable. **Suitable area:** Area within the existing industrial area in Hub.
Sufficient distance from population centers; and	The population density is high close to the Hub City and decreases westwards towards the coast. There are a few small settlements in this area. **Suitable area:** Preferably areas close to the coast, west of the Hub River.
Away from ecologically sensitive areas.	There are no ecologically sensitive areas in the region where the Project is being planned.

Exhibit 7.8: Locations of Karachi Ports and the Project Transportation



7.6.1 Transportation of Coal to the Project Site during Emergency

The basis of coal transport and its associated traffic impact is discussed in **Section 8.5**. There are three options for transporting coal during emergency, by road, from KP to the Project-site as shown by **Exhibit 7.9**.

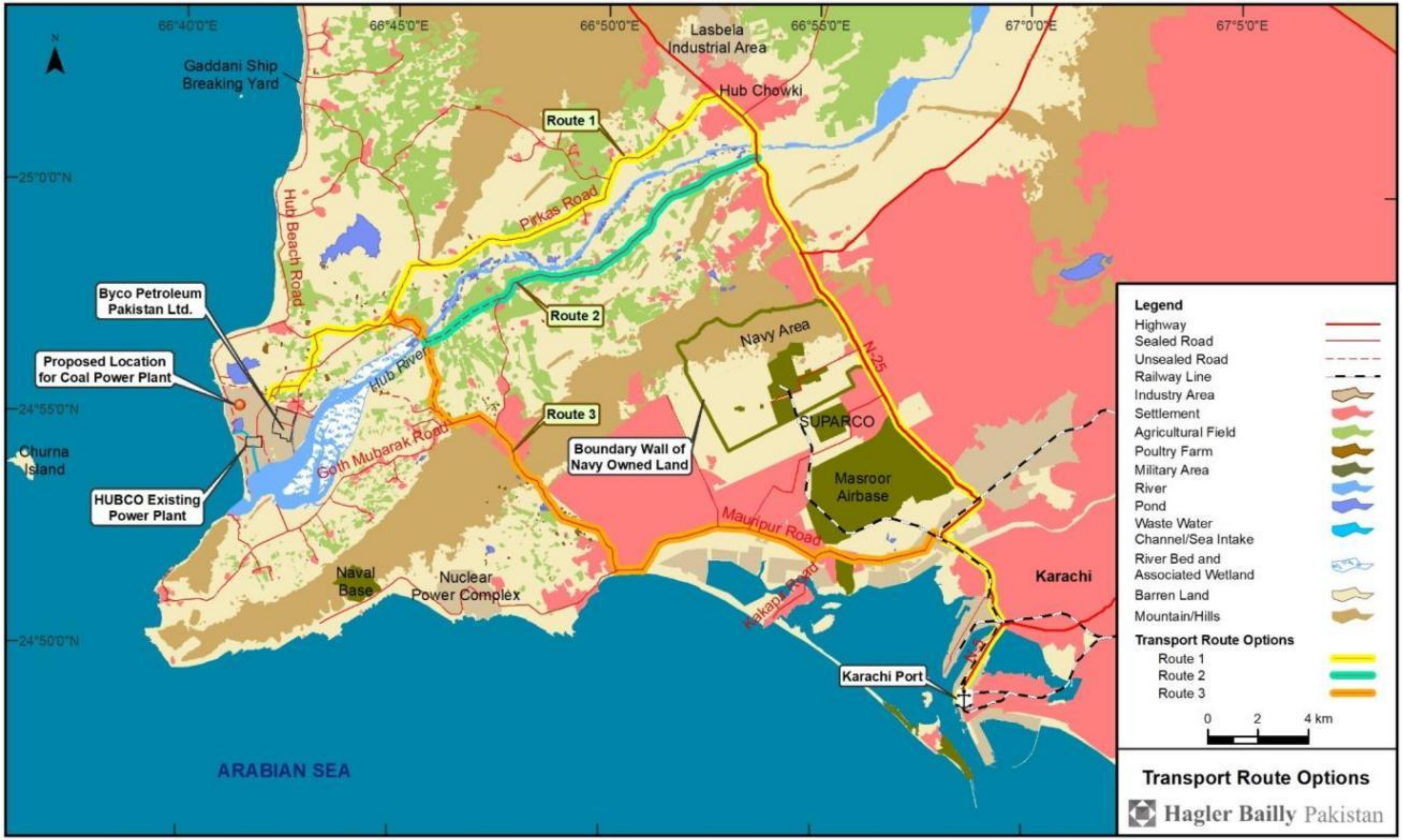
- Route-1 - the 'Hub Chowki Route':
  - KP – Northern Bypass (N25) – M10 – Pirkas Road – Proposed Plant
  - Distance: 54 km
  - Condition: Paved Surface
- Route-2 - the 'Hub River Route' :
  - KP – Northern Bypass (N25) – M10 – 'Village Road North of Hub River' – Proposed Plant
  - Distance: 68 km
  - Condition: Combination of Paved and Unpaved (6 km) Surfaces
- Route-3 – 'Maripur Route' :
  - KP – Northern Bypass (N25) – M10 – Mauripur Road – Goth Mubarak Road – 'Village Road' – Proposed Plant
  - Distance: 71 km
  - Condition: Combination of Paved and Unpaved Surfaces

Route-1 is the shortest route, approximately 54 km from KP to the Project. It is also the only route which has a paved road surface throughout. The only heavily populated area it traverses through before arriving at the Project-site would be Hub city. However, as it the shortest and the only paved route throughout, it is the preferred option for the Project.

Route-2 is, approximately, 68 km from KP to the Project. This route avoids passing through Hub City by turning left off the M10 onto a village road. The village road is followed by an, approximately, 6 km stretch of an unpaved road passing through sparsely populated villages on route to the Project-site. Although longer than Route 1, this may be a viable option in the future if the unpaved road can be developed. By avoiding Hub City, it may save on time and fuel required to reach the proposed plant from KP. This route will not only ease potential congestion at Hub city as a result of the Project, it will also provide local villagers better accessibility by developing the unpaved village roads. If this route is developed in the future, Route-2 will become the preferred option for transporting coal by road.

Route-3 is, approximately, 71 km from KP to the Project. It is the longest among the three options. The only heavily populated urban center it traverses through is the Masroor Air Base. After the Masroor Base, the route traverses through empty barren lands, some possessing indications of use as industrial storage yards. After this part, the route traverses through sparsely populated villages on route to the Project-site. Approximately, 5 km of the route, in this section is unpaved. Although longer than both Route 1 and Route 2, it may become a viable option in the future if the unpaved road can be developed. By avoiding all the densely populated areas the other two routes traverse through, it may save on the time and fuel required to reach the proposed plant from KP. This route will not only ease potential congestion at Hub City, as a result of the Project, it will also provide local villagers better accessibility by developing the unpaved village roads.

Exhibit 7.9: Routes for Transportation of Coal from Karachi Port to the Project



7.7 Boiler Combustion Technology

Coal based thermal power plants with advanced coal technologies aim to increase the amount of electrical energy extracted from each unit of coal fired boiler. The coal boiler solutions considered are:

- Various advanced pulverized coal (PC) combustion technologies (subcritical, supercritical, ultra supercritical)
- Fluidized bed combustion (FBC) technologies (atmospheric, circulating and pressurized).

It is important that the proposed solution for coal fired steam generators is a technologically proven and commercially available. Although a number of new technological advances in this field have been achieved, it is imperative that only commercially proven systems are considered to reduce risks during implementation and subsequent operation and maintenance.

7.7.1 Pulverized Coal-Fired

Pulverized Coal (PC) fired stations have been in use more than 60 years and, in terms of overall numbers and generating capacity, they dominate the global market. Pulverized fuel (PF) based plant is in widespread use throughout the world, in both the developed and developing nations. PF firing technology has emerged as an environmentally acceptable technology for burning a wide range of solid fuels to generate steam and electric power. Plants with PF boilers are available up to a current maximum capacity of 1,300MW.

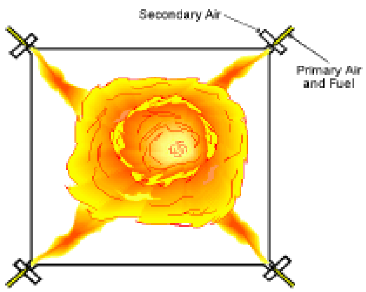
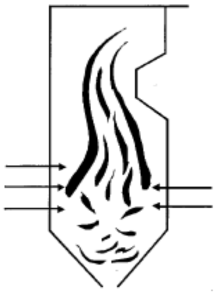
Over the years, many advances have been made with pulverized fuel technology, including environmentally focused measures to minimize emissions of SO_x, NO_x and particulates, as well as application of advanced steam cycles that allow for greater plant efficiency. Globally, PF plant is characterized by overall thermal efficiencies of up to roughly 36% (Lower Heating Value [LHV] basis), whereas plant with higher steam temperatures and pressures can attain up to some 45%. As further developments take place in the metallurgy of critical components of boiler and turbine that are exposed to high pressure and high temperature steam, it is expected that efficiencies of 50% to 55% will ultimately be achieved.

It has to be noted however, that the increase in efficiency of the generating plant is due to the combination of the boiler and steam turbine working at higher pressures and temperatures. As far as the steam generation is concerned, the efficiency of the boiler per say does not vary much as steam pressures and temperatures are increased.

Firing System

Controlling parameters in the PF combustion process are time, temperature and turbulence. In a PF boiler, furnace temperature shall be about 1,300 to 1,500°C and fuel residence time is about 2 to 5 seconds. The most popular system for firing pulverized coal is the use of tangential firing and opposing firing shown in **Exhibit 7.10.**

Exhibit 7.10: Type of PF Firing System

Type of Firing	*Tangential firing*	*Wall/Opposing firing*
Description	Four burners corner to corner to create a fire ball at the center of the furnace.	Typically the combustion is staged, with the first stage combustion taking place from the burners to the center of the furnace. The partially combusted material mixes in the flow upwards; there over fire air ports encourage complete combustion by supply air for the second stage of combustion.
Schematic diagram		

Advantages of PF Combustion

The following are the advantages of the PF combustion technology:

- *Fuel Flexibility* - PF boiler has the ability to burn varying quality of coals and all ranks of coal from anthracitic to lignite, and it permits combination of firing (i.e., can use coal, oil and gas). Because of these advantages, there is widespread use of pulverized coal furnaces.
- *High Combustion Efficiency* - Since the coal is being burnt in pulverized form, the rate of burning the amount of excess air required are optimized resulting in better combustion efficiency than the other types of boilers.
- *Sustainability to load variations* – The boiler is known to have high thermal inertia than any equipment in a power station. In such case, the rate of reaction with respect to load variation is the most essential. A PF boiler has the flexibility to sustain load variations in very short periods than any other type of boiler. This will increase the operational flexibility for the plant operator.
- *Maintenance problems* – Pulverized fuel boilers are less outage-prone when compared with other types of boilers such as Fluidized Bed Combustion boilers. Erosion of economizer and pressure parts are less, and hence the outages are less. However, there is a need to be vigilant and maintain the grinding elements of the pulverizers.
- *Proven-ness and Reliability* – Pulverized fuel fired boilers are reliable and proven worldwide since 1918, when Milwaukee Electric Railway and Light company, later Wisconsin Electric, conducted tests in the use of pulverized coal in 1918. Plants with PF boilers are available up to a maximum capacity of 1,300MW.

Classification of PF Coal Power Plants

Pulverized coal power plants are broken down into three categories; subcritical pulverized coal plants, supercritical pulverized coal plants, and ultra-supercritical pulverized coal plants. The classifications are mainly based on the live steam parameters and reheat steam temperature. Some of the well-known classifications are presented in **Exhibit 7.11**.

Exhibit 7.11: Classification of Pulverized Coal Plants

Category	*Unit*	*Subcritical*	*Supercritical*	*Ultra supercritical*
Year		<1950	1950s	2000-
Live steam pressure	Bar	165	>221	>300
Live steam temperature	°C	540	540-560	>600
Reheat steam temperature	°C	540	560	>600
Single Reheat		Yes	Yes	No
Double Reheat		No	No	Yes
Power Plant Generating Efficiency	%	~38	~41	~46+

Source: Henderson, 2003; Smeers et al., 2001.

7.7.2 Fluidized Bed Combustion

Fluidized bed combustion (FBC) power plants use the same steam cycle as conventional PF plant. They raise steam via a different combustion technology. The possibility of applying fluidized bed combustion technology for the generation of electricity from coal first attracted worldwide interest in the 1960´s. This was especially because it promised to be a cost effective alternative to PF plants, while at the same time allowing sulfur capture without use of add-on scrubbers. Moreover, the technology is suitable for high ash, variable quality, high moisture and high sulfur fuels.

FBC is a method of burning coal in bed of heated particles suspended in a gas flow. An evenly distributed air or gas stream is passed upward through a finely divided bed of solid particles such as sand supported on a fine mesh; the particles are undisturbed at low velocity. As air velocity is gradually increased, a stage is reached when the individual particles are suspended in the air stream and the bed is called “fluidized”.

Classification of FBC

FBC falls into three main categories which is atmospheric fluidized bed combustion (AFBC), pressurized fluidized bed combustion (PFBC), and advanced pressurized fluidized bed combustion (APFBC).

Atmospheric fluidized-bed combustion (AFBC) technology is commercially available in subcritical pressure with a size limit of about 350 MW. FBC is commercially available as bubbling fluidized bed combustion (BFBC) or circulating fluidized bed combustion (CFBC) version. CFBC technology has emerged as an environmentally acceptable technology for burning a wide range of solid fuels to generate steam and electric power.

In PFBC type, a compressor supplies the forced draft (FD) air and the combustor is a pressure vessel. In PFB plant, the boiler combustion occurs under pressure. The pressure is typically 6 to 16 times higher than atmosphere pressure. The heat release rate in the bed is proportional to the bed pressure and hence a deep bed is used to extract large amounts of heat. This improves the combustion efficiency and sulfur dioxide absorption in the bed.

APFBC, a technology that will not be commercially available for at least 10 years, will utilize high temperature gas turbines and have cycle efficiency of above 50% by fuel gasification. The bed also operates at a higher temperature which improves efficiency at expense of higher NO_x emission.

Advantages of FBC

The following are few of the advantages of FBC:

- *Fuel Flexibility* - The relatively low furnace temperatures are below the ash softening temperature for nearly all fuels. As a result, the furnace design is independent of ash characteristics which allow a given furnace to handle a wide range of fuels.
- *Low SO_2 Emissions* - Limestone is effective sulfur sorbent in the temperature range of (815 – 925°C). SO_2 removal efficiency of 95% and higher has been demonstrated along with good sorbent utilization.
- *Low NO_x Emissions* - Low furnace temperature plus staging of air feed to the furnace produce very low NO_x emissions.
- *Combustion Efficiency* - The long solids residence time in the furnace resulting from the collection/recirculation of solids via the cyclone, plus the vigorous solids/gas contact in the furnace caused by the fluidization airflow, result in better combustion efficiency, even with difficult-to-burn fuels.

7.7.3 The Proposed Technology for Boiler Combustion

Exhibit 7.12 presents a comparison of various types of pulverized coal combustion and fluidized bed combustion technologies. The selected coal combustion technology for the proposed Plant is the PF fired supercritical boiler. The main reason for selecting PF boiler was low complexity of the firing system. The supercritical boiler was selected for its high efficiency.

Exhibit 7.12: Technical and Economic Status for Coal Combustion Technologies

Criteria	*Pulverized Coal-Fired Combustion*		*Fluidized Bed Combustion*	
	Subcritical	*Supercritical*	*CFBC*	*PFBC*
Status	Commercial	Commercial	Commercial	Demonstrated
Complexity	Low	Medium	Medium	Medium
Usage	Base/medium load	Base/medium load	Base/medium load	Base/medium load
Fuel range	All coals, Co-firing with selected biomass	All coals, Co-firing with selected biomass	All coals, residuals, biomass	All coals
Operational flexibility	Medium – performance limited at low load	Medium – performance limited at low load	Medium – potentially similar to PF but not yet proven.	Medium – potentially similar to PF but not yet proven.
Unit size	< 1000 MW	400 – 1,000 MW	≤460 MW	≤360 MW
Environmental performance	Requires ESP for Particulate Matter Control, FGD for SO_x Emission Control. NO_x reduction mainly achievable via burner design and configuration	Requires ESP for Particulate Matter Control, FGD for SO_x Emission Control. NO_x reduction mainly achievable via burner design and configuration	Requires ESP for Particulate Matter Control. SO_x Emission controlled by in furnace limestone injection. NO_x reduction mainly achievable via low temperature combustion	Requires ESP for Particulate Matter Control. SO_x Emission controlled by in furnace limestone injection. NO_x reduction mainly achievable via low temperature combustion
Availability	Proven to be excellent	Proven to be good	Proven to be good	Limited experience

7.8 Environmental Control Technology

7.8.1 Particulate Matter Treatment Options

Particulate matter treatment technologies are electrostatic precipitators (ESP), fabric filters, cyclones and wet scrubbers. **Exhibit 7.13** presents a comparison among the technologies in terms of efficiencies, advantages and disadvantages.

Exhibit 7.13: Particulate Matter Control Technologies

Control Technology	*Description*	*Control Efficiency*	*Advantages*	*Disadvantages*
Electrostatic precipitator (ESP)	ESP is applicable to a variety of coal combustion sources and the negatively charged dry precipitator is most commonly used. The high-voltage fields to apply large electrical charges to particles moving through the field. The charged particles move toward an oppositely charged collection surface, where they accumulate. The accumulated particles are than removed by rapper and collected at ESP hopper.	>99 %	High collection efficiency of 99% or greater at relatively low energy consumption. Low pressure drop. Continuous operation with minimum maintenance. Relatively low operation costs. Operation capability at high temperature (up to 700 °C) and high pressure (up to 10 atm) Capability to handle relatively large gas flow rates. (up to 50,000 m3/min)	High capital cost High sensitivity to fluctuations in gas stream (flow rates, temperature, particulate and gas composition, and particulate loadings) Difficulties with the collection of particles with extremely high or low resistivity. - High space requirement for installation - Highly trained maintenance personnel required.
Fabric filters or bag houses	Fabric filters are widely applied to combustion sources since 1970s. It consist of a number of filtering elements (bags) along the bag cleaning system contained in a main shell structure incorporating dust hopper. The particle-laden gas stream pass through the tightly woven fabric and the particulates are collected on one side of fabric. Filtered gas passes through the bags and is exhausted from the unit. When cleaning is necessary, dampers are used to isolate a compartment of bags from the inlet gas flow. Then, some of the filtered gas passes in the reverse direction in order to remove some of the dust cake. The gas used for reverse air cleaning is re-filtered and released.	99.9%	Very high collection efficiency (99.9%). Relative insensitivity to gas stream fluctuations and large changes in inlet dust loadings (for continuously cleaned filters). Recirculation of filter outlet air. Dry recovery of collected material for subsequent processing and disposal. No corrosion problems. Simple maintenance, flammable dust collection in the absence of high voltage Various configurations and dimensions of filter collectors Relatively simple operation	Requirement of costly refractory mineral or metallic fabric at temperatures in excess of 290 °C. Need for fabric treatment to remove collected dust and reduce seepage of certain dusts. Relatively high maintenance requirements Shortened fabric life at elevated temperatures and in the presence of acid or alkaline particulate. Respiratory protection requirement for fabric replacement. Medium pressure-drop.

Control Technology	*Description*	*Control Efficiency*	*Advantages*	*Disadvantages*
Wet scrubber	Wet scrubbers including venture and flooded disc scrubbers, tray or tower units, turbulent contact absorbers or high pressure impingement scrubbers are applicable particulate matter and SO_x control on coal-fired combustion sources. The system requires substantial amounts of water and chemicals for neutralizing. Water is injected into the flue gas stream at the venture throat to form droplets. Fly ash particles impact with the droplets forming a wet by-product which then generally requires disposal.	95-99%	Relatively small space requirement. Ability to collect gases, as well as “sticky” particulates. Ability to handle high-temperature, high-humidity gas streams Low capital cost (if wastewater treatment system is not required) High collection efficiency of fine particulates (95-99%).	Potential water disposal/effluent treatment problem. Corrosion problems (more severe than with dry systems). Potentially objectionable steam plume opacity or droplet entrainment Potentially high pressure drop. Potential problem of solid buildup at the wet-dry interface Relatively high maintenance costs
Cyclone or multi-cyclone	A cyclone is a cylindrical vessel which can be installed singly, in series or groups as in a multi-cyclone collector. The flue gas enters the vessel tangentially and sets up a rotary motion whirling in a circular or conical path. The particles are hits against the walls by centrifugal force of the flue gas motion where they are impinge and eventually settle into hoppers. Cyclones is referred as mechanical collectors and are often used as a pre-collector upstream of an ESP, fabric filter or wet scrubber so that these devices can specified for lower particle loadings to reduce capital and operating costs.	90-95%	Low capital cost. Relative simplicity and few maintenance problems. Relatively low operating pressure drop. Temperature and pressure limitations imposed only by the materials of construction used Dry collection and disposal. Relatively small space requirements	Relatively low overall particulate collection efficiencies especially for particulate sizes below 10 micron (PM_{10}). Inability to handle sticky materials.

For the proposed supercritical PF boiler, ESP is the preferred alternative to control particulate matter emission in the flue gas. The exhaust hot flue gas from the boiler will carry the fine particle pass flows through the heat recovery area and then the fine particle will be captured by the ESP and transported to dry fly ash silos. The clean flue gas shall induce by induced draft fan and exhaust through chimney. The ESP has been selected to control PM emission since ESP can be applied to wide range of system sizes and should have no effect on combustion system performance. Besides that, ESP will enable the proposed Project to meet the Pakistan emission standard. The outlet particulate concentration at the ESP is estimated to be less than 50 mg/Nm^3.

7.8.2 SO_2 Treatment Options

Several techniques are used to reduce SO_2 emissions from coal combustion. Flue gas desulfurization (FGD) systems are in current operation on several coal-fired utility boilers. Post combustion FGD techniques can remove SO_2 formed during combustion by using an alkaline reagent to absorb SO_2 in the flue gas. Flue gases can be treated using wet, dry, or semi-dry desulfurization processes of either the throwaway type (in which all waste streams are discarded) or the recovery/regenerable type (in which the SO_2 absorbent is regenerated and reused).

- Wet FGD is the most commonly applied techniques for SO_x emission reduction. Wet systems generally use alkali slurries as the SO_2 absorbent medium and can be designed to remove greater than 90% of the incoming SO_2. The effectiveness of these devices depends not only on control device design but also on operating variables. Lime or limestone scrubbers, sodium scrubbers, and dual alkali scrubbers are among the commercially proven wet FGD systems.
- Seawater FGD: The Seawater FGD process is a variant of the Wet FGD method which takes advantage of the natural properties of Seawater to absorb and neutralize SO_2. Seawater contains significant amounts of HCO3- and other alkaline compounds that help SO_2 in flue gas dissolve in water. During seawater desulfurization, water is the primary absorber. The overall Seawater FGD system is extremely simple, composed of only a few pieces of equipment, leading to fewer mechanical problems, and ease in operation and maintenance. Seawater FGD offers some significant advantages over a conventional limestone FGD system: the only absorbents are the seawater and air; and, there are no by-products which required particulate removal. The spent seawater in Seawater FGD is discharged into the sea after recovery of pH, COD and DO.
- Dry FGD/ Spray Drying: Dry scrubbers are an alternative application for SO_2 removal. Dry FGD require the use of efficient particulate control device such as ESP or fabric filter. Instead of saturating the flue gas, dry FGD uses little or no moisture and thus eliminates the need for dewatering. The spray dryer solids are entrained in the flue gas and carried out of the dryer to a particulate control device such as an ESP or baghouse. Dry FGD have been proven with low-sulfur coal in the United States and elsewhere, but their applicability for use with high-sulfur coals has not been widely demonstrated.

- Furnace Injection: A dry sorbent is injected into the upper part of the furnace to react with the SO_2 in the flue gas. The finely grinded sorbent is distributed quickly and evenly over the entire cross section in the upper part of the furnace.
- Duct Injection: In duct injection, the sorbent is evenly distributed in the flue gas duct after the pre-heater where the temperature is about 150 $^{\circ}$C. At the same time, the flue gas is humidified with water if necessary. Reaction with the SO_2 in the flue gas occurs in the ductwork and the by product is captured in a downstream filter. Removal efficiency is greater than with furnace injection systems. An 80% SO_2 removal efficiency has been reported in actual commercial installations.

Exhibit 7.14 presents the post combustion SO_x control for coal combustion sources. The typical control efficiencies percentage is higher for pulverized technology with higher combustion temperature.

Given the intended use of seawater for cooling water purposes by the Project, and the high cleaning efficiencies and greater economy of the system, the Seawater FGD, was selected as the SO_x emission treatment option.

Exhibit 7.14: Post combustion SO_x control for Coal Combustion Sources

Control Technology	*Description*	*Control Efficiency*	*Remarks*
Wet scrubber	Lime/limestone	80 – ≥95%	Applicable to high sulfur fuels, wet sludge products.
	Sodium carbonate	80 – 98%	430 MMBTU/hr typical application range, high reagent costs.
	Magnesium oxide/hydroxide	80 – ≥95%	Can be regenerated.
	Dual alkali	90 – 96%	Used lime to regenerate sodium-based scrubbing liquor.
	Seawater	≥98%	Has the largest fuel flexibility, including all types of heavy fuel oils with up to 4.5% sulphur content.
Spray drying	Calcium hydroxide slurry, vaporizes in spray vessel	70 – 90%	Applicable to low and medium sulfur fuels, produces product.
Furnace injection	Dry calcium carbonate/ hydrate injection in upper furnace cavity	25 – 50%	Commercialize in Europe, several U.S demonstration projects are completed.
Duct injection	Dry sorbent injection into duct, sometimes combined with water spray	25 – ≥50%	Several research, development and demonstration projects underway, not yet commercially available.

7.8.3 NO_x Treatment Options

NO_x control technologies are mainly two categories: primary control technologies and secondary control technologies. Primary control technologies reduce the amount of NO_x produced in the primary combustion zone. In contrast, secondary control technologies reduce the NO_x present in the flue gas away from the primary combustion zone. Some of the secondary control technologies actually use a second stage of combustion, such as reburning. **Exhibit 7.15** summarizes available NO_x control technologies.

The standard practice of modern PF Boilers is to have both Low NO_x burners with Overfire air ports. This is by far the easiest solution, which also has one of the highest NO_x reduction rates. The proposed Project will also be using this arrangement to lower NO_x emissions to ensure compliance with NEQS Ambient Air Quality Requirements.

Exhibit 7.15: NO_x Control Options for Coal-Fired Boilers

Control Technique	*Description of technique*	*Applicable boiler designs*	*NO_x reduction potential*	*Commercial availability R&D status*	*Comments*
Combustion Modifications					
Load reduction	Reduction of coal and air.	Stokers	Minimal	Available	Applicable to stokers that can reduce load without increasing excess air; may cause reduction in boiler efficiency; NO_x reduction varies with percent load reduction.
Operational modifications (BOOS, LEA, BF, or combination)	Rearrangement of air or fuel in the main combustion zone.	Pulverized coal boilers (some designs); Stokers (LEA only)	10-20	Available	Must have sufficient operational flexibility to achieve NO_x reduction potential without sacrificing boiler performance.
Overfire Air	Injection of air above main combustion zone	Pulverized coal boilers and stokers	20-30	Available	Must have sufficient furnace height above top row of burners.
Low NO_x Burners (LNB)	New burner designs controlling airfuel mixing	Pulverized coal boilers	35-55	Available	Available in new boiler designs.
LNB with OFA	Combination of new burner designs and injection of air above main combustion zone	Pulverized coal boilers	40-60	Available	Available in new boiler designs.
Reburn	Injection of reburn fuel and completion air above main combustion zone	Pulverized coal boilers, cyclone furnaces	50-60	Commercially available but not widely demonstrated	Reburn fuel can be natural gas, fuel oil, or pulverized coal.

Control Technique	*Description of technique*	*Applicable boiler designs*	*NO_x reduction potential*	*Commercial availability R&D status*	*Comments*
Post-Combustion Modifications					
SNCR	Injection of NH3 or urea in the convective pass	Pulverized coal boilers, cyclone furnaces, stokers, and fluidized bed boilers	30-60	Commercially available but not widely demonstrated	Applicable to new boilers or as a retrofit technology; must have sufficient residence time at correct temperature (1,750E±90 EF); elaborate reagent injection system; possible load restrictions on boiler; and possible air preheater fouling by ammonium bisulfate
Selective Catalytic reduction (SCR)	Injection of NH3 in combination with catalyst material	Pulverized coal boilers, cyclone furnaces	75-85	Commercially offered, but not yet demonstrated	Applicable to new boilers or as a retrofit technology provided there is sufficient space; hot-side SCR best on low-sulfur fuel and low fly ash applications; cold-side SCR can be used on high-sulfur/high-ash applications if equipped with an upstream FGD system.
LNB with SNCR	Combination of new burner designs and injection of NH3 or urea	Pulverized coal boilers	50-80	Commercially offered, but not widely demonstrated as a combined technology	Same as LNB and SNCR alone.
LNB with OFA and SCR	Combination of new burner design, injection of air above combustion zone, and injection of NH3 or urea	Pulverized coal boilers	85-95	Commercially offered, but not widely demonstrated as a combined technology	Same as LNB, OFA, and SCR alone.

7.9 Cooling-Water Technology

There are four major types of cooling-water systems: once-through cooling, closed-cycle wet cooling, dry cooling (direct and indirect), and hybrid systems.[7]

- **Once-Through Cooling.** Once-through systems withdraw water from a natural source (typically a lake, river, or ocean), use it to extract waste heat from the steam cycle, and then return it to the water body at a slightly elevated temperature. The systems consist of a steam condenser, typically of the shell-and-tube type, circulating water pumps, circulating water lines, intake and discharge structures, and in most cases, some water treatment equipment, typically chlorination for biofouling control. Through the early 1970s, once-through systems were the systems of choice for steam-electric plants, and today, in the United States, more than 1,200 generating units (about 40% of U.S. capacity) still use these systems. However, their use has been limited or prohibited on the basis of environmental concerns, including thermal discharge, cooling water intake issues of entrainment and impingement, and in-stream flow maintenance. They are now rarely considered for new plants, and, in fact, pressure has developed for the retrofit conversion of some once-through cooled plants to closed-cycle cooling.
- **Closed-Cycle Wet Cooling.** Closed-cycle (or recirculating) wet cooling systems are similar to once-through cooling in that the steam is condensed in a water-cooled, shell-and-tube steam condenser, but differ in that the heated water is not returned to the environment. Instead the hot water is conveyed to a cooling component, typically a wet cooling tower (other options include cooling ponds, spray-enhanced ponds, spray canals, etc.), where it is cooled and then recirculated to the condenser. Cooling towers are of two types: natural-draft and mechanical-draft. The cooling is accomplished by the evaporation of a small fraction (approximately 1 to 2%) of the water. Some portion of the circulating water flow is discharged as "blowdown" from the system back to the environment to control the build-up of suspended and dissolved solids brought into the cooling system with the make-up water.
- **Dry Cooling.** Dry cooling systems reject the heat of condensation directly to the atmosphere with no consumptive use of cooling water. Systems are of two types: direct and indirect dry cooling. Direct dry cooling systems utilize air-cooled condensers (ACCs) to which turbine exhaust steam is ducted from the turbine exit through a large horizontal duct to a lower steam header feeding several vertical risers. Dry cooling technology has been used for nearly 70 years, and was pioneered in regions as diverse as Western Europe, South Africa, and the Middle East. Since 1999, nearly 20 GW of new U.S. capacity has utilized dry cooling. Indirect dry cooling systems have a separate condenser, typically of the conventional shell-and-tube type. The heated cooling water leaving the condenser

[7] Maulbetsch, John , and Jeff Stallings. *"Evaluating the Economics of Alternative Cooling Technologies."* - Power Engineering. http://www.power-eng.com/articles/print/volume-116/issue-11/features/evaluat-economics-alternative-cool-technologies.html (accessed September 26, 2014).

is then circulated to an air-cooled heat exchanger (ACHE) for ultimate heat rejection to the atmosphere. Indirect systems are more costly and less efficient than direct dry cooling system, because of the two-step heat transfer path to the atmosphere, the circulating water pumping power requirement, and the temperature rise of the cooling water as an additional temperature difference between the ambient air and the steam condensing temperature. These systems have seen limited use in Africa and the Middle East, but no indirect, all-dry systems are operating in the United States at this time.

- **Hybrid Cooling.** Hybrid cooling systems are intended to exploit the virtues of both the wet and dry systems. In hybrid systems, both air-cooled and wet cooling equipment is available for handling the plant heat load as conditions dictate. The two major categories of hybrid cooling systems are plume-abatement systems and water-conservation systems. Plume-abatement towers are essentially all-wet systems that employ an ACHE, which provides some amount of dry cooling, but whose primary function is to provide a flow of heated dry air that can be mixed with the saturated exhaust plume from the wet portion of the system. Water-conservation systems have received increasing interest in recent years, although to date only a few are installed on U.S. power plants. They are intended to reduce the amount of water required for power plant cooling by using dry cooling during the cooler periods of the year and supplementing the dry capability with wet cooling during hotter periods when dry cooling systems cannot maintain a turbine exhaust pressure as low as is desired.

Comparison of Cooling-Water Systems

Water Consumption

Recirculating wet cooling systems with a mechanical-draft wet cooling tower significantly reduce (by a factor of 20 to 50 times) the amount of water drawn into a plant compared to plants using once-through cooling, but nearly all the water withdrawn for cooling purposes is evaporated in the process. Water-conserving systems, such as dry cooling using air-cooled condensers or hybrid wet/dry systems using parallel dry and wet condensing loops, can further reduce the water used for cooling.

Typical values for closed-cycle wet cooling systems range from 400 to 700 gallons/MWh.

For combined-cycle plants, because only about one-third of the energy is produced by the steam portion of the plant, the normalized water use on the basis of total plant energy production ranges from about 170 to 250 gallon per plant MWh. For hybrid systems, the amount of water used can be selected by design and is typically chosen to be 30 to 70% of the amount used in all-wet systems.

Capital Costs

Cooling system capital costs for a specified plant at a given site cannot be determined in the absence of a full consideration of performance issues and of the project's economic and business objectives. The choice of a larger, higher-capacity cooling system will result in higher capital costs, but will provide higher plant output and more efficient operation over the life of the plant.

The capital and operating costs should include the equipment, labor, and expendables costs for all plant elements influenced by the choice of cooling system, such as the cost of water and water supply, treatment, and discharge/disposal facilities.

Wet Systems

In the case of wet systems, the optimized system is determined by the balance between capital cost and the operating power cost for the tower fans and the circulating water pumps. Because wet cooling systems are typically sized to achieve design backpressure at the "1% wet-bulb" condition, the heat rate and capacity penalties are not an important consideration in the design optimization.

Water consumption is essentially the same for all wet system designs at a given site. Therefore, the cost of water is not an important factor for the selection of an optimum wet system design. It is an important factor in comparisons between wet and dry systems.

Dry Systems

Two types of dry systems can be considered: direct dry cooling using an air-cooled condenser, and indirect dry cooling using an air-cooled heat exchanger (ACHE) paired with a conventional shell-and-tube steam condenser.

For similar applications, ambient conditions, and design points, the indirect system is more costly with higher capital cost, higher operating power requirements, and greater performance penalties than the corresponding direct system.

Hybrid Systems

As in the case of the all-dry systems, two types of hybrid system were considered: a direct system in which the dry portion uses an air-cooled condenser, and an indirect system in which the dry portion uses an ACHE.

The optimization of a hybrid system with parallel wet and dry steam condensing loops introduces additional complexity. The relative capability of the wet and dry systems is the primary determinant of the system cost. This comparison, in turn, depends both on the amount of water available for cooling, and the value of plant output during the hottest hours of the year compared to the average value over the entire year.

As in the case of the all-dry systems, the indirect hybrid has higher capital and operating costs than the direct system.

Performance

For optimized designs under nearly all conditions, wet cooling systems are not only the least expensive but result in the highest plant output and efficiency. For hybrid systems, the performance penalty, as well as the system cost, varies depending on the amount of water available. For annual water use ranging from approximately 30 to 80 percent of the amount required for an all-wet system, the costs of the direct hybrid are typically less than those for the all-dry system. For the indirect systems, the hybrid system cost can approach or exceed the cost of the all-dry system. A more complete analysis is required to fully understand the trade-offs for indirect systems.

Water Conservation

The use of either dry or hybrid cooling can result in a large reduction in the amount of water used by a plant. Depending on the plant design and the water required for uses other than cooling, the dry-cooled plant will save from 95 to 75 percent of the water used by a wet-cooled plant. For the cooling alone, recirculating wet cooling at a 500-MW coal-fired steam plant consumes approximately 5,000 to 7,000 acre-feet per year, which is saved by the use of dry cooling. The savings come at a cost of about $7 to $10 million per year depending on the meteorology at the site, which represents a cost of $1,000 to $2,000 per acre-foot of water saved.

Preferred Option for the Project

As the source of water supply for the Project is seawater from the Arabian Sea, conservation of water is not an environmental imperative for the Project, nor will it result in indirect cost savings in the form of ecological services from the volume of water conserved. Therefore, the suitable choice for a cooling-water system for the Project will be either the once-through cooling system or the closed-cycle wet cooling system.

Between the two, the former has a lower initial capital cost and requires less space as there is no need for a cooling tower and other auxiliary cooling equipment which the closed-cycle wet cooling system requires. However, as discussed above, the once-through system utilizes considerably more water with higher intake and outfall rates. The cooling water, when released back into the environment at the outfall, possesses a higher temperature than its original temperature at intake.

Taking all of the above into account, the once-through system was chosen for the Project with the added design configuration that will ensure compliance with environmental regulations governing temperature increase out the location of outfall. Within the legally stipulated 3 °C-temperature-increase-limit, there will be no significant impact to the marine environment at the location of the outfall. Similarly, the intake and outfall channels will be designed according to the mitigation measures proposed in this ESIA report to prevent entrainment and impingement of marine species in the channels and to provide them safe passage to escape.

7.10 Ash Disposal Options

As described in **Section 3**, the residuals of coal combustion in power plants that are captured by pollution control technology include fly ash and bottom ash. There will be no FGD residuals, such as Gypsum, produced by the Project as it will be using a Seawater FGD system. Given the industry practice, alternatives that can be considered for disposal of ash that will be generated by the Project are recycling, or storage in an ash pond yard. Given the fact that a lined ash facility involves investment, land, and continuing management to contain the material stored, recycling is the preferred alternative from both environmental and economic viewpoint.

7.10.1 Ash Recycling Options

Fly ash is a product of burning finely ground coal in a boiler to produce electricity. It is removed from the plant exhaust gases primarily by electrostatic precipitators or baghouses and secondarily by scrubber systems. Physically, fly ash is a very fine, powdery material, composed mostly of silica. Fly ash is a pozzolan, a siliceous material which in the presence of water will react with calcium hydroxide at ordinary temperatures to produce cementitious compounds. Because of its spherical shape and pozzolanic properties, fly ash is useful in cement and concrete applications. The spherical shape and particle size distribution of fly ash also make it good mineral filler in hot mix asphalt applications and improve the fluidity of flowable fill and grout when it is used for those applications. Fly ash applications include its use as a:

- Raw material in concrete products and grout
- Feed stock in the production of cement
- Fill material for structural applications and embankments
- Ingredient in waste stabilization and/or solidification
- Ingredient in soil modification and/or stabilization
- Component of flowable fill
- Component in road bases, sub-bases, and pavement
- Mineral filler in asphalt

A review of the utilization of fly ash produced in the coal powered plants in India[8] shows that on an average the utilization of fly ash produced by the coal fired power plants is over 50%, with a number of plants achieving 100% utilization. Pakistan Standards and Quality Control Authority (PSQCA), on the initiative of cement manufacturers have modified the Portland cement standards in 2008[9] to allow for up to 5% blending of fly ash in the manufacturing of cement. There are a number of potential users of ash produced by the Project in southern Sindh. These include cement plants located at a distance of 100-150 km from the plant mainly on the main highway M-9 linking Hyderabad to Karachi (**Exhibit 7.16**).

Ash Reutilization Trends in Pakistan

The major portion of ash re-utilization is carried out in the cement manufacturing industry and the block manufacturing industry. These two industries have a high potential to re-use ash produced from coal-fired power plants. The potential demand from cement industry exists due to the presence of cement manufacturing plants in southern Sindh. The potential demand for ash in the block industry exists due to the close proximity of the city of Karachi where brick block is key construction material.

To analyze the future possibilities of ash re-utilization in cement industries in Pakistan, the possible growth of cement production over 30 years was studied. On the basis of the

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[8] Report on Fly Ash Generation at Coal/Lignite Based Thermal Power Stations and its Utilization in the Country for the Year 2010-11, Central Electricity Authority, New Delhi, December 2011

[9] PS 232-2008 (R), Pakistan Standard: Ordinary Portland Cement (OPC) (33, 43 & 53 Grades), Pakistan Standards and Quality Control Authority

growth of cement production in Pakistan, the potential future demand for ash was calculated. Cement production data over the last 25 years was obtained from All Pakistan Cement Manufacturer Association (APCMA) which represented an average annual growth in production of 7.53%.[10] Only the cement manufacturing plants close to the proposed Project-site were considered:

- Al-Abbas Cement Limited
- Attock Cement Pakistan
- Dewan Cement Limited
- Lucky Cement Limited
- Thatta Cement Limited

The above listed cement plants are shown in **Exhibit 7.16.** According to the data obtained from APCMA, the current cumulative production of the plants listed above is approximately 7.2 million tons per annum. Using a growth rate of 7.53% over the next 30 years, the total production of cement from the area is expected to rise up to 64 million tons per annum. According to existing international ash re-utilization trends, approximately 5% of the cement produced is the ash demand. Using this figure, the expected demand of ash over the next 30 years in the region is 3.2 million tons per annum. The ash demanded in the region will be supplied by the coal power plants in the region therefore a competition exists for the re-utilization of ash.

The second option for re-utilization of ash near the plant site is for block manufacturing plants. In Pakistan, no mechanism of ash re-use in the block industry is currently in place due to absence of coal power plants and any potential supply of ash in large quantity. However, in future, as the number of power plants increase in the country, a potential for demand of ash in the block industry exists. This is mainly due to the proximity of large urban city Karachi from the project site where most of the construction work is done using blocks. In a country like India, whose economic dynamics are similar to that of Pakistan, ash re-utilization in brick and block industry is approximately 6.3% of the total ash-re-utilization. Using this assumption, it can be predicted that in 30 years, ash demand from the block industry will be approximately 0.2 million tons per annum.

Therefore, the total demand for ash from the cement manufacturing industry and the block manufacturing industry is expected to be 3.2 million tons per annum after 30 years.

7.10.2 Preferred Ash Disposal Approach for the Project

Recycling of ash will be the preferred option for ash disposal. The Project can generate revenue by properly planning ash disposal. As the cement industry has already shown interest in utilizing ash produced by coal power plants, Owner's management will consult and enter into agreements with cement factories and other construction industries for utilization of the ash.

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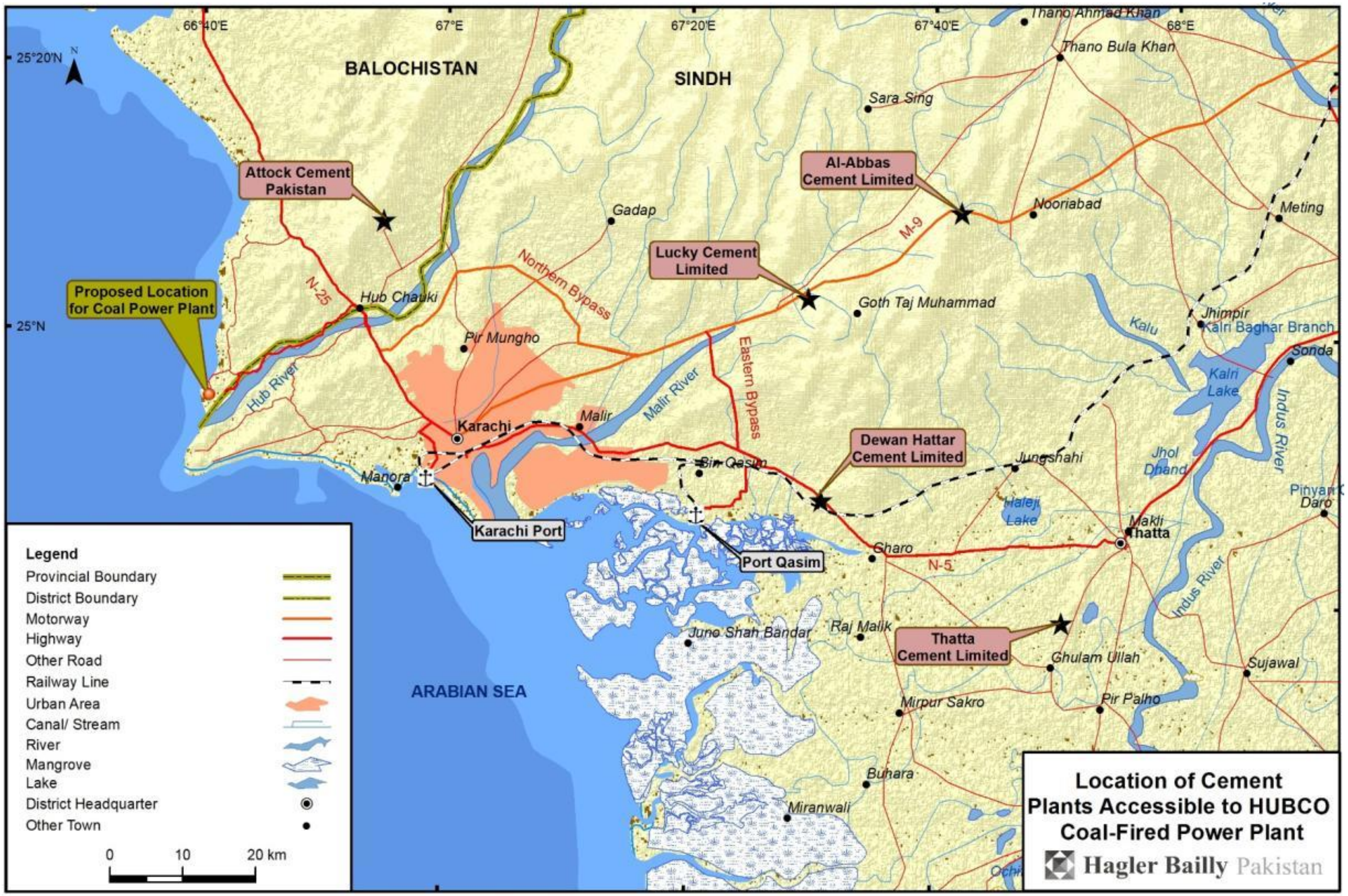
[10] All Pakistan Cement Manufacturer Association (APCMA), http://www.apcma.com/data_history.html, accessed on 24/07/2014

Exhibit 7.16: Location of Cement Plants Accessible to the Project



8. Environmental Impacts and Mitigation Measures for the Proposed Project

This section summarizes the impacts of Project design, construction and operation on the physical environment, ecological environment and socioeconomic environment. Impacts due to the cooling water system on marine ecology have been assessed in **Section 8.9**. Cumulative impact assessment on air quality due to other proposed projects in the region are discussed in **Section 8.10**.

8.1 Methodology

The methodology used for the assessment of Project related impacts is outlined below.

8.1.1 Impact Description

There are several guidelines and textbooks on identification and description of environmental and social impacts. These documents use various types of tools in an attempt to define a comprehensive and consistent method to capture all potential impacts of a proposed project. However, it is now widely recognized by ESIA practitioners that impact evaluation is not a purely objective and quantitative exercise. It has a subjective element; often based on judgment and values as much as scientific criteria. Recognizing this, a uniform system of impact description is used to enable the reviewers to understand how impacts have been interpreted. The description of each impact will have the following features:

- A definition of the impact using an impact statement;
- The impact statement clearly identifying the project activity or activities that causes the impact, the pathway or the environmental parameter that is changed by the activity, and the potential receptors of the impact;
- Establishing the sensitivity of the receiving environment or receptors;
- Based on the stakeholder consultations undertaken, outlining of the level of public concern regarding the specific impact;
- Calculating the significance of the impact;
- Description of the mitigation and management measures and the effectiveness of proposed measures; and
- Characterization of the level of uncertainty in the impact assessment.

The significance of an impact is determined based on the product of the consequence of the impact and the probability of its occurrence. The consequence of an impact, in turn, is a function primarily of three impact characteristics: magnitude; spatial scale; and duration.

Magnitude is determined from quantitative or qualitative evaluation of a number of criteria discussed further below. Where relevant, this includes comparison with standards or thresholds. Examples of thresholds include:

- Legal thresholds—established by law or regulation.
- Functional thresholds—if exceeded, the impacts will disrupt the functioning of an ecosystem sufficiently to destroy resources important to the nation or biosphere irreversibly and/or irretrievably.
- Normative thresholds—established by social norms, usually at the local or regional level and often tied to social or economic concerns.
- Preference thresholds—preferences for individuals, groups or organizations only, as distinct from society at large.
- Reputational thresholds—the level of risk a company is willing to take when approaching or exceeding the above thresholds.

Once the impact consequence is described on the basis of the above impact characteristics, the probability of impact occurrence is factored in to derive the overall impact significance. The probability relates to the likelihood of the impact occurring, not the probability that the source of the impact occurs. For example, a continuous Project activity may an unlikely probability of impact, if there are no receptors within the area influenced by that activity.

The resulting significance rating may be further qualified by explaining the effectiveness of proposed management measures designed to mitigate or enhance the impact, and by characterizing the level of confidence or uncertainty in the assessment.

8.1.2 Impact Significance Rating

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the approval process; secondly, it serves to show the primary impact characteristics, as defined above, used to evaluate impact significance. The impact significance rating system is presented in **Exhibit 8.1.**

Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale and duration,

Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A, and

Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

Using the matrix, the significance of each described impact is rated.

8.1.3 Mitigation and Good Practice Measures

Wherever, the Project is likely to result in unacceptable impact on the environment, mitigation measures are proposed.

In addition, in certain cases good practice measures are proposed.

Exhibit 8.1: Method for Rating the Significance of Impacts

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE			
Impact characteristics	**Definition**	**Criteria**	
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded	
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded	
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded	
	Minor+	Minor improvement; change not measurable; or threshold never exceeded	
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction	
	Major+	Substantial improvement; within or better than the threshold; or favorable publicity	
DURATION/ FREQUENCY		**Continuous aspects**	**Intermittent aspects**
	Short term/ low frequency	Less than 4 years	Occurs less than once a year
	Medium	More than 4 years up to end of life of project (approximately 30 years)	Occurs less than 10 times a year but more than once a year
	Long term/ high frequency	Beyond the life of the project (greater than 30 years)	Occurs more than 10 times a year
SPATIAL SCALE		**Biophysical**	**Socio-economic**
	Small	Within 200 meters (m) of the Project footprint	Within the Study Area
	Intermediate	Within 3 kilometer (km) of the Project footprint	10 km from the Project facilities
	Extensive	Beyond 3 km of the Project footprint	Beyond 10 km from the Project facilities

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE		
			Small	Inter-mediate	Extensive
MAGNITUDE					
Minor	DURATION/ FREQUENCY	Long / high	Medium	Medium	Medium
		Medium	Low	Low	Medium
		Short / low	Low	Low	Medium
Moderate	DURATION/ FREQUENCY	Long / high	Medium	High	High
		Medium	Medium	Medium	High
		Short / low	Low	Medium	Medium
Major	DURATION/ FREQUENCY	Long / high	High	High	High
		Medium	Medium	Medium	High
		Short / low	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Low	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

+ denotes a positive impact.

8.2 Soil and Water Quality Impacts

The Hub River is east of the existing HUBCO industrial site. The section of Hub River upstream of the wastewater outfalls of HUBCO and Byco and downstream of a *bund* (small dam) constructed by the community is dry (**Section 4.2.6**). Impacts upstream of the proposed plant on surface water and soils are not expected. There is no proposal to utilize water from the Hub River as part of the proposed Project.

A total of five groundwater extraction wells were identified within the Study Area. The depth to groundwater, as measured, varies from 3.8 to 13 m from ground surface. Groundwater uses are restricted to washing and ablution due to high salinity (**Section 4.2.6**). Since there is no proposal to utilize groundwater, the groundwater resources in the area will not be impacted, other than potential contamination through accidental spillage of pollutants and effluents and any unlined untreated wastewater channels.

Plant operation and design will be such that all discharges of wastewater into the environment surrounding the HUBCO industrial site will be within the NEQS limits. The potential impacts on soil and water resources in construction and operation phase of the Project are discussed in **Section 8.2.1** and **Section 8.2.2**.

8.2.1 Construction Phase Impacts

In the absence of national or domestic regulations and an effective wastewater management system, wastewater disposal can potentially become a serious environmental issue. Similarly, poor management can lead to contamination of soils and groundwater. Potential water and soil impacts of the proposed Project and mitigation strategies associated are provided in the tables below:

Impact PC1: Discharge from construction activities and sites can potentially result in the contamination of soil and consequent deterioration of groundwater and surface water quality.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Short	Intermediate	Medium	Possible	Medium	-	High
Mitigation Measures: • All areas containing potentially hazardous materials will be hydrologically isolated by preventing any potential water or liquid flowing to the remaining site from such areas. • Soil banks from ditching operations will not be placed where they might impair natural drainage. • Channel runoff will be provided at the periphery of the site to avoid flooding, particularly of contaminated streams. • No untreated effluents will be released to the environment.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High
Monitoring: • Quarterly monitoring of level of wastewater in soak pits and septic tanks. • Continuous monitoring of flow in waste streams.								

Impact PC2: Spills during refuelling, discharges during vehicle and equipment maintenance, traffic accidents, handling of chemicals and relatively large leakages from equipment and vehicles can result in contamination of soil during construction and consequent deterioration of groundwater and surface water quality.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High

Mitigation Measures:

- Spill prevention trays will be provided and used at refueling locations.
- On–site maintenance of construction vehicles and equipment to be carried out at designated places within the Project site.
- Regular inspections will be carried out to detect leakages in construction vehicles and equipment.
- Fuels and lubricants will be stored in covered and dyked areas, underlain with impervious lining.
- Spill control kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas.
- Contaminated soil will be removed from the site and disposed in a manner to ensure protection of water sources.
- An emergency spill management plan will be prepared; the staff will be trained to handle spills and ensure compliance with the emergency spill management plan.
- Measures will be taken to minimize soil contamination. Contaminated soil will be immediately collected to minimize the volume of contaminated soil. Heavily contaminated soil will be segregated from the rest of the soil. Various final disposal options for contaminated soil are available. These include incineration at facilities in Karachi, disposal through licensed hazardous waste contractors, encapsulation at site, and bioremediation at site or off–site location. Appropriate disposal methods will be employed; however, until an acceptable method is found the contaminated soil will be stored at the site in secure containers.
- All areas containing potentially hazardous materials will be hydrologically isolated by preventing any potential water or liquid flowing to the remaining site from such areas.
- Channels will be excavated, where necessary, to avoid flooding.
- No untreated effluents will be released to the environment.

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High

Monitoring:

Record of spills and volume of contaminated soil.

Impact PC3: Runoff after a storm from the Project site may contain oil that may pollute the creeks. Construction related earthwork may also alter the drainage pattern and affect the storm water flow and result in possible flooding of sections of surrounding land.

Applicable Project Phase

Construction

Impact Rating

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Short	Intermediate	Medium	Possible	Medium	-	High

Mitigation Measures:

- Through contouring and installation of embankments, where necessary, it will be ensured that stormwater from the surrounding areas does not enter the construction site and construction site runoff will be routed to an appropriate water treatment facility.
- All unpaved exposed areas of the construction site will be compacted to minimize soil erosion.
- All areas containing potentially hazardous materials will be, hydrologically, isolated from the remaining site.
- Soil banks from ditching operations will not be placed where they might impair natural drainage
- Channels will be excavated, where necessary, to avoid flooding.

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High

Monitoring:

No monitoring measures proposed.

Impact PC4: Various types of wastes such as packing waste, metal scrap and excess materials, uprooted vegetation, and excess soil will be generated during the construction and operation phases. Besides being an eyesore, the waste can be a health hazard and pollute waterways, if disposed improperly.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Short	Intermediate	Medium	Possible	Medium	-	High
Mitigation Measures: • In the scrap yard, all waste will be segregated and clearly marked with a proper hazard sign, if required. • Waste will not be burned in open air or disposed-off by dumping in the areas surrounding the plant site. • Before final disposal, any potentially hazardous substance such as lead or material containing lead shall be identified and disposed off accordingly. • Solid waste generated during plant construction, operation, maintenance activities, office works, and housekeeping will be accumulated in a scrap yard and auctioned to government authorized contractors having NOCs for recycling and dumping the waste at government approved sites for safe disposal as per practice in vogue.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High
Monitoring: • Monthly record of waste generation								

8.2.2 Operational Phase Impacts associated with Plant Operation

The plant will rely on seawater as the only source of water for operations. A relatively small amount of total makeup water requirement, approximately 1.5%, will be desalinated to be used as plant service water, fire water, potable water, power cycle makeup, and for uses such as the heating, ventilating and air-conditioning (HVAC) and vacuum pump sealing. Similarly, a very small amount of makeup water will be used at ash handling facilities and coal stockyard. Impacts associated with ash handling are discussed in **Section 8.6**.

Wastewater streams from the Plant and associated facilities will be sent to an effluent monitoring sump and then to a disposal and treatment system. After treatment, the effluents will be discharged to the sea via an outfall channel after treatment.

Based on the discussion above, two key wastewater outflows from operations include:

- heated cooling water from the cooling water system (condenser); and
- saline desalination plant effluent.

Ocean temperature increases associated with discharge from the outfall channel are expected. Thermal plume modeling was carried out to predict the extent of the impact and determine whether the increase in temperature is below the NEQS. The results of the thermal plume modeling, and associated impact assessment, are provided in **Section 8.9**.

The potential impacts and proposed mitigation measures are provided below:

Impact PO1: Discharge related to plant operations particularly wastewater from the effluent monitoring sump and the water with higher salinity relative to sea water generated from the desalinization plant to the sea can potentially result in the contamination of seawater.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Medium	Small	Medium	Possible	Medium	-	High
Mitigation Measures: • Effluents being discharged into the sea will meet the NEQS.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Moderate	Medium	Small	Medium	Unlikely	Low	-	High
Monitoring: • Quarterly monitoring of NEQS composition level of effluent monitoring sump.								

Impact PO2: Spills during refuelling, discharges during vehicle and equipment maintenance, traffic accidents, handling of chemicals and leakages from equipment and vehicles often result in contamination of soil or water resource during operations.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • Spill prevention trays will be provided and used at refueling locations. • On–site maintenance of construction vehicles and equipment to be carried out at designated places within the plant site. • Regular inspections will be carried out to detect leakages in plant routine vehicles and equipment. • Fuels and lubricants will be stored in covered and dyked areas, underlain with impervious lining. • Spill control kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas. • Contaminated soil will be removed from the site and disposed in a manner to ensure protection of water sources.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High
Monitoring: • Record of spills and volume of contaminated soil.								

Impact PO3: Effluent monitoring and sewerage treatment sumps, coal settling pond, ignition fuel storage tanks may result in contamination of soil or water resource during operations.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • Impervious lining will be provided at the effluent monitoring and sewerage treatment sumps, coal settling pond, ignition fuel storage tanks. • Groundwater monitoring wells will be installed considering groundwater head nearby ash settling plant, effluent monitoring and sewerage treatment sumps, coal settling pond, ignition fuel storage tanks to detect any seepage or leakage from these.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Monitoring: • Groundwater samples will be drawn from monitoring wells in every six months and analyzed to detect any potential contamination and its source.								

8.3 Noise

The current ambient noise levels were measured in the vicinity of the Project and were measured to be in the range 45-60 dBA discussed in **Section 4.2.8**. The NEQS limits for daytime noise in residential areas is 55 dBA and for nighttime is 45 dBA and for industrial area is 75 dBA and 65 dBA for daytime and nighttime respectively. It was observed that on average, daytime limits were within allowance range for both industrial and residential standards but nighttime noise levels exceeded the NEQS guidelines for residential areas. The major contributions in the noise levels were from wind, general activity at HUBCO township and existing plant operations. No sensitive receptors are located near the plant therefore no major impact due to noise is envisaged.

The construction and related activities for the Project, including civil works, equipment transfer and commissioning will contribute to noise in the area. Noise control measures will be adopted by the construction contractor to make sure that noise levels are maintained close to the baseline noise levels. The impact of noise that will be generated from traffic is assessed as part of traffic impact assessment in **Section 8.5.**

Impact PC5: Noise from construction activities may cause nuisance in the vicinity of the Project facilities.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High

Mitigation Measures:

- Construction equipment that could potentially generate high noise levels will have an adequate muffler system.
- All stationary noise generating equipment such as air compressors and power generators will be placed at least 200 m away from the residential area.
- In case threshold values are exceeded then adjusting the distances for the equipment on the basis of monitoring report.
- A preventive maintenance procedure for Project vehicles and equipment will be set and followed which will help prevent noise levels from deteriorating with use.
- Provision of Personal Protective Equipment (PPEs), i.e. ear muffs and plugs, will reduce noise impact on personnel.
- Restriction on pressure horn.

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+/-*	*Confidence*
Residual Impact	Minor	Short	Small	Low	Possible	Low	-	High

8.4 Air Quality Impacts

8.4.1 Impacts on Air Quality from Stack Emissions

The major source of air pollution during operation of the Plant will be associated with the boiler and the combustion of fuel (including coal). The main pollutants are particulate matter (PM_{10} &$PM_{2.5}$), nitrogen oxides (NO_x) and sulfur dioxides (SO_2). To ensure protection of human health and environment, maximum acceptable concentration of these pollutants in the ambient air have been prescribed by Federal EPA of Pakistan and provincial regulatory authorities, such as BEPA.

The baseline concentration of air pollutants (**Section 4.2.8**) were used to forecast the concentration in the year 2018, when the proposed Plants will become operational. The forecasted 2018 values were added to the modeled increment in pollutants due to the plant.

The United States Environmental Protection Agency (US EPA) approved regulatory air quality model, AERMOD, was used to simulate emissions from the proposed Plant during the operation phase. A description of AERMOD is provided in **Appendix J**. The results of AERMOD provide the incremental increase in air pollutants, including NO_x, SO_2, PM_{10}, and $PM_{2.5}$, due to the proposed Plants.

Objectives

The objectives of the air quality impact assessment were:

- predicting the impact of the proposed Project on the air quality of the surrounding area,
- determining whether predicted air quality exceeds applicable standards and guidelines, and
- identifying mitigations measures that may be required to ensure compliance with the applicable standards and guidelines.

Assumptions

All the modeling and assessment is carried out for the worst case scenario, and using following assumptions:

- The Plant will utilize emission control measures with efficiencies of 91.5% for FGD, 99.65% for ESP and low NO_x burners (limiting release of NO_x to 400 mg/Nm^3).
- All the oxides of nitrogen which are in the atmosphere and which will be emitted from the Project are in the form of NO_2. NEQS and SEQS limit for NO_x was calculated by combining the limits of NO and NO_2.
- The ratio between NO and NO_2, which was measured during the field visit (**Section 4**), was assumed to prevail and remain constant in the Study Area throughout the year.
- The ratio between the monthly average and 24–hour average measured during the field survey (**Section 4**) remains constant. Since the long term data provided by HUBCO included monthly averages, this ratio was used to calculate the potential 24–hour concentration for SO_2 and NO_x,

Forecasted Background Concentration in 2018

Long term (1996–2013) ambient air quality data provided by HUBCO at 14 locations in the Study Area; was used to forecast the background concentration in 2018, when the plant will be operational. The monitored data showed an increasing trend of concentration of NO_2 and SO_2 in the Study Area.

Since the data provided by HUBCO included annual averages for the monitoring points, potential annual average concentrations at monitoring point was directly predicted using linear extrapolation. The 24–hour values for each monitoring point were calculated using the ratio between the concentration measured using diffusion tubes over a period of one month and the concentration measured using SUPARCO's mobile air–monitoring vehicle over a period of 24–hour. This ratio was used to convert the monthly long term data into 24–hour data assuming the ratio remains same throughout the year. A conservative approach was followed, where the maximum ratio between the available monthly and 24–hour data was used.

Long term data regarding PM_{10} and $PM_{2.5}$ was not available. The average concentration for PM_{10} and $PM_{2.5}$ at six locations recorded during the baseline survey (**Section 4**) was used to calculate the background concentration in the Study Area. The average concentration of PM_{10} and $PM_{2.5}$ recorded at all the six locations during the phase II baseline survey (**Section 4**) at Project site was 166.6 and 83.3 µg/m^3 for PM_{10} and $PM_{2.5}$ respectively.

Since the average was high due to very high instantaneous values near unpaved roads and settlements, the values recorded near unpaved roads and settlements were replaced with the typical average values recorded in the Study Area. The final average baseline concentration for PM_{10} and $PM_{2.5}$ was calculated to be 125 and 51.4 µg/m^3 respectively.

Exhibit 8.2 shows the maximum values of background concentration for each pollutant.

Exhibit 8.2: 2018 Background Concentrations (Forecast)

Pollutant	*Concentration ($\mu g/m^3$)*		*NEQS[1] ($\mu g/m^3$)*		*SEQS[2] ($\mu g/m^3$)*	
	24–hour (98th percentile)	*Annual (highest)*	*24–hour (98th percentile)*	*Annual (highest)*	*24–hour (98th percentile)*	*Annual (highest)*
Sulfur Dioxide (SO_2)	77.6	62.8	120	80	120	80
Nitrogen Oxides (NO_x) [3]	92.0	61.5	141.2	101.2	141.2	101.2
Coarse particulate matter, less than 10 Microns (PM_{10})	138.6	–	150	120	150	120
Fine particulate matter, less than 2.5 Microns ($PM_{2.5}$)	59	–	35	15	75	40

As shown in **Exhibit 8.2** the baseline forecasted concentration of all the pollutants are within the NEQS and SEQS limits except $PM_{2.5}$. Due to high background concentration the $PM_{2.5}$ levels exceed the limit prescribed by NEQS, however, the levels are within the limits prescribed by SEQS. A review of information available within the South Asia region indicates is reflective of the high $PM_{2.5}$ levels in the ambient air. The annual limits for $PM_{2.5}$ in India and Sri Lanka are 40 $\mu g/m^3$ and 25 $\mu g/m^3$, respectively. The 24–hr limits for $PM_{2.5}$ in India and Sri Lanka are 60 and 50 $\mu g/m^3$, respectively. Given the high natural background particulate levels in Pakistan where environmental conditions are somewhat similar to those in India and the current level of controls on industrial and vehicular emissions, it is unlikely that compliance with the NEQS of 15 $\mu g/m^3$ for the $PM_{2.5}$ can be achieved in urban and rural parts of Sindh and Baluchistan.

A detailed assessment of background concentration levels of particulate matter was carried out for an Environmental Assessment carried out for the Jamshoro Thermal Power Generation Project where dust levels are similarly high.[4] It has been argued that dust levels in Pakistan are naturally high due to dry conditions.[5] A source apportionment study[6] carried out in Lahore indicated that 68–89% of PM_{10} in ambient air is from re–

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1 National Environmental Quality Standards effective from January 1, 2012

2 Sindh Environmental Quality Standards effective from July 1, 2014

3 The limits for NO_x were calculated in terms of NO_2 using the stoichiometric calculations. According to the balanced equation for conversion of NO into NO_2, 1 g of NO reacts with approximately 0.5 g of oxygen to form approximately 1.5 g of NO2. This ratio was used to convert the values of NO into NO_2, hence all the NO_x were represented in form of NO_2.
[Limits of NO_x = Limits of NO_2 + (1.5 × Limits of NO)]

4 Environmental Impact Assessment of Jamshoro Thermal Power Generation Project. Report prepared for GENCO Holdings (Pvt.) Limited and Asian Development Bank. (October 2013).

5 See for example, JICA, Pak-EPA (2001). Retrieved September 25, 2014, from http://www.environment.gov.pk/pub–pdf/3city–inv.pdf

6 Yuanxun Zhang, T. Q. (2008). Daily Variations in Sources of Carbonaceous Aersol in Lahore, Pakistan during a High Pollution Spring Episode. Vol. 8. Retrieved September 25, 2014, from http://aaqr.org/: http://aaqr.org/VOL8_No2_June2008/2_AAQR-07-09-OA-0042_130-146.pdf

suspended soil and dust. The re–suspended solid includes natural dust and dust from traffic movement. Similar results have been reported in India.[7] In the Project area both these sources are likely to contribute.

Recognizing this, the Baluchistan EPA has revised standards for $PM_{2.5}$. The new limits for $PM_{2.5}$ by SEPA are provided in **Exhibit 8.2.** The $PM_{2.5}$ level in the Study area meets the new limits prescribed by SEQS; however these limits do not apply beyond the provincial boundary of Sindh. In Baluchistan the limits set by NEQS apply.

Modelled Incremental Concentration using AERMOD

Model Area

The modeling area was defined as 70 km by 70 km, encompassing the entire Far–Field Study Area (**Exhibit 4.2**), centered at the stacks for the proposed Plant. The size of the area was defined considering:

- distance from the center of the source, the stacks, at which the pollutants concentrations become negligible;
- location and distance of other sources of emissions; and
- Location and distance of receptors.

Model Grid

The model area was divided into a circular polar grid receptor network centered at the Project site. The receptor locations were placed along 36 direction radials; beginning with 10 degrees and incrementing by 10 degrees in a clockwise fashion up to a radius of 35 km, with an interval of 500 meters. **Exhibit 8.3** shows part of the grid within the Study Area.

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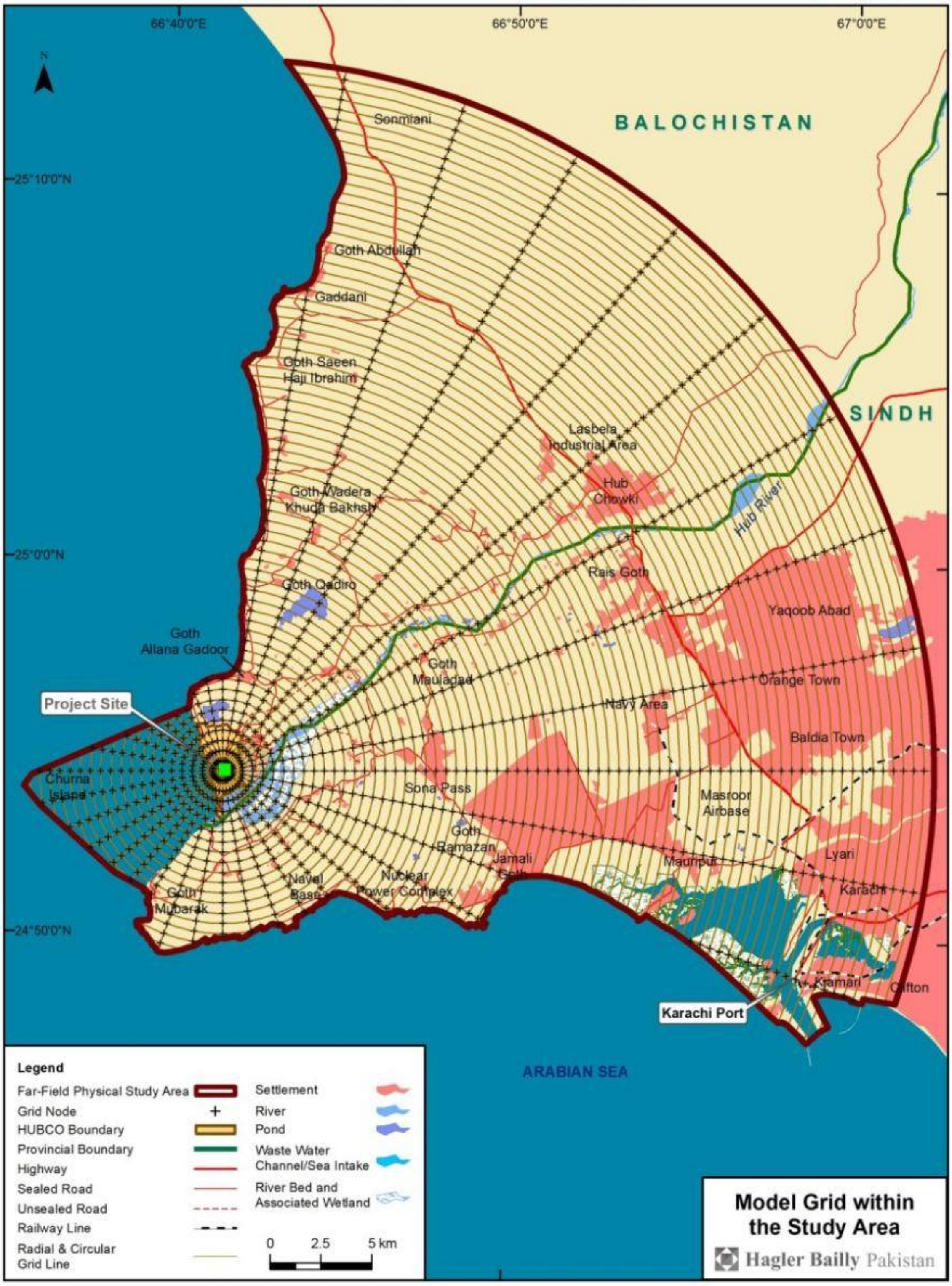
[7] T. Pachauri, et al. in *Aerosol and Air Quality Research*, 13: 977–991, 2013 have reported that $PM_{2.5}$ levels in Agra is 308 and 91 µg/m^3 for traffic and rural sampling sites respectively. After subtracting the organic and elemental carbon (contributed by biomass burning and vehicular emission), the background level in rural area is still 38 µg/m^3.

Exhibit 8.3: Model Grid within the Study Area



Sensitive Receptors

The Project site is located approximately 22 km southwest of Hub and 30 km west of Karachi. There are no major parks, schools or hospitals in the Study Area. All the industries and the settlements in the Study Area are considered as sensitive receptors.

Modeling Data and Parameters

Exhibit 8.4 shows the data and modeling parameters used for the assessment. The data and parameters used for modeling take into account installation of GGH in the FGD.

Exhibit 8.4: Modeling Data and Parameters

Parameter/ Data Category	*Parameter/Data*	*Value*	*Unit*	*Source/Notes*
Plant Information	Plant Power Generation Capacity (gross)	1320	MW	HUBCO
	Net Efficiency	39[8]	%	HUBCO
	Plant Load	85	%	HUBCO
	Stack Height	210	m	HUBCO
	Diameter (Stack Pipe 1)	6.4	m	HUBCO, with GGH in FGD circuit
	Diameter (Stack Pipe 2)	6.4	m	HUBCO, with GGH in FGD circuit
	Location (Stack Pipe 1)	66°41'23.67	Easting	HUBCO
		24°54'44.19"	Northing	
	Location (Stack Pipe 2)	66°41'23.92"	Easting	HUBCO
		24°54'44.25"	Northing	
Flue Gas	Total Flow Rate	1580.3	m^3/s	790.1m^3/s for one stack provided by HUBCO
	Exit Velocity	24.56	m/s	HUBCO
	Temperature	343	Kelvin	HUBCO, with GGH in FGD circuit
Emissions Rates	Sulfur Dioxide	233.3	g/s	116.6 g/s for one stack provided by HUBCO
	PM_{10}	51.14	g/s	25.57 g/s for one stack provided by HUBCO
	Oxides of Nitrogen (NO_x)	446.66	g/s	223.3 g/s for one stack provided by HUBCO
Building Heights used for Building Downwash	Boiler	60	m	HUBCO
	Turbine building:	34	m	HUBCO
	FGD	38	m	Typical heights assumed
	Control Building	18	m	

[8] Design coal consumption based on this efficiency used for modelling.

Parameter/ Data Category	*Parameter/Data*	*Value*	*Unit*	*Source/Notes*
	Administrative Building	16	m	

In addition to data provided in **Exhibit 8.4**, modeled weather and climate data of the years 2012 and 2013 for the Project site was obtained and used for the modeling. This is modeled using nearby stations and the MM5 model **(Appendix B**). A summary of the climate (temperature, relative humidity, and wind speed and wind direction) and wind rose for the Project site based on this data is provided in **Exhibit 4.15** and **Exhibit 4.16**, in **Section 4** respectively.

Modeling Results

The maximum concentration levels in ambient air were calculated for SO_2, NO_2 and $PM_{10.}$ The maximum concentration levels were modeled for a 24–hour average and annual average to correspond with the NEQS requirements. The model predicted the incremental values on the nodes of the grid defined for the simulations.

The contours for annual and 24–hour incremental concentrations for the proposed Project are presented in **Exhibit 8.5** to **Exhibit 8.12**.

Exhibit 8.5: Predicted Increment to the Annual SO_2 Levels

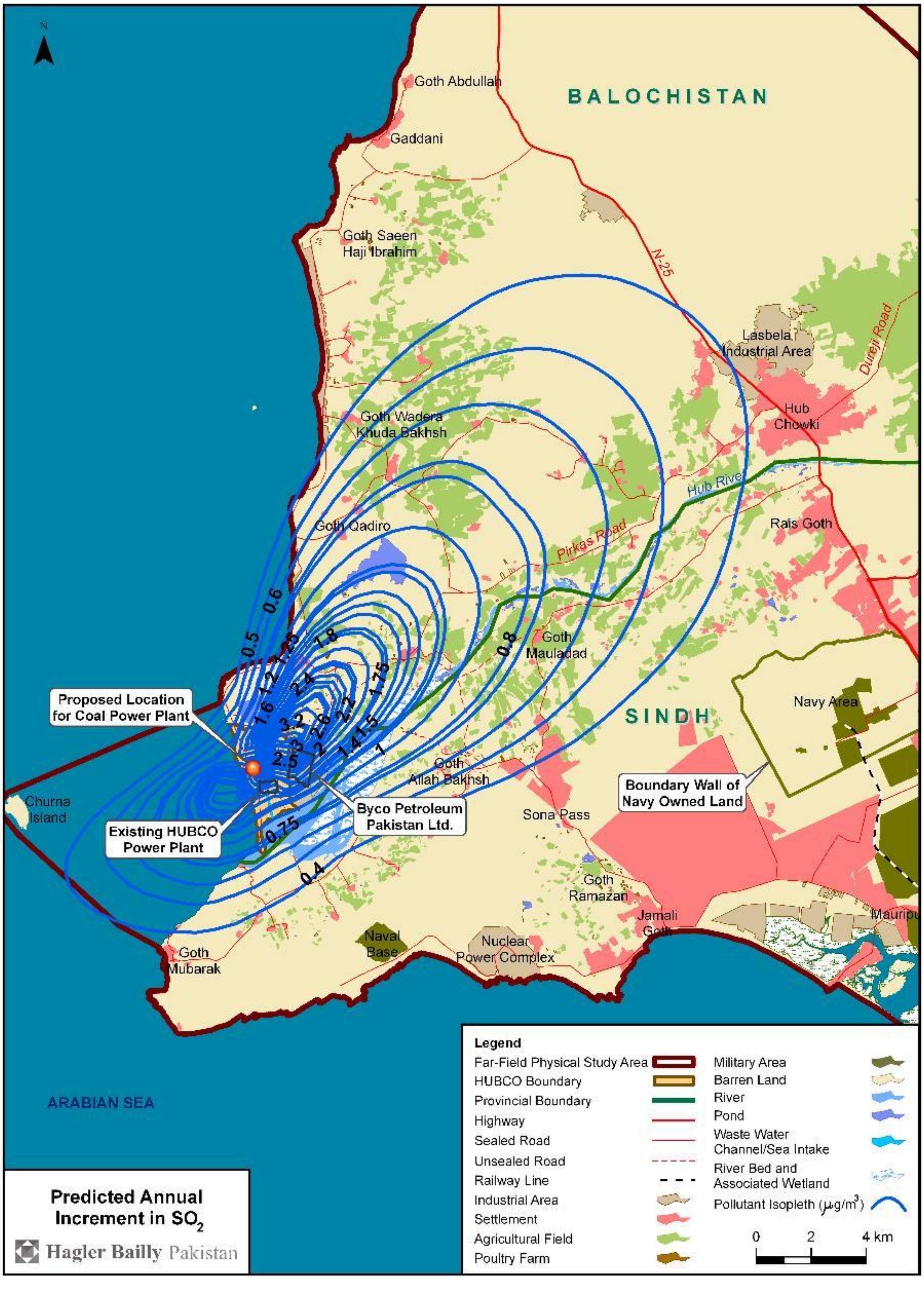


Exhibit 8.6: Predicted Increment to the Annual NO_x Levels

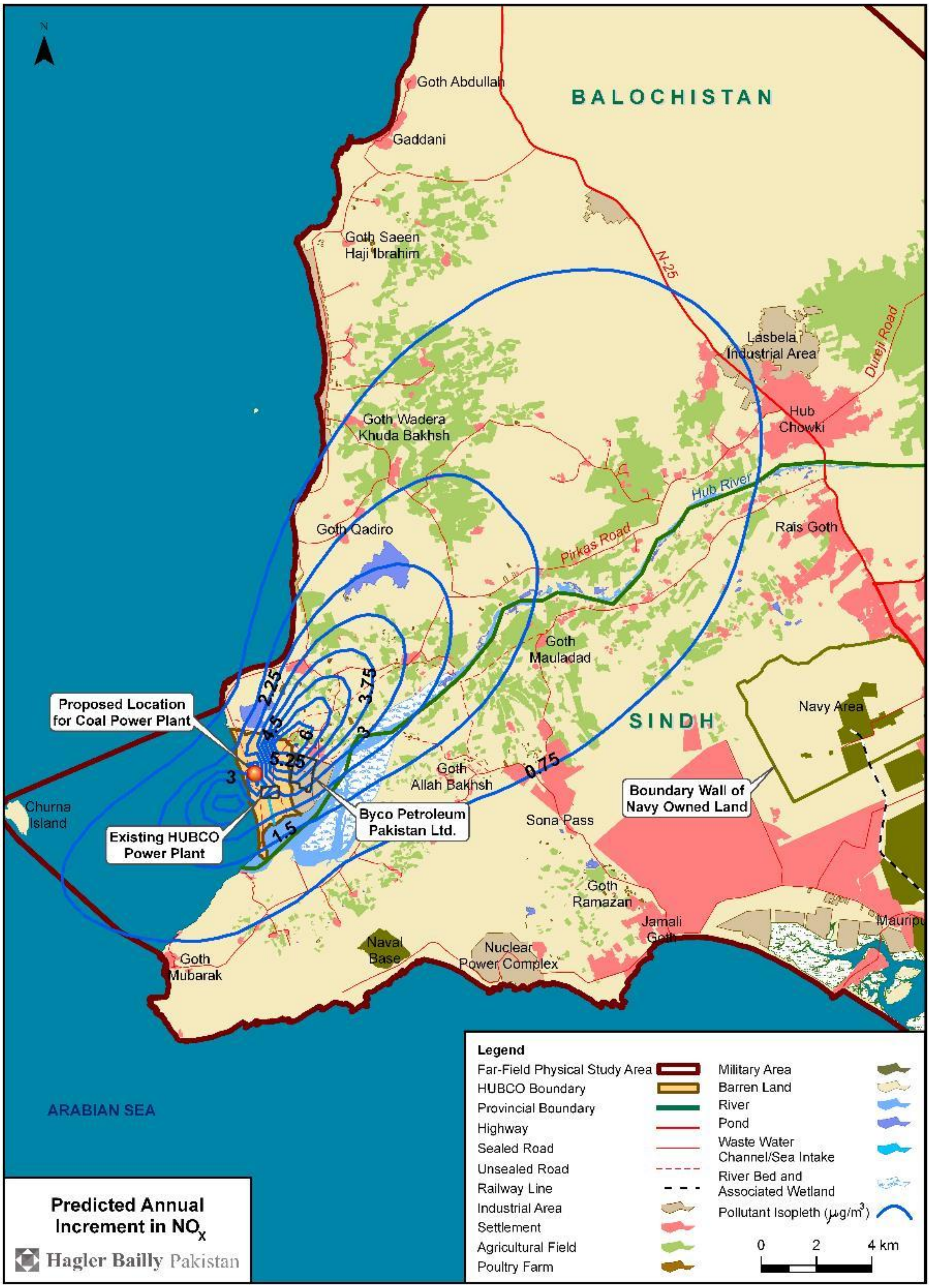


Exhibit 8.7: Predicted Increment to the Annual PM_{10} Levels

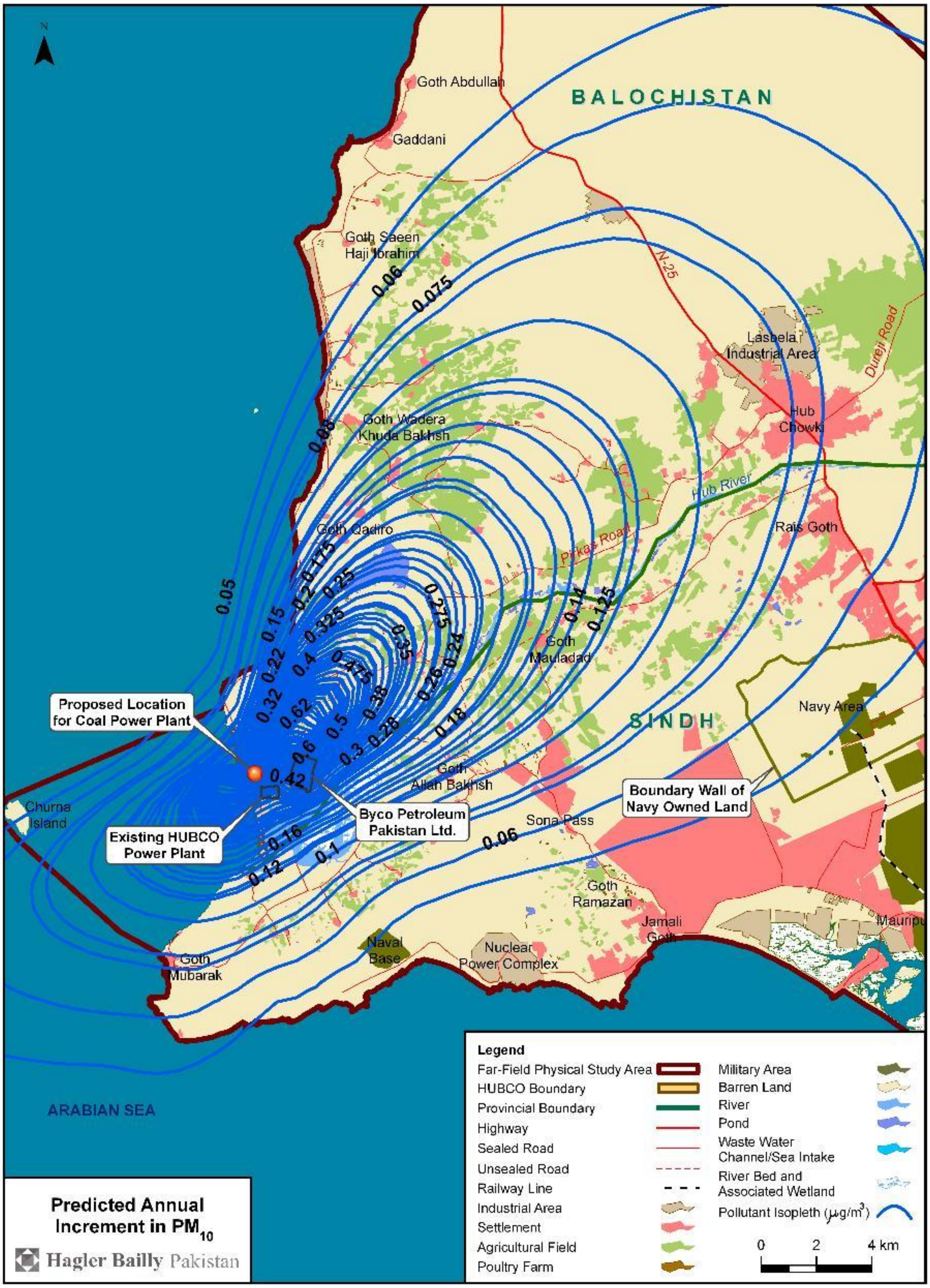


Exhibit 8.8: Predicted Increment to the Annual $PM_{2.5}$ Levels

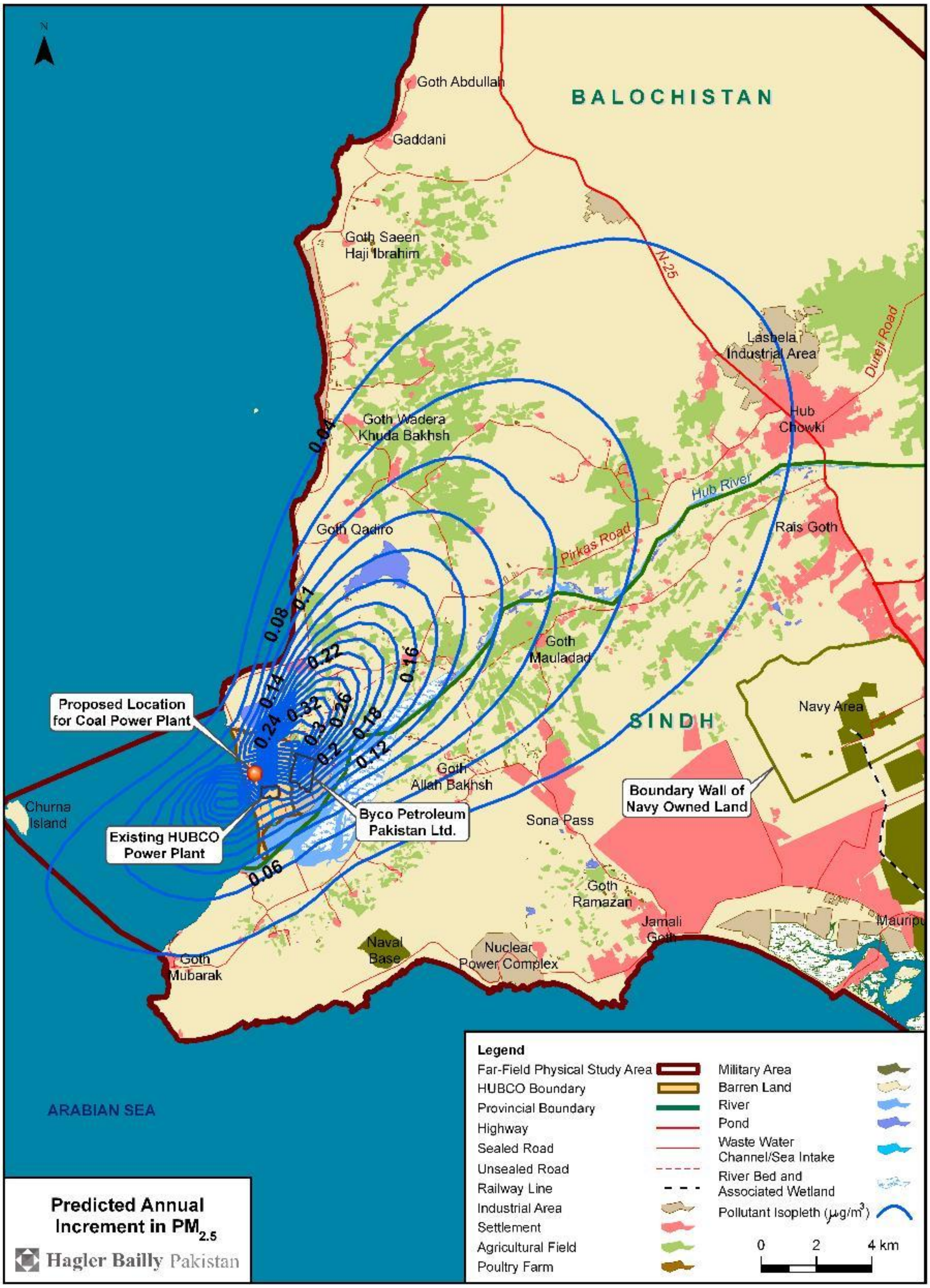


Exhibit 8.9: Predicted Increment to the 24–hour SO_2 Levels

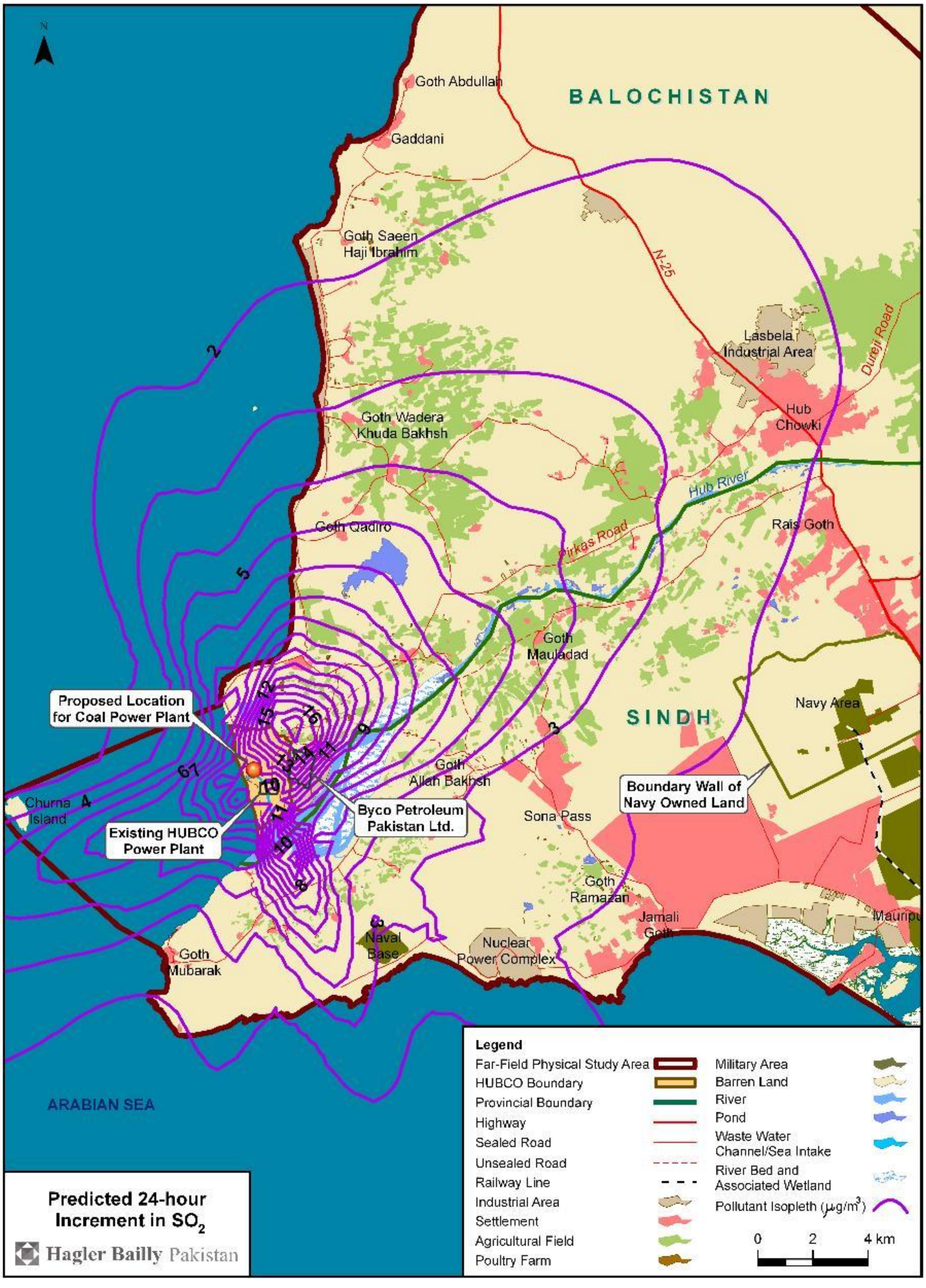


Exhibit 8.10: Predicted Increment to the 24–hour NO_x Levels

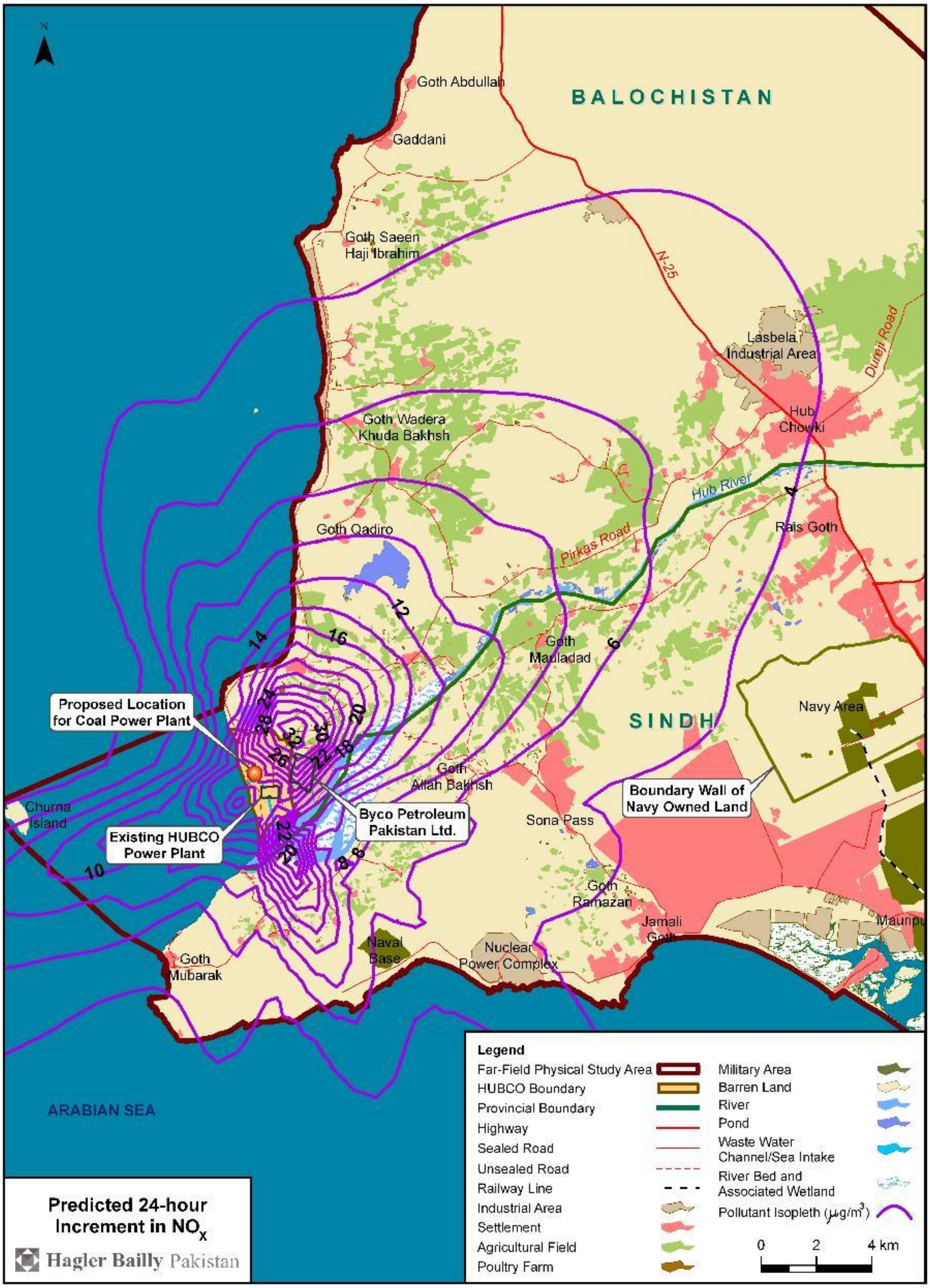


Exhibit 8.11: Predicted Increment to the 24–hour PM_{10} Levels

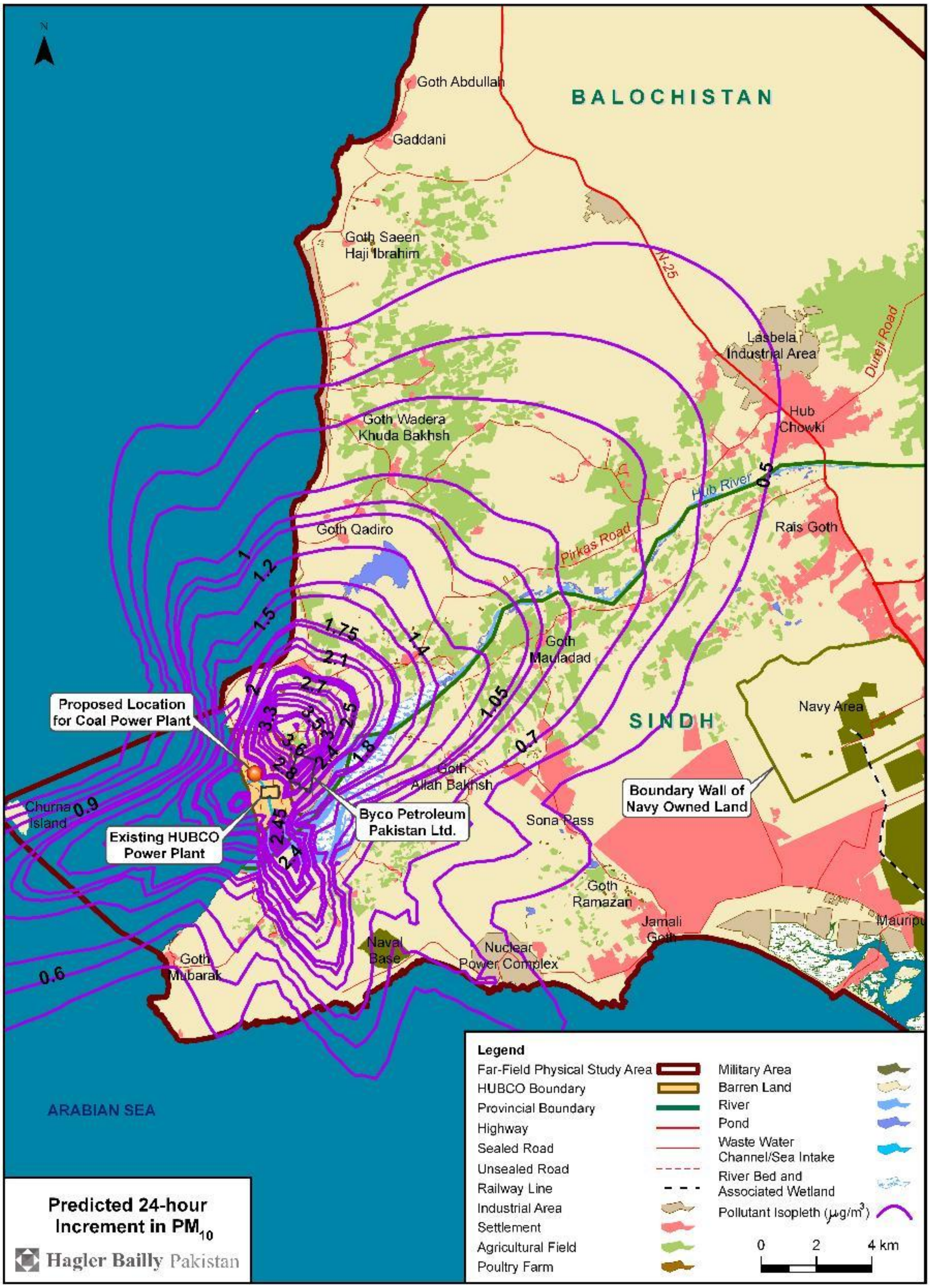
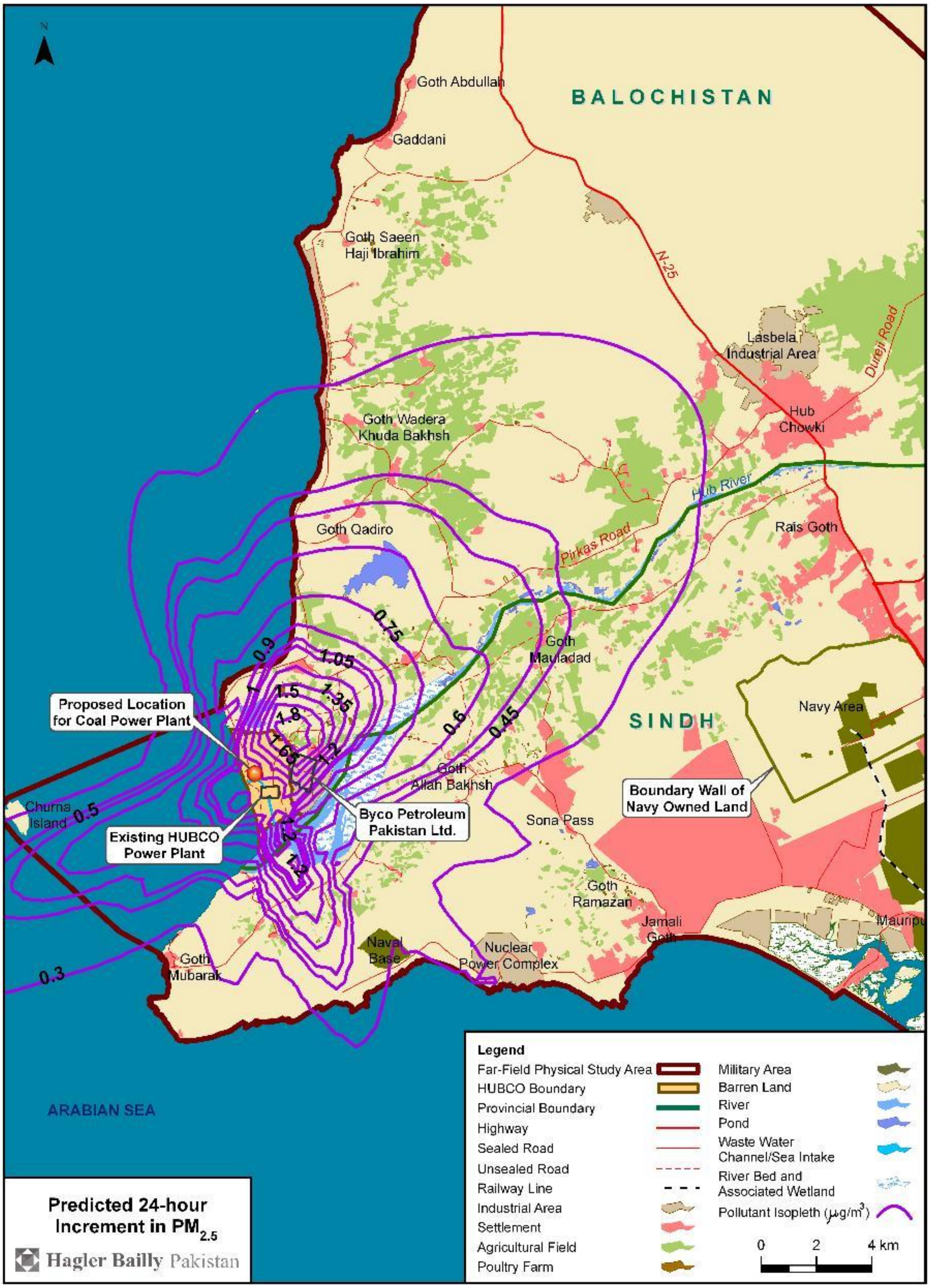


Exhibit 8.12: Predicted Increment to the 24–hour $PM_{2.5}$ Levels



Total Air Quality with Plant in Study Area

The forecasted 2018 background concentration was added to the incremental modelled concentration of air pollutants due to the Plant to get the total concentration of pollutants:

Total concentration of pollutant (x,y)

= Forecasted Background in 2018 (x,y) + Incremental Modelled Concentration due to Plant (x,y)

Where x is x-coordinate and y is y is y-coordinate

The contours for the total concentration of pollutants, including the 2018 background concentration and the increment due to the proposed Plant are presented in **Exhibit 8.13** through **Exhibit 8.20.**

Exhibit 8.13: Total Annual SO_2 Levels in 2018

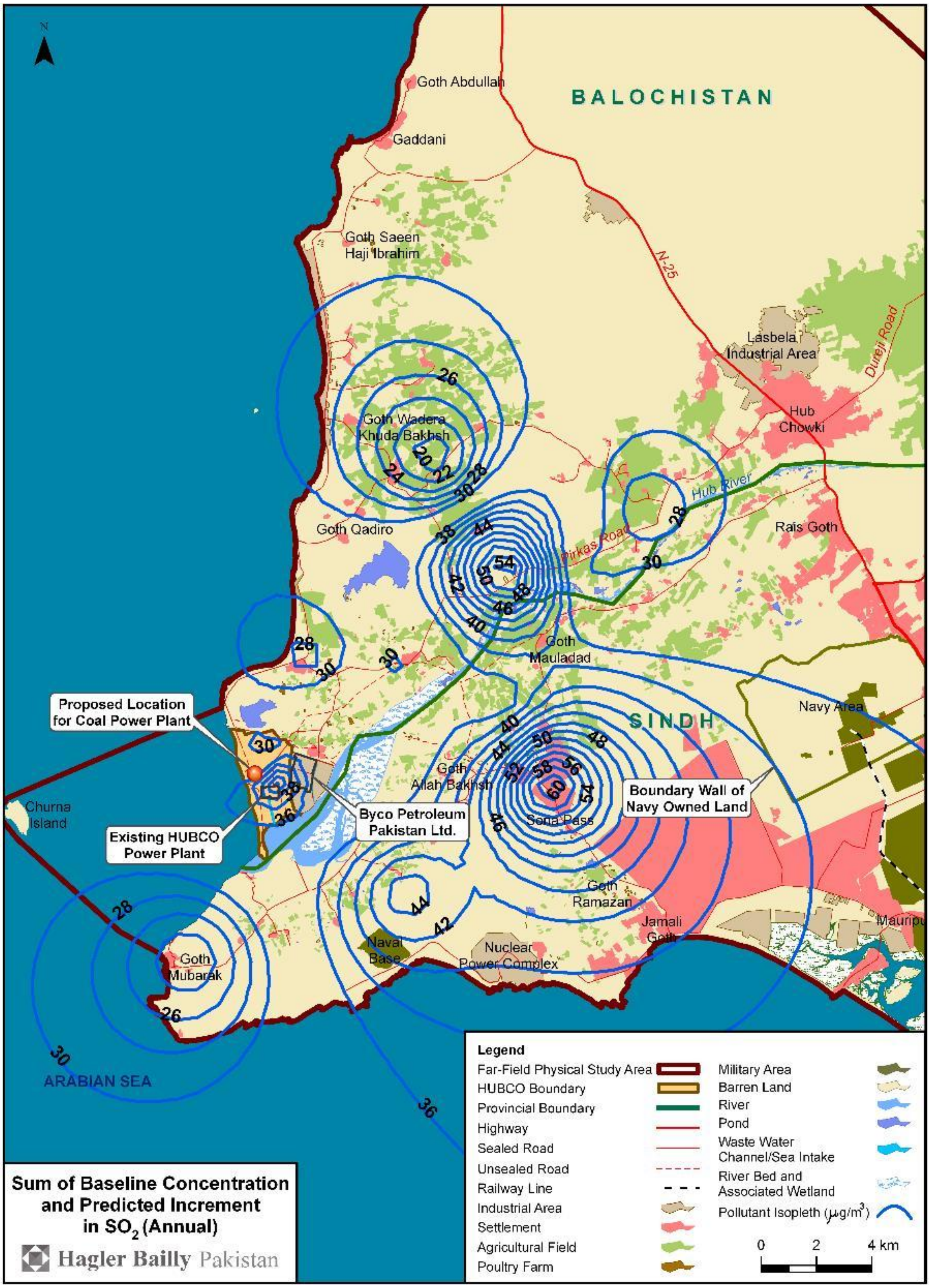


Exhibit 8.14: Total Annual NO_x Levels in 2018

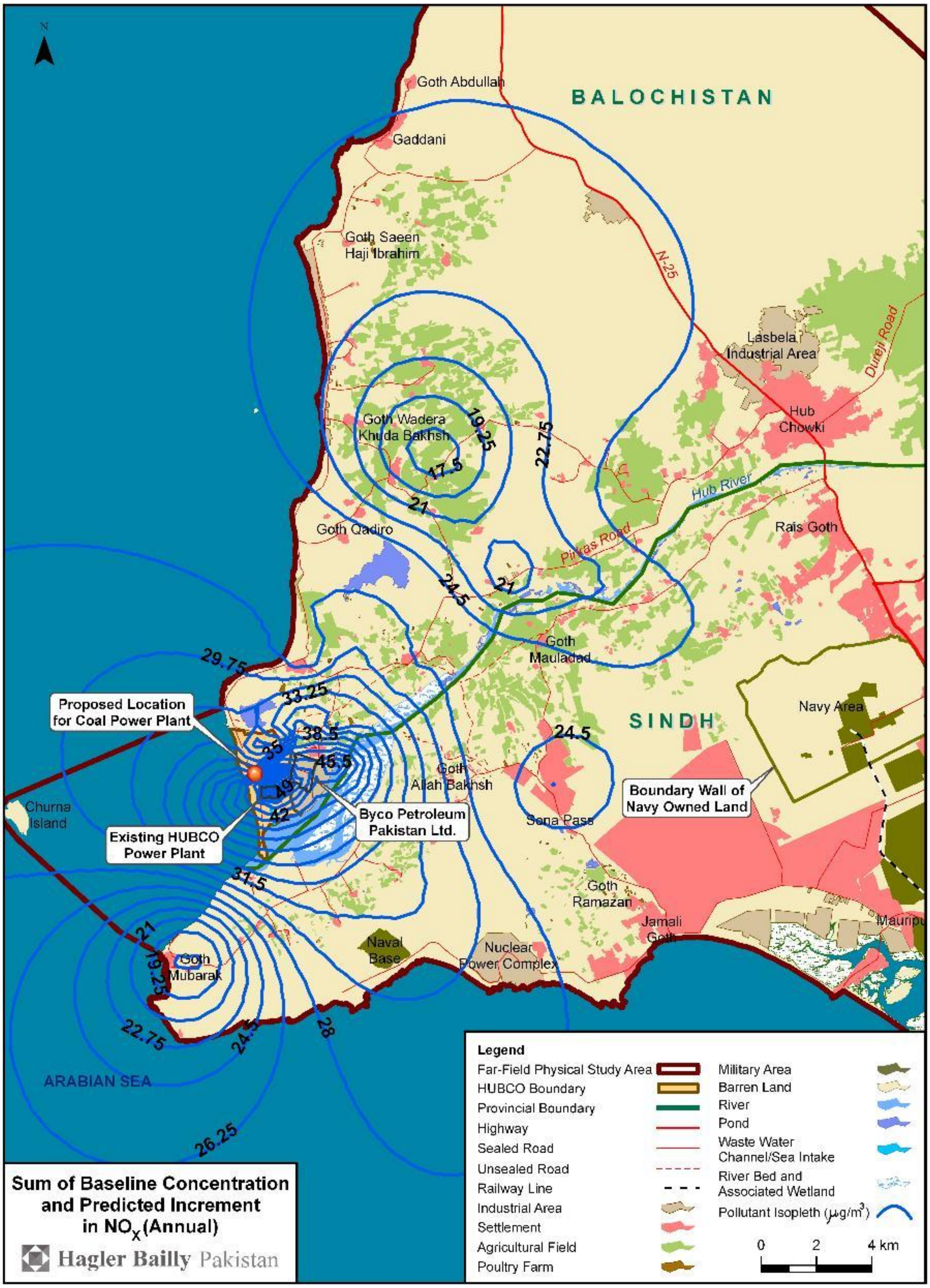


Exhibit 8.15: Total Annual PM_{10} Levels in 2018

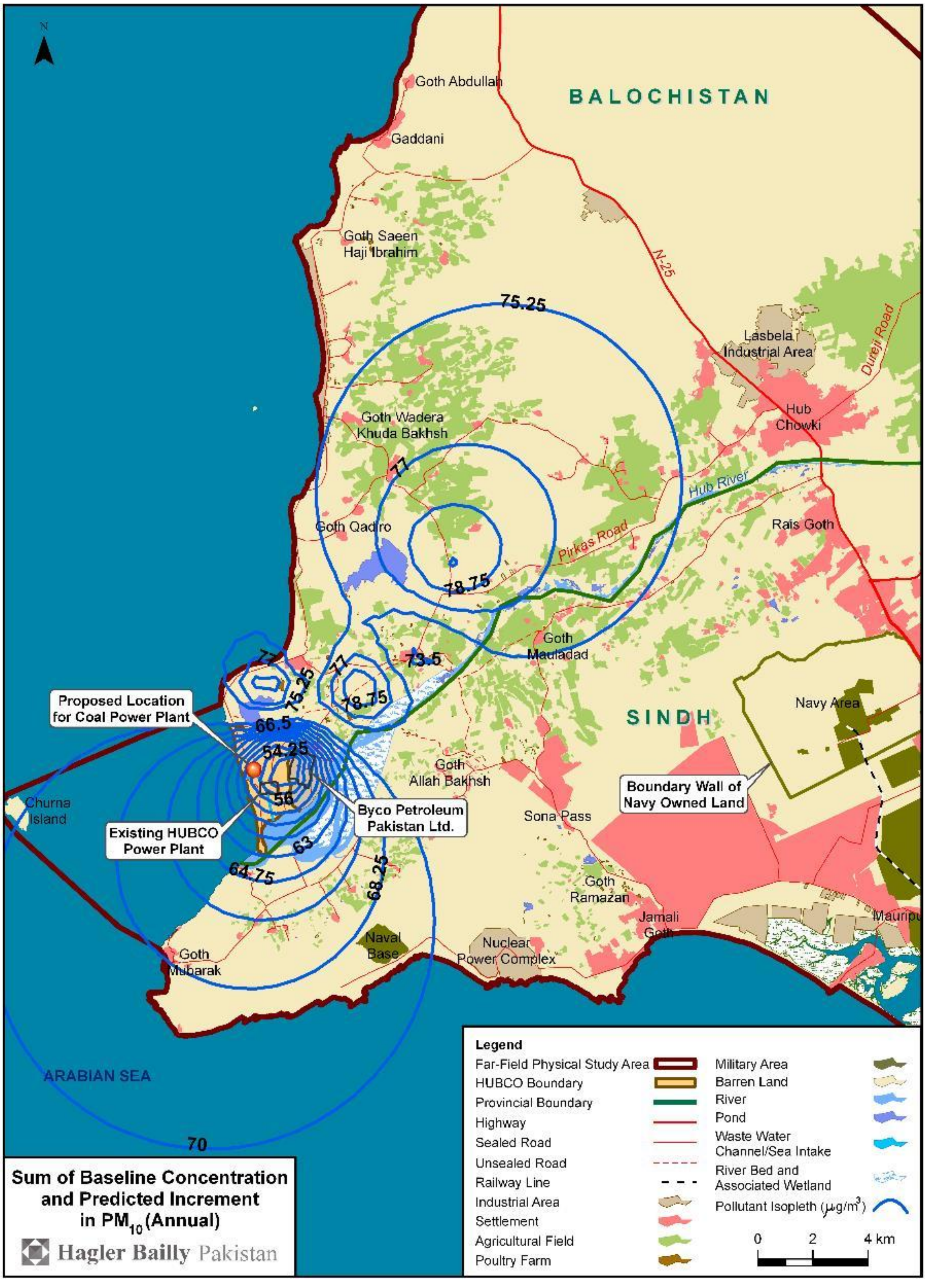


Exhibit 8.16: Total Annual $PM_{2.5}$ Levels in 2018

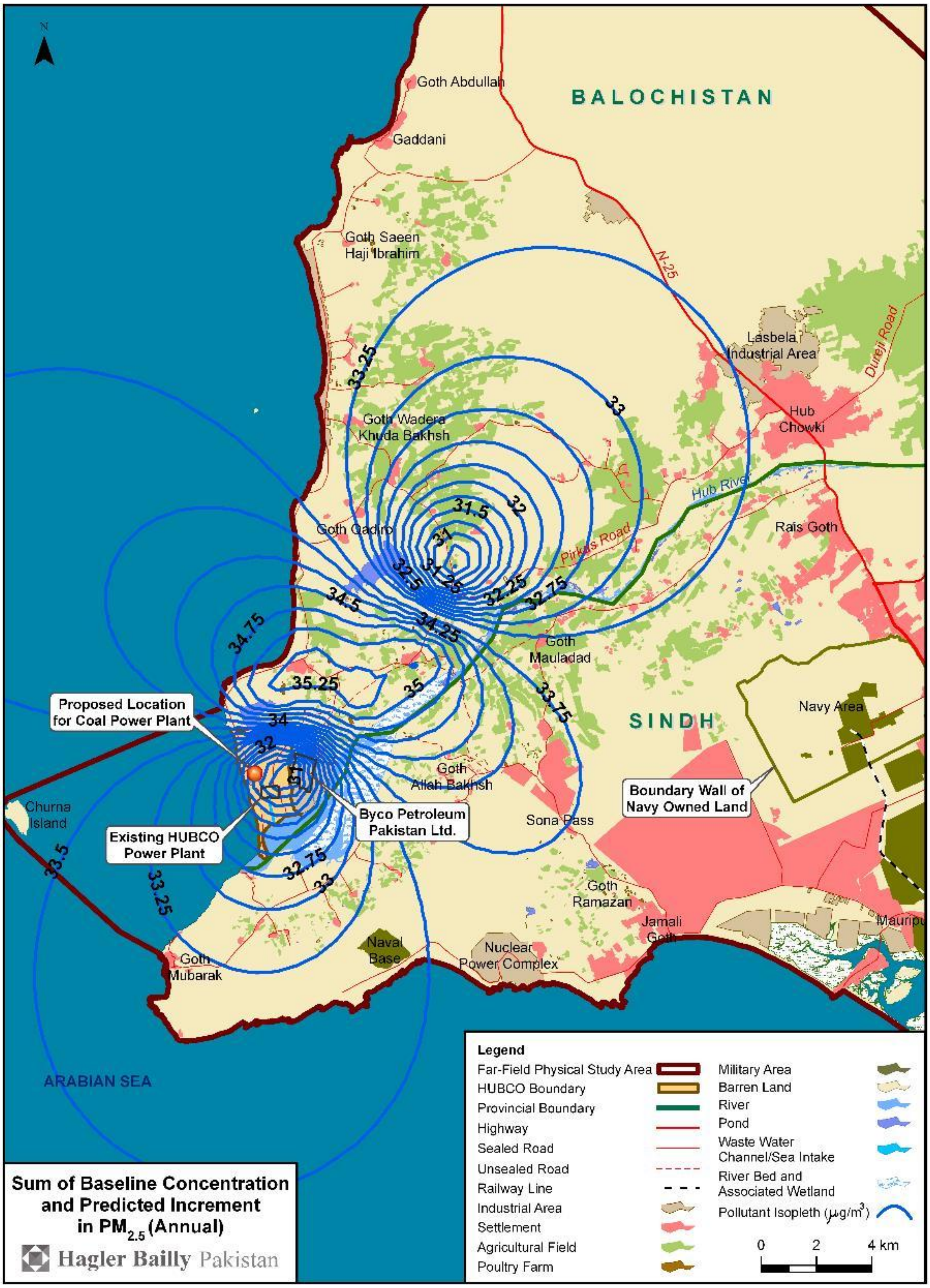


Exhibit 8.17: Total 24–hour SO_2 Levels in 2018

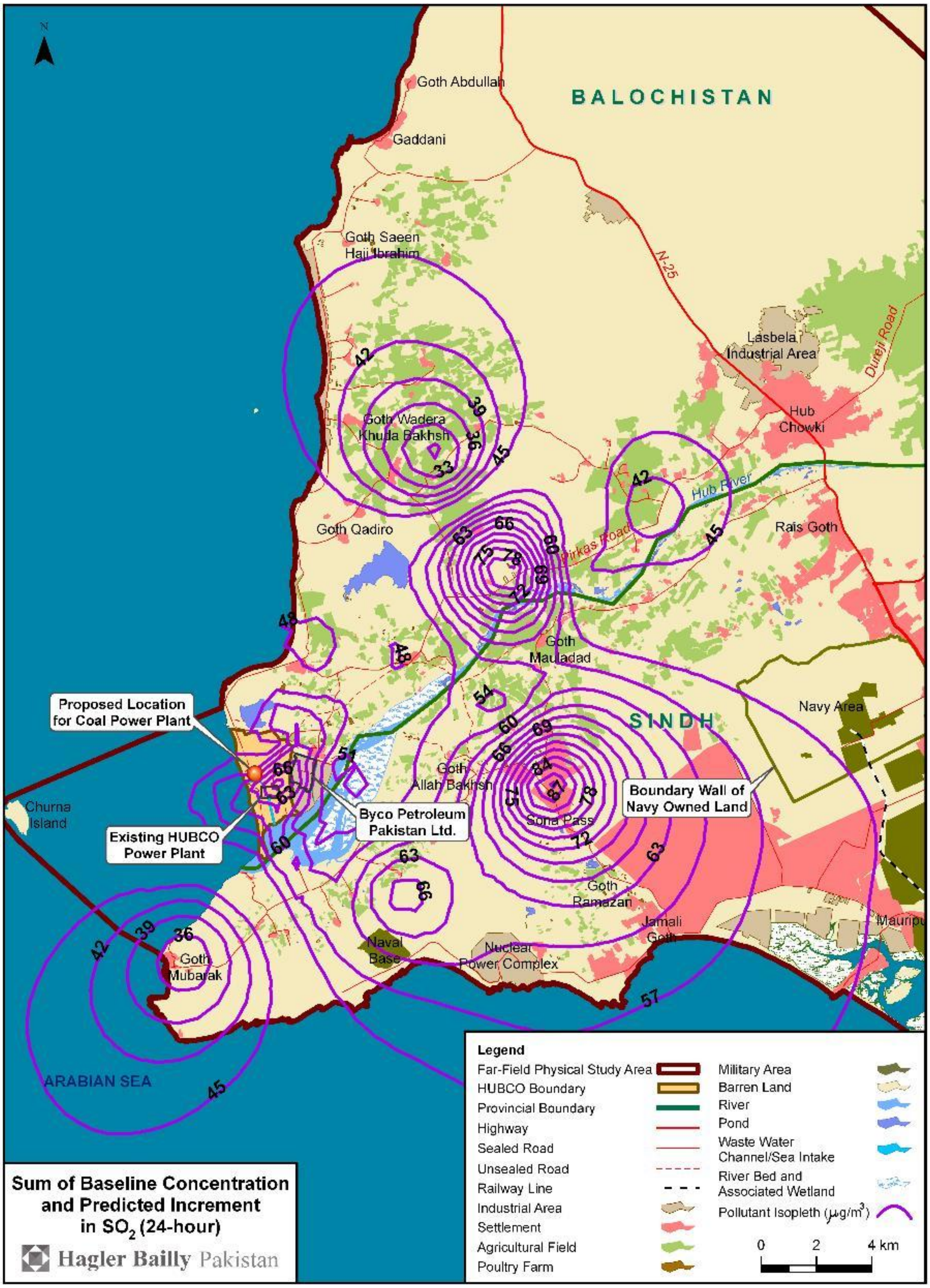


Exhibit 8.18: Total 24–hour NO_x Levels in 2018

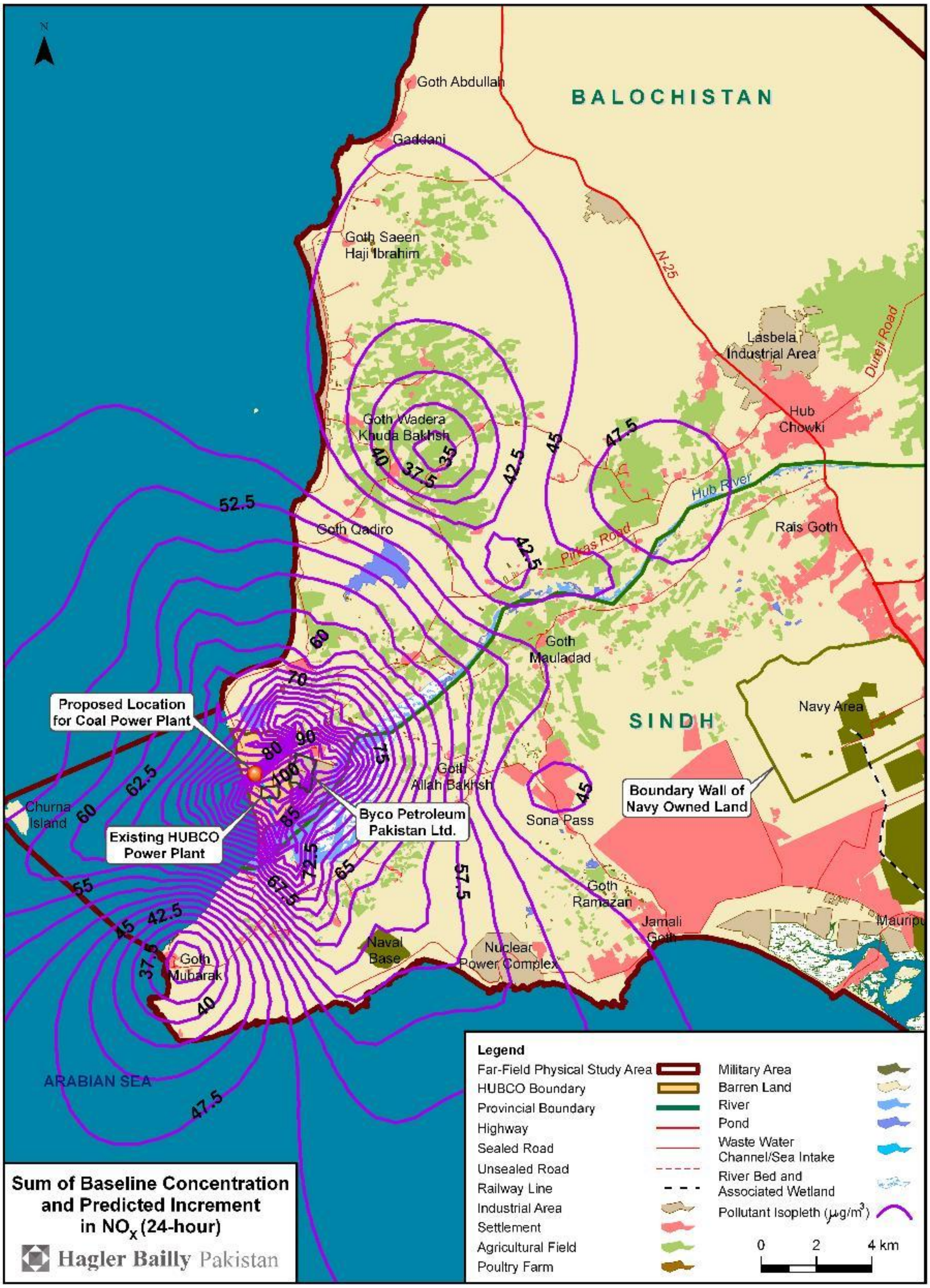


Exhibit 8.19: Total 24–hour PM_{10} Levels in 2018

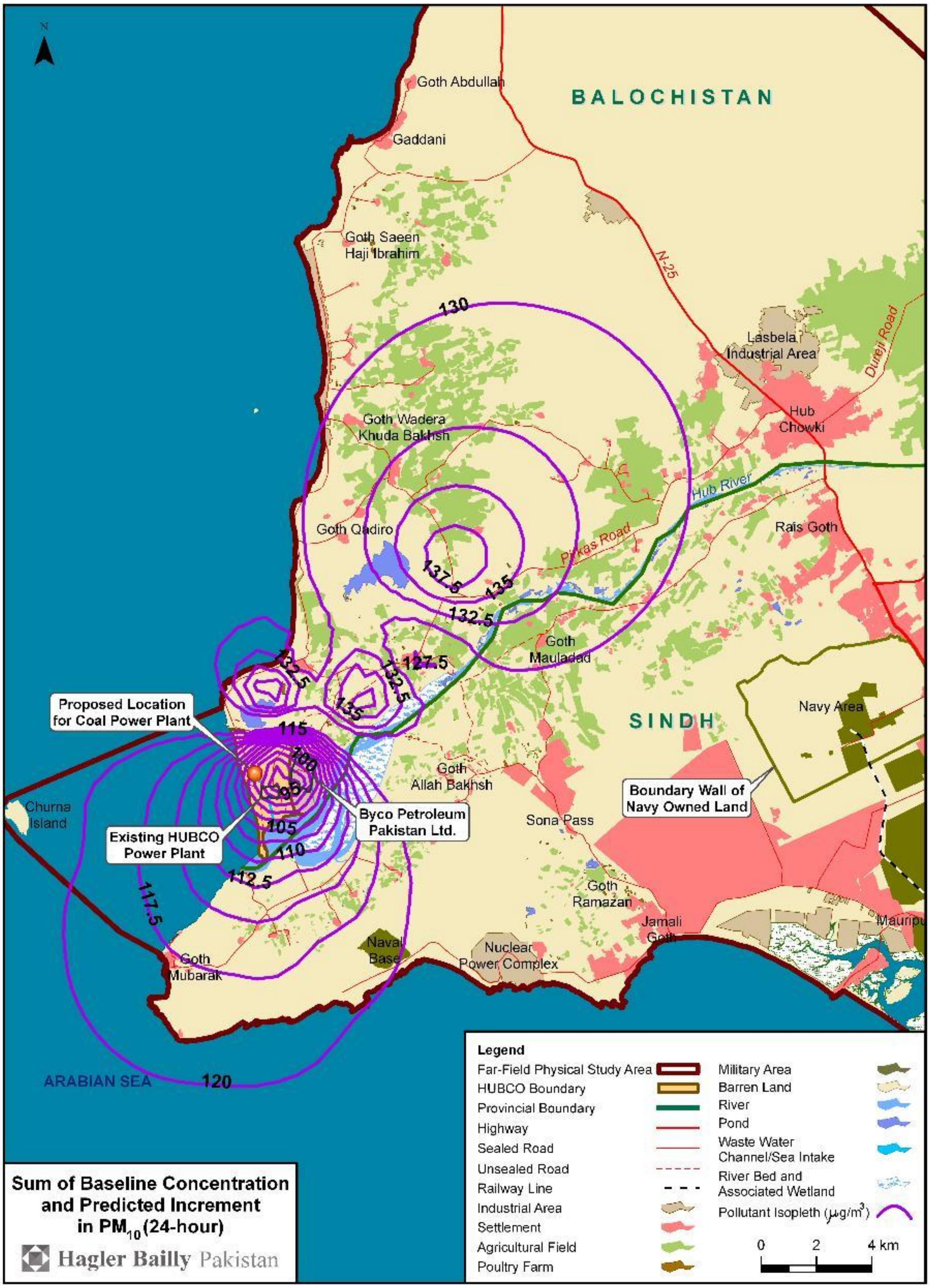
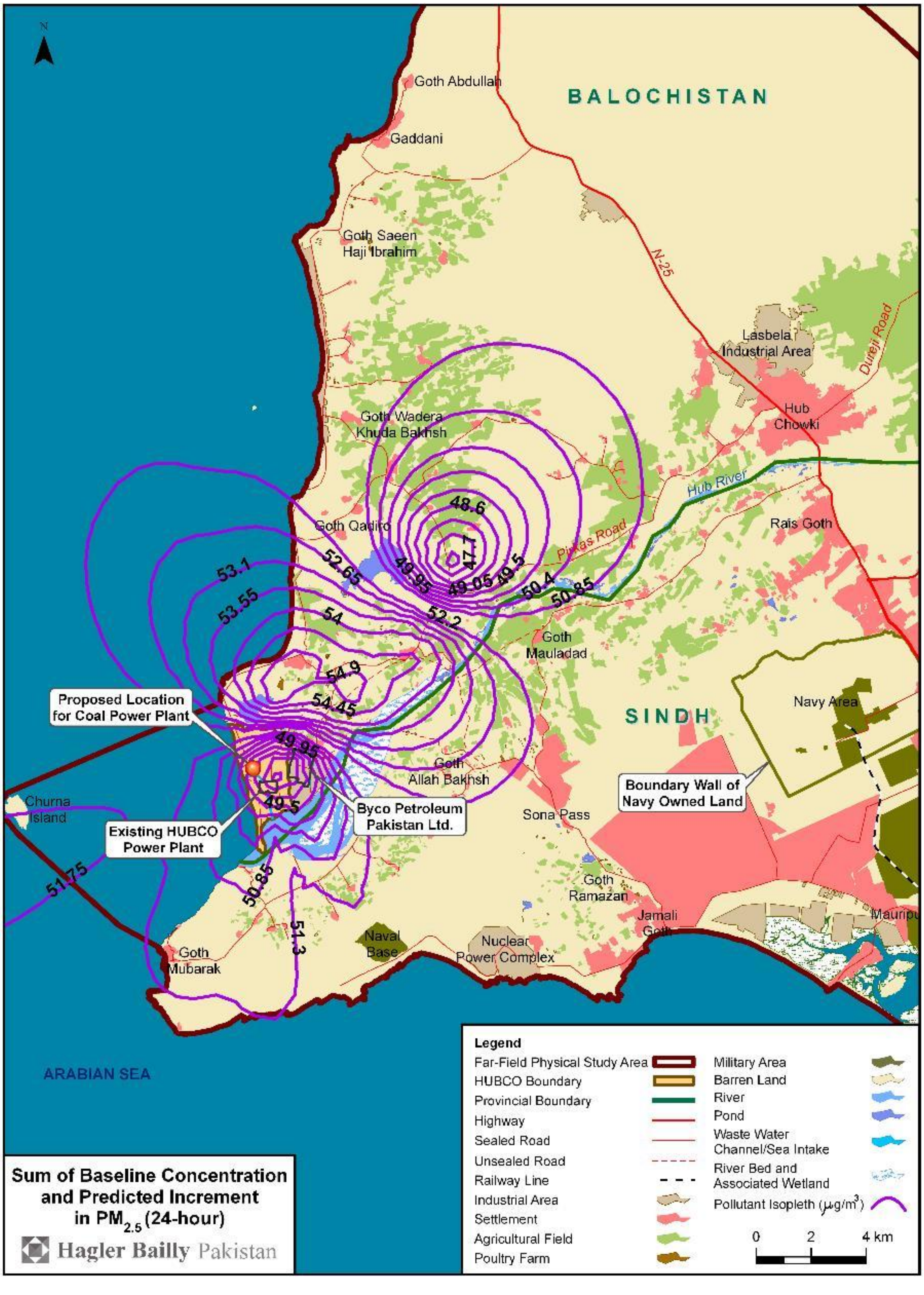


Exhibit 8.20: Total 24–hour $PM_{2.5}$ Levels in 2018



Compliance with Guidelines and Standards

Ambient Air Quality

The results of the air dispersion modeling indicate that SO_2 and NO_x, concentrations in the air with the Plant in operation will be compliant with NEQS as well as SEQS. For PM_{10} all the SEQS limits and 24-hour NEQS limits will be met, however if the 8-hour values recorded during the field survey are assumed to prevail throughout the year, the annual values will exceed the annual NEQS limit. The $PM_{2.5}$ levels are within the SEQS limits but exceed the limits prescribed by NEQS. However the predicted PM incremental value is very small in comparison to the background concentration. Therefore, the emission of PM from the proposed Project will cause almost no impacts on air quality of the Study Area. Any high levels of PM can be attributed to the topography and metrological conditions of the area. Moreover, the increment contour maps provided show that the values of pollutants decrease to insignificant level 15 to 20 km from the Project site. Therefore the Plant will not impact air quality levels in Karachi.

Exhibit 8.21 shows the maximum predicted values of pollutants in the study area and compares them with the applicable standards.

Exhibit 8.21: Compliance with Ambient Air Quality Guidelines and Standards

Pollutant	*Averaging Time*	*Maximum Background Concentration Levels (µg/m³)*	*Maximum Incremental Concentration Level (µg/m³)*	*Maximum Total Concentration Level (µg/m³)*	*NEQS (µg/m³)*	*SEQS (µg/m³)*
SO_2	24–hr (Max)	89.6	18.5	91.99	–	–
	24–hr (98th Percentile)	77.6	16.4	79.47	120	120
	Annual (Max)	62.8	3.9	63.164	80	80
NOx	24–hr (Max)	108.5	35.3	127.8	–	–
	24–hr (98th Percentile)	92	31.4	114.0	141.2	141.2
	Annual (Max)	61.5	7.5	65.0	101.2	101.2
PM_{10}	24–hr (Max)	138.7	4.0	140.9	–	–
	24–hr (98th Percentile)	138.7	3.6	138.7	150	150
	Annual (Max)	80.5	0.9	80.9	120	120
$PM_{2.5}$	24–hr (Max)	54	2.0	55.4	–	–
	24–hr (98th Percentile)	53.8	1.8	55.1	35	75
	Annual (Max)	35.2	0.45	35.5	15	40[9]

[9] Annual average limit of 40 (µg/m³) or background annual average concentration plus allowable allowance of 9 (µg/m³), whichever is low

Stack Emissions

The compliance status of the Project for stack emissions is shown in **Exhibit 8.22**. It shows that the plant will meet the NEQS for emission parameters.

Exhibit 8.22: Compliance with Emission Standards

Parameter	*Units*	*Emission from the Proposed Plant*	*NEQS Standards*
Particulate matter	mg/Nm^3	45.8	500
Sulfur oxides	Tons per day	20.2	100 – 500
Oxides of nitrogen	nanogram per Joule of heat output	143.5	300

Impact of removing Gas-Gas Heater from Seawater FGD Circuit

Gas-Gas Heater (GGH) will be used in the FGD which will increase the temperature of flue gases leaving the stack to 70 °C. The air quality impact of such scenario is discussed in **Exhibit 8.21** and **Exhibit 8.22.** Air dispersion modeling was conducted for No-GGH option and it was concluded that even if GGH is not used, NEQS will be complied. For simulating the model for without GGH option stack diameter of 6.9 m, exit velcoity of 19.28 m/s and flue gas temperature of 313 K was used. Rest of the parameters remained the same as for with GGH option.

Exhibit 8.23 provides a comparison between the total concentration of pollutants in ambient with GGH and the total concentration of pollutants in ambient without GGH option.

Exhibit 8.23: Comparison between Total Concentration of Pollutants in Ambient With GGH and Without GGH Options

Pollutant Name	*Averaging Time*	*Maximum Incremental Concentration Level (µg/m³)*		*Maximum Total Concentration Level (µg/m³)*		*NEQS (µg/m³)*	*SEQS (µg/m³)*
		With GGH	*Without GGH*	*With GGH*	*Without GGH*		
SO_2	24–hr (Max)	18.5	23.7	92.0	92.6	–	–
	24–hr (98th Percentile)	16.4	22.1	79.5	81.4	120	120
	Annual (Max)	3.9	5.4	63.2	63.2	80	80
NOx	24–hr (Max)	35.3	45.3	127.8	139.5	–	–
	24–hr (98th Percentile)	31.4	42.3	114.0	123.0	141.2	141.2
	Annual (Max)	7.5	10.3	65.0	67.0	101.2	101.2
PM10	24–hr (Max)	4.0	5.2	140.9	141.4	–	–

	24–hr (98th Percentile)	3.6	4.8	138.7	138.9	150	150
	Annual (Max)	0.9	1.2	80.9	81.0	120	120
PM2.5	24–hr (Max)	2.0	2.6	55.4	55.7	–	–
	24–hr (98th Percentile)	1.8	2.4	55.1	55.3	35	75
	Annual (Max)	0.45	0.6	35.5	35.5	15	40

8.4.2 Impacts on Air Quality from Coal–Handling at the Coal Storage Yard

The predominant discharge from the proposed coal yard will be particulate matter. Small quantities of engine exhaust emissions will be generated from the mobile equipment used on the site. The emissions from the engines are considered to be relatively minor and are expected to be well dispersed prior to reaching sensitive receptors. The dust that will be discharged from the coal stockpile in the coal yard will be comprised of a wide variety of size fractions. The larger deposited dust is material generally greater than 50 µm in diameter. It poses a nuisance potential due to soiling of surfaces and can cause irritation to eyes and nose. Because it is relatively large in size, deposited particulate usually falls out of the air within a short distance of the source and usually within 100 m. There are no sensitive receptors within a 100 m radius of the Plant Site.

The finer materials commonly referred to as Total Suspended Particulate or TSP, and generally less than 20 µm, can travel large distances downwind. While these pose the greatest potential health effect, the major source of the finer particulates in the atmosphere is combustion processes which have been discussed in the air quality section. The particulate generated from processes such as those involved in a coal yard are likely to be predominantly made up of larger size fractions (greater than 10 µm).

The major factors that influence dust emissions on the surfaces are[10]:

- wind speed across the surface (the critical wind speed for pickup of dust from surfaces is 5 m/s; above 10 m/s pickup increases rapidly);
- percentage of fine particles in the material on the surface;
- moisture content of the material on the surface;
- the area of exposed surface;
- disturbance such as traffic, excavation, loading and unloading of materials; and
- height of the source above the surrounding ground level.

Dust emissions from material handling and storage can be significant if not controlled. However, if standard dust control techniques are used the emissions can be reduced significantly. The smaller the particle size of the material on the surface of a road or an

[10] Beca Pty Ltd (Beca). (2010). L&M Coal Ltd Assessment of Environmental Effects of Discharges to Air from Proposed Coal Stockpiles. Greymouth, New Zealand: West Coast Regional Council.

exposed surface, the more easily the particles are able to be picked up and entrained in the wind. Moisture binds particles together preventing them from being disturbed by wind or vehicle movements. Each coal type and grade has a unique moisture content above which dust emissions are substantially reduced. It will be ensured that the moisture content of the coal is maintained as required throughout the coal handling process from the point it arrives at the ports, to its injection into the boilers, to minimize dust emissions.

Coal–handling operations will have dust–suppression systems spraying water on the coal at the ports and prior to unloading at plant–site and being exposed to the sun and wind in order to cater for some evaporation and seepage.

Sources of Particulates and Proposed Mitigation Methods

The activities that will take place at Project's coal storage yard, that may generate discharge to air are:

- construction;
- vehicle movements on unpaved surfaces and roads;
- wind generated dust from dry exposed surfaces such as stockpiles and yard areas;
- loading and unloading of materials; and
- stockpiling.

The methods proposed to mitigate the potential sources of particulate emissions are summarized in the following sections.

Construction

During the excavation of the site designated for the coal yard, stripping of soil from the surface and the formation of bunds and roads have the potential to generate significant quantities of dust if the processes are not carefully controlled. To control dust from these activities during the preparation of the coal yard following mitigation methods will be used:

Keep exposed surface areas to a minimum and vegetate exposed areas as soon as practical.

Restrict potentially dusty activities such as the stripping and spreading of topsoil on days when conditions are dry and winds are strong and blowing towards sensitive receptors.

Since the climate and weather conditions in the Project site will be dry and windy on most days, dust from the construction of the coal yard has the potential to generate a lot of dust. Therefore, availability of large quantities of water will be ensured. This water will be used as a dust suppressant to keep unvegetated surfaces and roads damp.

Yard Areas and Roads

Vehicle traffic on access roads and vehicle traffic around the stockpile all have the potential to be significant sources of dust. Dust from yard areas and roads will be controlled primarily by limiting the amount of fine particles exposed to the wind and, keeping surfaces damp.

On areas of the yard and roads that are crossed by vehicles any coal deposited onto the surface can be ground into small particles which are particularly susceptible to pick up by the wind. This dust will be controlled by removing the buildup of fine material on a regular basis and replacing the surface of the area with coarser grade material.

Yard areas disturbed, and roads used frequently will be watered regularly. It is also recommended that control shall be applied on vehicle speeds in the vicinity of the coal stockpile. Limiting the speed of vehicles reduces the turbulent wake behind moving vehicles and reduces the amount of material picked up and entrained by the wind.

The coal stockpile area will be designed to minimize haul distances between the stockpile and the boiler loading area and the number of vehicle movements. Bunds will be built strategically to shelter the yard area from the wind, providing a significant barrier to dust being carried beyond the boundary wall of the Project site.

In summary the following dust mitigation methods will be adopted:

- Coal stockpile to be inside bund area.
- Vehicle speeds to be controlled in the vicinity of the stockpile.
- Road and yard surfaces to be cleaned or kept damp when required.
- Internal haul roads and yard areas to be maintained by removal of fine material and the laying of fresh gravel.

Travel distances be minimized by using conveyors to load coal onto the stockpiles and by locating the stockpile in close proximity to the boilers.

Loading and Unloading of Materials

Coal falling onto a stockpile and at conveyor transfer points is a potential source of dust as the wind picks up fine dry particles of coal from the surface of the conveyors. Coal falling off conveyors due to blockages and dropping from return belts can result in a buildup of coal under conveyors. This material can become a source of dust if not removed.

Transfer points to the yard conveyor will be covered, however, some parts, such as the transfer point between the yard conveyor and the stacker may not be able to be covered due to the design of the equipment. Dust suppression systems will be installed in those parts.

Elevated stacker conveyors will be provided with covers or windshields to shelter the coal from the wind and reduce dust potential. The coal will be damp when it is loaded onto the stockpile and water will be available to dampen the coal plume falling onto the stockpile to reduce dust formation. This will be required especially when thermal coal is being stockpiled given the high percentage of fine material in the coal. However, ensuring relatively high moisture content of the coal being carried by the conveyor belt to the yard will reduce this risk.

Conveyor belts at the plant will be fitted with belt scrapers to remove coal build up on the return belts. Coal dropping onto the ground as a result of spillages will be regularly removed. Coal being reclaimed from the stockpile for use in the boilers will also lead to possible spillage. Such loading areas will be cleared of any spilled coal regularly and bunds surrounding the stockpile area will shelter the load out activities from the wind and water used to dampen surfaces. These mitigation methods will reduce the potential for dust generated from these activities leaving the site.

To control dust from the loading and unloading of coal the following methods will be adopted:

- A conveyor and travelling stacker be used to transfer material to the stockpiles.
- Water will be used to dampen any dust produced from the coal falling onto the stockpiles.
- Transfer points on the yard conveyors will be covered.
- The elevated stacker conveyor will be provided with wind shields or covers.
- Conveyors will be fitted with belt scrapers.
- Coal deposits under the conveyors and at the conveyor unloading area will be regularly removed.

Bunds will be strategically located around points of frequent handling of coal at the stockpile to shelter the loading and unloading activities from the wind.

Dust Control System for the Project

Dust control is achieved by dust suppression and collection system. Dust suppression will be achieved by either of two methods; Plain Water Dust Suppression System or Dry Fog Type Dust Suppression System. Design and construction features of Dust control system shall be generally in conformity with the recommendation of "American Conference of Governmental Industrial Hygienists" or applicable international standards.

Dust extraction system shall be provided at the bunker floor and crusher house. At the outlet of the dust extraction system, the dust concentration shall be well below applicable International Standards for working areas

Coal Stockpiles

Wind blowing across the stockpile and vehicle movements disturbing the surface of the stockpile has the potential to generate dust. The amount of dust generated from surfaces such as stockpiles is dependent on the wind speed across the surface and the proportion of fine material on the surface of the pile exposed to the wind. Inactive stockpiles develop a crusty surface that effectively minimizes dust emissions.

The principal means of controlling dust from stockpiles is the use of water as a dust suppressant and minimizing the disturbance of the surface with vehicles. The coal will have inherently high moisture content when it is loaded onto the stockpile. Moisture loss from evaporation will reduce the surface moisture content quickly and increase the dust potential if it is not replaced.

Considering the dry and windy conditions for the bulk of the year in the Study Area, dust–suppression watering system will be installed to maintain the moisture content of the stockpile surfaces all year around.

Monitoring

If the mitigation measures proposed above are set in place, there is no significant risk to the environment outside of the plant's boundary. However, considering occupational health and safety standards for the plant's workers and those working in industries in the vicinity of the Plant site, dust from the coal yard has a high potential for causing respiratory ailments. The high winds, along with the hot and dry climate for most of the year in Hub will constantly contribute to dust generation and emission from the coal handling activities at the coal yard.

Therefore a monitoring system should be installed in place to regulate all the dust suppression systems and monitor TPM samples at different locations within the plant site to check dust levels are in control (**Section 9: Environmental Management Plan**).

8.5 Traffic Impact

As described in **Section 3**, plant equipment and coal (approximately 30 days per year requirement) will be transported to the Project from the port in Karachi through N-25 and Pirkas Road. Currently the road(s) are spacious and no major traffic congestion issues have been reported. The only bottleneck expected will be the settlement of Hub Chowki. During construction, the only impact expected on traffic will be due to equipment transfer. As all the construction works will be carried out within HUBCO's owned land and plant premises, it will not impact the traffic in any way. The heavy equipment will be transferred from Port to the Project site at low traffic conditions as identified in **Section 4.2.9** and NHA rules will be followed so that the impact on traffic is minimum. This study focuses on the routes that may be used for Project related traffic and the likely impacts that may be caused due to the Project. Traffic count surveys were conducted to assess the baseline traffic load.

The basis for contingency road transport is 30% of total coal consumption for maximum 4 months duration per year. This translates into about 70 trucks per day of 50 ton each or 44 trucks of 80 ton each. **Exhibit 8.24** shows the three segments that a truck will pass through from Karachi Port to the Project site. Segment A, is a dual carriageway where heavy vehicles are allowed 24 hours. That route is normally used by heavy traffic to transport goods to and from Karachi Port towards the western part of Pakistan. This route has capacity to accommodate additional trucks due to wide clearance. The impact on road safety and congestion is low. However, mitigation measures to control the environmental and social impacts and will be adopted. The route Segment B has two roads on this route, one single carriageway and one dual carriageway. Light vehicles and public transport use dual carriageway on this route and heavy vehicles use the single carriageway. No major communities are settled close to the single carriageway therefore noise impact will be very low. As the heavy vehicular traffic will be using a separate single carriageway, the impacts on traffic congestion will not be major. During operation phase, the impact will be significant near Hub Chowki on this segment only during emergencies when coal transport through jetty will not be possible and the coal yard supplies will be unable to support the requirements of the plant. The probability of such an event is low but still possible. As social receptors exist in Hub Chowki area posing a potential risk of congestion, coal transport will be restricted to low traffic hours only. Strict mitigation measures will be adopted on roads to minimize traffic impact if such an emergency situation arises .For Segment C, Pirkas Road, a traffic count survey was conducted to assess the traffic conditions on this road. The baseline Passenger Car Unit (PCU) values at Pirkas Road at traffic survey Location 2 are as low as 1,433 and 1,170 per day for traffic in the two directions (**Section 4.2.9**, Traffic Baseline Survey). This is a Type 5 single carriageway with PCU capacity of 800 PCU/hr. [11] The PCU for combined flow on traffic survey Location 1 where PCU was higher than Location 2 is only 217 PCU per hour. The traffic flow is therefore low and with additional traffic the impact will not be significant on this segment.

The following are the potential impacts are envisaged:

- Traffic congestion at the junction of Hub Chowki and in Karachi city.
- Noise due to the movement of heavy traffic especially near community areas.
- Fugitive dust emission due to movement of heavy traffic and especially the dust emissions from the trucks that would be carrying quarried material to and away from the quarrying site while transporting the spoil load for disposal away from site. Also, dust from coal carrying trucks is also a potential environmental impact.
- Increased risk of road side accidents as the traffic would have to pass through several small and large settlements where the shops, schools, mosques and other such types of places are located close to the road shoulder.
- Accidental breakdown or accident of a heavy vehicle carrying equipment or construction material could block the road entirely could result in blockage of traffic.
- Exhaust emissions from vehicles would impact the ambient air quality as well and in case of traffic blockages or congestion it may be a nuisance for the community.

[11] The Highway Capacity Manual (HCM) is a publication of the Transportation Research Board of the National Academy of Science in the United States.

Exhibit 8.24: Traffic Sampling Locations

Impact PO4: Traffic congestion, reduced road safety, and higher levels of noise, dust and other pollutants.								
Applicable Project Phase								
Construction/Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Initial Impact	Moderate	Medium	Extensive	High	Definite	High	-	High
Mitigation Measures: • Specialized covered trucks will be used for transporting coal to minimize coal dust emissions. • Contractor's vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations imposed by National Highway Authority (NHA) especially near sensitive receptors (schools, hospital, mosques, etc.). • In no case horn will be used during the day timings near the sensitive receptors. • Over speeding will be subject to disciplinary actions. • Local traffic will be allowed to overtake and drivers will be encouraged to make way for the local commuters, ambulances, army and special persons conveys in all cases. • Contractor's personnel will only use access routes assigned to them for project activities which will be finalized during meeting with the representatives of Owner and subcontractors. • Trucks and vehicles will not be overloaded and will follow NHA guidelines for loads and size. • Large vehicles that can slow down the local traffic significantly will only travel in the night time or a special permission from the district administration will be obtained. • Contractor's vehicles and equipment will be parked at identified designated area. • Vehicles and machinery will be appropriately parked/placed to avoid inconvenience to local commuters and pedestrians. • Prior communication to residents and safety signs will be installed well before the commencement of any movement of major machinery or plant components from KPT to the Project. • Vehicle maintenance work will only be carried out in designated workshops.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor	Medium	Extensive	Medium	Possible	Medium	-	High
Good Practice Measures: • Diversion plans shall be developed to minimize disturbance to local population during occasional high activity timings / days. These plans shall be communicated to residents well in advance and proper diversion signs will be placed to inform locals. • Movement of contractor's vehicles for transportation of material and wastes from and to the site shall be restricted to low traffic timings.								
Monitoring: • Random speed checks and inspections and investigations in case of complaints by community								

8.6 Ash Disposal and Handling Impacts

The ash disposal mechanism expected to be followed by the Project is described in **Section 3.7** Ash handling and Disposal. The ash produced by the Project during power generation will be disposed off in an ash yard but the preferred option will be ash re-utilization. Due to the large amount of ash being handled on site, there is a risk of ash related dust emissions. Adequate mitigation measures will be adopted during the management of ash yard to ensure no damage to the environment is done.

Impact PO5: Dust emissions from ash yard								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Long	Intermediate	High	Possible	Medium	-	High
Mitigation Measures: • Ash yard will be sprinkled with water to suppress dust. • Compaction will be carried out so that hydrolysis forms a hard layer on the top to protect ash from wind • Quantity and quality of ash will be monitored regularly • Off-site disposal i.e., selling to cement and construction industry will be considered • Heaps of ash will be rehabilitated by laying a layer of clay and plantation of vegetation.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Monitoring: Quarterly monitoring of NEQS for PM near the vent of the silo and near ash yard.								

8.7 Terrestrial Ecology Impacts

This section summarizes the impact of Project construction and operation on the terrestrial ecological resources of the Study Area. Baseline information is presented in **Section 4**, Description of the Environment. Impact on the marine ecological resources is presented in **Section 8.10**.

Site clearance and construction of Project infrastructure will result in immediate and direct modification of land at Project site. There will be a permanent modification of land within the footprint of specific Project facilities and its ancillaries but the loss will be less severe in the areas that lie adjacent to and immediately outside the Project facilities. Habitat loss, habitat fragmentation and sensory disturbances may result in a decrease in species abundance and possibly change in species diversity. The predominant habitat at the Terrestrial Ecology Study Area is Plains as described in Section 4, Description of the Environment. The habitat is largely degraded due to anthropogenic disturbances. The vegetation is sparse though there are some clusters of vegetation where the vegetation cover is comparatively higher. Species observed consisted largely of common grasses and shrubs, and invasive species such as mesquites were abundant. No threatened flora or fauna species were observed or reported from the Terrestrial Ecology Study Area and no critical habitat, threatened or unique ecosystem was identified in this area. The marine mammals such as Olive Ridley Turtle *Lepidochelys olivalea* and Green Turtle *Chelonia mydas* do not use the beaches in and around the Project site for nesting. The habitats are homogenous and widespread and hold no significance for the survival of endemic or restricted range species. Therefore, the habitat loss associated with the Project infrastructure will not have any significant impact on the floral and faunal species of the area.

Construction activities may cause disturbance and displacement of plants and animals in the Project site and vicinity due to noise, vibrations and lighting. Land disturbance may lead to a localized reduction in food, shelter and range for mammals, birds and herpeto-fauna (reptiles and amphibians). Surface stripping will result in the removal of vegetation cover and may cause accidental death of small mammals and reptiles. Pollution may increase due to vehicles and machinery emissions and there could be deterioration in habitat quality due to spillage of fuels, chemicals or construction waste. However, since no threatened flora or fauna species were found or reported from the Terrestrial Ecology Study Area and no critical habitat, threatened or unique ecosystem was identified in this area, the impacts on terrestrial ecology from Project construction are not considered significant particularly if Construction Management Plan (Section 9) is implemented.

Potential disturbances for ecological resources once the Project becomes operational include noise, lighting, vibrations, dust, introduction of alien species, and increase in air pollution. The migratory birds reported from the area such as Macqueen's Bustard *Chlamydotis macqueenii* (Vulnerable in IUCN Red List 2014[12]) Houbara Bustard *Chlamydotis undulate* (Vulnerable in IUCN Red List 2014), Falcons (Family Falconidae) and Cranes (Family Gruidae) are likely suffer negative health impacts due to an increase in concentrations of air pollutants.[13] Even though some migratory birds have been observed in the Hub River and in the coastal areas near the Project site, the population of these birds is small, most likely due to the existing anthropogenic disturbances in the area. Most of the migratory birds use the Hub Dam (located about 55 km from the Study Area) as staging grounds. The increase in concentration of PM_{10} and $PM_{2.5}$ caused by Project operations is estimated to be small in comparison to the background concentrations. In addition, the level of pollutant gases such as SO_x and NO_X will remain within the NEQS[14] limits due to installation of FGD and ESP (**Section 8.4**, **Air Quality Impacts**).

Adequate and appropriate disposal of solid waste generated during construction and operation is important. Scavenger mammal species will be attracted to this waste and suffer negative health impacts if the waste contains toxic materials. Leakage of the waste in to the nearby water bodies particularly the Hub River can have an impact on animal species that use this contaminated water for drinking.

Inadequate management and disposal of ash during Project operations can lead to deterioration of soils and decline in quality of water bodies in the vicinity of the Project due to seepage from the ash yards (Section 3, Proposed Project Design). If the mitigation measures described in **Section 8.6**, **Ash Disposal and Handling Impacts**) are implemented, this impact is not likely to be significant.

Influx of Project staff and contractors during construction and operations may increase likelihood of hunting particularly of birds in the area. To prevent this, awareness training regarding importance of biodiversity and penalties for poaching will be provided to them.

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12 The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 29 September 2014

13 S.Llacuna et.all (1993), Effects of air pollution on passerine birds and small mammals, Archives of Environmental Contamination and Toxicology, 24, 59-66

14 National Environmental Quality Standards

Increased vehicular traffic from Project operations will not have any impact on the biodiversity of the areas since existing road routes will be used.

Impact TE1: Loss and decline in abundance and diversity of terrestrial flora and fauna caused by Project construction and operation								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Initial Impact	Minor	Medium term	Small	Low	Definite	Low	-	High

Mitigation Measures:

Impact	Mitigation measures
Disturbance to animals due to noise and vibration	• See **Section 8.3** and **Section 9** Construction Management Plan
Effects on animal health due to inadequate disposal of ash and creation of ash yard	• See **Section 8.6**
Effects on animal health due to air pollution and dust	• See **Section 8.4**
Deterioration of soil and habitat quality due to leakages from Project vehicles and machinery, uncontrolled disposal of Project construction waste, as well as waste water and solid waste from camp sites	• See **Section 8.2**
Spread of Alien Invasive Species (AIS)	• Source goods/materials locally where possible. • Minimize disturbance to, or movement of, soil and vegetation. • Prevent soil damage and erosion.
Involvement of Project staff in hunting activities and wildlife trade	• Provide awareness training to staff and contractors on hunting regulations, prevention of injury of animals; identification of likely species found on site; identifications of animal hazards (such as venomous snakes); and what to do if dangerous animals are encountered.

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor	Medium term	Small	Low	Definite	Low	-	High

8.8 Socioeconomic Impacts

This section assesses the potential socioeconomic impacts of the proposed Project. The socioeconomic impacts are grouped according to the broader socioeconomic category to which they relate, such as, social infrastructure, economy, education and health. The potential socioeconomic impacts described in this section are primarily caused by changes to the socioeconomic and biophysical environment brought on by the Project and should thus be interpreted in conjunction with the sections of the report addressing these biophysical dimensions (**Section 4**). The term “local” in this section refers to the Socioeconomic Study Area, whereas, term “domestic” is used to represent the whole country.

8.8.1 Impact Assessment Methodology

The first step undertaken was to assess the significance of the pre-mitigation or pre-enhancement[15] socioeconomic impacts identified during stakeholder and focused group consultations (see **Section 5).** After initial assessment the impacts are reassessed using the same significance scoring process, but assuming that recommended mitigation or enhancement measures are in place, to derive the residual or enhanced impacts. The mitigation and enhancement measures recommended in this section were designed to avoid or reduce the overall negative socioeconomic impacts of the Project and maximize those which are positive. Details of the recommended mitigation and enhancement measures are outlined for each identified impact.

A number of construction and operation related socioeconomic impacts are analyzed and assessed on the basis of the socioeconomic baseline developed for the Project. There exist multiple variables which can contribute to alter the magnitude and significance of the identified impacts. These may include force majeure and unpredictable human nature. Such factors will significantly affect the scope and nature of predicted socioeconomic impacts and their mitigation. The following work represents an expert’s-guess based on the knowledge about the area gained through the socioeconomic survey conducted for the Project, details of the proposed Projects and experience gained from the previous projects with approximately similar nature.

In this section, the construction-related impacts are referenced as ‘SC’ while those related to the operation of the proposed Project are referenced as ‘SO’.

8.8.2 Monitoring of Impacts

There are a multitude of variables involved in projects that can affect the scope and accuracy of the assessment of socioeconomic impacts. This challenge becomes even greater when it involves assessing project actions and impacts many years in advance of their likely occurrence. Therefore, a purely ex-ante—based on forecast rather than actual results–approach is inadequate and it will be necessary to implement a socioeconomic monitoring program. A framework for this monitoring program is outlined in the EMP which is provided in **Section 9** of this ESIA report. The EMP is designed to continually evaluate project plans and key socioeconomic variables in partnership with the community and facilitate identification through to project closure. It also covers the following aspects:

- Deviations from proposed actions;
- Changing community needs;
- Unanticipated impacts; and
- Necessary adjustments to mitigation and enhancement plans and measures.

[15] Term pre-mitigation or pre-enhancement refers to the significance of the impact which may affect the socioeconomic conditions prevailing in the Socioeconomic Study Area prior to any step taken to mitigate its effects or enhance its positive impacts.

8.8.3 Summary of Impacts

The potential socioeconomic impacts of the Project are categorized into the following groups:

- **Economy related impacts:** Impacts related to domestic and local economy
- **Community and governance related impacts:** Impacts related to demographical changes induced by the Project which may affect the community's social culture and structure.
- **Social setting and services related impacts:** Impacts related to migration of people from distant area to the Project location in search of jobs.
- **Health related impacts:** Health impacts related to gaseous and dust emissions and waste generation from the Project.
- **Livelihood and asset related impacts:** Impacts related to the livelihood and assets of the fishermen being affected by the proposed Project development.

The identified socioeconomic impacts are summarized in **Exhibit 8.25**.

Exhibit 8.25: Potential Socioeconomic Impacts of the Project

Impact Group	*Identified Potential Socioeconomic Impacts*
Construction Impacts	
Community and governance related impacts	**Impact SC1:** Increase in population due to inward migration affecting community structure and culture
	Impact SC2: Inward migration of foreign people[16] elevating levels of social conflict, anti-social deviance and criminal behavior
Social infrastructure and service related impacts	**Impact SC3:** Inward migration increases the burden on local social infrastructure and services.
	Impact SC4: Inward migration increasing the burden on local health service provision
	Impact SC5: Project site works risk to community health and safety
Health related impacts	**Impact SC6** Increase in population density increasing incidence of communicable diseases
	Impact SC7: Increased noise and dust risk to community health
Economy related impact	**Impact SC8:** Construction requirements generating direct, indirect and induced employment
Operation Impacts	
Economy related impacts	**Impact SO1:** Availability of power to meet growing demand in the economy and reduction in power outages

[16] The term 'foreign' refers to the people belonging to some region, province, or district other than the area under study (in this case 'Socioeconomic Study Area').

Impact Group	*Identified Potential Socioeconomic Impacts*
	Impact SO2: Government revenues from the Project in the form of taxes and royalties leading to increased developmental spending.
	Impact SO3: Project employee and contractors expenditures (tax, revenues) promoting domestic and local economic growth.
	Impact SO4: Training and skill development
	Impact SO5: Operational requirements generating direct, indirect and induced employment
Livelihood and asset related impact	**Impact SO6:** Income differentials; uneven distribution of materials and cultural goods between the members of community
	Impact SO7: Deterioration in existing fish population affecting the livelihood of the fishermen
	Impact SO8: Damage to the fishing boats owned by the local fishermen due to release of thermal water into the sea

8.8.4 Assessment of Socioeconomic Impacts

Construction Impacts

Increase in population due to inward migration affecting community structure and culture

The Project will have construction and operational labor requirements beyond that which can be exclusively met by the local population. This will result in investment and expenditures at the local, provincial, and national levels. In the context of this, and the relatively high levels of involuntary unemployment, underemployment, and subsistence dependency evident in the socioeconomic baseline, both phases of Project development, construction and operation phase, will attract a large influx of people to the Socioeconomic Study Area. This inward migration will be either for seeking and undertaking employment at the Project and its associated facilities or seeking employment opportunities at businesses established to meet Project demand for domestic goods and services (supply of raw material including stone, crush, bricks etc.)

Demographically, this migrant influx is likely to increase the population density of the Socioeconomic Study Area. The influx of in-migrants due to the Project may also include the family members of those migrating. The migrants are likely to be young and male. This will worsen the imbalanced gender ratio and youth to elder age profile.

Communities within the Socioeconomic Study Area maintain a social structure and culture that has evolved largely without external influence over a long time period, no significant migration was reported during collection of baseline information, and exhibits a unique blend of characteristics. This includes:

- Strong and detailed governing codes, norms and customs;
- Sustained attachment and adaptation to the surrounding biophysical environment;
- Religious differentiation and hierarchical distinction,
- Relative friendliness, respect, and a strong sense of interdependency and cohesiveness amongst themselves, which also extends to the outsiders.

<table>
<tr><td colspan="9">Impact SC1: Increase in population due to inward migration affecting community structure and culture</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="9">Construction</td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+ /-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Minor-</td><td>Medium</td><td>Extensive</td><td>Medium</td><td>Possible</td><td>Medium</td><td>-</td><td>Medium</td></tr>
<tr><td colspan="9">Mitigation Measures:
The Project plans to prioritize the recruitment of people living, or originating from, the Project affected communities during Project operation.
Irrespective of origin, the Project is designed to accommodate all construction and operation workers within a camp inside the Project location Coordinate recruitment efforts related to non-skilled labor, including for non-skilled labor positions required by contractors.
Local recruitment commitment will be clearly defined and extended to the employees of contractors and to the construction phase of the Project and the geographic scope of local recruitment will be based on prioritization by proximity to the Project.
The commitments will be articulated as a clearly defined policy supported by procedures and quantified targets.
To specifically help reduce significant potential social and demographic impacts for more vulnerable or marginalized sectors of the host communities, the Project employment opportunities for women and senior citizens will be promoted wherever feasible and culturally appropriate.
The vulnerable people of the communities located in the vicinity of the power plant will be given priority in provision of jobs, donations and scholarships. Through its CSR activities, a special focus will kept on the vulnerable people and their socioeconomic status will be regularly monitored.
A grievance redress mechanism will be especially designed for the vulnerable people of the community. Their complaints will be addressed on priority basis and a liaison officer will be designated to accommodate them and address their grievances.
Feedback consultations will be held with the vulnerable people to record the efficiency and effectiveness with which their complaints are addressed. Their views and feedback will be registered and if required, improvements in the grievance redress mechanism will be made.
The Project labour will be sensitized on local cultural and social values as part of the induction program who originates from other parts of the country or from abroad
</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Minor-</td><td>low</td><td>small</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>Medium</td></tr>
</table>

Inward migration of foreign people elevating levels of social conflict, anti-social deviance, and criminal behavior

Accompanied by Project investment, expenditure, and employment, and impact on community structure, the demographic changes have important consequences for social setting, which are examined in **Section 4.4.4**. Such Project induced population dynamics can also impact the social and cultural structure of the communities. These impacts are of particular significance in the context of the traditional nature of the communities of the Socioeconomic Study Area. While the Pakistani society as a whole has been affected by globalization, market liberalization, and cultural modernity, rural localities of the Socioeconomic Study Area have been less exposed to, and more slowly affected by, these forces due to their limited communication networks and relative geographic and economic isolation. The surveyed communities in the Project vicinity have shown no characteristics of modernization and social deviance from typical Pakistani rural society.

The investment, expenditure, and employment induced by the Project are likely to impose a challenge on the existing structural and cultural system of belief of the communities. Social networks, values, behavioral norms, and customs will be influenced. Some of the impacts are summarized below:

- Economic prosperity can improve trend for literacy and increase welfare;
- Over time their social tenets might be influenced. There is the possibility of introduction of increased materialistic and individualistic values, rising levels of social and familial atomization, and reduced levels of social cohesion, spirituality and mutual support;
- The inward migration and resultant social changes can lead to elevated levels of anti-social, deviant, and criminal behavior. This includes drug abuse, prostitution and assault.

Actual or perceived competition for employment and more limited natural resources because of in-migration, and contrasting cultural and behavioral norms of the migrant population, can lead to the incidence of inter-community and intra-community disputes and conflicts. Resultant disputes and anti-social and criminal activities can serve to accelerate and bring about an on-going shift in power and influence. This may result in a change from informal, customary, and local governance systems toward more formal, bureaucratic, and regional, governance systems.

Impact SC2: Inward migration of foreign people elevating levels of social conflict, anti-social deviance and criminal behaviour								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
Initial Impact	Minor-	Medium	Extensive	Medium	Possible	Medium	-	Medium
Mitigation Measures: • As of SC1 and, • Company work in partnership with local governing bodies to agree a complimentary strategy for addressing this impact, and authorities to use additional project tax revenue to strengthen the capacity of existing legal justice and enforcement bodies. • Recruitment commitment articulated as a transparent policy supported by relevant procedures and monitored by independent third party								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+/-*	*Confidence*
Residual Impact	Minor-	low	small	Low	Possible	Low	-	Medium

Inward migration increasing the burden on local social infrastructure and services

The anticipated increase in the population of the communities located in the Socioeconomic Study Area as a result of the, a) in-migration of people, and b) their dependents seeking and undertaking employment either at the project or associated businesses during construction and operation will increase the burden on the poorly developed local social infrastructure.

In the absence of Project proponents or government measures to enhance and maintain social infrastructure, existing limited electricity supplies, restricted heating fuel and water availability, and poor domestic and human waste sanitary conditions are likely to be even further compromised

Impact SC3: Inward migration increasing the burden on local social infrastructure and services								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate-	Medium	Intermediate	Medium	Possible	Medium	-	Medium
Mitigation Measures: • Concrete measures to help ensure local authorities execute their obligations to use project revenue to enhance local infrastructure. • Undertake a rapid community needs assessment (CNA). • Use CNA to identify low-cost mechanisms for enabling project community members to benefit from the transport, power, water supply and other technical project requirements.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	Low	Small	Low	Possible	Low	-	Medium

Inward migration increasing the burden on local health service provision

A possible increase in the population density due to influx of people to the Socioeconomic Study Area will impose burden on the existing health service which are already not sufficient for the resident communities (see **Section 4.4.4**). The area under study has poorly developed and inadequately staffed health care facilities. There are few facilities including clinics and periodically established health camps functioning in the area which are managed and funded by HUBCO. Therefore, due to limited health facilities, the current health infrastructure does not have the capacity to accommodate any migrants.

As mentioned, currently, only HUBCO in its very own capacity distributes medicines, runs health clinics and arrange eye camps for the surveyed communities residing in Lasbela District. An increase in population will result in competition among locals and migrants to avail such facilities.

Impact SC4: Inward migration increasing the burden on local health service provision								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate-	Medium	Intermediate	Medium	Possible	Medium	-	Medium
Mitigation Measures: • Undertake a full project community risk assessment followed by the development of a community emergency preparedness and response plan appropriate to its findings. • Identify concrete measures to help ensure local authorities execute their obligations to use project revenue to enhance health services								

• Undertake a rapid community needs assessment (CNA) • Use CNA to identify low-cost mechanisms for enabling host community members to benefit from project health facilities, staffing or medicines. • Establishment of health facilities to accommodate both indigenous and migrant population. • Provision for local communities to access the health infrastructure constructed for Project employees.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	low	small	Low	Possible	Low	-	Medium

Project site works risk to community health and safety

Significantly elevated levels of construction and operation related heavy goods vehicle movements on the public roads and highways connecting the site will increase the traffic on the roads. The road accident risk for community members using these highways either as pedestrians, cart riders, motorcyclists, or drivers, particularly within close proximity of the site may increase, especially where traffic will be more concentrated. During the operational phase this road accident risk will be compounded by an anticipated increase in private vehicle ownership and use locally as a result of population increases and the income generating potential of the project.

The potential for major accident that may result due to failure of ash yard can have a significant impact on the community health. The incident may result in deterioration of ground and surface water quality and loss in fertility of agricultural land.

Impact SC5: Project site works risk to community health and safety								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Major-	Medium	High	High	Possible	High	-	High
Mitigation Measures: • Undertake a full project community risk assessment followed by the development of a community emergency preparedness and response plan appropriate to its findings. • A traffic management plan will be developed to prevent incidents of accidents which may occur due to transportation of machinery and equipment to the Project site.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	low	small	Low	Possible	Low	-	High

Increase in population density increasing incidence of communicable diseases

Increase in the population of the host communities as a result of inward economic migration will raise the incidence of communicable diseases already prevalent in Lasbela and Karachi South Districts, including, but not limited to hepatitis B and C, diarrhea, cholera, tuberculosis, and malaria (see **Section 4.5.4**). The incidence rates will increase as a result of closer human proximity and interaction and as a result of additional demand on water supply and human and domestic waste facilities, which will further compromise the already poor sanitary conditions in the host communities.

Impact SC6: Increase in population density increasing incidence of communicable diseases								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate-	Medium	Small	Medium	Possible	Medium	-	Medium
Mitigation Measures: • As of SC4 and, • Establishment of health camps on regular intervals to maintain the health profile of the affected communities. • Regular check-up of the Project staff to ensure health status of the workers.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	low	small	Low	Possible	Low	-	Medium

Increased noise and dust risk to community health

Initial review of anticipated noise and dust levels from construction activities like land preparation and transportation of equipment and emission of coal dust and sulfur during operations could pose a risk to community health and wellbeing in the context of the climatic and physical environment in which the project is proposed.

Impact SC7: Increase noise and dust risk to community health								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate-	Medium	Small	Medium	Possible	Medium	-	Medium
Mitigation Measures: • Ensure the formulation and implementation of traffic management plan in harmony to the existing physical and social environment to mitigate the impacts of noise and dust emissions. • Sprinkling of water on adobe roads to prevent dust emissions from movement of heavy traffic. • Proper maintenance of vehicles to prevent emissions from their exhausts. • The power plant will employ ESP and FGD to mitigate the impacts of coal dust and sulfur resulting from the burning of coal in the boilers to generate steam.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	low	small	Low	Possible	Low	-	Medium

Construction requirements generating direct, indirect and induced employment

The Project construction activities will include various civil and electrical works including both skilled and unskilled labor. This will result in opening of various job opportunities for the communities residing in Socioeconomic Study Area.

Impact SC8: Construction requirements generating direct, indirect and induced employment								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Major+	Long	Extensive	High	Definite	High	+	High
Enhancement Measures: • Ensure the hiring of the local people. The plant owners and operators should ensure that the recruitment process is fully transparent and is based on merit. • Maintain regular communication with local communities								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Enhanced Impact	Major+	Long	Extensive	High	Definite	High	+	High

Operation Impacts

Availability of power to meet the growing demand in the economy and reduction in power outages

The Government of Pakistan has announced to promote cheap fuels, especially coal, in its National Power Policy, 2013. This is owing to the prevalent energy crisis in the country (see economic justification for the Project, **Section 1**). The Project's expected economic impacts are described below:

Considering the widely recognized restraints that inadequate electricity generation imposes on national economic growth, Project operation will most positively impact the national economy directly, and as a result of the provision of electric power for the expansion of electricity generating capacity and narrow the gap between supply and demand.

Impact SO1: Availability of power to meet the growing demand in the economy and reduction in power outages								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Major+	Long-term	Extensive	High	Definite	High	+	High

Increase in Government Revenues

The Project will invest in equipment, construction materials, infrastructure and human resources. This investment and the return generated from the Project will be circulated within the domestic and local economy through the following mechanisms:

- Payments made to domestic suppliers against the goods and services procured under the Project.
- Expenditures made by Project staff on purchasing local goods and services, using the income earned under the Project.

- Government spending on developmental activities against the taxes and royalties collected under the Project.

The increased government income from the Project would carry a high rate of social return if invested in infrastructure such as roads, educational institutions, hospitals, and public services. The term "rate of social return" reflects the total value of all benefits associated with an investment that accrue to members of society. The increased government revenue could be used to meet this objective by improving infrastructure and services in areas local to the Project. The realization of this impact relies on government decisions regarding the allocation of its revenues.

Impact SO2: Increase in Government revenues; Government revenues from the Project, in the form of taxes and royalties, leading to increased developmental spending in the country								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate+	Long-term	Extensive	High	Definite	High	+	High

Project employee and contractor expenditures promoting regional and local economic growth

The most immediate benefit of project operation for the regional and local economy will be from project, employee, and contractor, expenditures. In the short to medium term the local economy will benefit from increased access to markets for purchases and sales provided by project supported year-round cross-district road use. In the longer-term, a commitment by the operator to prioritize the sourcing of local produce and ancillary services, will promote vertical and horizontal economic linkages and the growth of existing and new local enterprises.

Impact SO3: Project employee and contractor expenditures promoting regional and local economic growth								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate+	Long-term	Intermediate	High	Definite	High	+	High

Training and skill development

Training is anticipated, which will also include specialist courses in; bulldozing, excavating, drilling, heavy vehicle driving, process plant working, electrical equipment handling, installation, operation and maintenance of the electrical and civil structures, boiler works, and material flow management and handling. This training, and the subsequent experience of working at the Project, will increase the transferable skill base and future income generating prospects of community members selected for Project employment.

Impact SO4: Training and skill development								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
	Major+	Long-term	Intermediate	High	Definite	High	+	High

The proactive training and skills development of local employees must take place prior to the relevant phase of Project development to ensure that relevant capacity is developed on a timely basis that allows local communities to take advantage of Project economic opportunities.

Operational requirements generating direct, indirect and induced employment

The Project operations will require both skilled and unskilled staff to operate the power plant and for the maintenance of civil and electrical installations. Distribution of jobs among the indigenous people matching their education and level of skills will positively impact the socioeconomic conditions prevailing in the neighboring communities.

Impact SO5: Operational requirements generating direct, indirect and induced employment								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
Initial Impact	Major+	Long	Extensive	High	Definite	High	+	High
Enhancement Measures: • Ensure the hiring of the local people. The plant owners and operators should ensure that the recruitment process is fully transparent and is based on merit. • Maintain regular communication with local communities								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+/-*	*Confidence*
Enhanced Impact	Major+	Long	Extensive	High	Definite	High	+	High

Income differentials; uneven distribution of materials and cultural goods between the members of community

While local positions will largely be of an unskilled nature, their salaries will be comparable to industry averages and therefore considerably higher than the current salaries or subsistence level equivalent received from livestock, fishing, daily wage laboring or crop farming carried out by the majority of the working population in the Socioeconomic Study Area.

In the absence of mitigation, however, comparatively high project salaries and 'spin off[17]' generated income could fail to be utilized to improve the economic security and welfare of non-beneficiary, and potentially more vulnerable, households and individuals.

[17] A by-product or incidental result of a larger project.

Moreover, the economic marginalization of non-beneficiary community members will be further highlighted if project-related demand during project construction and operation inflates the cost of local goods, services, and labor. Affordability will increase in the medium and long term as supplies are enhanced, income opportunities expand, and some earnings are redistributed or trickle down. There is a likelihood of inflation at construction reducing the purchasing power of a large proportion of the community and jeopardizing their short-term economic security.

Impact SO6: Income differentials; uneven distribution of materials and cultural goods between the members of community								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate-	Medium	Intermediate	Medium	Possible	Medium	-	Medium
Mitigation Measures: • Workers' salaries to be paid into a bank account or equivalent post office or project guaranteed facility • A course on personal financial management as part of their wider standard worker induction process • Recruitment policy needs to balance meritocratic appointment, with the need to meet preferential appointment to locals and promoting opportunities and training to the less advantaged, including women.								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+/-	*Confidence*
Residual Impact	Minor-	Low	Small	Low	Possible	Low	-	Medium

Deterioration in existing fish population effecting the livelihood of the fishermen

The discharge of thermal water from the power plant may increase the existing temperature of the seawater forcing the fish to migrate to the cooler waters. This may affect the livelihood of the locals dependent on fishing. The fishermen may have to sail to the deep sea to catch fish. This may increase the cost of fishing trip and reduce the profits.

Damage to the fishing boats owned by the local fishermen due to release of thermal water into the sea

The increase in exiting seawater temperature may also damage the boats of the fishermen. As reported by the respondents of Mubarak village during stakeholder consultations, increase in seawater temperature provided breeding ground and habitat to a water borne vector which damages the anchored boats near the coast. As discussed in Section 8.9.1, the temperature difference in sea water will comply with NEQS standards.

Impact SO7: Deterioration in existing fish population effecting the livelihood of the fishermen **Impact SO8:** Damage to the fishing boats owned by the local fishermen due to release of thermal water into the sea								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Major-	Long	Extensive	High	Definite	High	-	High

<table>
<tr><td colspan="9">Mitigation Measures:
• Employment of technologies to treat the thermal water before its discharge into the sea to ensure minimum rise in the existing seawater temperature and prevent migration of indigenous fish population.
• The existing water temperature will be maintained by employing technologies to treat thermal water to ensure no harm to the fishing boats.</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Minor-</td><td>Low</td><td>Small</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>Medium</td></tr>
</table>

Arrangements and Activities to Mitigate or Enhance the Socioeconomic Impacts

The following arrangements will be needed by the Project proponent well in advance of the construction and power generation operations to ensure no or minimum impact on the prevailing socioeconomic conditions in the Socioeconomic Study Area. The Project proponents will need to incorporate plans in company’s Corporate Social Responsibility (CSR) policy to ensure the socioeconomic development of the communities residing in the Socioeconomic Study Area.

- **Institutional Arrangements:** Identification of relevant institutions (provincial and local government, NGO’s and community based organizations) and ensure their participation for improved public relations; socioeconomic development activities; and internal and external monitoring and evaluation.
- **Community Participation and Consultation:** The affected villages will be consulted and encouraged to participate on a continuing basis in the processes of social development, planning, and implementation activities.
- **Disclosure of Information:** The Project proponents will disclose the information on project scope to the potentially affected households, and keep them well informed on any subsequent changes to be made.
- **Grievance Redress:** The Project will set-up a grievance redress mechanism to resolve the complaints in an effective and timely manner and an appeal mechanism to address the grievance, if the complaints are not resolved through normal means.
- **Community Development Policy:** The Project will develop and adhere to a community development policy under which community development initiatives will be setup following principles of sustainable development.
- **Monitoring and Evaluation:** The mitigation activities related to the affected villages and community development of the affected villages will be closely monitored and periodically evaluated internally as well as externally for the transparency and rectification purposes. Accordingly, the Project will have both internal monitoring carried out by its staff and/or external monitoring to be entrusted to a consultant or NGO to independently monitor the Project’s performance in these activities and recommend corrective measures. The Project will be submitting both internal and external monitoring and evaluation reports to the regulators (for example, BEPA) on a periodic basis, and will be put on Owner’s website as part of its disclosure strategy.

8.9 Cooling Water Impacts

This section summarizes the thermal impacts of cooling water discharge into the Arabian Sea.

8.9.1 Thermal Plume Modeling

Thermal plume modeling was carried out using the PDS model available within the Visual Plumes© modeling suite (2001).

The objectives for the modeling include:

- Ensuring that NEQS[18] temperature requirements are met at the outfall channel.
- Assessing marine ecological impacts (**Section 8.10**).

Data and Calculations

The parameters used for the modeling are calculated on the basis of the plant design, information present in secondary literature and plant design calculations. The data, parameters, and results of the calculations are provided in **Exhibit 8.26**. Plume modeling is carried out separately for the summer and winter monsoon periods as average ocean currents and velocities are different in these periods. A schematic of the summer and winter Indian Ocean currents is provided in **Exhibit 8.27**.

Outfall channel dimensions are required for thermal plume modeling using Visual Plumes©. Channel dimensions were calculated to ensure a discharge velocity for cooling water of no more than 1.26 m/s. As part of the detailed design of the proposed Plant and associated infrastructure, the channel dimensions may be changed; however, it is important to note that the velocity at the discharge point should not exceed 1.26 m/s for these results to remain valid. The model makes the following assumptions:

- The location of outfall channel is assumed to be at a distance from the shore where the culvert is completely submerged into water at all times. It is recommended that engineering design considers the location of discharge at a distance from the source, approximately 100 m such that waves do not break at the shore and carry heated water to the beaches. It is expected that this distance will be far more than 100 m keeping in view the requirement of submergence of the outfall channel at all times in the sea even at lowest tide level. 100 m is the minimum distance required so that the waves do not break at the shore and carry heated water to the beach.
- Approximate dimensions of each channel assumed by the model: 5m x 5m. However it can be of different dimensions having same cross sectional area to meet the velocity of 1.26 m/s
- Modelling is carried out assuming that mixing is only due to laminar currents.

---

[18] NEQS requirement: maximum temperature change at 100 m from discharge location has to be less than or equal to 3°C

- Waves are not considered within the thermal plume model; waves will cause further dilution through introducing turbulence; therefore the model is considered conservative.
- Additional considerations include release of waters with rip currents, so advection forces the thermal plume away from the shore.

Thermal impact assessment was conducted for two seasons, summer and winter monsoon. For summer monsoon ambient seawater temperature, maximum seasonal value was used and for winter monsoon minimum seasonal value was used. This was to consider the worst case scenario and to check if the thermal impact due to the outfall will comply with NEQS during all seasons.

Exhibit 8.26: Modeling Parameters and Data

Parameter	*Value*	*Units*	*Source*
Cooling Water Requirement			
Plant Power Generation Capacity (gross)	1320	MW	Plant Design
Power Plant Generation Capacity (net)	1214	MW	Plant Design
Density of Water	1,022	kg/m³	
Cooling Water Requirement	229,080[19]	m^3/hr	Plant Design
Temperature and Ocean Current Data			
Seawater Temperature (Summer)	33[20]	°C	**Exhibit 8.27**
Seawater Temperature (Winter)	22[21]	°C	**Exhibit 8.27**
Increase in Temperature at the Outfall	Δ8.5	°C	Plant Design
Winter Current Direction	NW		
Winter Current Speed	430	m/hr	
Summer Current Direction	SSE		
Summer Current Speed	320	m/hr	
Channel Dimensions for Plume Modeling			
Culvert dimensions	5 x 5 (2 culverts)[22]	m	Project Design
Velocity (constraint)	1.26	m/s	Plant Design

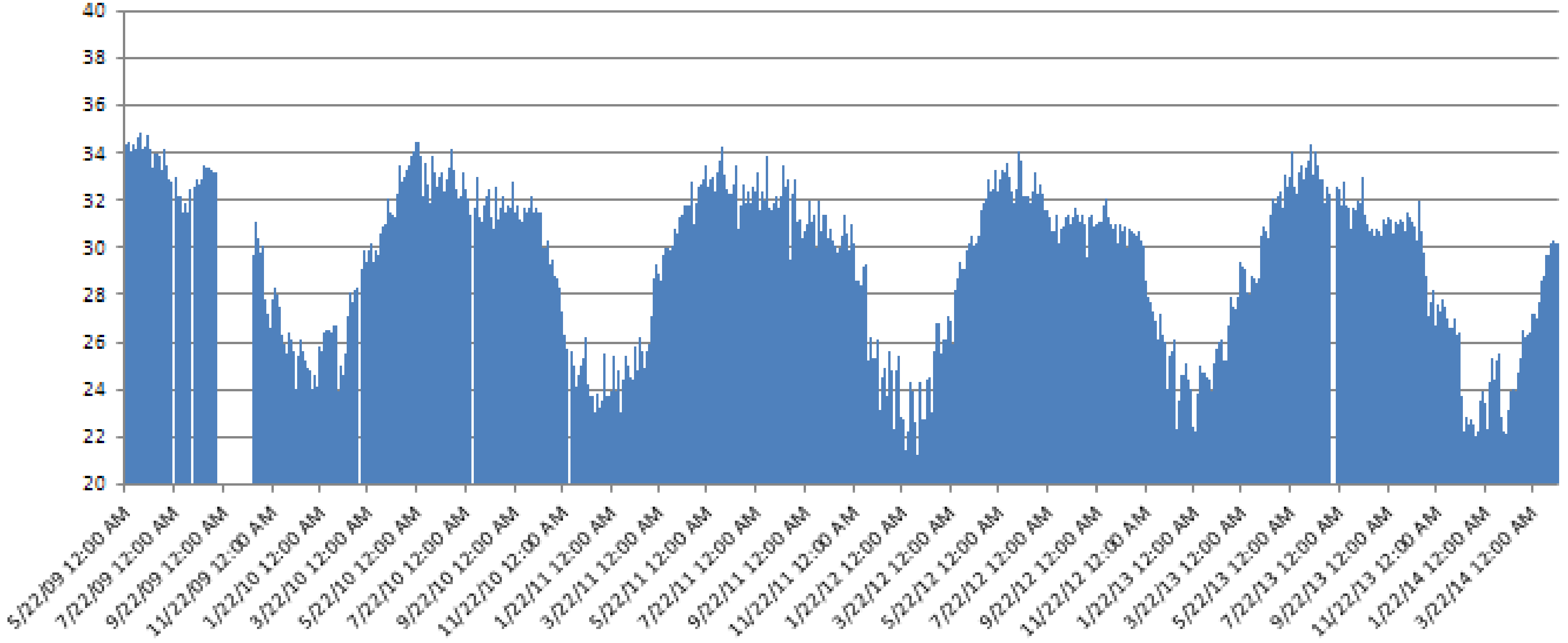
[19] Slight change in flow is acceptable provided the discharge velocity constraint is met

[20] This is summer average of five year sea water temperature data collected at HUBCO's existing plant. It is based on temperature readings from thermocouples installed at condenser inlet

[21] This is winter average of five year sea water temperature data collected at HUBCO's existing plant. It is based on temperature readings from thermocouples installed at condenser inlet

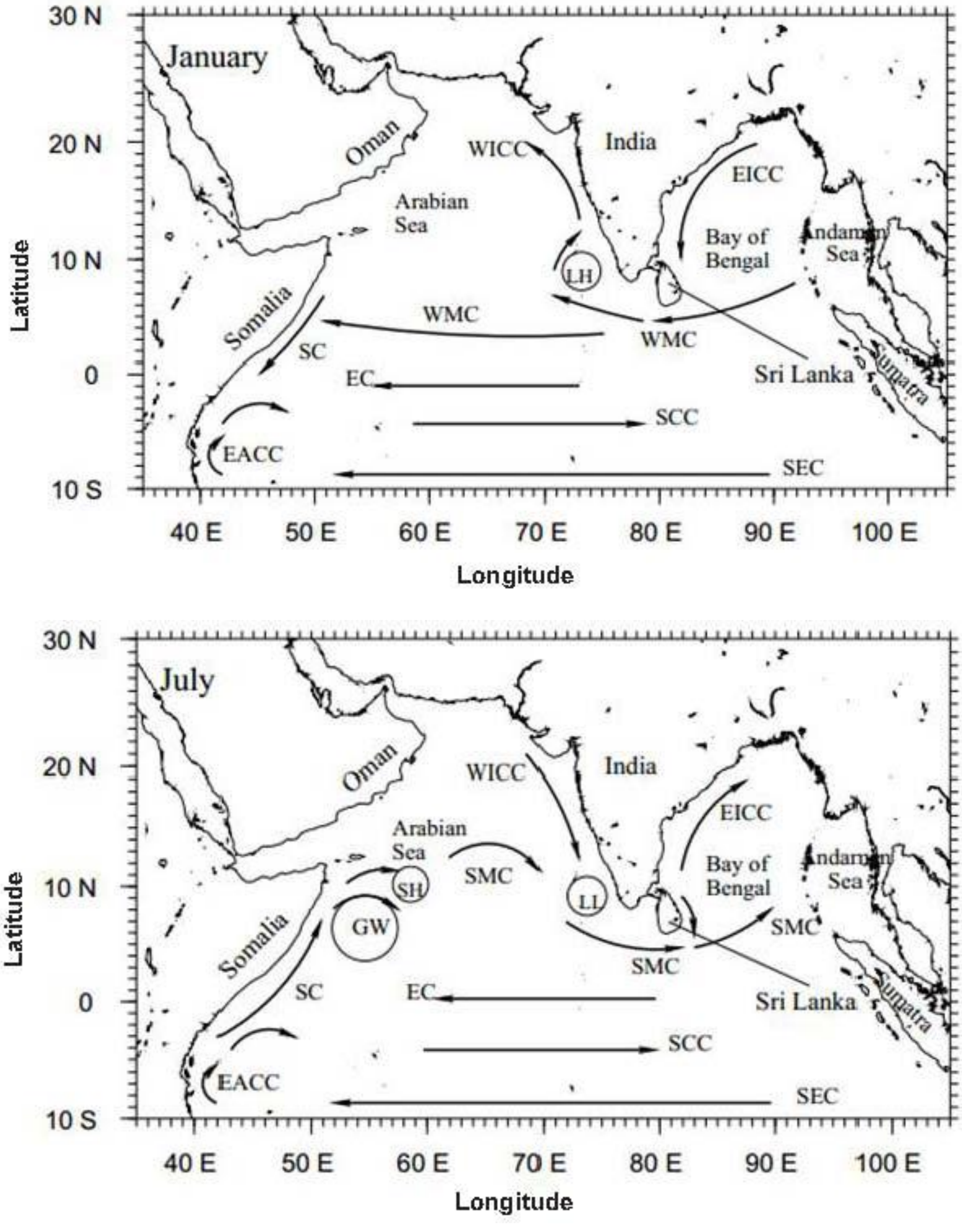
[22] The dimensions can be changed provided the velocity constraints are met.

Exhibit 8.27: Seawater Temperature at Hub for Five Years[23]



[23] Five year sea water temperature data collected at HUBCO's existing plant. It is based on temperature readings from thermocouples installed at condenser inlet

Exhibit 8.28: Schematic of Circulation in the Arabian Sea[24]



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[24] Shankar, D., P. N. Vinayachandran, A. S. Unnikrishnan, and S. R. Shetye. "The Monsoon Currents in the North Indian Ocean." *Progress in Oceanography* 52, no. 1 (2001): 63-120.

Model Results

Graphs of temperature versus distance from the outfall (source) are provided in **Exhibit 8.29** and **Exhibit 8.30** for the winter and summer monsoon periods, respectively. It is noted that the change in temperature (ΔT) at 100 m from the discharge location (source) is below the regulatory NEQS limit of 3°C for both the winter and summer monsoon periods. Plume centerlines are shown in **Exhibit 8.31** and **Exhibit 8.32**.

Exhibit 8.29: Temperature vs Distance from Outfall (Winter Monsoon)

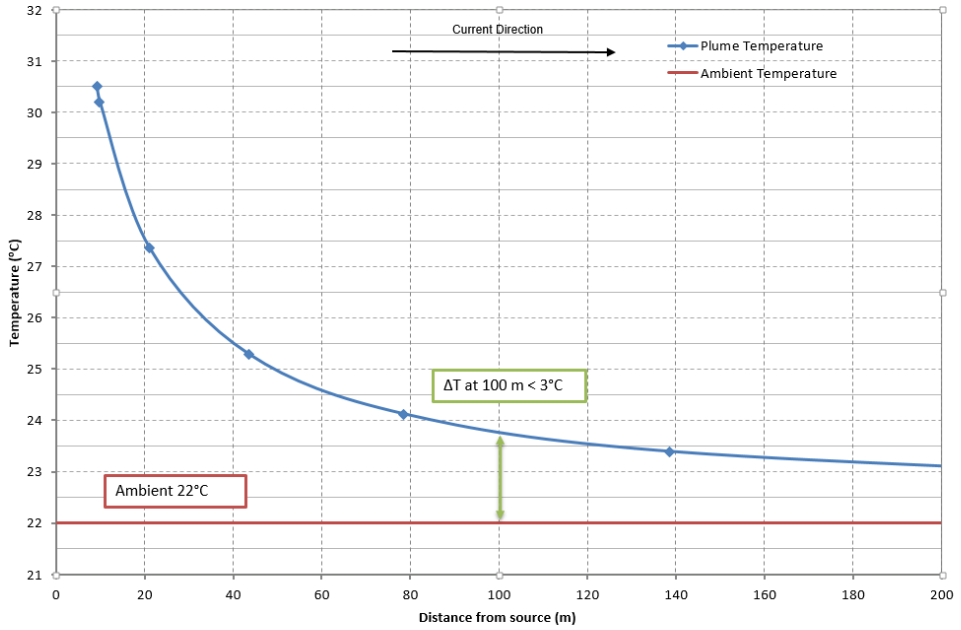


Exhibit 8.30: Temperature vs Distance from Outfall (Summer Monsoon)

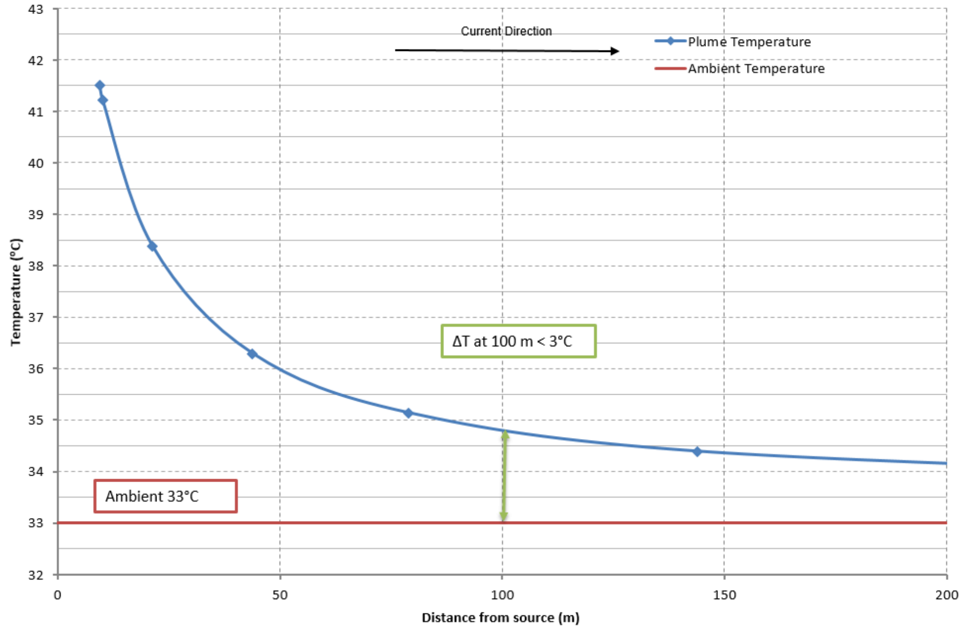


Exhibit 8.31: Plume Centerline Path (Winter Monsoon)

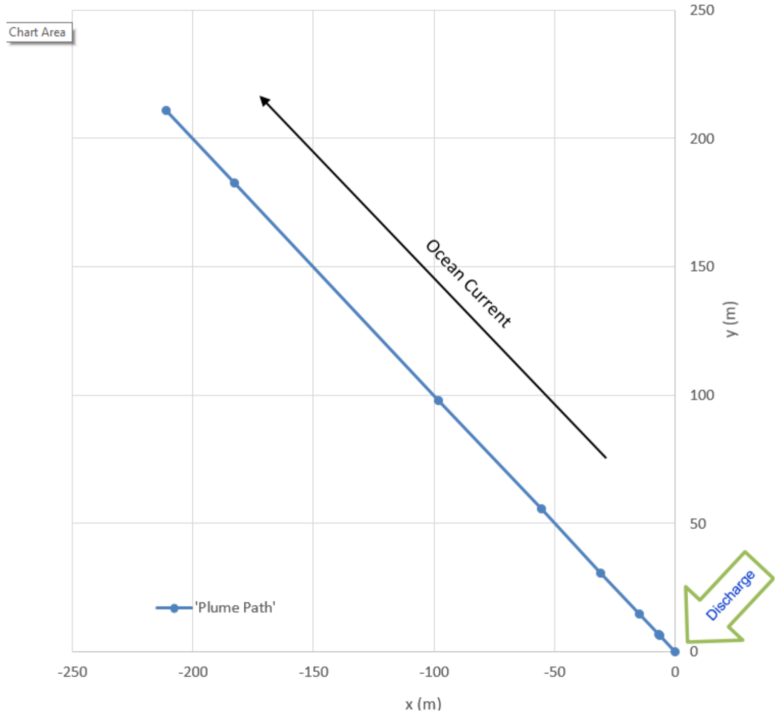
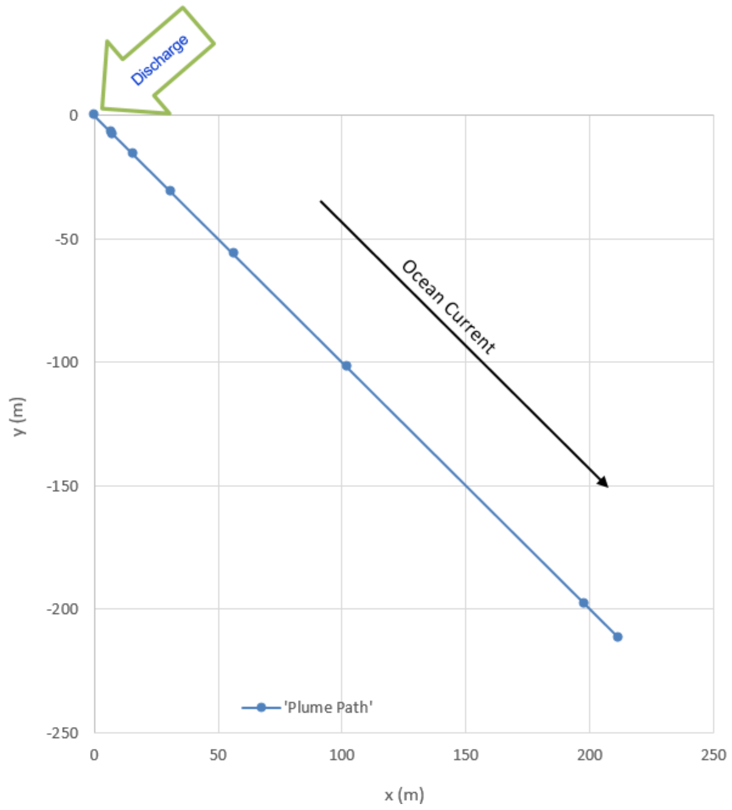


Exhibit 8.32: Plume Centerline Path (Summer Monsoon)



Impact PO5: Increase in temperature in the Arabian Sea due to release to cooling water.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+/-*	*Confidence*
Initial Impact	Minor	Medium	Small	Low	Definite	Low	-	High
Mitigation Measures: • No mitigation measures necessary as it meets NEQS standard.								
Good Practice Measures: • Use of recirculation cooling methods to utilize lower amount of water required for cooling.								

8.10 Marine Ecology Impacts

8.10.1 Entrainment of marine fauna in water intake channel

The Project has been designed to use seawater for cooling purposed that will flow in through an intake channel. The water will flow towards the plant from the sea under the action of gravity. Moveable screen trash racks and traveling screens will be installed at the pump intake (Section 3, Proposed Project Design).

The abstraction of water inevitably carries the risk of fish entrainment (drawing of fish of any life stage at a water intake) and trapping of marine fauna.[25] Young fish are prone to being drawn in, especially when the intake is located close to spawning and breeding habitats and migration routes. To prevent mortality of the marine organisms trapped by entrainment as well as damage to Project equipment, it is important to use appropriate screening techniques. Fish protection at water intakes is traditionally achieved by physical screens, but behavioral systems may also provide sufficient protection.

Small Coastal Dwelling fish (Mullets) can navigate in current water velocities of up to 1 m/s. Nektons (Large pelagic Fast swimming fishes e.g tuna, cetaceans etc) can navigate in coastal water currents between 5-10 m/s. Divers and scuba enthusiasts can navigate in water current velocities of over 10 m/s. The velocity range recommended for the intake of this Project is between 1-5 m/s preferably closer to the lower end of the velocity range.

Impact EC1: Mortality of marine fauna caused by entrainment in water intake channel								
Applicable Project Phase								
Design								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
Initial Impact	Moderate	Medium	Small	Medium	Possible	Medium	-	High
Mitigation Measures: • There will be a sufficient depth of water at the intake heads to protect against low water conditions below mean sea level at low water mark (LLWM -0.4m). The sill of the intake will be high enough above seabed level to prevent sediment and debris being drawn from the seabed into the intake. This also reduces the risk of drawing in benthic fish. • The intake heads will not be close to the inter-tidal zone where juvenile fish and shellfish are concentrated and abundant (**Exhibit 8.33**). • The orientation of the intake screens on the intake heads should be such that the inflow direction is								

[25] International Fish Screening Techniques, 2014, Edited by A.W.H. Turnpenny, R.A. Horsfield, WITO Press

perpendicular to the main tidal currents to prevent entrainment (**Exhibit 8.33**). Other schemes may be suitable if the intake designs are compatible and viable with respect to HUBCO coastline (rocky cum sandy).

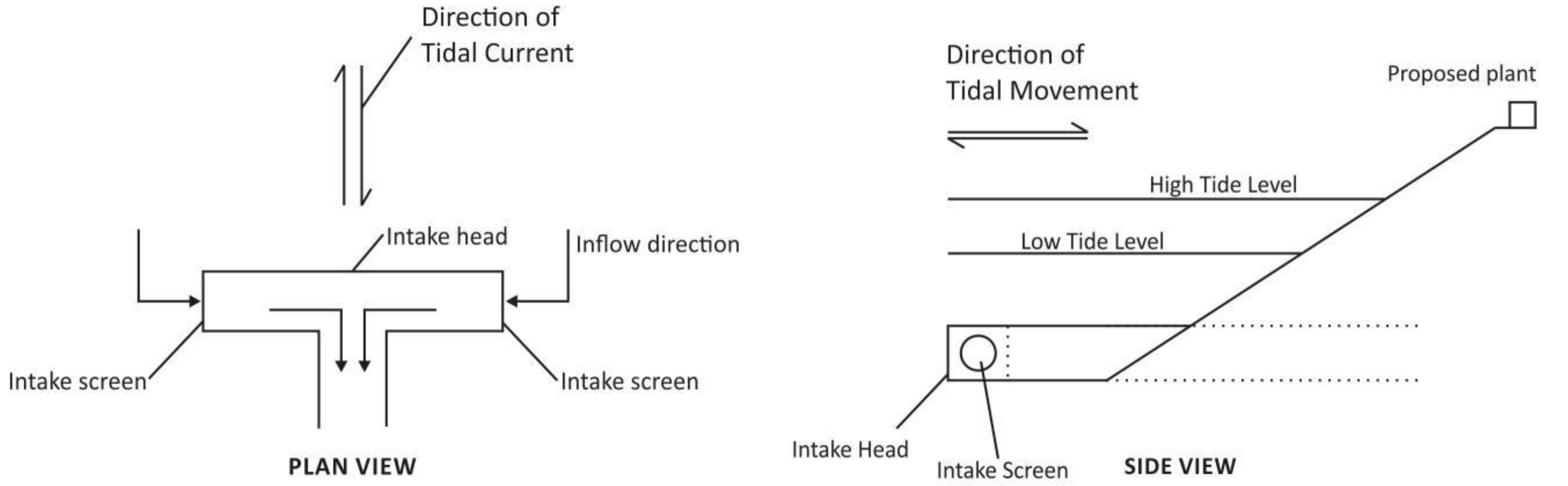
- The intake velocities should be designed to be minimal to prevent pinning a swimmer or diver to the bars of the intake channel. This will also protect aquatic mammals.
- The dimensions of bar spacing in the intake screen will be between 50 and 250 mm to protect marine mammals from being entrained as well as for the exclusion of fish, diving birds and other biota. This is also important for public safety (divers, swimmers and anyone falling into the water).
- Intake screen/s will be installed at (a) strategic location/s to prevent the entrainment of aquatic life. The gaps in the screens, in conjunction with the intake flow velocities should allow any impinged fish to escape.
- The material of the screen will be mild steel protected by a suitable corrosion protection system. Alternatively the bars could be constructed in stainless steel or a non-ferrous metal that inhibits marine growth. Consideration will be given to making the screen in removable sections to facilitate maintenance and cleaning. The intake channel can be injected with dosages of chlorine to discourage larvae of biofouling organism entering the channel.
- The intake channel will be fitted with a combination of acoustic fish deterrent (AFD) system and fish recovery and return (FRR) provision. The combination of both processes caters for hearing-sensitive, delicate species (AFD) as well as more insensitive demersal and epibenthic species, including crustaceans.

	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Medium	Small	Low	Unlikely	Low	-	High

Monitoring:

- Monitoring of intake channel during operation using underwater cameras and occasionally through divers. The latter will be carried out during one of the scheduled plant outages.

Exhibit 8.33: Schematic Layout of Intake Structure illustrating perpendicular arrangement of Intake Screen and Inter-tidal Flow



8.10.2 Discharge of heated cooling water

Seawater from the Arabian Sea will be used as a cooling medium in the Cooling Water System (condenser) and will be discharged back into the sea via the outfall system (Section 3, Description of the Environment). Elevated temperature of this discharged cooling water may have a negative impact on the coastal marine life. This is because the marine flora and fauna consisting of the marine epifaunal invertebrate species, phytoplankton, zooplankton, fish and marine turtles are adapted to ambient water temperatures (26 to 29.5^{o}C surface water temperature). Any change in temperature of sea water has the potential to cause changes in abundance and diversity of these ecological resources.[26] Coral species are particularly sensitive to temperature alterations.[27]

Increase in water temperature promotes bacterial degradation of organic matter that leads to a greater demand for oxygen in the water column. Elevated water temperatures may also cause harmful and sometimes toxic algal blooms that can also deplete dissolved oxygen from the water. This decline in dissolved oxygen impacts the productivity of plankton, shrimps, fish, and coral communities.

According to results of thermal plume modeling (**Section 8.9.1**), the temperature of the discharged cooling water will not be more than 3° C higher than the existing seawater temperature, at 100 m from the outfall location. This corresponds to the NEQS requirements. Moreover, with an increasing distance from the outfall channel, this temperature difference will become progressively less. The corals that are located around the Churna Island approximately 8 km from the Project site will not be impacted from this change in temperature due to the dilution effects of the sea water. The marine turtles such as the Olive Ridley Turtle *Lepidochelys olivalea* and Green Turtle *Chelonia mydas* do not nest on the beaches near the Project site and vicinity. In most cases fish have been reported to avoid areas disturbed by anthropogenic activities.[28] Moreover, no endangered or threatened fish species (in IUCN Red List 2014[29]) has been reported from the coastal waters near the Project site. Therefore, even though there will irreversible short term harm to some ecological receptors (individuals of marine epifaunal communities and fish), the species will not suffer as the area impacted by elevation in sea water temperature is small.

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[26] Hobday, AJ & Matear R (eds) 2005, 'Review of climate impacts on Australian fisheries and aquaculture: implications for the effects of climate change', Report to the Australian Greenhouse Office, Canberra

[27] Ben I. McNeil et al 2004 Coral reef calcification and climate change: The effect of ocean warming, Geophysical Research Letters, Volume 31, Issue 22.

[28] James R. Karr (1981) Assessment of Biotic Integrity Using Fish Communities, Fisheries, Vol. 6, No. 6

[29] The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 02 October 2014.

<table>
<tr><td colspan="9">Impact EC2: Changes in abundance and diversity of marine flora and fauna caused by discharge of heated cooling water into the Arabian Sea</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="9">Operation</td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Moderate</td><td>Medium</td><td>Small</td><td>Medium</td><td>Definite</td><td>Medium</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Mitigation Measures:
• No mitigation measures necessary as it meets NEQS standard.</td></tr>
<tr><td colspan="9">Good Practice Measures:
• Use of recirculation cooling methods to utilize lower amount of water required for cooling.</td></tr>
</table>

8.10.3 Discharge of contaminated effluent into sea water

Waste water discharge from effluent monitoring sump (that includes the cooling water outfall and saline desalination plant effluent) can contaminate the sea water due to presence of pollutants such as oils, hazardous chemicals, and toxic metals or increased TDS (salinity). The marine life consisting of the marine epifaunal invertebrates, phytoplankton, zooplankton, fish and marine turtles will suffer negative impacts demonstrated by ill health as well as changes in abundance and diversity. If the edible species of fish and crabs are contaminated, the negative health impacts will be transferred to other organisms in the food chain including humans.

The marine ecological resources are also liable to suffer harm from the coal dust and ash dust generated as a result of project activities. Leakage from the prospective ash disposal site due to seepage or an accident may release toxic or hazardous materials into the sea water, negatively impacting marine biodiversity.

The Project has been designed so that wastewater streams from the plant and associated facilities will be sent to an effluent monitoring sump and then to a disposal and treatment system. After treatment, the effluents will be discharged to the sea via an outfall channel (Section 3, Proposed Project Design). The effluent from the effluent monitoring sump will be monitored regularly to comply with NEQS.

Impact EC3: Decline in marine life caused by discharge of contaminated waste water from effluent monitoring sump								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Medium	Small	Medium	Possible	Medium	-	High
Mitigation Measures: • Effluents being discharged into the sea will meet the NEQS. (see PO1)								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Residual Impact	Minor	Medium	Small	Low	Unlikely	Low	-	High
Monitoring: • Refer to waste management measures outlined in the Waste Management Plan (**Exhibit 9.4**) • Monitoring of liquid effluents from effluent monitoring sump to ensure it meets the NEQS. • Monitoring of gaseous emissions including coal and ash dust • Monitoring to ensure that there is no leakage from the ash disposal site.								

8.11 Cumulative Air Quality Impacts

Objectives

To consider the cumulative impacts on ambient air quality from future coal-fired plants in Hub and Gadani.

Scope

The scope of this cumulative impact assessment is limited to the study of impacts on ambient air quality only. The significance criteria considered for assessing the cumulative air quality impacts are the concentrations of NO_x, SO_2, PM_{10} and $PM_{2.5}$ in ambient air and their limits as defined in the NEQS and SEQS Ambient Air Quality Limits.

The assessment of the cumulative impacts on ambient air quality focused solely on the impacts from gaseous emissions into the ambient air from coal-fired power plants, including Owner’s proposed Project.

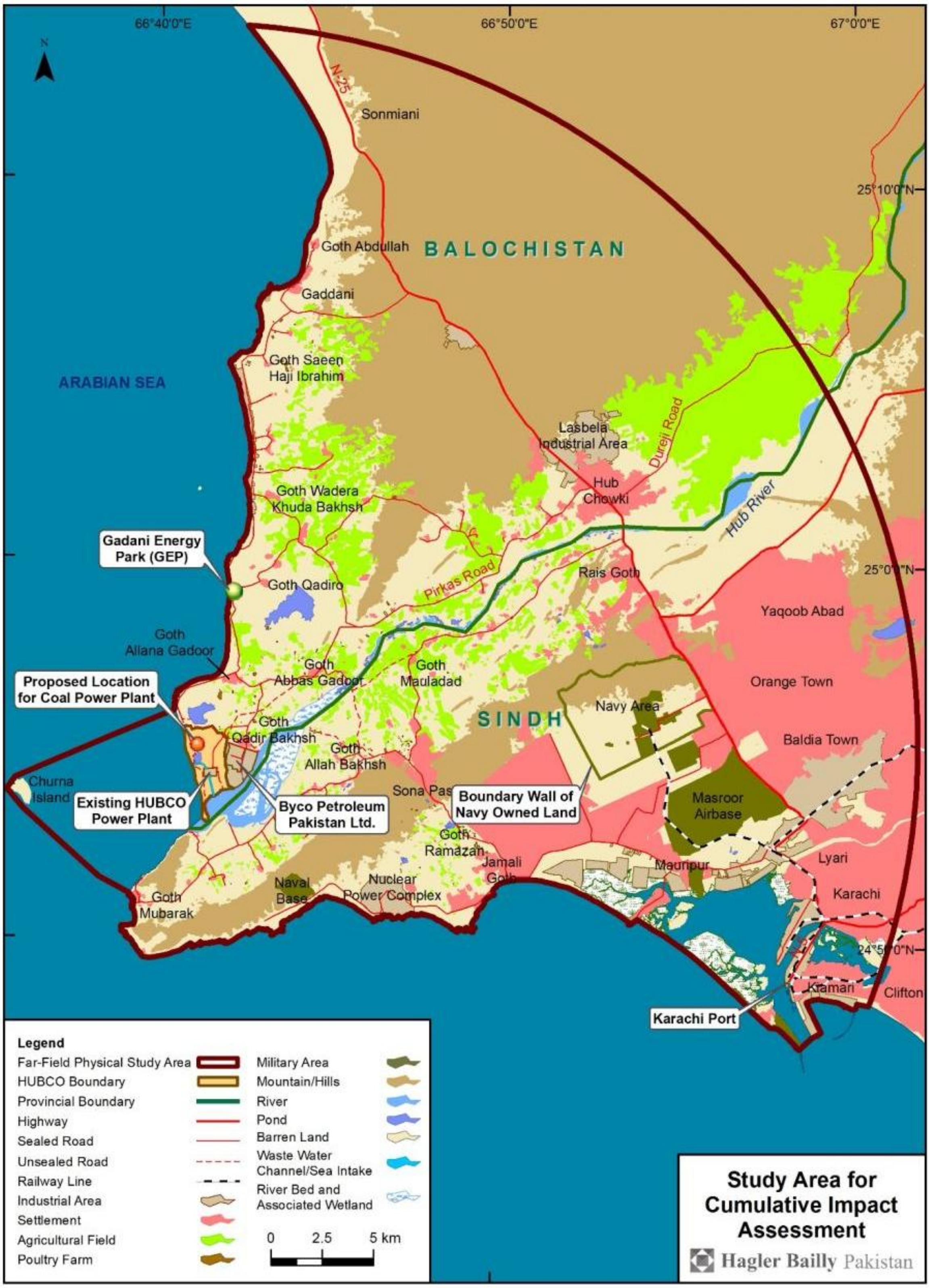
Among all possible coal-fired power plants which may be developed in the region in the future, this cumulative impact assessment considered only those plants which may be developed in Gadani Energy Park[30] (GEP) and those which may be developed within the boundary of the land owned by HUBCO, where the proposed Project will be developed. These potential projects, including the proposed Project, will be referred to as “Future Projects” in this section.

[30] PPIB "Private Power & Infrastructure Board."http://www.ppib.gov.pk/N_news.htm (accessed October 3, 2014).

Due to the geographical proximity of the two sites, ambient air quality data used to represent the existing air quality for modeling cumulative impacts was identical to the one used for the impact assessment of the proposed Project in **Section 8.4**.

The Cumulative Study Area for the cumulative impact assessment study, along with the locations of GEP and HUBCO is shown in **Exhibit 8.34**.

Exhibit 8.34: Study Area for Cumulative Impact Assessment



Future Projects

Future Projects considered in this cumulative impact assessment study include the proposed Project, 2 additional coal-fired power plants which may be developed by the Owner within the boundary of the land owned by them in Hub, and the potential development of 10 coal-fired power plants in GEP in Gadani. The rationale for the selection of these two locations and number of potential plants in each location are explained below.

Hub

HUBCO is developing the proposed Project and utilizing the available space on its property in a way that will allow HUBCO to develop more coal-fired power plants in the future alongside the proposed Project.

Given the economic benefits of using its own land for future developments and technical benefits from shared facilities, such as common intake and outfall channels, HUBCO's additional coal-fired power plants are most likely to be located alongside the proposed Project. And, given the construction and operational practicality, additional coal-fired power plants developed by HUBCO will most likely share identical design features with the proposed Project.

Therefore, given these considerations, particularly the availability of space, it is likely that two more 660 MW coal-fired power plants may be developed by HUBCO in the future, alongside the proposed Project.

Gadani

Gadani is a coastal village of Lasbela District located in the southern part of Baluchistan along the Arabian Sea. It is also a Union Council of Hub Tehsil and is just a 1-hour-drive away from Karachi, Sindh. Gadani is located 20 km north of HUBCO, however the GEP location determined using available information is 8 km north of HUBCO. GEP is a government enterprise designed to reduce the chronic power shortage problems being faced by Pakistan. The GEP, on completion, will house 10 imported coal-based power plants, each with a gross installed capacity of 660 MW. It has been decided that supercritical boilers will be utilized by all the plants and their operation will strictly comply with all national environmental laws including ambient air quality standards. In order to ensure compliance, the plants will be equipped with Electrostatic Precipitators (ESP) to control the emission of particulate matters (PM); a Flue Gas Desulphurization (FGD) system to control SO_x emissions; and, a combination of low NO_x burners with Over-fire Air Ports (OFA) and a Selective Catalytic Reduction (SCR) system to control NO_x emissions. A stack height of 210 meters has been proposed for the plants to ensure greater dilution of emissions through wider dispersion.[31]

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[31] Imaduddin, "Master plan, feasibility study for Gadani Power Park being prepared", Business Recorder, February 4th, 2014

Other Locations

Up to the point of preparation of this ESIA report, there was no indication or information available regarding any future plans for developing other coal-fired power plants in Baluchistan, other than those discussed above.

Methodology

Based on the discussion above, the cumulative impact assessment study assumes all Future Projects to be identical 660 MW plants. Based on the same control measures designed for the proposed 660 MW coal-fired power plant in Hub, it is assumed all the Future Projects will also have the same controls in place. Accordingly, it is assumed that the Future Projects will be equipped with a FDG system for SO_x removal with 91.5% efficiency and ESPs for removal of PM matter with 99.7% efficiency.

The coal-quality specifications used for modeling gaseous emissions for the cumulative impact study was based on the same imported coal proposed for use by the Project (**Section 8.4**).

United States Environmental Protection Agency approved regulatory model, AERMOD (**Appendix J**) was used to simulate emissions from the proposed

Two scenarios were developed for modeling air emissions from the Future Projects.

- Scenario 1: The Future Projects were assumed to be running with the aforementioned control measures for SO_x and PM emissions. For NO_x emissions, a maximum allowable emission rate of 300 Nanogram per Joule (ng/J) of energy output was used as stipulated by the NEQS gaseous emissions standards. . These assumptions for control on SO_x and PM emissions were done using the information regarding the under construction coal fired power plants in Pakistan. The under construction coal fired power plants with same control measures include 660 MW power plant at Port Qasim[32] and 660 MW power plant in Lakhra[33]. However, for NO_x the maximum allowable emission rate prescribed by NEQS and SEQS was used because the emission of NO_x depends on the boiler technology and all the under construction projects used different technologies to limit NO_x.
- Scenario 2: In the second scenario, only the emission rate for NOx was changed and the new value was used for all Future Projects. The new emission rate for NO_x was developed using iterations until such a value was obtained for which the ambient air quality concentration for NO_x emissions was within the standards stipulated by the NEQS.

The modeling parameters used for both scenarios are detailed in **Exhibit 8.35**.

The same existing ambient air quality data used for the impact assessment of the proposed Project in **Section 8.4**.

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[32] EIA of Sinohydro's 2×660 MW Coal Power Plant Port Qasim Authority, Karachi. Hagler Bailly Pakistan. June 2014.

[33] EIA of Lakhra Coal Fired Power Plant, Lakhra. Hagler Bailly Pakistan, September 2014.

The recommendations for SO2 and PM were made on the results from Scenario 1; however, for NO_x several simulations were done and for the control of NO_x emissions, a maximum allowable emission rate was determined based on results from Scenario 2

Incremental concentrations to the ambient air from the emissions of the Future Projects were obtained from an air modeling exercise and the values were added to the existing background concentration. The final concentrations were compared with the applicable standards to check if the Future Projects, together, complied with the NEQS and SEQS air quality standards once the plants are commissioned. The air-modeling results and compliance-status of the Future Projects is provided in **Exhibit 8.37**.

Exhibit 8.35: Modeling Parameters and Data for Scenario 1

Parameter	*Area*	*Scenario 1*	*Scenario 2*	*Unit*	*Notes*
No of Plants	HUB	4	4	–	As discussed in ‘Future Projects’
	Gadani	10	10	–	As discussed in ‘Future Projects’
Stack Height	HUBCO	210	210	m	As discussed in ‘Future Projects’
	Gadani	210	210	m	As discussed in ‘Future Projects’
Stack Diameter	HUBCO	12.8[34]	12	m	Calculated keeping from flue gas flow rate and exit velocity (Cumulative Diameter)
	Gadani	20.2[35]	19	m	
Exit Velocity	HUBCO	24.6	24.6	m/s	Exit velocity calculated for the Project
	Gadani	24.6	24.6	m/s	–
Temperature	HUBCO	343	343	K	–
	Gadani	343	343	K	–
Emission rates (For each plant)	SO_x	116.6	–	g/s	FGD 91.5% control efficiency
	PM_{10}	25.6	–	g/s	ESP 99.7% control efficiency
	$PM_{2.5}$	12.27	–	g/s	50% of PM_{10}
	NO_x	507.69	223.3	g/s	Scenario 1: NEQS limit of 300 ng/J of energy output was used Scenario 2: Maximum
		300	160.6	ng/J	

34 Cumulative diameter of 4 power plants at HUB

35 Cumulative diameter of 10 power plants at Gadani was calculated

Parameter	*Area*	*Scenario 1*	*Scenario 2*	*Unit*	*Notes*
		910	400	mg/Nm^3	allowable limit calculated through multiple AERMOD simulations

Results – Incremental Ambient Air Concentrations

The results of the air-modeling exercise predicted the incremental concentrations of NO_x, SO_x, and PM in the existing ambient air quality.

Exhibit 8.36 shows the predicted increment in the concentration of pollutants for both scenarios.

Exhibit 8.36 Maximum Increment in Pollutants Concentration by the potential projects *(µg/m³)*

Pollutant	*Scenario 1*		*Scenario 2*		*NEQS*		*SEQS*	
	Annual	*24–hour (98th Percentile r*	*Annual*	*24–hour (98th Percentil e r*	*Annual*	*24–hour (98th Percentile*	*Annual*	*24–hour (98th Percentile*
SO_x	5.8	30.3	–	–	80	120	80	120
NO_x	25.3	132.1	10.45	59.0	101.2	141.2	101.2	141.2
PM_{10}	1.0	4.4	–	–	120	150	120	150
$PM_{2.5}$	0.67	3.3	–	–	15	35	40	75

Results – Total Ambient Air Concentrations

Exhibit 8.37 shows the highest annual and 98th percentile 24–hour values for background concentration, increment due to proposed projects and the total concentration of pollutants.

Exhibit 8.37: Compliance with Ambient Air Quality Guidelines and Standards

Pollutant	*Control Meausres on potential plants*	*Averaging Time*	*Background Concentration Levels (µg/m³)*	*Incremental Concentration Level (µg/m³)*	*Predicted Concentration Level (µg/m³)*	*NEQS (µg/m³)*	*SEQS (µg/m³)*
SO_2	92 % control efficiency of FGD	24–hr (98th Percentile)	77.6	30.3	83.4	120	120
		Annual	62.8	5.8	63.6	80	80
NO_x	Maximum 350 mg/Nm^3 emission from boilers (Scenario 2)	24–hr (98th Percentile)	92.0	58.1	118.9	141.2	141.2
		Annual	61.5	11.1	65.6	101.2	101.2
PM_{10}	99.7% efficiency for	24–hr (98th	138.7	4.4	139.6	150	150

Pollutant	*Control Meausres on potential plants*	*Averaging Time*	*Background Concentration Levels (µg/m³)*	*Incremental Concentration Level (µg/m³)*	*Predicted Concentration Level (µg/m³)*	*NEQS (µg/m³)*	*SEQS (µg/m³)*
	ESP	Percentile)					
		Annual	80.5	1.0[36]	81.0	120	120
$PM_{2.5}$	50 % of PM_{10} realeased with 99.7% control	24–hr (98th Percentile)	53.8	3.3	56.3	35	75
		Annual	35.2	0.67	36.7	15	40

Conclusion and Recommendations

On the basis of the modeling assumptions and results above and assuming that all Future Projects will be developed at some point in the future and will be operational during the same time period, the following recommendations can be made with regards their cumulative impacts on ambient air quality:

- Since the background $PM_{2.5}$ levels in the area are high and exceed the limits prescribed by the NEQS, stringent control on emission of PM should be adopted. However, the concentration of $PM_{2.5}$ will be under the SEQS limits, which were revised considering the high background levels of $PM_{2.5}$ (**Section 8.4**).
- FGDs having at least 92% control efficiencies should be incorporated in the project design for all the plants.

To ensure compliance with the NEQS and SEQS limits for NO_x in ambient air, all Future Projects should, individually, not be allowed to exceed a concentration of 400 mg/Nm^3 for NO_x at the stack. This is within the emission limits for NO_x prescribed by NEQS (1200 mg/Nm^3), and by IFC (510 mg/Nm^3).

36 The maximum annual increment in PM_{10} will be 4.9 µg/m³ which is very small in comparsion to the background concentration of 138.6 µg/m³.

9. Environmental Management Plan

This section presents an Environmental Management Plan (EMP) based on the mitigation measures identified in **Section 8**.

9.1 Purpose and Objectives of the EMP

The primary objectives of the EMP are to:

- Facilitate the implementation of the identified mitigation measures in the environmental assessment
- Define the responsibilities of the project proponent and contractor, and provide a means of effective communication of environmental issues between them.
- Identify monitoring parameters in order to ensure the effectiveness of the mitigation measures.
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations.
- Identify training requirements at various levels.

The EMP is prepared on the basis of detail currently available on the construction phase of the project. As a construction contractor is appointed and further information is available, the EMP will be amended to reflect the changes. However, no mitigation measures committed in the EMP can be changed unless approved by the relevant regulatory authority.

9.2 Management Approach

The organizational roles and responsibilities of the key players are summarized below:

The Owners: The Project Proponent will undertake overall responsibility for compliance with the EMP. The Proponents will carry out verification checks to ensure that the contractors are effectively implementing their environmental and social requirements.

Contractors: The contractors will implement the majority of environmental and social mitigations as required by their contract with the Owners. The contractors will carry out field activities as part of the proposed project. The contractors are subject to certain liabilities under the environmental laws of the country, and under their contracts with the Owners.

9.3 Management Responsibilities

The responsibilities of the client and contractor are briefly described below:

- Primary responsibilities:
  - As regards environmental performance during the project, the respective highest-ranking officers in the country will assume the primary responsibilities on behalf of both the project proponent and EPC contractor.
  - The Owner's Project Manager will be responsible for environmental assessment and EMP compliance throughout the project on behalf of the company itself.
  - The Owners will coordinate with the concerned government departments.
- Project management and quality control:
  - Carrying out construction activities in an environmentally sound manner during the project will be the responsibility of the contractor's site manager.
  - Owner's representative will be responsible for the overall environmental soundness of all field operations.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 9.1**.

Exhibit 9.1: Roles and Responsibilities for Environmental Monitoring

Aspect	*The Owners' Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Contracting	Ensuring that monitoring and mitigation requirements are included in the contract between the Owners and the construction contractor(s).	Understanding the requirements and estimating the required resources	Contract between the Owners and the construction contractor(s)
Monitoring plan	Ensuring finalization of monitoring plan before commencement of principal part of project construction	Prepare a construction management plan	Finalized monitoring plan and Construction Management Plan
Resources	Ensuring availability of resources required for environmental monitoring	Ensuring availability of resources required for environmental monitoring	Project budgets
Environmental staff	Designating an Environmental Manager for the project	Designating an Environmental Manager for the project (may be combined with health and safety)	Job descriptions
Monitoring surveys and inspections	Undertaking regular inspections and carrying out further measurements when necessary	Undertaking regular inspections and collecting data on environmental performance, and carry out surveys	Inspection and survey reports
Environmental audit	Conducting periodic audits of the construction site	Conducting periodic internal audits	Audit reports

Aspect	*The Owners' Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Reporting	Ensuring that periodic environmental monitoring reports are received from the construction contractor(s) and reviewing those reports	Producing environmental monitoring reports periodically and distributing those among the Owners management and appropriate staff members	Environmental monitoring reports
Corrective actions	Verifying that activities carried out comply with the EIA/EMP and identifying corrective actions if needed	Carrying out corrective actions as required	Corrective action record
Maintenance of record	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Environmental databases

9.4 Mitigation Plan

The mitigation plan is a key component of the EMP. It lists all of the mitigation measures identified in the environmental assessment and the associated environmental and social aspects of those measures. The mitigation measures for the proposed Project are presented in **Exhibit 9.2** for the construction phase and in **Exhibit 9.3** for the operational phase. Major mitigation measures are proposed for following environmental aspects:

9.5 Waste Management

The Contractor is responsible for preparing a waste management plan. It is summarized in **Exhibit 9.4**.

Exhibit 9.2: Mitigation Plan during Construction Phase

Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
Air Quality	1.1	Water will be sprinkled when there is an obvious dust problem on all exposed surfaces (in the construction area) susceptible to producing dust emissions. Treated wastewater will be used for sprinkling.	Construction contractor
	1.2	Soil and aggregate storage piles stored for extended periods will be kept moist, and will either be covered with a tarpaulin or thick plastic sheets or have windshield walls 0.5 m higher than the pile.	Construction contractor
	1.3	All roads within the plant site and campsite that are to be paved or sealed will be paved as soon as possible after the commencement of construction work. Tracks will be sprinkled regularly until they are paved. Temporary roads will be compacted and sprinkled with water during construction.	Construction contractor
	1.4	Project traffic will observe a maximum speed limit of 20 km/h during construction on all unsealed roads within the construction site.	Construction contractor
	1.5	Construction materials that are susceptible to dust emission will be transported only in securely covered trucks. Aggregate material will be delivered in a damp condition, and water sprays will be applied if needed.	Construction contractor
Soil and Water Contamination	2.1	Measures will be taken to avoid oil and grease spills, and immediate remedial measures will be taken in the event of a spill.	Construction contractor
	2.2	Tarpaulins or other impermeable materials will be spread on the ground to prevent contamination during on-site maintenance of construction vehicles.	Construction contractor
	2.3	Regular inspections will be carried out to detect leakages from construction vehicles and equipment, and vehicles/equipment with leakages will not be used until repaired.	Construction contractor
	2.4	Fuels, lubricants and chemicals will be stored in covered areas, underlain with impervious liners.	Construction contractor
	2.5	Spill control arrangements including shovels, plastic bags, and absorbent materials will be available near hazardous material storage areas.	Construction contractor

Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
	2.6	The contractor will conduct a borehole-study at the site of the foundation prior to construction to check for the presence of contaminated water or soil	Construction contractor
	2.7	Measures will be taken to deal with soil contamination. Contaminated soil will be immediately collected and disposed of appropriately.	Construction contractor
	2.8	Storm water runoff will be redirected away from the construction site through the use of contouring and embankments.	Construction contractor
	2.9	Soil banks from ditching operations will not be placed where they might impair drainage.	Construction contractor
	2.10	Areas containing potentially hazardous materials will be hydrologically isolated from the rest of the site.	Construction contractor
	2.11	Deploy erosion control and sediment management measures around areas disturbed during construction.	Construction Contractor
Traffic	3.1	All vehicles will be NEQS compliant for noise and air emissions.	Construction contractor
	3.2	Construction materials that are susceptible to dust emission will be transported only in securely covered trucks. Aggregate material will be delivered in a damp condition, and water sprays will be applied if needed.	Construction contractor
	3.3	Over-loading of vehicles will be avoided. The recommended axle load of each truck will be logged and it will be ensured that the load limit is not exceeded.	Construction contractor
	3.4	Non-conformance and incident reporting system will be used to record and evaluate the cause of traffic accidents and to update traffic safety procedures accordingly.	Construction contractor
	3.5	Compliance to NHA speed limits on public roads and a speed-limit of 20 km/h within the construction site will be ensured by all Project related traffic.	

Environmental or Social Aspects	*ID*	*Measure*	*Responsibility*
Construction of Intake and Outfall Channels	4.1	To the extent possible, construction activities during the spawning period of coastal fish (July – August) will be avoided.	Construction contractor
	4.2	Debris netting to be applied around the sides of the construction site of the channels to prevent any materials or debris falling into the ocean.	Construction contractor
	4.3	To contain any other debris generated, a layer of terram (or any geosynthetic material) will be laid across platforms of working stations at the beginning of each shift and removed at the end of the shift ensuring all debris resulting from the works is restricted from entering the marine environment.	Construction contractor
	4.4	Waste materials generated during the construction of the channels shall be trapped and collected on the temporary works platform for appropriate disposal off site.	Construction contractor
	4.5	The proposed paint system for underwater structures, if any, will have low VOC content and fast curing times. An example of such paint is Baltoflake Ecolife paint protection system, considered as one of the most environmentally friendly products on the paint protection market.	Construction contractor
Occupational health and safety	5.1	Personnel will be provided with appropriate personal protection equipment (PPE). Staff will be trained in PPE use.	Construction contractor
	5.2	Vehicles and equipment maintenance will be scheduled in accordance with manufacturer's instructions.	Construction contractor
	5.3	Visitors to the construction site will be required to wear PPE (helmets, hard boots, ear protection, and safety goggles) if visiting areas where occupational health and safety hazards exist.	Construction contractor
	5.4	Health and safety management plan will be developed for construction phase to cover identified health and safety risks that are likely to occur during construction.	Construction contractor
	5.5	Health and safety risks in the construction phase will be systematically and continuously identified, assessed and responded to.	Construction contractor
	5.6	Access to areas with high hazard potential and clearly will be prevented by marking such areas with suitable warning signs showing written and visual representation of the hazard.	Construction contractor
	5.7	Encourage personnel to report near misses where construction activities or infrastructure could have potentially resulted in harm to staff, visitors, local communities or ecological systems.	Construction contractor

Exhibit 9.3: Mitigation Plan for the Operation Phase

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Air Quality	1.1	Maintain vehicles and equipment (including abatement equipment) in accordance with manufacturer's instructions.	Maintenance log
	1.2	Soil and ash piles and aggregate storage piles will be kept moist or will be covered with a tarp or thick plastic sheets or have windshield walls 0.5 m higher than the pile. Wind shields will be used around coal yards for protection against fugitive dust emissions.	Visual inspection
Hazardous Materials	2.1	Develop and implement a Hazardous Material Management Plan including procedures for transport, handling and storage of hazardous substances to minimize risk of accidental exposure. Include clear instructions on what to do should exposure occur. Hazardous materials include explosives, fuel, lubricants, laboratory chemicals, hazardous waste etc.	Procedures for transport, handling and storage of hazardous substances with evidence of implementation
	2.2	Require vehicle maintenance be performed in designated workshops where appropriate pollution control measures are provided.	Visual inspection
	2.3	Record and report information on spills including: location of spill; material type (hazard potential) and quantity released; quantity of material recovered; media affected (soils, water, air); actions taken to contain, recover and remove material released; methods and location of disposal of recovered material or affected media; cause of the spill; and how future spills could be avoided.	Records of spills showing lessons learnt
	2.4	Provide spill prevention and response training to staff , contractors and visitors, including: an explanation of good house-keeping practices; identification and use of equipment and engineering controls designed to prevent spills; description of proper spill response procedures; and indication of possible health, safety and environmental risks potentially occurring as a result of a spill.	Training/induction logs

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	2.5	Develop and implement Spill Prevention and Mitigation Plan for the plant site and road transportation	Plan document, training provided as documented in training logs
Health	3.1	Undertake health screening of employees.	Health screening reports
Local Economy	4.1	Locally award contracts that are within the capability of local contractors.	Records of procurement contracts awarded to local companies
	4.2	Develop and maintain a supplier and contractor database, along with a process to review, monitor and strengthen capabilities of local suppliers and contractors on an ongoing basis.	Database established and being used
Noise impacts	5.1	Provide hearing protection for operators.	Protective equipment available and staff know how to use
	5.2	Maintain vehicles and equipment in accordance with manufacturer's instructions.	Maintenance log
	5.3	Require visitors to the site to wear ear protectors if working or visiting areas where appropriate occupational health and safety sound levels are exceeded.	Protective equipment available for use
Occupational health and safety	6.1	Develop health and safety management plan to cover identified health and safety risks likely to occur during start up, operation, phases of the project.	Plan in place with evidence of review
	6.2	Systematically and continuously identify, assess and respond to health and safety risks throughout the Project life cycle.	Record of risk identification and management
	6.3	Restrict the noise levels emitted from equipment or provide suitable personal protection devices if this limit cannot be achieved.	Noise levels known and equipment provided where necessary
	6.4	Provide fire protection systems to comply with United States of America's National Fire Protection Association regulations.	Systems in place and tested
	6.5	Provide personnel with appropriate personal protection equipment (PPE). Provide staff with training on how and when to use the PPE.	PPE available and staff know how to use it

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	6.6	Prevent access to areas with high hazard potential and clearly mark such areas with suitable warning signs showing written and visual representation of the hazard.	High hazard areas identified on a plan and barriers in place with suitable warning signs
	6.7	Encourage personnel to report near misses where Project activities or infrastructure could have potentially resulted in harm to staff, visitors, local communities or ecological systems.	Near miss register established and used
Road traffic	7.1	Provide driver training, assessment and monitoring including what to do in the event of an emergency.	Training reports
	7.2	Maintain vehicles in accordance with manufacturer’s instructions.	Maintenance logs
	7.3	Use the non-conformance and incident report system to record and evaluate the cause of traffic accidents and update traffic procedures accordingly.	Accidents are recorded and investigated
	7.4	Prohibit unnecessary off road driving.	No visual evidence of Project related off road driving.
	7.5	Loading on each truck should be measured using axle load checking facilities and should not exceed the allowable limit.	Vehicle log
	7.6	All vehicles will be covered to avoid dust emissions during transportation.	Visual inspections
Stakeholder engagement	8.1	Develop and implement Stakeholder Engagement Plan that includes: ▶ maintaining regular communication with stakeholders to address any potential issues in timely manner; ▶ maintaining a grievance procedure, and encourage and facilitate stakeholders to use the mechanism to express concerns; and ▶ providing sufficient resources to the community relations team to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion.	Plan in place with records of implementation including records of communication/ information sharing

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
Waste Management	9.1	Prepare operation waste management plans and implement these consistent with Pakistan regulations and international standards to the extent practicable.	Plan in place with evidence of review
	9.2	Include in the waste management plans the following: ▶ a commitment to a waste hierarchy comprising a) waste avoidance, source reduction, prevention or minimization; b) waste recovery for materials that can be re-used specifically ash; c) waste treatment to avoid potential impacts to human health and the environment or to reduce the waste to a manageable volume; and d) safe and responsible waste disposal specifically for ash disposal; ▶ inventory of wastes identifying the source/s, characteristics and expected volumes; ▶ waste segregation requirements; ▶ location and type of waste collection points, which are conveniently located, have adequate capacity, are frequently serviced and clearly labeled; ▶ storage requirements; ▶ opportunities for source reduction, re-use or recycling; ▶ targets for waste re-use, recycling and incineration; ▶ opportunities to minimize bulk or render waste non-hazardous; ▶ procedures for operating waste storage, treatment and disposal facilities; ▶ labeling requirements for waste disposed of offsite; ▶ method of tracking waste recovered, incinerated or disposed of to the site's landfill; ▶ method of tracking quantity, date, transporter and fate of waste disposed of offsite; ▶ a contingency plan should waste disposal facilities be unavailable for a time; and ▶ training requirements for waste management staff and other employees and contractors.	Waste management plan in place with evidence of implementation
	9.3	Recycle and reuse non-hazardous waste to the extent practicable.	Records of waste recycled, composed or incinerated
	9.4	Preferably return hazardous waste to the associated supplier or transport to other appropriately licensed facilities off-site to the extent practicable and permitted.	Records of waste returned to supplier

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	9.5	Provisionally store hazardous waste not transported off site in appropriate storage facilities on-site until their final disposal is determined. Include a roofed enclosure over a concrete pad with a low concrete wall to provide containment to hold 110% of the volume of stored hazardous liquids. Also include a fenced open area of storage of empty containers. Restrict access to this area to qualified personnel only.	Visual inspection
	9.6	Develop and implement supporting procedures to the waste management plans as needed, for the transport, storage, handling and disposal of waste materials (including hazardous waste)	Procedures in place with evidence of implementation
	9.7	Maintain sewage treatment facilities according to manufacturers' specifications and Pakistan requirements.	Maintenance logs
Wastewater	10.1	Minimize release of potentially contaminated storm water from the plant site by segregating water from potentially contaminated areas from rest of the plant.	Construction signed off by appropriately qualified engineer
	10.2	Treat sewage effluent.	Sewage treatment facilities in place and operating according to instructions
Water conservation	11.1	Use water efficiency technologies, as far as practicable, to minimize raw water consumption.	Maintenance of water balance to track water usage
	11.2	Train staff and keep them aware of good water conservation practices.	Training material and records
	11.3	Develop a water management plan for the Project that includes monitoring of water use, development of water balance, and periodic review of use predictions, impacts and mitigation.	Plan in place with evidence of implementation and review
Ash Disposal	12.1	Collect the ash from different sources in a timely manner	Waste management plan in place with evidence of implementation
	12.2	Segregate dry ash	Waste management plan in place with evidence of implementation
	12.3	Transport the ash from different sources to the ash disposal area immediately after collection	Waste management plan in place with evidence of implementation

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	12.4	Proper lining of the ash disposal area with geomembrane or clay.	Construction signed off by appropriately qualified engineer
	12.5	Compaction of the cell during the ash disposal	Plan in place with evidence of implementation and review
	12.6	Continuous controlled sprinkling to avoid ash dust generation	Waste management plan in place with evidence of implementation
	12.7	Cleaning loadouts on paved road from connections with unpaved tracks.	Waste management plan in place with evidence of implementation
Coal Dust	13.1	Develop a detailed coal dust management plan	Plan in place
	13.2	Use sprinkler system to suppress emission of dust from coal	Installation of system
	13.3	Rainfall runoff from the coal pile and runoff from the application of dust suppression sprays will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for the dust suppression system	Installation of system
	13.4	Maintain all dust collection and suppression systems	System maintained
Intake Channel	14.1	There will be a sufficient depth of water at the intake heads to protect against low water conditions below mean sea level at low low water mark (LLWM -0.4m). The sill of the intake will be high enough above seabed level to prevent sediment and debris being drawn from the seabed into the intake. This also reduces the risk of drawing in benthic fish.	Construction signed off by appropriately qualified engineer
	14.2	The intake heads should not be close to the inter-tidal zone where juvenileg fish and shellfish are concentrated and abundant.	Construction signed off by appropriately qualified engineer
	14.3	The orientation of the intake screens on the intake heads will be such so that the inflow direction is perpendicular to the main tidal currents to prevent entrainment. Other schemes may be suitable if the intake designs are compatible and viable with respect to HUBCO coastline (rocky cum sandy).	Construction signed off by appropriately qualified engineer
	14.4	The intake heads should be sufficiently distant from the discharge heads, and in deep enough water, to ensure that discharged heat is not recirculated in the intake system.	Construction signed off by appropriately qualified engineer

Aspect	*ID*	*Mitigation Measure*	*Achievement Indicators*
	14.5	If there are more than one intake heads, there should be significant separation between the intake heads on one tunnel and the intake heads on the other tunnel in order to provide segregation to protect against localized external hazards.	Construction signed off by appropriately qualified engineer
	14.6	The intake velocities should be designed to be minimal to prevent pinning a swimmer or diver to the bars of the intake channel. This will also protect aquatic mammals.	Construction signed off by appropriately qualified engineer
	14.7	The dimensions of bar spacing in the intake screen will be between 50 and 250 mm to protect marine mammals from being entrained as well as for the exclusion of fish, diving birds and other biota. This is also important for public safety (divers, swimmers and anyone falling into the water).	Construction signed off by appropriately qualified engineer
	14.8	Intake screen/s shall be installed at (a) strategic location/s to prevent the entrainment of aquatic life. The gaps in the screens, in conjuction with the intake flow velocities should allow any impinged fish to escape.	Construction signed off by appropriately qualified engineer
	14.9	The material of the screen will be mild steel protected by a suitable corrosion protection system. Alternatively the bars could be constructed in stainless steel or a non-ferrous metal that inhibits marine growth. Consideration will be given to making the screen in removable sections to facilitate maintenance and cleaning. The intake channel can be injected with chlorine to discourage larvae of biofouling organism entering the channel. The chlorine concentration at the outfall will comply with NEQS.	Construction signed off by appropriately qualified engineer
	14.10	The intake channel will be fitted with a combination of acoustic fish deterrent (AFD) system and fish recovery and return (FRR) provision. The combination of both processes caters for hearing-sensitive, delicate species (AFD) as well as more insensitive demersal and epibenthic species, including crustaceans.	Construction signed off by appropriately qualified engineer
	14.11	Monitoring of intake and outfall channels will take place during operation using underwater cameras and occasionally through divers. The latter will be carried out during one of the scheduled plant outages.	Systems in place and tested

Exhibit 9.4: Waste Management Plan Summary

No.	*Material Waste*	*Final Disposal Method*	*Associated Risks*	*Recommended Procedure*
1	Iron	Material returned to Store as unserviceable Scrap Store Recycling	Equipment and parts may be contaminated with oil or other liquids. This may pose hazards during recycling and/or melting.	Separate contaminated parts and ensure disposal contractor cleans and removes contaminations before recycling equipment.
2	Copper	Recycling Scrap Store	Copper wires and tubes may be covered with insulation and may pose hazard if melted.	Separate insulated copper from rest and ensure disposal contractor removes it before recycling.
3	Other Materials	Material returned to Store as unserviceable Scrape Store Recycling Landfill	Some waste materials may contain hazardous materials (such as mercury and lead) which may pose health risks if not handled or disposed of properly.	All hazardous substances such as lead and mercury will be identified and separated. Ensure waste contractor disposes hazardous materials in accordance with accepted methods.
4	Wood, Cotton, Plastic, Waste and Packing Materials	Recycling Landfill	Burning of wood, paper, plastic and other materials may cause air pollution Littering due to improper disposal	Ensure waste contractor disposes all non–recyclable plastic wastes and other non–recyclable materials at land disposal.
5	Electronics	Material returned to Store as unserviceable	Some electronic equipment may contain toxic materials and pose a health risk if opened or dismantled.	Ensure contractor disposes equipment properly and equipment is opened only under guidance of qualified professional.
6	Insulation	Material Re–used Landfill	Burning may cause air pollution. Littering due to improper disposal	Ensure contractor disposes insulation properly at landfill site.
7	Oil	Recycling Contractors	May cause contamination of soil or waterways	Ensure properly certified recycling contractors are used.
8	Concrete	Landfill or reuse as for filling	None	Ensure safe storage till disposal

9.6 Monitoring Plan

Environmental monitoring is a vital component of an EMP. It is the mechanism through which the effectiveness of the EMP is gauged. The feedback provided by environmental monitoring is instrumental in identifying any problems and planning corrective actions.

9.6.1 Objective of Monitoring

The main objectives of environmental monitoring during the construction phase of the proposed coal conversion plan will be:

- To provide a mechanism to determine whether the project construction contractors and the Owners plant management are carrying out the project in conformity with the EMP.
- To identify areas where the impacts of the projects are exceeding the criteria of significance and, therefore, require corrective actions.
- To document the actual project impacts on physical, biological, and socioeconomic receptors, quantitatively where possible, in order to design better and more effective mitigation measures.
- To provide data for preparing the monitoring report to be submitted to the Baluchistan EPA in accordance with the national law requirement.

9.6.2 Performance Indicators

The environmental parameters that may be qualitatively and quantitatively measured and compared are selected as 'performance indicators' and recommended for monitoring during project stages. These monitoring indicators will be monitored to ensure compliance with the national or other applicable standards and comparison with the baseline conditions established during design stage. The list of indicators and their applicable standards to ensure compliance are given below.

Construction Phase

1. Noise levels – Pakistan National Standards, NEQS 2010.
2. Wastewater quality – Pakistan National Standards, NEQS 2010.

Operation Phase

1. Stack emissions (SO_2, NO_x, PM_{10}) – NEQS. Continuous emission monitoring on new boilers.
2. Ambient air quality (PM_{10}, $PM_{2.5}$, SO_2, and NO_2) –Pakistan National Environmental Quality Standards,(NEQS) 2010.
3. Noise levels – Pakistan National Standards, NEQS 2010.
4. Wastewater quality – Pakistan National Standards, NEQS 2010.
5. Cooling water inlet and outlet temperature – Continuous measurement
6. Coal consumption per unit of power generated (kg/unit) – Comparison with design data

9.6.3 Environmental Monitoring Plan

The detailed environmental monitoring plan will be finalized prior to commencement of construction and operation. The requirements identified in the environmental assessment are presented in **Exhibit 9.5** for construction phase and in **Exhibit 9.6** for operation phase.

Exhibit 9.5: Monitoring Plan during Construction Phase

Project Activity and Potential Impact	*Objective of Monitoring*	*Parameters to be Monitored*	*Measurements*	*Location*	*Frequency*	*Responsibility*
Air Quality Dust emissions during construction	To determine the effectiveness of dust control programs at receptor level	PM_{10} (particulate matter <10 microns) and $PM_{2.5}$ concentration	1 hour and 24 hour concentration levels	At three representative locations	Once every three months on a typical working day	Contractor's environmental officer, the Owners
		Visible dust	Visual observation of size of dust clouds, their dispersion and direction of dispersion	Construction site	Daily during construction period	Contractor's environmental officer, the Owners
Exhaust emissions from generators and other construction equipment	To determine the effectiveness of gaseous emission control measures	Gaseous emission rates from generators and other equipment	CO_x, NO_x. SO_x, and PM measurements should be taken at full, typical, and idling conditions	Exhaust	Baseline when equipment is first put into use, and once a month after that	Contractor's environmental officer, the Owners
Shoreline Erosion Bank erosion due to wind and construction activities	To determine the effectiveness of erosion control measures		Visual inspections	Banks	Weekly	Contractor's environmental officer, the Owners
Water/Soil Contamination Contamination due to oil/chemical leakages	To determine the effectiveness of control measures taken to minimize the risk of oil and chemical spills	Procedures in place to handle liquids and availability of procedures and equipment for emergency response incidents	Visual inspections and availability checks	Construction site	Weekly	Contractor's environmental officer, the Owners

Project Activity and Potential Impact	*Objective of Monitoring*	*Parameters to be Monitored*	*Measurements*	*Location*	*Frequency*	*Responsibility*
Traffic Exhaust and PM emissions from trucks transporting construction materials	To determine the effectiveness of control measures taken to minimize exhaust and dust emissions from trucks	Vehicle exhaust emissions and visual inspection to ensure vehicle load is secured	Vehicle exhaust emissions, Smoke, NO_x, SO_x and CO	Construction material transport trucks	Quarterly	Contractor's environmental officer, the Owners

Exhibit 9.6: Monitoring Requirements during Operational Phase

Aspect	*Type of monitoring*	*Frequency*	*Location/s*
Land disturbance	Soil quality (major metals, nutrients, organic contents, and TPH)	Every two years	4 monitoring points around the plant and Ash Disposal Area
	Visual inspection of road condition	Quarterly or on receipt of grievance	Access road for coal transport
Effluent Water	Water quality (as indicated in NEQS)	Monthly[1]	All the effluent channels exit point from the plant into the sea
Water resources	Groundwater quality around ash disposal site to monitor any leachate	Quarterly	3 monitoring points around the plant and Ash Disposal Area
Air	PM_{10} and TSP for 24 hour filter-based low-volume sampler	Quarterly	4 monitoring points around the plant
	Ambient 24 hr NO_2 and SO_2 concentrations (using active sampler)	Quarterly	4 monitoring points around the plant
	Stack testing	Monthly[2]	All stacks
		Continuous Emission Monitoring (CEM)	New coal boilers
	Times and duration of upset conditions	When upset conditions occur	All plant stacks

1 According to an amendment to the SMART rules in 2005, after proving compliance with NEQS for two consecutive years, the Project proponents may submit the monitoring reports quarterly.

2 Ibid.

Aspect	*Type of monitoring*	*Frequency*	*Location/s*
Vehicles and equipment	Random speed checks	At different locations and different time	Access road and plant road
	Records of vehicle and equipment maintenance	As per manufacturer's instructions	Transport office and workshop
	Baseline noise emissions of new equipment	On commissioning of new equipment	Within 100m of equipment
Ecological	Records of animal and fish kills	On occurrence	Surrounding areas around plant site and ash disposal area
	Records of major wildlife sightings	On occurrence	Access road and surrounding areas
Community	Community grievances or complaints, categorized by type.	Monthly	Grievance register maintained at plant site
Hazardous material	Records of hazardous materials used	On arrival at site	Warehouse or storage facility
	Inspections of hazardous substances containment facilities, instrumentation and detection systems.	Evert three months	Hazardous material containment facilities
Waste	Volume of different wastes types disposed of to landfill or incineration	Continuous	Waste disposal sites
	Volume of different waste types recycled or reused	Continuous	Waste disposal sites

9.6.4 Environmental Records

The following environmental records will be maintained:

- Periodic inspection reports of Contractor’s Environmental Officer or his designate
- Incident record of all moderate and major spills. The record will include:
  - Location of spill
  - Estimated quantity
  - Spilled material
  - Restoration measures
  - Photographs
  - Description of any damage to vegetation, water resource
  - Corrective measures taken, if any
  - Corrective measures taken, if any
- Waste Tracking Register that will records of all waste generated during the construction and operational period. This will include quantities of waste disposed, recycled, or reused
- Survey reports, in particular, the following:
  - Soil erosion: Baseline survey, including photographs (or video), will be conducted to document pre-construction condition of the construction corridor
  - Vehicle and equipment noise
  - Ambient noise survey reports

9.7 Communication and Documentation

An effective mechanism to store and communicate environmental information during the project is an essential requirement of an EMP.

9.7.1 Meetings

Two kinds of environmental meetings will take place during the Project:

- Kick-off meetings
- Monthly meetings

The purpose of the kick-off meeting will be to present the EMP to project staff and discuss its implementation.

A monthly meeting will be held during construction phase at site. The purpose of this meeting will be to discuss the environmental issues and their management. The proceedings of the meeting, the required action, and responsibilities will be recorded in the form of a brief report.

9.7.2 Reports

Environmental reports will be prepared on a quarterly basis during the construction and quarterly during the operation. The report will be provided to the Owners.

9.7.3 Change-Record Register

A change-record register will be maintained at the site, in order to document any changes in EMP and procedures related to changes in the project design, construction plan or external environmental changes affecting the EMP. These changes will be handled through the change management mechanism discussed later in this chapter.

9.8 Change Management

An environmental assessment of the proposed project has been made on the basis of the project description available at the time the environmental assessment report was prepared. However, it is possible that changes in project design may be required at the time of project implementation. This section describes the mechanism that will be put into place to manage changes that might affect the project's environmental impacts.

Potential changes in project design have been categorized as first-order, second-order, and third-order changes. These are defined below.

9.8.1 First-Order Change

A first-order change is one that leads to a significant departure from the project described in the environmental assessment report and consequently requires a reassessment of the environmental impacts associated with the change.

In such an instance, the environmental impacts of the proposed change will be reassessed, and the results sent to the Baluchistan EPA for approval.

9.8.2 Second-Order Change

A second-order change is one that entails project activities not significantly different from those described in the environmental assessment report, and which may result in project impacts whose overall magnitude would be similar to the assessment made in this report.

In case of such changes, the environmental impact of the activity will be reassessed, additional mitigation measures specified if necessary, and the changes reported to the Baluchistan EPA.

9.8.3 Third-Order Change

A third-order change is one that is of little consequence to the environmental assessment reports' findings. This type of change does not result in impact levels exceeding those already discussed in the environmental assessment; rather these may be made onsite to minimize the impact of an activity. The only action required in this case will be to record the change in the change record register.

9.8.4 Changes to the EMP

Changes in project design may necessitate changes in the EMP. In this case, the following actions will be taken:

- A meeting will be held between the Owners and the contractor representatives, to discuss and agree upon the proposed addition to the EMP
- Based on the discussion during the meeting, a change report will be produced collectively, which will include the additional EMP clause and the reasons for its addition
- A copy of the report will be sent to the head offices of the Owners and the contractor
- All relevant project personnel will be informed of the addition

9.9 Environmental Training

Environmental training will help to ensure that the requirements of the environmental assessment and EMP are clearly understood and followed by all project personnel in the course of the project. The contractor will be primarily responsible for providing training to all project personnel. An indicative environmental and social training program is provided in **Exhibit 9.7**, which will be finalized before the commencement of the project.

Exhibit 9.7: Training Program

Type of Training	*Training By*	*Personnel to be Trained*	*Training Description*	*Period*	*Duration*
Occupational Health and Safety	External Sources	EHS Manager	Training should be provided to aware staff to conform to safety codes.	Before starting of project activities	Full day (8 hour session)
Occupational Health and Safety	EHS Manager	Workers Staff	Health, safety and hygiene Proper usage of personnel protective gear Precautions to be taken for working in confined areas.	Before starting of project activities During Project Activities	Full day (8 hour session)
Health, Safety and Environmental Auditing	External Sources	Staff responsible for inspection/audits	Procedures to carry out Health, Safety and Environmental Audits Reporting requirements	Before starting of project activities	Full day (8 hour session)
Waste Disposal and Handling	External Sources	Relevant Workers Relevant Staff	Segregation, identification of hazardous waste, use of PPEs, waste handling	Before starting of project activities	Full day (8 hour session)
Social & Environmental laws & regulations, norms, procedures and guidelines of Government	External sources	EHS staff Plant managers and supervisors	Environmental standards and their compliance Govt. regulations	Before starting the project activities	Full day (8 hour session)
Implementation of environmental management and monitoring plant	External Sources	EHS staff Responsible supervisory staff Management	Concepts of environmental management and monitoring plan	Once in 3 months during the entire construction period	Full day (8 hour session)

9.10 Construction Management Plan

The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the **Exhibit 9.8**. The CMP will be submitted to the Owner for approval.

The CMP will clearly identify all areas that will be utilized during construction for various purposes. For example, on a plot plan of the construction site the following will be shown:

- Areas used for camp,
- Storage areas for raw material and equipment,
- Waste yard,
- Location of any potentially hazardous material such as oil,
- Parking area,
- Loading and unloading of material, and
- Packaged treatment.

Exhibit 9.8: Construction Management Plan

Aspect	*Objective*	*Mitigation and Management Measure*
Vegetation clearance	Minimize vegetation clearance and felling of trees	▶ Removal of trees should be restricted to the development footprint. ▶ Construction activities shall minimize the loss or disturbance of vegetation ▶ Use clear areas to avoid felling of trees ▶ A procedure shall be prepared to manage vegetation removal, clearance and reuse ▶ Inform the plant management before clearing trees
Poaching	Avoid illegal poaching	▶ Contractual obligation to avoid illegal poaching ▶ Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching
Discharge from construction sites	Minimize surface and ground water contamination Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life	▶ Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials ▶ Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot ▶ Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil Erosion and siltation	Avoid sediment and contaminant loading of surface water bodies and agricultural lands.	▶ Minimize the length of time an area is left disturbed or exposed. ▶ Reduce length of slope of runoff ▶ Construct temporary cutoff drains across excavated area ▶ Setup check dams along catch drains in order to slow flow and capture sediment ▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds) ▶ All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).

Aspect	*Objective*	*Mitigation and Management Measure*
Excavation, earth works, and construction yards	Proper drainage of rainwater and wastewater to avoid water and soil contamination.	▶ Prepare a program for prevent/avoid standing waters, which Construction Supervision Contractor (CSC) will verify in advance and confirm during implementation ▶ Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there
Ponding of water	Prevent mosquito breeding	▶ Do not allow ponding of water especially near the waste storage areas and construction camps ▶ Discard all the storage containers that are capable of storing of water, after use or store them in inverted position ▶ Reinstate relief and landscape.
Storage of hazardous and toxic chemicals	Prevent spillage of hazardous and toxic chemicals	▶ Implement waste management plans ▶ Construct appropriate spill containment facilities for all fuel storage areas ▶ Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results
Land clearing	Preserve fertile top soils enriched with nutrients required for plant growth or agricultural development.	▶ Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m and with a slope of 1:2 ▶ Spread the topsoil to maintain the physio–chemical and biological activity of the soil. ▶ The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites ▶ Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions will include: ▷ Anaerobic conditions – turning the stockpile or creating ventilation holes through the stockpile; ▷ Erosion – temporary protective silt fencing will be erected;
	Avoid change in local topography and disturb the natural rainwater/ flood water drainage	▶ Ensure the topography of the final surface of all raised lands are conducive to enhance natural draining of rainwater/flood water; ▶ Reinstate the natural landscape of the ancillary construction sites after completion of works

Aspect	*Objective*	*Mitigation and Management Measure*
Construction vehicular traffic	Control vehicle exhaust emissions and combustion of fuels.	▶ Use vehicles with appropriate exhaust systems. ▶ Establish and enforce vehicle speed limits to minimize dust generation ▶ Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site ▶ Level loads of haul trucks travelling to and from the site to avoid spillage ▶ Use of defined haulage routes and reduce vehicle speed where required. ▶ Regular maintenance of all vehicles ▶ All vehicle exit points from the construction site shall have a wash-down area where mud and earth can be removed from a vehicle before it enters the public road system.
	Minimize nuisance due to noise	▶ Maintain all vehicles in good working order ▶ Make sure all drivers comply with the traffic codes concerning maximum speed limit.
	Avoid impact on existing traffic conditions	▶ Prepare and submit a traffic management plan ▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions.
	Prevent accidents and spillage of fuels and chemicals	▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions. ▶ Design and implement safety measures and an emergency response plan to contain damages from accidental spills. ▶ Designate special routes for hazardous materials transport.
Construction machinery	Prevent impact on air quality from emissions	▶ Use machinery with appropriate exhaust systems. ▶ Regular maintenance of all construction machinery ▶ Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages

Aspect	*Objective*	*Mitigation and Management Measure*
	Reduce impact of noise and vibration on the surrounding	▶ Appropriately site all noise generating activities to avoid noise pollution to local residents. ▶ Ensure all equipment is in good repair and operated in correct manner. ▶ Install high efficiency mufflers to construction equipment. ▶ Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment
Construction activities	Minimize dust generation	▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds). ▶ Stored materials such as gravel and sand should be covered and confined ▶ Locate stockpiles away from sensitive receptors
	▶ Reduce impact of noise and vibration on the surrounding ▶ Avoid driving hazard where construction interferes with pre– existing roads.	▶ Notify adjacent landholders or residents prior to noise events during night hours ▶ Install temporary noise control barriers where appropriate ▶ Avoid working during 22:00 to 06:00 within 500m from residences.
	▶ Minimizing impact on water quality	▶ Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage.
		▶ Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. ▶ An Emergency Spills Contingency Plan shall be prepared.
Siting and location of construction camps	Minimize impact from construction footprint	▶ Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view.

Aspect	*Objective*	*Mitigation and Management Measure*
Construction Camp Facilities	Minimize pressure on local services	▶ Adequate housing for all workers ▶ Safe and reliable water supply. ▶ Hygienic sanitary facilities and sewerage system. ▶ Treatment facilities for sewerage of toilet and domestic wastes ▶ Storm water drainage facilities. ▶ In–house community entertainment facilities.
Disposal of waste	Minimize impacts on the environment	▶ Ensure proper collection and disposal of solid wastes in the approved disposal sites ▶ Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. ▶ Establish waste collection, transportation and disposal systems ▶ Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site. ▶ Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers.
Fuel supplies for cooking purposes	Discourage illegal fuel wood consumption	▶ Provide fuel to the construction camps for domestic purpose ▶ Conduct awareness campaigns to educate workers on preserving the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Site Restoration	Restoration of the construction camps to original condition	▶ To the extent possible, restore the camp site and all other areas temporarily used for construction to their conditions that existed prior to commencement of construction work.
Construction activities near religious and cultural sites	Avoid disturbance to cultural and religious sites	▶ Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. ▶ It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management. ▶ Maintain appropriate behavior with all construction workers especially women and elderly people ▶ Resolve cultural issues in consultation with local leaders and supervision consultants

Aspect	*Objective*	*Mitigation and Management Measure*
Best practices	Minimize health and safety risks	▶ Implement suitable safety standards, ▶ Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas, ▶ Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full–face eye shields, and ear protection. ▶ Maintain the PPE under a regular checking and replacement program
Water and sanitation facilities at the construction sites	Improve workers' personal hygiene	▶ Provide portable toilets at the construction sites and drinking water facilities. ▶ Portable toilets should be cleaned once a day. ▶ All the sewerage should be pumped from the collection tank once a day to a packaged treatment facility for further treatment.

9.11 Coal Dust Management Plan

Coal dusts from coal stockpile and coal conveyor belt area are the major source of fugitive emissions. Dust suppression using a sprinkler system will be primarily employed to control the coal dust from these areas. Recycled water from the waste water treatment plant will be the primary source of water to the sprinkler system.

Two methods of dust control will be implemented: dust extraction and dust suppression.

Coal dust suppression will comprise wetting air-borne dust particles with a fine spray of water, causing the dust particles to agglomerate and move by gravity to the coal stream flow. Once properly wetted, the dust particles will remain wet for some period and will not tend to become airborne again. The dust suppression system in the stockpile yard will consist of swiveling and wide-angle full-cone spray nozzles. These nozzles will be provided on both sides of the pile and at ground level. Ventilation slots are proposed in the top portion of the raw coal bunkers, allowing coal fed into the bunkers to displace any gases that may have formed as a result of resident coal.

In the coal dust extraction system, dust will be extracted from screening feeders and belt feeders by suctioning the dust-laden air and trapping coal particles in fine water sprays, thereafter discharging the clean air into the atmosphere. The dust collection equipment may include cyclones, wet scrubbers, fans, collecting hoppers, filters, hoods, ducts, dampers, and drain pipes. In this system, the dust-laden air will enter the collector where it comes in contact with water; the slurry will be collected in the hopper and disposed of in the settling pond. Settle dust will be put back into the stockyard where it will be mixed with crushed coal for use. In addition, roof extraction fans will be provided in essential areas like crusher house and boiler bunker floors. Air conditioning for control room and pressurized ventilation with unitary air filter unit for Electrical and Control buildings of coal handling plant will be provided.

Rainfall runoff from the coal pile and runoff from the application of dust suppression sprays will contain mainly suspended solids. This runoff will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for the dust suppression system.

The volatility of the coal of this project is high, easy to cause spontaneous combustion; therefore, the coal to the coal yard must be stored in different piles and compacted, the earlier it comes, the earlier it is to be used, with regular rearrangement of the coal piles. The bucket wheel machine itself is equipped with water tank to spray water over the fly dust points so as to reduce the fly dust. The coal pile shall have an automatic temperature monitoring system; when an increase in temperature is detected, an alarm will be immediately triggered, alerting of the presence of hot spots. Based on the temperature and the risks, the coal will be either immediately sent to the boiler for utilization, or the portion of coal will be isolated and allowed to burn off. Water sprinkling system may be used to reduce the temperature of the hot zone and avoid coal fire or smoldering. Rubber belt of the belt conveyer shall use flame retardant material.

9.12 Ash Management Plan

The emergency ash yard will have a dam of height 4 m and a covered area of approximately 300,000 m^2. It will be located in the north east corner and south of the site plant site. The lower soil layer of the proposed ash storage yard is composed of clayey silt, silty clay, sand and gravel. A separate study will be conducted for selection of environmental friendly permanent ash disposal site.

The options of ash utilization including the ash–based products include:

- Brick/Block/Tiles Manufacturing
- Cement Manufacturing
- Roads and Embankment Construction
- Structural Fill for Reclaiming Low Lying Areas
- Agriculture, Forestry and Waste–land Development
- Part Replacement of Cement in Mortar, Concrete and Ready Mix Concrete Hydraulic Structure (Roller Compacted Concrete)
- Ash Dyke Raising
- Building Components – Mortar, Concrete,
- Concrete Hollow Blocks, Aerated Concrete Blocks etc.
- Fill material for structural applications and embankments
- Ingredient in waste stabilization and/or solidification
- Ingredient in soil modification and/or stabilization
- Component of flowable fill
- Component in road bases, sub–bases, and pavement
- Mineral filler in asphalt
- Other Medium and High Value Added Products (Ceramic Tiles, Wood, Paints) Pavement Blocks, Light Weight Aggregate, Extraction of Alumina, Cenospheres, etc.

The following strategies will be adopted to ensure full fly ash utilization in brick and cement block manufacturing:

Other environmental protection measures proposed for the ash yard include the following:

- The most simple, the most realistic and the most effective measure for dry ash yard is to prevent the dust emissions of fly ash by sprinkling water on ash surface to keep ash surface in wet state Sprinkling water cycle and water quantity should be according to the seasons and the weather, especially during the dry windy season, sprinkling water is very critical.
- Compaction of ash after spraying the surface, avoids artificial disturbance. After compaction of the ash and sprinkling water on the surface, hydrolysis of calcium

oxide and alumina cement forms a layer of protection on the surface of ash shell. This increases the pressure on the surface of the solid ash and provides wind resistance ability which reduces the pollution of fly ash.

- Fly ash curing agent on the ash surface can be adopted, which makes the ash surface form a layer of protection shell, increases compaction of ash surface and provides wind resistance ability.

9.13 Spill Management

Liquid waste spills that are not appropriately managed have the potential to harm the environment. By taking certain actions Owner can ensure that the likelihood of spills occurring is reduced and that the effect of spills is minimized.

To enable spills to be avoided and to help the cleanup process of any spills, the EPC contractors and the management and staff of the Owners should be aware of spill procedures. By formalizing these procedures in writing, staff members can refer to them when required thus avoiding undertaking incorrect spill procedures.

A detailed spill management plan will be prepared for the construction phase. Similar, plan will also be developed for specific areas during plant operation. The plan will contain the following:

- Identification of potential sources of spill and the characterization of spill material and associated hazards.
- Risk assessment (likely magnitude and consequences)
- Steps to be undertaken taken when a spill occurs (stop, contain, report, clean up and record).
- A map showing the locations of spill kits or other cleaning equipment.

9.13.1 Avoiding Spills

By actively working to prevent spills, money and time can be saved by not letting resources go to waste. In addition, the environment is protected from contaminants that can potentially cause harm.

All liquids will be stored in sealed containers that are free of leakage. All containers will be on sealed ground and in an undercover area. Sharp parts will be kept away from liquid containers to avoid damage and leaks.

Bunding: To prevent spills from having an effect on the plant site operations or the environment, bunding will be placed around contaminant storage areas. A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or similar and is used to capture spilt liquid for safe and proper disposal.

9.13.2 Spill Kits

Spill kits are purpose designed units that contain several items useful for cleaning up spills that could occur. Typical items are:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite)
- Absorbent pads, granules and/or pillows
- Booms for larger spills
- Mops, brooms and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner. Sufficient number of spill kits will be provided. Spill kits will be kept in designated areas that are easily accessible to all staff. Staff members will be trained in using the spill kit correctly.

After cleaning up a spill, the materials used to clean up will be disposed of correctly. Depending on the spill material, the used material may be disposed in the hazardous waste facility or the landfill site.

9.13.3 Responding to Spills

Stop the source: If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.

Contain and control the flow: To stop the spill from expanding, absorbent materials and liquid barriers should be placed around the spill. Work from the outside to soak up the spill. It is vital that spilt liquid is not allowed to reach storm water drains, sewer drains, natural waterways or soil.

For large scale spills that involve hazardous materials, authorities may have to be alerted.

Clean up: Using information from Material Safety Data Sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills should be cleaned up promptly.

Record the incident: By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future.

9.14 Grievance Redress Mechanism

Timely and effective redress of stakeholder grievances contribute to bringing sustainability in the operations of a project. In particular, it will help advocate the process of forming and strengthening relationships between project management and the stakeholder community groups and bridge any gaps to create a common understanding, providing the project management the ‘social license’ to operate in the area. The grievance redress mechanism proposed for the Project will help achieve the objectives of sustainability and cooperation by dealing with the environmental and social issues of the Project.

The proposed grievance redress mechanism will be designed to cater for the issues of the people that can be affected by the Project. The population that can be affected by the Project is identified in Section IVC – Description of Environment, and comprises of the people residing within five km of the plant site. The potential impacts of the Project are described in Section V – Anticipated Environmental Impacts and Mitigation Measures.

9.15 Framework for Grievance Redress Mechanism

The Owners will develop a stakeholder grievance redress mechanism.

9.15.1 Pakistan Environmental Protection Act 1997

The Federal Agency, under Regulation 6 of the IEE-EIA Regulations 2000, has issued a set of guidelines of general applicability and sectoral guidelines indicating specific assessment requirements. Under the regulations and guidelines, no specific requirements are laid out for developing a grievance redress mechanism for projects. However, under its Guidelines for Public Consultation, 1997, the proponents are required to consult stakeholders during the implementation phase of the project. In this regards, it is stated that the representatives of local community partake in the monitoring process to promote a stable relationship between the project management and the community.

9.15.2 Outline of Mechanism for Grievance Redress

The Owners will have an effective mechanism to ensure timely and effective handling of grievances related to the power plant, including those related to transportation of coal. It may include:

- A Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints; and,
- A Grievance Redress Committee (GRC), responsible to oversee the functioning of the PCU as well as the final non-judicial authority on resolving grievances that cannot be resolved by PCU;
- Grievance Focal Points (GFPs), which will be educated people from the fishing community that can be approached by the community members for their grievances against Owner. The GFPs will be provided training by the Owners in facilitating grievance redress.

9.16 Plant Decommissioning Plan

It is expected that the decommissioning plan for the Project will be prepared by a qualified consultant. The plan will include cataloging hazardous materials and carrying out assessment and abatement works; contingency and Environmental Control Plans; ash yard rehabilitation; plant, equipment re-sale and salvage evaluations; and, construction management during the demolition and deconstruction work.

By completing site inspections and interviews with plant personnel, the following should be reviewed during the assessment for the preparation of a decommissioning plan:

- ***Compliance Plans and Permits*** – identification of personnel changes and required notifications.
- ***Site Construction Documents and History*** – inventorying underground structures, tanks, piping and other facilities.
- ***Hazardous Materials Assessment*** – addressing Lead-Based Paint (LBP), Mercury-Containing Devices, Oil-Filled Equipment and PCBs in Building Materials.

- ***Soil, Groundwater and Sediment Impacts*** – assessment of impacts from historic discharges and leaks including environmental site assessments to delineate impacts and risk assessment to identify areas requiring remediation.
- ***Equipment Salvage Value*** – evaluation of equipment for re-sale or salvage. The closure actions are documented in the following project deliverables:
  - Specifications and drawings for removal/abatement of hazardous materials;
  - Inventory of items to sell, salvage, recycle or for disposal;
  - Schedule and task structure with identification of critical path items; and
  - Cost estimates and procurement/bid documents for decommissioning.

The specific actions undertaken during the decommissioning varies considerably based upon the future plans for the power plant. The physical removal of the identified hazardous materials and contaminated soils which present a risk or exceed facility-specific cleanup goals must be completed prior to demolition and deconstruction work. It is critical to properly characterize materials and segregate materials to minimize disposal costs. The following identifies a number of specific actions that may be needed to support the decommissioning:

- Removal and closure of tanks;
- Draining of pipeline and oil-filled equipment;
- Reconfiguration of piping;
- Targeted actions addressing soil and groundwater contamination;
- Shut down or reconfiguration of water treatment systems and cooling water systems; and
- Closure of ash disposal areas.

The quantity and type of each material removed from the site during the hazardous materials removal/abatement as well as during the demolition should be documented to facilitate regulatory reporting, project close-out and for company records. These include:

- ***Hazardous Materials Identification and Abatement*** – identification of hazardous materials in equipment and building materials and assessment of contaminated soil and groundwater including development of removal and management plans.
- ***Permit Review and Compliance Assurance*** – revision of compliance documents to maintain compliance.
- Equipment and Machinery Evaluation – asset value determination.
- ***Procurement*** – cost estimating, preparation of design drawings and specifications for decommissioning tasks.
- ***Construction Management*** – direction and documentation of decommissioning work.
- ***Health and Safety*** – design and implementation of site-safety programs.
- ***Ash Landfill and Tank Closure*** – closure plan implementation.
- ***Site Reuse Planning*** – stakeholder engagement, economic analysis, land-use planning, habitat restoration and permitting.

10. Conclusions

The proposed Project entails the installation of a 2 x 660 MW supercritical coal-fired thermal power plant in Gadani tehsil, District Lasbela, Baluchistan. The Project will incorporate state of the art effluents and emissions treatment technologies to minimize the associated wastes and mitigate their adverse impacts on the physical and socioeconomic environment of the region to the maximum possible levels. The power plant will comprise of a once-through cooling system and the cooling water will be extracted from the Arabian Sea.

The ESIA has documented all major environmental concerns associated with the project. The main environmental concerns are:

- Impacts of liquid effluents and cooling water system outfall by the Project on sea and marine life.
- Impact of gaseous and dust emissions from the Project on the ambient air quality.
- Impacts due to disposal of ash which will be discussed in a separate study.

A series of mitigation and monitoring measures have been included to address these concerns. Assuming effective implementation of the mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (**Section 9**) the adverse environmental and social impacts of the proposed Project are likely to be within the acceptable limits.