Hagler Bailly Pakistan

Associated with PA Consulting Group

Technical, Management, and Economic Counsel

# 330 MW Coal-Fired Power Plant in Energy Park, Block II Thar Coalfields

# Environmental and Social Impact Assessment

**Final Report**

**Volume 1 of 2 (Main Report)**

HBP Ref.: R6V04HUP

**August 9, 2016**

**Thar Energy Limited.**

Karachi

# Executive Summary

Thar Energy Limited (TEL) plans to establish a 1x330 megawatt (MW) Thar Lignite Coal-based mine mouth Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh. TEL is a fully owned subsidiary of The Hub Power Company Limited (HUBCO).

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal which can be utilized to produce 100,000 MW for over 200 years. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (see **Exhibit I**).

Sindh Coal Authority (SCA) has awarded a 95.5 square kilometer ($km^2$) area of the coalfield, known as Thar Block II, to Sindh Engro Coal Mining Company (SECMC) for exploration and development of the coal deposits in the block

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of about 2 $km^2$ (500 acres).

## The Proposed Project

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

The proposed Project will be located on a 28 hectare (0.28 square km) plot located within the Energy Park, Block II of Thar Coalfields in Tharparker District of Sindh, as shown in **Exhibit II.** It is located adjacent to the under construction 2x330 MW Engro Powergen Thar (Private) Limited (EPTL) coal power plant (CPP).

The major systems in the proposed plant will include:

- Coal handling and processing system
- CFB boiler and environmental control equipment
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Ash handling system
- Utilities and waste management systems.

Emissions controls for pollutants of concern ($NO_X$, $SO_2$ and particulate matter) will be as follows:

- In CFB boiler, combustion takes place at relatively low temperatures as compared to pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these low temperatures results in an effective suppression of NOx

ensuring emissions to be below 510 mg/$Nm^3$ to meet the SEQS and IFC EHS limits of NOx in the stack

- $SO_2$ control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). $SO_2$ emissions of the plant will be below 850 mg/$Nm^3$ and meet SEQS and IFC EHS guidelines for stack emissions.
- The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). The ESP will be designed to have an efficiency greater than 99% and will be finalized based on the outlet flue gas particulate loading to achieve particulate matter emissions of below 50 ppm at all loads when burning design coal.

**Exhibit I:** Project Location within the Thar Coalfields

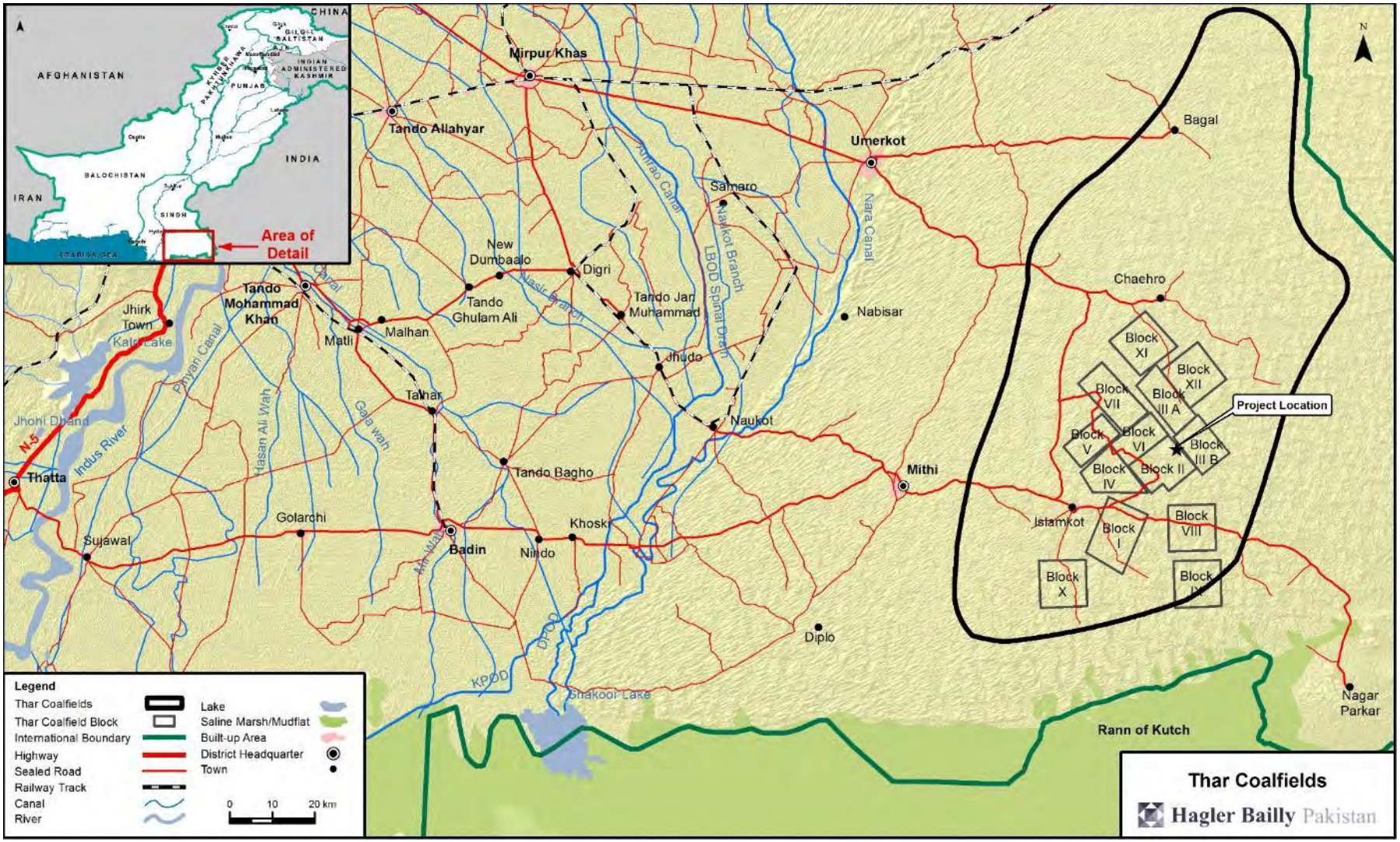
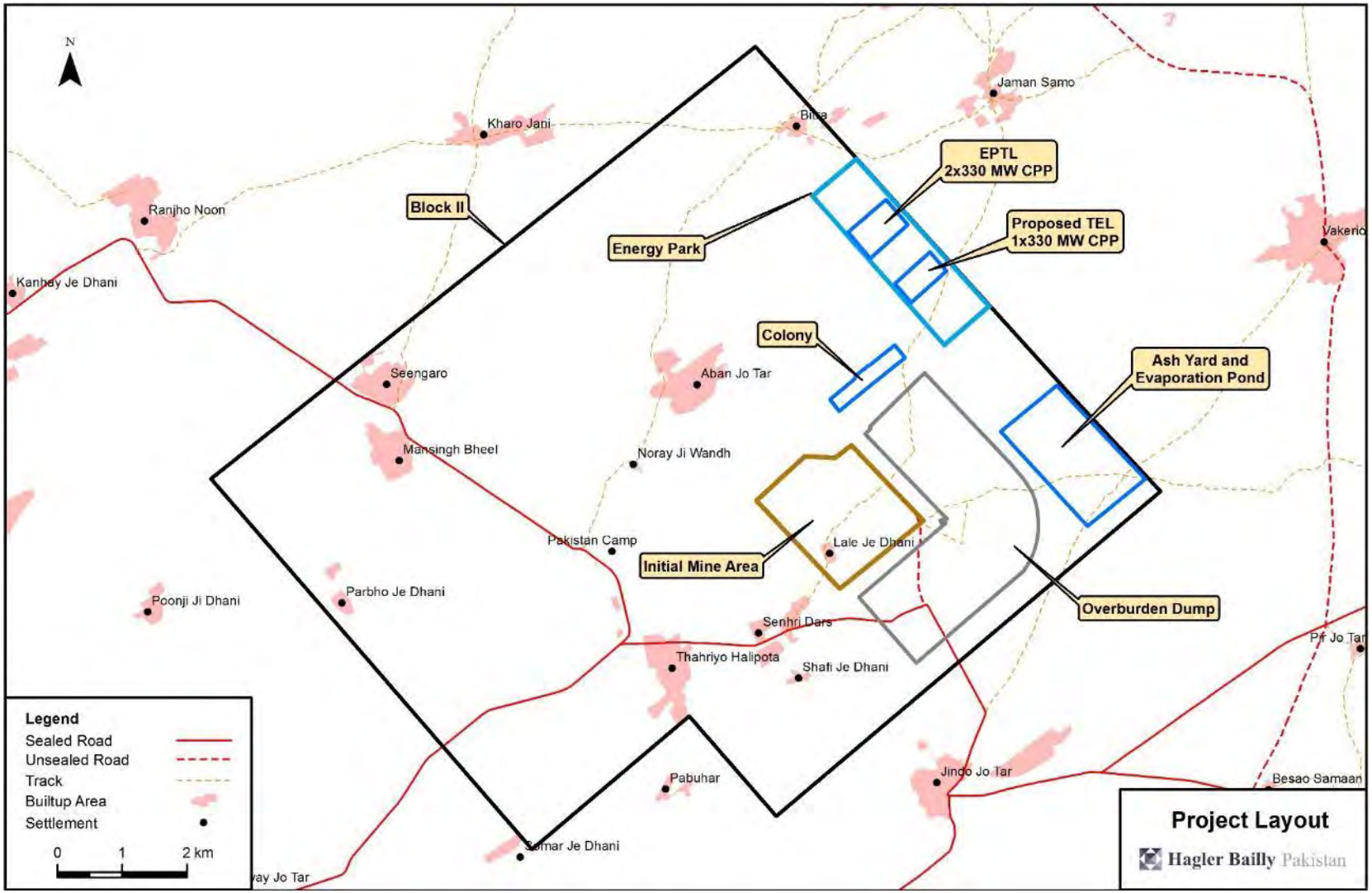


**Exhibit II**: Project Layout



### Coal Consumption

The main fuel for the power plant will be Thar Lignite Coal from Block II mine. Based on the lower heating value (LHV) of 2675 kcal/kg, net plant thermal efficiency of 37%, plant gross capacity of 1x330 MW, and 85% availability factor approximately 1.9 million tons per year of coal will be consumed.

### Water Consumption

The anticipated power plant demand for water is less than 800 $m^3$/hour.

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD) [1] to supply water to the Thar Coalfields after necessary treatment and storage provision. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts not evaluated as part of this ESIA.

LBOD treated water of 8.75 cusec (892 $m^3$/hour) will be allocated as the main source of water supply to the project which based on preliminary water balance is sufficient to satisfy the needs of 1x330MW plant at all loads and in peak summers.

The water from mine dewatering activity, if available in sufficient quantity for the Project, can be used as a secondary water source after necessary treatment. For this a mine water treatment plant (Reverse Osmosis based) may be considered. In this case about 1100 $m^3$/hour of mine water should be available before treatment to meet plant requirements.

To further reduce the plant water consumption (and reduce reject quantity) cooling tower blowdown treatment plant (Reverse Osmosis based) may also be considered.

### Waste Disposal

The major solid and liquid waste streams generated by the proposed coal power plant Project include ash-lime residue and waste water.

Ash-lime residue will be stored in the ash yard which will be developed in the area dedicated for this purpose in Block II (see **Exhibit II**). The dumped ash in the yard will be compacted, mixed with sand and given leaching protection by clay or geomembrane lining of the area. The Ash yard will be big enough to store ash lime residue for about 2

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[1] The LBOD is an environmental improvement project which was conceived in the 1960s as a response to the problem of rising water tables and resulting waterlogging and salinity. The project area includes some of the most hard-hit areas on the left side of the Indus River in the arid zones of Sindh Province. The project's primary function is to remove and safely convey saline water to the sea through a network of drains. The project provides for the integrated development of irrigation and drainage which include an outfall for saline drainage effluent to the Arabian Sea, phased construction of three drainage subareas in Nawabshah, Mirpurkhas and Sanghar, remodeling of the Nara/Jamrao Canal system, and watercourse improvement in the arid zones in Sindh Province.

The World Bank. "Left Bank Outfall Drain Project Tackling Pakistan's Waterlogging and Salinity Problems." Projects and Operations. http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20017537~menuPK:64282137~pagePK:41367~piPK:279616~theSitePK:40941,00.html (accessed October 15, 2014).

years until it is transported to the mine area when it is available for final disposal as backfill in the spent mine pit.

The maximum possible water from the coal power plant will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. A sewage treatment plant will treat sewage from the housing complex and construction camp. Wastewater from the sewage plant will be discharged or recycled in appropriate processing streams. Wastewater from the industrial and sewage treatment plants will meet SEQS for liquid effluents.

Non-recycled wastewater from the Project will be disposed through third aquifer reinjection or via evaporation pond. Location of third aquifer reinjection of cooling water blowdown or RO treatment plant reject (if installed) will be finalized through separate study and effluent limits will be defined. The evaporation ponds will be installed to handle continuous steams of minor flow or streams of major flow in case of emergency. They will be in the vicinity of the ash yard within the designated area of Block II.

### Air Emissions

Main gaseous emissions of concern from the coal power Project include sulfur dioxide ($SO_2$) and oxides of nitrogen ($NO_x$) along with particulate matter emissions ($PM_{10}$ and $PM_{2.5}$, which refers to particulate matter less than 10 and 2.5 microns respectively are pollutants of health concern). The release and dispersion of these pollutants is discussed in detail in later sections.

## Description of the Environment

The Study Area selected for the ESIA includes sensitive receptors that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it

A detailed description of the existing environment, including the physical, ecological and socioeconomic baseline conditions, is described in the report. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

### Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic.

#### *Topography, Geology and Seismic Hazards*

The topography of the Study Area is typical of the Thar Desert. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (amsl). The entire surface of the Study Area is covered by aeolian sands of the Quaternary. The Thar Desert lies at the north-western corner of the Indian Plate.

The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi. Based on the Global Seismic Hazard Assessment Program

(GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 m/s$^2$.

### *Climate*

The seasons in the Study Area are classified as:

#### *Summer (mid-March to mid-June)*

Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.

#### *Summer Monsoon (mid-June to mid-September)*

The summer Monsoon, hereafter referred to as the Monsoon, is characterized by high temperatures (milder than summers), high rainfalls with high atmospheric humidity and moderate speed-winds.

#### *Post-Monsoon Summer (mid-September to mid-November)*

Characterized by moderately high temperatures, low rainfalls and low speed-winds blowing from southwest towards northeast.

#### *Winter (mid-November to mid-March)*

Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

### *Air Quality Baseline*

Ambient air quality is established using primary and secondary data along with modelled emissions of approved developments in the area. **Exhibit III** presents the current pollutant levels of the Study Area that are established based on measured data. Expected activities near the Study Area, that may influence the air quality baseline of the Project are shown in **Exhibit IV**

The influence of the 2 x 330 MW power plant was modelled and a simulated baseline for ambient air quality conditions expected to be present at the time of operation of the proposed Project is shown in and **Exhibit V**. The expected extent of dust emissions due to the mining activities are discussed in the report. In **Exhibit V** the measured baseline consists of average values of ambient air quality measurements made in the area, the modelled increment consists of modelled ambient air quality impacts of expected developments in the area, and simulated baseline consists of the sum of the measured and modelled baselines. Contour maps that show the spatial distribution of the simulated baseline of the Project are provided in the report.

**Exhibit III:** Baseline Ambient Air Quality in the Study Area (µg/m$^3$)

| | $NO_2$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|---|
| Baseline Levels | *3 ± 3* | *7 ± 6* | *140 ± 93*[2] | *30 ± 40* |
| SEQS (annual) | 40 | 80 | 120 | 40 |
| SEQS (24-hour) | 80 | 120 | 150 | 75 |
| IFC EHS (annual) | 40 | - | 70[a] | 35[a] |
| IFC EHS (24-hour) | - | 125 | 150 | 75 |

**Exhibit IV:** Approved Developments

| *Block No.* | *Coal Mine* | *Power Plant* | *Source* |
|---|---|---|---|
| Block II | up to 22 mtpa | 2x330 MW | ESIA of Block II Mining Project[3]<br>ESIA of Block II Power Plant Project[4] |
| Block VI | 2.5 mtpa | - | ESIA of Block VI Mining Project[5] |

**Exhibit V:** Ambient Air Quality Baseline (µg/m$^3$)

| *Pollutant* | *Averaging Period* | *Measured Baseline* | *Modeled Increment* | *Simulated Baseline* | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|
| $SO_2$ | 24-hour (98$^{th}$ percentile) | 7 | 23.8 | 30.8 | 120 | 125 |
| | Annual Average | | 7.1 | 14.1 | 80 | - |
| $NO_2$ | 24-hour (98$^{th}$ percentile) | 3 | 15.5 | 18.5 | 141 | - |
| | Annual Average | | 4.6 | 7.6 | 101 | 40 |
| $PM_{10}$ | 24-hour (98$^{th}$ percentile) | 140 | 0.6 | 140.6 | 150 | 150 |
| | Annual Average | | 0.2 | 140.2 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98$^{th}$ percentile) | 30 | 0.2 | 30.2 | 75 | 75 |
| | Annual Average | | 0.1 | 30.1 | 40 | 35 |

[2] The reading of 780 µg/m$^3$ is removed as it was 5 times the median value and is likely a low occurring outlier.

[3] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

[4] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

[5] Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

The following conclusions can be drawn:

- The 24-hour and annual concentrations of $SO_2$ and $NO_2$ are low and comply with both SEQS and IFC EHS limits.
- The 24-hour and annual concentrations of $PM_{2.5}$ and 24-hour $PM_{10}$ are high due to the desert environment but comply with both SEQS and IFC EHS limits.
- The $PM_{10}$ concentrations are above the annual limit. However, this does not necessarily mean that the concentrations exceed the limit as there is allowance in the limit for the concentrations to exceed limits for 8 days of the year.
- Measured particulate matter readings show large variability (as seen from the large standard deviation). This is due to:
  - Seasonal influence such as the monsoons, that result in large amounts of greenery in the Thar Desert which suppress dust emissions to dry and windy dust storms that result in large dust emissions.
  - Location of measurement with reference to sand dunes, which can both shade from the wind and also are a source of dust emissions depending on whether the measurement location is upwind or downwind of the dune.
- Based on initial modelling of the coal mine the coal mining operations will dominate in a 3 to 5 km area around the active mine pit and dump. However, the influence of the coal mines are not included in these results

### *Baseline Sound Levels*

Baseline sound levels were established using a total of 7 readings of 24 hour each, 4 of which were primary data collected for this Study and the remainder available from secondary sources. The resulting baseline sound levels are shown in **Exhibit VI.** The sound levels are generally low and comply with limits.

**Exhibit VI:** Sound Level Baseline of the Study Area

| *Location* | *Average $L_{eq}$ (dBA)* | |
|---|---|---|
| | *Daytime* | *Nighttime* |
| Desert Background | 44.6 | 40.5 |
| Village | 49.4 | 43.0 |
| Village & Road | 52.2 | 48.6 |
| SEQS | 55 | 45 |
| IFC Limits[6] | 55 | 45 |

[6] For IFC EHS limits, daytime is from 7 am to 10 pm, whereas for SEQS daytime is from 6 am to 10 pm. Values in this study were calculated based on SEQS daytime classification. Furthermore, IFC requires hourly Leq to comply with the limit.

### Ecological Baseline

The ecological baseline includes nearby protected areas, habitat types and ecological resources.

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

The Protected Area closest to the Study Area is the Rann of Kutch Wildlife Sanctuary. It is located 32 km from Study Area. The Rann of Kutch Ramsar Site is the only designated area of global conservation importance present in the vicinity of the Study Area, being a part of the 1.6 million hectares of wetlands of international importance stretching across the two countries of India and Pakistan.[7]

Detailed descriptions of the flora and fauna of the Study Area are presented in the report. The following conclusions can be drawn:

- Vegetation – there are no plant species of conservation importance in the Study Area.
- Mammals – none of the mammal species are of conservation importance based on the IUCN Red List of Threatened Species. However, according to Pakistan's National Red List, there are certain species which are of conservation importance, however, their distribution is widespread and not limited to the Study Area.
- Herpetofauna – there is at least one endemic species and possibly three. However, their distribution is widespread and they are not restricted to any habitat type, therefore, there is no species of conservation importance in the Study Area amongst herpetofauna.
- Birds – the main concern is with respect to vulture species and certain bird species such as the Laggar Falcon which are of conservation importance according to the IUCN Red List of Threatened Species.

### Socioeconomic Baseline

There are ten villages in the Study Area. The population of the area is estimated to be a little over 6,000 individuals. These villages and their relative populations are shown in **Exhibit VII**.

The area has a weak infrastructure when compared to other districts provincially and nationally. Water supply is one of the major problems faced by villages in the area. Most of the underground water is brackish. The villagers travel to the nearby towns of Mithi and Islamkot for health facilities.

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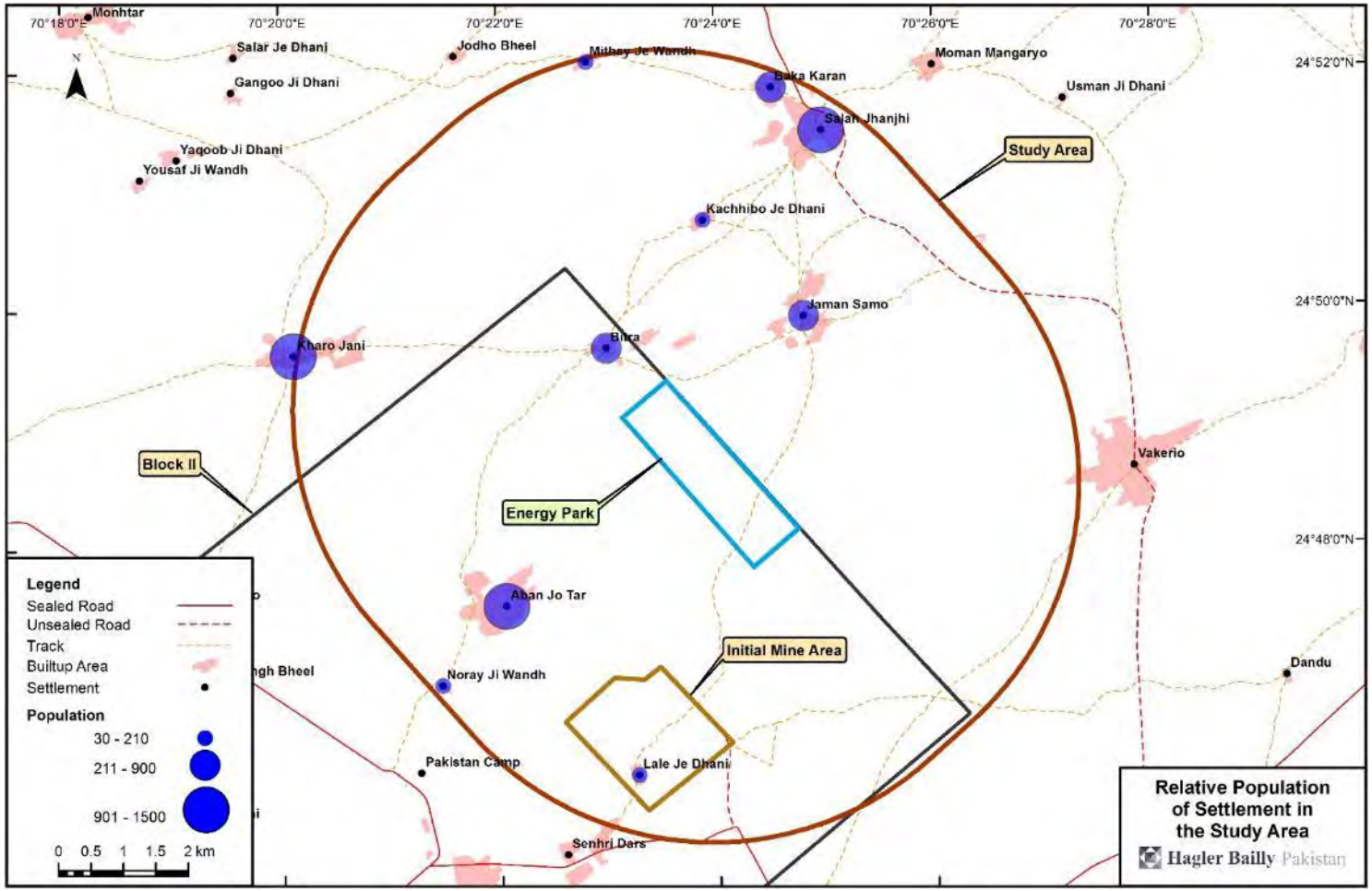
[7] World Wildlife Fund (WWF). Desert wetlands, World Wildlife Fund Global, News and Stories (February 2003)

**Exhibit VII:** Population Distribution in the Study Area [8]




[8] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

### *Gender and Age Profile*

The population pyramid has a broad base with a relatively large number (40%) of children (10 years of age or less), which indicates high birth rates. The sharp decline of the pyramid signifies a low life expectancy amongst the population of the Study Area, as those above 60 years of age account for only 4% of the population. The structure also shows that more than half (around 60%) of the population is 20 years of age or younger.

### *Ethnology and Religion*

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes.

The main languages spoken in the Tharparkar District are Sindhi and Dhatki. In the Study Area, Muslims typically speak Sindhi and/or Dhatki as their primary language while Hindus primarily speak Dhatki only

### *Governance*

The Study Area falls within the Tharparkar District of Sindh Province. The District lies between 24° 10' to 25°45' N latitudes and 69' 04' to 71°06' E longitudes. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*zila*) Council Chairman. The District administration comprises District offices including sub-offices at UC and town level (includes municipal and town committees).

The District is bounded on the east by India (Jaisalmer District), whereas the northern and western peripheries are bounded by the Mirpurkhas and Badin districts respectively. In the south of Tharparkar, there is an extensive marsh, known as Rann, and the Indian district of Kutch.

Civil society organizations have been active in Tharparkar District since the 1960s. Save the Children Fund, now transformed into Thardeep Rural Development Program (TRDP), is the largest NGO in Sindh. It has staff, offices and programs in all *talukas* of the Tharparkar district, and a field office in the town of Islamkot near Thar coal field. and Participatory Village Development Programme (PVDP) works mostly with the *Kolhi* and *Bheel* scheduled castes. Other NGOs working in Tharparkar include the Trust for Voluntary Organizations (TVO), Baanhn Beli (helping hands) organization and the Marooara Coordination Council. Civil society groups in the area include the Press Club Mithi, Press Club Islamkot and Sindhi Adabi Sungat among others.

### *Livelihoods and the Local Economy*

The majority (77%) of the employed population of the District was engaged in primary occupations such as agriculture and livestock according to the 1998 population census. Images of livestock are shown in **Exhibit VIII**. Other occupations in the district include woodwork, wool-weaving, leather work, jewelry-making, cloth-dyeing, embroidery, and snake-charming. The number of artisans has increased over the last decade to meet the demand for handicrafts.

Tharparkar has been consistently ranked as one of the most deprived districts provincially and nationally. The Annual Report on Poverty 2001 by the Social Policy Development

Center (SPDC) ranked Tharparkar as the most deprived district in Sindh and 84th out of 98 districts in Pakistan in terms of depravation.

**Exhibit VIII:** Typical images of Livestock

*Camels*

*Livestock use roads to access grazing areas.*

### *Physical Infrastructure*

The area has a weak infrastructure when compared to other districts provincially and nationally

Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais,* and small underground tanks called *tankas*. There are also wells in lower lying areas that collect rainwater. The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season.The main mode of construction in rural Tharparkar consists of huts called c*haunras* with pointed thatched roofs of shrubs and grasses they are built on mud plastered platforms. The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar.

### *Social Infrastructure*

Literacy[9] in Tharparkar district is low and shows high gender disparity. The 1998 population census reported the literacy rate of Tharparkar district at 18.32%; 28.3% for males and 6.9% for females. In rural areas, the literacy rate was 25.72% for males and a mere 4.8% for females.

A high maternal mortality rate of 800 deaths per 100,000 live births in 1992, and a high infant mortality rate (IMR) of the district in 1992 at 150 (deaths per 1,000 live births) indicates a lack of health facilities in the area.

### *Cultural Heritage*

There are a large number of religious, archeological and cultural sites of significance in the Thar area. These include temples, forts, and tombs. The site closest to the Study Area

[9] Literacy is defined as “all those persons ten years of age and above who could read and write in any language with understanding, as percentage of the population ten years and above.”

is the Gad of Mirs (Talpurs) in Block II. It is located in the south of Seengaro Village about 10 km southeast of the Energy Park.

Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. Except the Thakurs, who first cremate their dead and the ashes are buried, people of all lower castes bury their dead

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

## Public Consultation and Disclosure

Community consultations were conducted with the community members for all 10 settlements within the Study Area. Separate consultation sessions were arranged for the community women. Institutions identified as important stakeholders were also consulted. A combined list of stakeholders which were consulted for the Project is given in **Exhibit IX**. Key concerns raised by the stakeholders and complete logs of the consultations are presented in the report.

**Exhibit IX:** List of Consulted Stakeholders

| *No* | *Stakeholder Group* | *Stakeholders* | *Date of Consultation* |
|---|---|---|---|
| 1. | Villages within the Study Area | Baka Karan, Salah Jhanjhi,Kachhibo Je Dhani, Jaman Samo, Bitra, Mithay Je Wandh, Kharo Jani, Aban Jo Tar, Noray Ji Wandh and Lale Ji Dhani | May 12, to May 25, 2016 |
| 2. | NGOs | Participatory Village Development Programme, Baanhn Beli, Sukar Foundation, Social Welfare, National Commission For Human Development | May 24, to May 25, 2016 |
| 3, | Government | Assistant Commissioner Islamkot | May 24, 2016 |
| 4. | Civil Society | Press Club, Thar Coal Action Board | May 24, to May 25, 2016 |
| 5. | Other Developers in the Area | ThalNova Thar Power (Private) Limited (TNPTL) | May 27, 2016 |

## Project Impacts and Mitigation Measures

Impacts for the construction and operation of the Projects are discussed in detail in the report. This is followed by a cumulative impact assessment of the expected coal mines and power plants in the area.

### Impacts to Air Quality

Impacts to air quality can be assessed by comparing impacts to standards for stack emissions and to standards for ambient air quality.

#### *Stack Emissions*

The Project will be compliant with both SEQS and IFC guidelines for coal power plant emissions as shown in **Exhibit X**.

**Exhibit X:** Compliance with SEQS and IFC Emission Standards for Coal Fired Power Plants[10]

| *Parameter* | *SEQS* | *IFC Guidelines* | *Proposed Project Emission Limits* | *Expected Project Emissions* | *Status* |
|---|---|---|---|---|---|
| Sulfur Dioxide | 500 tons per dayf | For NDA: 900-1500 mg/Nm$^3$<br>For DA: 400 mg/Nm$^3$ | 24.7 tons per day and 850 mg/Nm$^3$ | 17 tons per day and 584 mg/Nm$^3$ | Compliant |
| Oxides of nitrogen | 260 ng/J of heat input | For NDA: 510 mg/Nm$^3$<br>For DA: 200 mg/Nm$^3$ | 260 ng/J of heat input and 510 mg/Nm$^3$ | 168 ng/J of heat input and 381 mg/Nm$^3$ | Compliant |
| Particulate matter | 500 mg/Nm$^3$ | For NDA: 50 mg/Nm$^3$<br>For DA: 30 mg/Nm$^3$ | 50 mg/Nm$^3$ | 23 mg/Nm$^3$ | Compliant |

NDA: Non Degraded Airshed

DA: Degraded Airshed

### *Ambient Air Quality*

As there are a number of existing, planned, and foreseeable gaseous emission sources in the area, it is essential to consider their impacts on the ambient air quality in appropriate manner. This inventory of the sources and the scheme under which they are considered are discussed in **Exhibit XI** and the results provided in **Exhibit XII**. Project impacts were assessed based on the proposed Project emission limits.

**Exhibit XI:** Gaseous Emission Sources and their Assessment

| *Additional Sources* | *Approach* | *Section* |
|---|---|---|
| **Existing** | Measured Baseline | **Section 4.3.6** |
| Natural<br>Biomass Burning<br>Traffic | Measured | |
| **Planned Projects** | Simulated Baseline | **Section 4.3.6** |
| 2x330 MW Plant, Block II | Modelled + Measured | |
| **Proposed 330 MW Plant** | Impact of Proposed Plant | **Section 6.3.2** |
| 1x330 MW Plant, Block II | Incremental Impact of Proposed Plant based on proposed project emissions limits+ Simulated Baseline | |
| **Second 330 MW Plant being developed Simultaneously** | Impact of Second Plant | **Section 6.3.2** |
| 1x330 MW Plant, Block II | Incremental Impact of Second Plant + Impact of Proposed Plant | |

[10] For NOx and SO2 the ambient values are much below the SEQS and recommended IFC EHS limits. Therefore it can be considered a NDA. However, the particulate matter is naturally high in the dusty desert environment. Measured $PM_{10}$ concentrations are 85% of the 24 hour SEQS and exceed the annual SEQS. Strictly speaking this falls into the category of a degraded airshed as national ambient air quality standards have been exceeded. However, since the particulate matter is naturally high with no major human sources of particulate matter in the area, this can also be considered an NDA

Dispersion modelling was used to quantify the impact of air pollutants on nearby sensitive receptors. The United States Environmental Protection Agency approved regulatory air quality model AERMOD was used to model dispersion of the total pollutant loads. A stack height of 180 m and flue gas temperature of 170ºC was considered. Additional details of the assumptions and model inputs are given in the report.

**Exhibit XII:** Predicted Results (µg/m$^3$)

| *Pollutant* | *Avg Period* | *Simulated Combined Baseline* | *Impact of Proposed 1x330 MW Plant* | | *Impact of Additional 1x330 MW Plant* | | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|---|---|
| | | | Increment | Ambient | Increment | Ambient | | |
| $SO_2$ | 24-hour (98$^{th}$ percentile) | 30.8 | 0.9 | 31.7 | 2.0 | 33.7 | 120 | 125 |
| | Annual Avg. | 14.1 | 1.7 | 15.8 | 0.9 | 16.7 | 80 | - |
| $NO_2$ | 24-hour (98$^{th}$ percentile) | 18.5 | 0.6 | 19.1 | 0.7 | 19.8 | 80 | - |
| | Annual Avg. | 7.6 | 0.9 | 8.6 | 0.5 | 9.1 | 40 | 40 |
| $PM_{10}$ | 24-hour (98$^{th}$ percentile) | 140.6 | 0.8 | 141.4 | 0.9 | 141.5 | 150 | 150 |
| | Annual Avg. | 140.2 | 0.3 | 140.5 | 0.3 | 140.5 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98$^{th}$ percentile) | 30.2 | 0.3 | 30.5 | 0.3 | 30.5 | 75 | 75 |
| | Annual Avg. | 30.1 | 0.1 | 30.2 | 0.1 | 30.2 | 40 | 35 |

The following conclusions can be drawn:

*Incremental Impact of $SO_2$ and $NO_2$ Emission*

The 24-hour and annual concentrations of $SO_2$ and $NO_2$ will increase due to the proposed Plant. However, the incremental increase will be less than 10 µg/m$^3$ in all cases ($SO_2$ and $NO_2$, annual and 24-hour). The incremental impact of the second plant will be similar.

*$SO_2$ and $NO_2$ Concentration after the Proposed Plant*

The 24-hour and annual concentrations of $SO_2$ and $NO_2$ complies with both SEQS and IFC EHS limits. This is true for the proposed Plant as well the future projects envisaged at the time of this ESIA.

*Incremental impact on $PM_{10}$ and $PM_{2.5}$ Concentrations*

There is no significant impact of the proposed plant on $PM_{10}$ and $PM_{2.5}$ concentrations. The reason is as the plant is using high efficiency electrostatic precipitators that leave a minute amount of particulate matter in flue gas. As can be seen from **Exhibit XII**, the net increase even after both plant are operational will be less than 1 µg/m$^3$.

*$PM_{10}$ and $PM_{2.5}$ Concentration after the Proposed Plant*

The ambient 24-hour and annual $PM_{10}$ concentrations meet both the SEQS and IFC EHS values but are high due to the natural sources in the Thar Desert. The 24-hour $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits.

The air quality management of an area is the responsibility of SEPA under the Sindh Act. It is proposed that SEPA, working with the developers in Thar Coalfields, develop an ambient air quality management plan to mitigate the high concentration of natural dust in the area.

### Impacts to Socioeconomic Environment

Impacts to the socioeconomic environment are summarized below and described in detail along with the proposed mitigation measures in the report:

### Employment Impact

The Project will create additional job opportunities. It is expected that more than 100 staff positions will be created under the Project. Most of these positions will be skilled, having expertise in handling the new equipment and processes.

To maximize employment of people from within the Study Area in the operational phase of the Project, the Project will invest in vocational training programs that focus on the Study Area.

#### *Increased Power Generation*

Due to the Project, about 300 MW net power will be added to the grid system of Pakistan. 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 faced by the country.

#### *In-Migration*

The increased job opportunities offered by the Project and by service providers to the Project will lead to an influx of job seekers in the Study Area. The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing facilities. The migrants can also effect the culture of the Study Area. This can possibly generate conflict between locals and the in-migrants. Mitigation measures to avoid this are detailed in the report.

### Impacts to Ecology

Any ecological impact from the Project will be incremental over the impact of the mining activities in Block II. In the ESIA for the Block II Coal Mine, it is stated that other than potential impact on the vulture habitat, no significant impact of the mining on the flora and fauna of the area are anticipated.

The vulture population in the Indian subcontinent is declining due to existing threat to their population. The cause of this is presumably poisoning by the veterinary drug Diclofenac, probably combined with other causes (Bird Life International 2010)[11]. The birds feed on carcasses of animals treated with the veterinary drug.

Availability of nesting sites and food are principle factors that determine the population of vultures in an area. Clearing of land for power plant will reduce the potential habitat area of these vultures. While the trees for nesting and the feeding areas are widespread in

[11] BirdLife International 2010. Species factsheet: *Neophron percnopterus.* Downloaded from http://www.birdlife.org on 27/6/2010.

the Thar Desert, a program for management of vulture population in the vicinity of the Energy Park supported by the Project will be required to contribute to the ongoing efforts of the Sindh Wildlife Department and other conservation groups in preventing the extirpation of this species from the Thar area.

### Environmental Management Plan

The Environmental Management Plan (EMP) is the fundamental tool that ensures that all mitigation measures to reduce the impacts of the Project discussed in **Chapter 6** are consolidated, their implementation responsibilities identified and the resources required to implement the measures are provided. Further, the EMP includes monitoring measures as a feedback mechanism on implementation and effectiveness of the mitigation measures.

The EMP contains the following elements:

- An institutional framework for effective implementation of the plan
- The Mitigation Plan which summarizes the mitigation measures to be implemented.
- A monitoring plan with guidelines on reporting and feedback
- Suggested training programs to build capacity for the implementation of the EMP
- A framework for the establishment of a grievance redress mechanism
- Guidelines for the development of supplementary, content specific plans including:
  - Construction Management Plan
  - Coal Dust Management Plan
  - Emergency Response Plan
  - Waste Management Plan
- Guidelines on how changes to the EMP and Project with be handled.

### Conclusion

Major potential impacts of the Project are associated with air quality and changes to the socioeconomic environment. However, if the field activities, including the implementation of all mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (**Chapter 7**), are carried out as described in this report, the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Chapter 2** of this report.

# Contents

# Exhibits

# 1. Introduction

Thar Energy Limited (TEL) plans to establish a 1x330 megawatt (MW) Thar Lignite Coal-based mine mouth Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh. TEL is a fully owned subsidiary of The Hub Power Company Limited (HUBCO).

This document identifies basic settings and design of the proposed project, prevalent national and international laws, regulations, physical, ecological and socioeconomic baseline conditions and assesses the environmental impact of the proposed Project. In accordance with the environmental regulations of Sindh, the results are presented as an Environmental and Social Impact Assessment (ESIA) for submission to the Sindh Environmental Protection Agency (SEPA) for review and grant of environmental approval.

TEL acquired the services of Hagler Bailly Pakistan (Pvt.) Ltd. (HBP) to undertake the ESIA study.

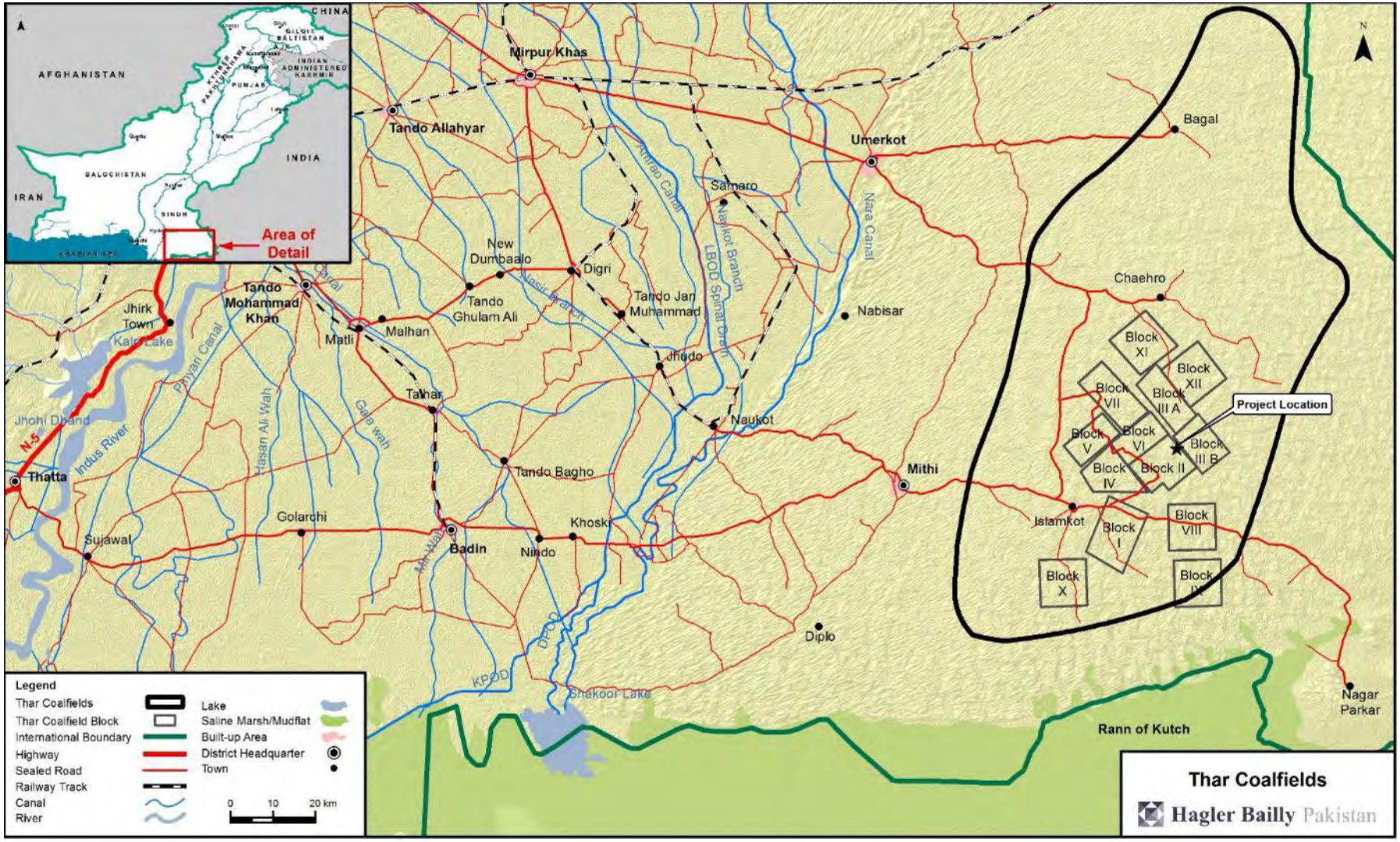
## 1.1 Project Setting

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (**Exhibit 1.1**), however, currently the exploration and development work is being carried out in less than half of the blocks.

Sindh Coal Authority (SCA) has awarded a 95.5 square kilometer ($km^2$) area of the coalfield, known as Thar Block II ('Block II'), to Sindh Engro Coal Mining Company (SECMC), which is jointly owned by the GoS and the Engro PowerGen Limited.

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of the about 2 $km^2$ (500 acres) and is expected to contain six power plants, with a combined power generation capacity of about 4,000 MW.

**Exhibit 1.1:** Project Location within the Thar Coalfields



## 1.2 Introduction to the ESIA Study

This ESIA was conducted to meet the regulatory requirements as set out in the Sindh Environmental Protection Act 2014 (Sindh Act 2014), and its associated rules and regulations. Wherever needed, reference is also made to the International Finance Corporation's (IFC) Performance Standards (PSs)[12] and Environmental, Health, and Safety Guidelines.[13] The guidelines provided by these documents are considered as the best industry practice in environment.

### 1.2.1 Objectives of the ESIA

The objectives of 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 environmental regulations of Pakistan.

The findings of the ESIA have been documented in the form of this report which is to be submitted to the SEPA as per regulatory requirements.

### 1.2.2 Scope of the ESIA

The scope of the ESIA includes an assessment of the environmental and social impacts of:

- Construction activities including, but not limited to, on-site civil works and installation activities of power plant, on-site coal yard, ash storage, and coal and ash transfer system.
- Disposal of waste from the construction activities;
- Unloading of coal and its handling at the Project Site;
- Operation of the power plant; and
- Hiring of labor and labor issues during construction and operation of the power plant and the associated social issues.

[12] Available at www.ifc.org/sustainability [3] Available at www.ifc.org/ehsguidelines [4]

[13] Available at http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines

## 1.3 Exclusion from Scope of the ESIA

The impacts of some of the associated activities are excluded from the scope of the ESIA. The activities and the reason for the exclusion are as follows:

- The mining of coal and all associated activities: This is covered in the ESIA of Block II which is already approved.
- Sourcing and transport of water to the Plant from LBOD: This is in the scope of the GoS and is subject to a separate environmental assessment.
- Final disposal of liquid effluents: A combined General Drainage System for all power plants in the Energy Park will be developed and is subject of a separate study.
- Evacuation of power: This is in the scope of the National Transmission and Despatch Company and is subject of a separate environmental assessment.
- Acquisition of land or resettlement for the power plant site: This is covered in the ESIA of Block II which is already approved.

## 1.4 Organization of this Report

The ESIA report is organized in the following sections:

**Chapter 1** (*Introduction*) provides an overview of the project, introducing the project proponent, and outlines the scope of this study.

**Chapter 2** (*Legal and Policy Framework*) presents the legislative requirements that need to be followed while conducting an EIA.

**Chapter 3** (*The Proposed Project*) contains information about key features of the proposed Project, such as its location and design.

**Chapter 4** (*Description of the Environment*) documents in detail the existing physical, ecological and socioeconomic conditions around the Project site.

**Chapter 5** (*Public Consultation and Disclosure*) presents the objectives and outcomes of the public stakeholder consultations that were conducted during the ESIA.

**Chapter 6** (*Project Impacts and Mitigation Measures*) presents an assessment of the Project's impact on the physical, ecological, and socioeconomic environment, as well as recommended mitigation measures.

**Chapter 7** (*Environmental Management Plan*) facilitates the implementation and monitoring of the mitigation measures identified in the environmental impact assessment.

**Chapter 8** (Analysis of Alternatives) discusses alternatives to the proposed Project that were considered.

**Chapter 9** (*Conclusion*) summarizes the findings and recommendations of this ESIA study and concludes the report.

# 2. Legal and Institutional Framework

In Pakistan, the history of legislation drafted specifically to protect the environment dates back to 1980s. This section provides a brief historical and constitutional context followed by a detailed discussion of relevant laws.

## 2.1 Historical and Constitutional Context

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 (Pak–EPA), the primary government institution at that time 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. In 1997, the Pakistan Environmental Protection Act (PEPA) 1997 was enacted to replace the 1930 Ordinance. PEPA conferred broad–based enforcement powers to the environmental protection agencies. This was followed by the publication of the *Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations 2000* which provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA).

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 were as follows:

- The Ministry of Environment at the federal level was abolished. Its functions related to the national environmental management were transferred to the provinces. To manage the international obligations in the context of environment, a new ministry—the Ministry of Climate Change—was created at the federal level.
- The PEPA 1997 is technically no longer applicable to the provinces. The provinces were required to enact their own legislation for environmental protection. However, to ensure legal continuity PEPA 1997 continued to be the

legal instrument for environmental protection in the provinces till enactment of provincial laws.

All four provinces have enacted their own environmental protection laws. These provincial laws are largely based on PEPA 1997 and, hence, provide the same level of environmental protection as the parent law.

## 2.2 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act 2014 (Sindh Act 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. As per the law, the Sindh Environmental Protection Agency (SEPA) is responsible to implement the provisions of this Act in Sindh. The Sindh Act 2014 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 articles of Sindh Act 2014 that have a direct bearing on the proposed Project are listed below. The details are discussed in the following sections.

Article 11 that deals with the Sindh environmental quality standards (SEQS) and its application

Article 13 that deals with hazardous substances

Article 14 that prohibits various acts detrimental to the environment

Article 17 that establishes the requirement for environmental impact assessment.

To implement the provisions of the Sindh Act 2014, *rules* and *regulations* are required.[14] The key rules and regulations are:

1. National Environmental Quality Standards (Self–Monitoring and Reporting by Industries) Rules, 2001
2. Environmental Samples Rules, 2001
3. Sindh Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2014 (IEE–EIA Regulations 2014)

Guidelines are issued by the Pak–EPA for preparation of environmental assessment. The relevant guidelines are discussed in **Section 2.3**. All the rules, regulations, and guidelines issued under PEPA 1997 and discussed above remain valid after promulgation of Sindh Act 2014.

[14] Rules and regulations are similar instruments but differ in their hierarchy. The power to make rules and regulations is given in the enabling law, PEPA 1997 and Sindh Act 2014 in this case. The rules are made by the government (federal or provincial, as the case may be) and require publication in the official gazette. Regulations are made by the government agency which is empowered by the law, environmental protection agencies in this case, and are not always published in the official gazette. Rules deal with relatively important matters such as delegation of powers and authorities, whereas regulations usually deal with procedural matters.

## 2.3 Requirements for Environmental Impact Assessment

The articles of Sindh Act 2014 that have a direct bearing on the environmental assessment of the proposed Project are:

> Article 17(1): 'No proponent of a project shall commence construction or operation unless he has filed with the Agency[15] an initial environmental examination or an environmental impact assessment, and has obtained from the Agency approval in respect thereof.'
>
> Article 17(3): 'Every review of an environmental impact assessment shall be carried out with public participation…'

The IEE-EIA Regulations 2014 provides the necessary details on the preparation, submission, and review of the IEE and the EIA. Categorization of projects for IEE and EIA is one of the main components of the IEE-EIA Regulations 2014. Projects have been classified on the basis of expected degree of adverse environmental impact. Project types included in Schedule II of the regulations those that are likely to have potentially significant impact on the environment and thus an EIA is required for such projects, whereas those included in Schedule I as having potentially less adverse effects and therefore require an IEE. Coal fired power plants with capacity less than 50 MW is included in Schedule I (List of Projects requiring an IEE) whereas Coal power projects above 50 MW is included in Schedule II (List of Projects requiring an EIA). As the project involves development of a power plant of more than 50 MW, it falls within the category of Schedule II and an EIA has been prepared for it.

The word 'project' as defined in the Sindh Act 2014 includes new developments as well as modifications, expansions and rehabilitations of the existing projects. The proposed Project is considered a new development and not a modification to the existing Project because it will have its own separate staff, resources, financing, accounting, utilities, and administrative control. None of these items will be shared. Hence the existing project is not the subject of this EIA.

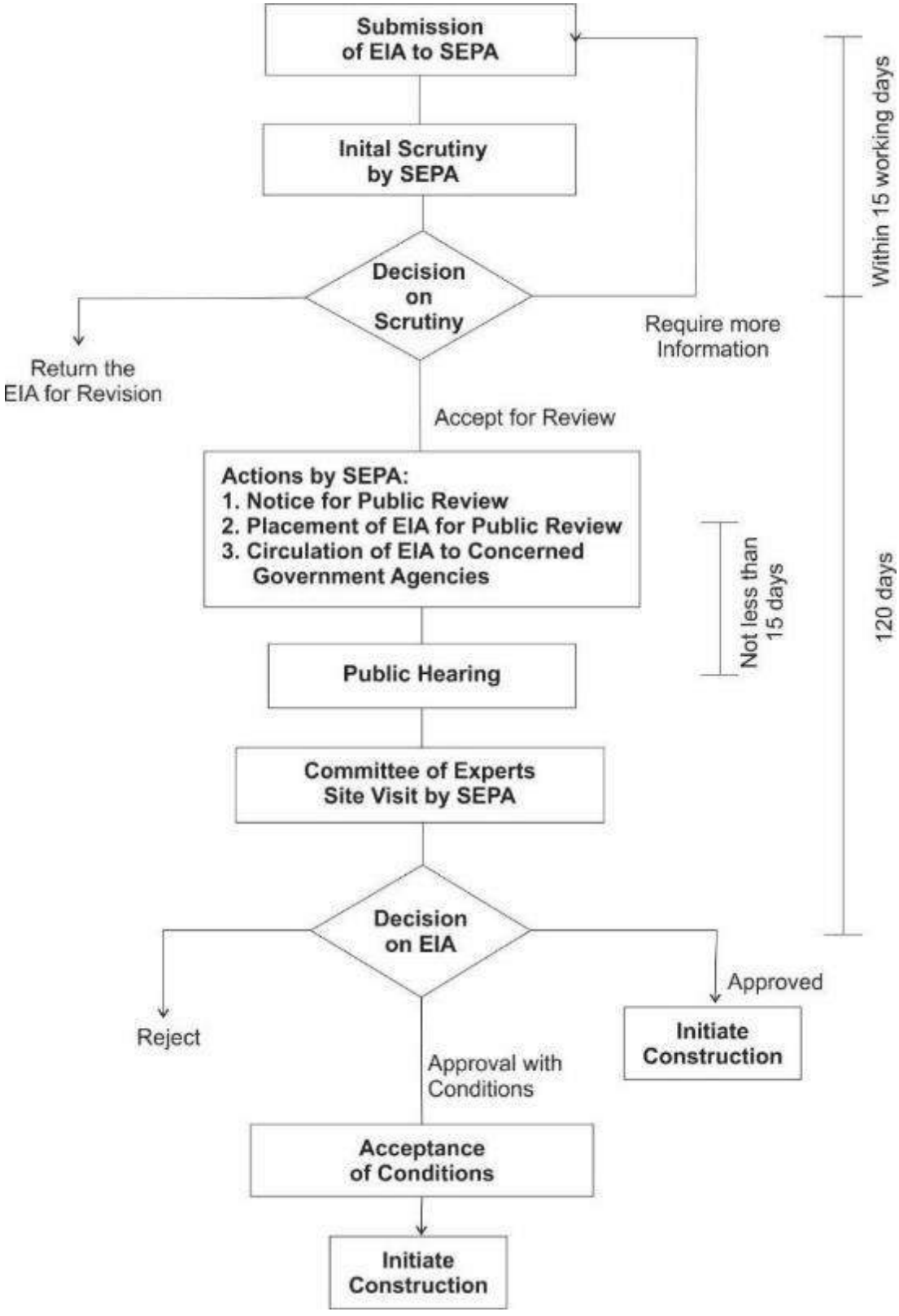
Regulation 9 of the IEE-EIA Regulations 2014 requires that '(1) Ten paper copies and two electronic copies of an lEE or EIA shall be filed with the Federal Agency; (2) Every lEE and EIA shall be accompanied by (a) an application, in the form set out in Schedule V; (b) copy of receipt showing payment of the review fee; (c) no objection certificates from the relevant departments in case of EIA shall be the part of reports; and (d) the environmental check list as per its guidelines.

The prescribed procedure for review of EIA by the EPA is described in Regulations 10–17 and is depicted in **Exhibit 2.1**. The key features are:

On acceptance of the EIA for review, EPA will place a public notice in national English and Urdu newspapers and in local language newspaper informing the public about the project and where it's EIA can be accessed. It will also set a date for public hearing which shall be at least 30 days after the publication of the notice.

[15] The term 'Agency' refers to the Sindh Environmental Protection Agency.

**Exhibit 2.1:** EIA Review and Approval Procedure



If it considers necessary, the EPA can form a Committee of Experts to assist the EPA in the review of the ESIA. The EPA may also decide to inspect the project site.

Article 17(4) of SEPA Act 2014 binds the SEPA to 'communicate its approval or otherwise … within a period of four months from the date the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which … 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'.

Regulation 7 of the IEE-EIA Regulations 2014 pertains to the guidelines. It states that: '(1) The Agency may issue guidelines for preparation of an lEE or EIA or an environmental checklist, including guidelines of general applicability and sectoral guidelines indicating specific assessment requirements for planning, construction and operation of projects relating to a particular sector. (2) where guidelines have been issued under sub-regulation (1), an lEE or EIA shall be prepared, to the extent practicable, in accordance therewith and the proponent shall justify in the lEE or EIA or in environmental checklist any departure therefrom.' An EIA is required for thermal power generation over 100MW and for coal power projects above 50 MW.

The relevant guidelines are the follows: *Policy and Procedures for the filling, Review, and Approval of Environmental Assessments* sets out the key policy and procedural requirement. 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).

Guidelines for sensitive areas which identifies the sensitive areas.

## 3.1 Other Relevant Laws

### 2.3.1 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 (EPA). As coal-fired thermal power plants fall under Schedule I Category B of industrial categorization and reporting procedure for SMART, the respective environmental monitoring reports are required to be submitted on quarterly basis to the relevant authorities. The project proponents will report their emission and effluent to SEPA in accordance with the rules.

### 3.1.1 The Forest Act 1927

The Act empowers the provincial forest departments to declare any forest area reserved or protected. The act also empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling, and lopping. Vegetation clearing will be required in the site preparation for the power plant but since the area is not declared as a reserve forest this law will have no implication on the project.

### 3.1.2 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.

### 3.1.3 The Sindh Irrigation Act 1879

This Act empowers the Government of Sindh (GoS) to use the natural sources of water such as lakes, rivers, and streams, for supply of water for irrigation and other purposes. It allows the government to develop the required infrastructure, for example, canals, channels, pipelines, for the supply of water. It also allows the government to charge fee for the supply of water and regulate the water supply.

## 3.2 Environmental Guidelines

### 3.2.4 World Bank/IFC Environmental, Health and Safety Guidelines for Thermal Power Plants 2008

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, based on environmental assessments and/or environmental audits as appropriate, with an appropriate timetable for achieving them.

This document includes information relevant to combustion processes fueled by gaseous, liquid, and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of these.

## 3.3 Institutional Framework

### 3.3.1 Sindh Government Institutions

Under the Sindh Act 2014, SEPA is an autonomous agency. For administrative purposes, it is part of the Forest, Environment and Wildlife Department of the Government of Sindh. SEPA is a regulatory agency with the following main functions:

- Enforcement of Sindh Act 2014
- Prepare environmental policies for approval of the GoS
- Implement environmental policies
- Publish annual state of the environment report for Sindh
- Prepare or revise SEQS

- Ensure implementation of SEQS
- Establish systems and procedures for environmental management
- Promote research and studies on environmental issues
- Issue license for handling of hazardous substance
- Certify environmental laboratories
- Initiate legislation for environmental protection
- Provide assistance to government agencies in case of environmental accidents
- Providing advice to the government on issues related to environment
- Assist governments agencies in implementation of waste management schemes
- Provide guidance to public on environmental matters
- Assist education institutions in prescribing environmental curricula
- Undertake measures to enhance awareness on environment among general public
- Disseminate knowledge on environment
- Specify safeguards for the prevention of accidents which may cause pollution
- Review and approve mitigation plans and give guidance for clean-up operations
- Encourage the formation and working of nongovernmental organizations, community organizations and village organizations for environmental protection
- Carry out any other task related to environment assigned by the government.

SEPA will be responsible for the review and approval of the EIA of the proposed Project.

## 3.4 International Treaties

Important international environmental treaties that have been signed by Pakistan and may have relevance to the Project are listed in **Exhibit 2.2**. 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 2.2:** 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 | 1997 | 2005 |

| *Topic* | *Convention* | *Date of Treaty* | *Entry into force in Pakistan* |
|---|---|---|---|
| | powerful and legally binding measures. It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions. | | |
| | 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 environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife. | 2001 | 2008 |
| 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 | 1994 | 1997 |

| *Topic* | *Convention* | *Date of Treaty* | *Entry into force in Pakistan* |
|---|---|---|---|
| | sustainable use of land and water resources and sustainable development in affected areas. | | |
| 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 to conserve 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 undertake 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 Species of Wild Fauna and Flora - to ensure that international trade in specimens of wild animals and plants does not threaten their survival. | 1973 | 1976 |
| | 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 (amended 1967) | 1958 (amended 1969) |

| *Topic* | *Convention* | *Date of Treaty* | *Entry into force in Pakistan* |
|---|---|---|---|
| | 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 |

## 3.5 Environmental Standards and Guidelines Applicable to the Projects

The proposed Project is legally required to comply with the SEQS for gaseous emission, and liquid effluent, and SEQS for ambient air quality. The environmental standards applicable in Sindh are NEQS as developed by Pakistan Environmental Protection Agency prior to 18th Amendment. The only exception is the ambient air quality standards which Sindh Environmental Protection Agency has notified separately. In **Exhibit 2.3** and **Exhibit 2.4**, comparisons of SEQS and IFC Guidelines for key parameters of emission and ambient air quality are provided. **Exhibit 2.5** provides a comparison of SEQS and IFC Guideline limits for effluents. **Exhibit 2.6** provide SEQS guideline values for sound levels. The IFC Guidelines are legally not applicable to this project and is provided here for reference only.

**Exhibit 2.3:** Comparison of SEQS and IFC Guideline Limits for Emission of Key Pollutants from Stack of Coal Fired Power Plant

| *Parameter* | *Source of Emission* | *National Standards* | *IFC Guidelines (For Reference only)* |
|---|---|---|---|
| Particulate matter | Boilers and furnaces: coal-fired | 500 mg/Nm$^3$ | For NDA: 50 mg/Nm$^3$<br>For DA: 30 mg/Nm$^3$ |
| Carbon monoxide | Any | 800 mg/Nm$^3$ | - |
| Nitrogen Oxides | Coal-fired | 1,200 mg/Nm$^3$<br>And for lignite fossil coal: 260 ng/J of heat input | For NDA: 510 mg/Nm$^3$<br>For DA: 200 mg/Nm$^3$ |

| *Parameter* | *Source of Emission* | *National Standards* | *IFC Guidelines (For Reference only)* |
|---|---|---|---|
| Sulfur Dioxide | Power plant operating on oil and coal | 500 tons per day<br>50 µg/m$^3$ increment to annual average | For NDA: 900-1500 mg/Nm$^3$<br>For DA: 400 mg/Nm$^3$ |

Notes:

1. For additional parameters and explanation, see complete SEQS in **Appendix A**
2. A "-" in the fourth column indicates that IFC has not provided any guidelines for the parameter
3. NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly
4. In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to SEQS for gaseous emissions, comply with the standards stated in SEQS for sulfur dioxide and nitrogen dioxides.

**Exhibit 2.4:** Comparison of SEQS and IFC Guideline Limits for Ambient Air Quality

| *Pollutants* | *Time-weighted Average* | *Sindh Standards (µg/m$^3$)* | *IFC Guidelines (µg/m$^3$) (For Reference)* |
|---|---|---|---|
| Sulfur Dioxide ($SO_2$) | Annual Average | 80 | – |
| | 24 hours | 120 | 125 |
| Oxide of Nitrogen as (NO) | Annual Average | 40 | – |
| | 24 hours | 40 | – |
| Oxide of Nitrogen as ($NO_2$) | Annual Average | 40 | 40 |
| | 24 hours | 80 | – |
| Ozone ($O_3$) | 1 hour | 130 | – |
| Suspended Particulate Matter (SPM) | Annual Average | 360 | – |
| | 24 hours | 500 | – |
| Respirable particulate Matter. $PM_{10}$ | Annual Average | 120 | 70 |
| | 24 hours | 150 | 150 |
| Respirable Particulate Matter. $PM_{2.5}$ | 24 hours | 75 | 75 |
| | Annual Average | 40 | 35 |
| Lead (Pb) | Annual Average | 1 | – |
| | 24 hours | 1.5 | – |
| Carbon Monoxide (CO) | 8 hours | 5,000 | – |
| | 1 hour | 10,000 | – |

Notes:

1. For additional parameters and explanation, see complete SEQS in **Appendix A**
2. A "–" in the fourth column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment

**Exhibit 2.5:** Comparison of SEQS and IFC Guideline Limits for Effluents (mg/l, unless otherwise defined)

| *Parameter* | *SEQS (Into Inland Waters)* | *IFC Guidelines (For Reference)* |
|---|---|---|
| Temperature increase | =<3°C | – |
| pH value | 6 to 9 | 6 to 9 |
| Five-day bio-chemical oxygen demand (BOD) at 20°C | 80 | - |
| Chemical oxygen demand (COD) | 150 | – |
| Total suspended solids (TSS) | 200 | 50 |
| Total dissolved solids (TDS) | 3,500 | – |
| Grease and oil | 10 | 10 |
| Phenolic compounds (as phenol) | 0.1 | – |
| Chlorides (as Cl') | 1,000 | – |
| Fluorides (as F') | 10 | – |
| Cyanide total (as CN') | 1 | – |
| Anionic detergents (as MBAS) | 20 | – |
| Sulfate ($SO_4$) | 600 | – |
| Sulfides (s') | 1.0 | – |
| Ammonia ($NH_3$) | 40 | – |
| Pesticides | 0.15 | – |
| Cadmium | 0.1 | 0.1 |
| Chromium (trivalent and hexavalent) | 1 | 0.5 |
| Copper | 1 | 0.5 |
| Lead | 0.5 | 0.5 |
| Mercury | 0.01 | 0.005 |
| Selenium | 0.5 | – |
| Nickel | 1 | – |
| Silver | 1 | – |
| Total toxic metals | 2 | – |
| Zinc | 5 | 1.0 |
| Arsenic | 1 | 0.5 |
| Barium | 1.5 | – |
| Iron | 8 | 1.0 |

| *Parameter* | *SEQS (Into Inland Waters)* | *IFC Guidelines (For Reference)* |
|---|---|---|
| Manganese | 1.5 | – |
| Boron | 6 | – |
| Chlorine | 1 | 0.2 |

Notes:

1. A "-" in the third column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment.
2. IFC General Guidelines describes "temperature of wastewater prior to discharge does not result in an increase greater than 3 °C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations".

**Exhibit 2.6:** Sindh Environmental Quality Standards for Noise

| *No.* | *Category of Area/Zone* | *Effective from 1st July, 2010* | | *Effective from 1st July, 2012* | |
|---|---|---|---|---|---|
| | | *Limit in dB(A) Leq** | | | |
| | | *Day Time* | *Night Time* | *Day Time* | *Night Time* |
| 1. | Residential are (A) | 65 | 50 | 55 | 45 |
| 2. | Commercial are (B) | 70 | 60 | 65 | 55 |
| 3. | Industrial area (C) | 80 | 75 | 75 | 65 |
| 4. | Silence zone (D) | 55 | 45 | 50 | 45 |

Note:

1. Day time hours: 6 .00 am to 10.00 pm
2. Night Time hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts and courts.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

# 3. The Proposed Project Design

This section provides a description of the proposed Project including the location, technology used, environmental controls, raw materials required and waste generated.

## 3.1 Project Location and Layout

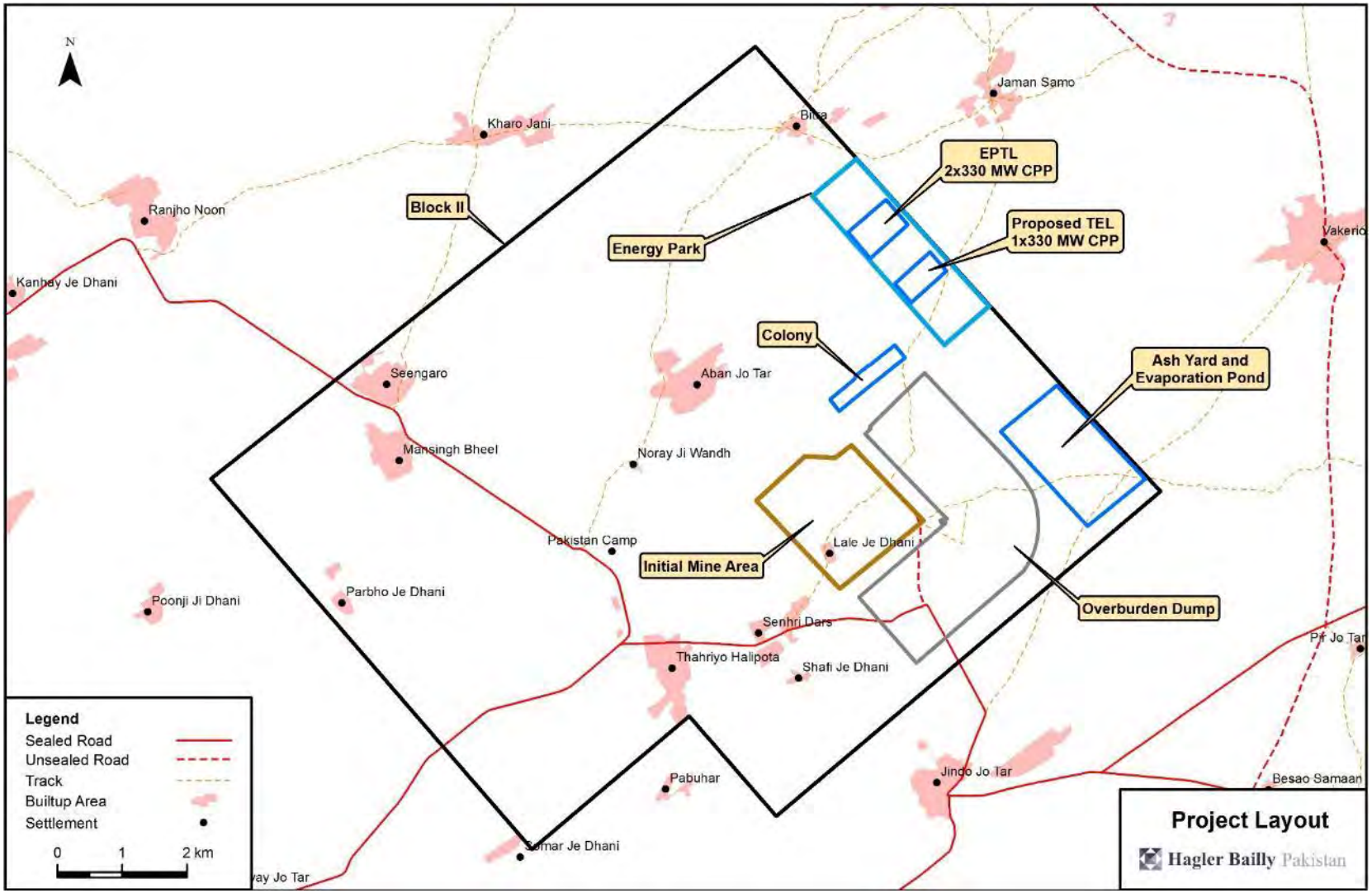
The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District of Sindh. A photograph of the Project site is shown in **Exhibit 3.1** and a map of the location is given in **Exhibit 3.2.**

**Exhibit 3.1:** Project Site as seen from Bitra

The major systems in the proposed plant will include:

- Coal handling and processing system
- CFB boiler and Environmental Control Equipment
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Ash handling system
- Utilities and waste management systems.

**Exhibit 3.2:** Project Layout



## 3.2 Project Technology

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters. Plant specifications are summarized in **Exhibit 3.3**. A block diagram of a CFB power plant is shown in **Exhibit 3.4**. A simplified layout of the power plant is shown in **Exhibit 3.5**. The main components are described below.

**Exhibit 3.3:** Power Plant Specifications

| *Plant Specifications* | *Approx. Value* | *Unit* |
|---|---|---|
| Gross Capacity | 330 | MW |
| Net Capacity | 300 | MW |
| Availability factor | 85 | % |
| Efficiency on LHV[16] | 37 | % |
| LHV of Coal | 2675 | kcal/kg |
| Coal Consumption[17] | 1.9 | million tons per year |

### 3.2.1 Combustion Chamber

The vertical combustion chamber is at the core of the CFB boiler. Fuel (in this case coal) and fine grained limestone are fed into the combustion chamber.

The bed material circulating in the combustion system consists primarily of the particles of coal ash, bed makeup material (such as sand), gypsum and excess calcined limestone. The 'bed' is where the coal or fuel spreads for combustion. A high pressure preheated air supply from the bottom lifts the bed material and coal particles and combustion takes place while it is suspended. Combustion of this suspended bed is known as 'fluidized bed combustion'.

### 3.2.2 Cyclone

Fine particles of partly burned coal, ash and bed material are carried along with the flue gases to the upper areas of the furnace and then into a cyclone. In the cyclone the heavier particles separate from the gas and fall to the hopper of the cyclone returning it to the furnace. Hence the name 'Circulating' as the unburnt material is circulated back into the furnace. The hot gases from the cyclone pass to the heat transfer surfaces and go out of the boiler after particles removal.

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, such as Thar coal.

[16] Lower Heating Value

[17] Based on above values in the table

### 3.2.3 Electricity Generation

Heat released from the combustion of coal in the CFB sub-critical boiler will be used to generate steam at a pressure of around 175 bar and 540 C. The steam will then be fed into the steam turbine, where it will rotate the turbine to generate mechanical energy. The steam, after passing through the turbine, will be condensed back to water and to be re-injected into the boiler after passing through condensate polishing system. The rotating steam turbine will operate the power generator, which will generate electricity. The voltage of the electricity will then be stepped-up and exported through the high tension transmission system of 500 kV.

The maximum furnace exit gas temperature will not exceed 950 ºC. The flue gas exit temperature from the air heater at all load conditions will not be lower than 10 ºC above the sulfuric acid dew point temperature.

### 3.2.4 Cooling System

The main components of the circulating water system are cooling towers, circulating water pumps, condenser and its associated valves, and instrumentation and controls.

Cooling towers will be installed to cool the heated circulating water by evaporation that occurs when water droplets are brought into direct contact with the upwards-flowing ambient air. Either mechanical draft or natural draft cooling towers can be used for the coal fired project. To maintain required water quality parameters, water from the cooling tower basin will be continuously removed through blowdown and dumped into the wastewater collection basin for reuse in various plant services, such as ash handling and coal dust suppression. The remaining non-recyclable water will be disposed through the 50 cusec drainage and wastewater effluent channel being constructed by the GoS scope.

The tower structure is generally constructed of a combination of reinforced concrete, the tower fill PVC or treated wood. The hyperbolic natural draft tower is extremely dependable and predictable in its thermal performance. Air flow through this tower is produced by the density differential that exists between the heated (less dense) air inside the tower and the relatively cool (more dense) ambient air outside. Mechanical cooling towers of large size usually employ induced draft fans to meet the high air flow requirement for cooling.

### 3.2.5 Emission Controls

Emissions controls for pollutants of concern ($NO_x$, $SO_2$ and particulate matter) are as follows.

***$NO_X$:***

Combustion takes place at relatively low temperatures when compared with pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these temperatures results in an effective suppression of NOx-formation and can be controlled below the SEQS/NEQS limit for lignite coal of 260 ng of $NO_x$ per joule of energy.

### *$SO_2$*

$SO_2$ control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). The efficiency of the system will meet limit $SO_2$ stack emissions to 850mg/$Nm^3$.

### *Particulate Matter*

The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). The ESP will limit the outlet flue gas particulate loading to below 50 ppm at all loads when burning design coal.

**Exhibit 3.4:** Schematic of CFB Power Plant

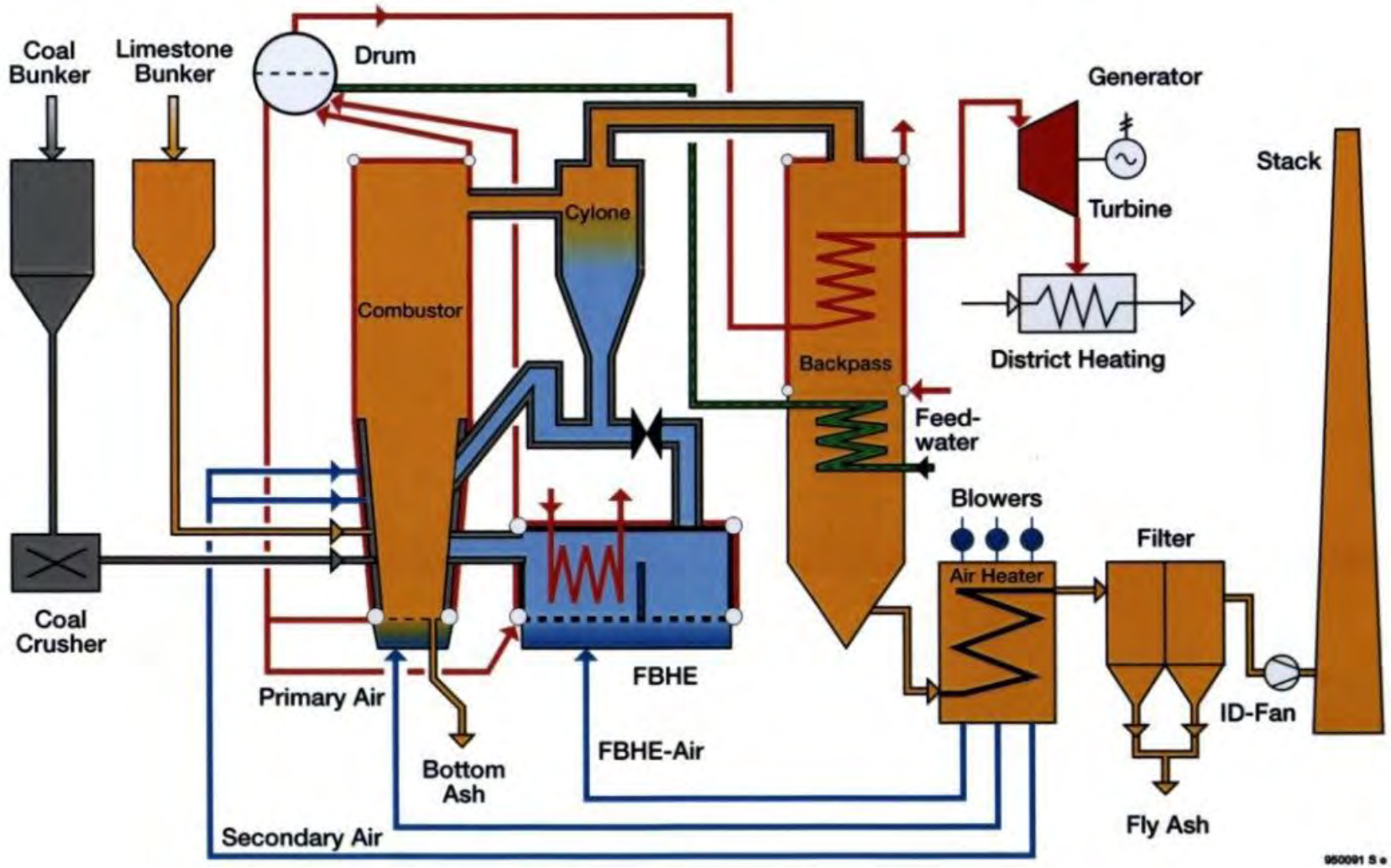
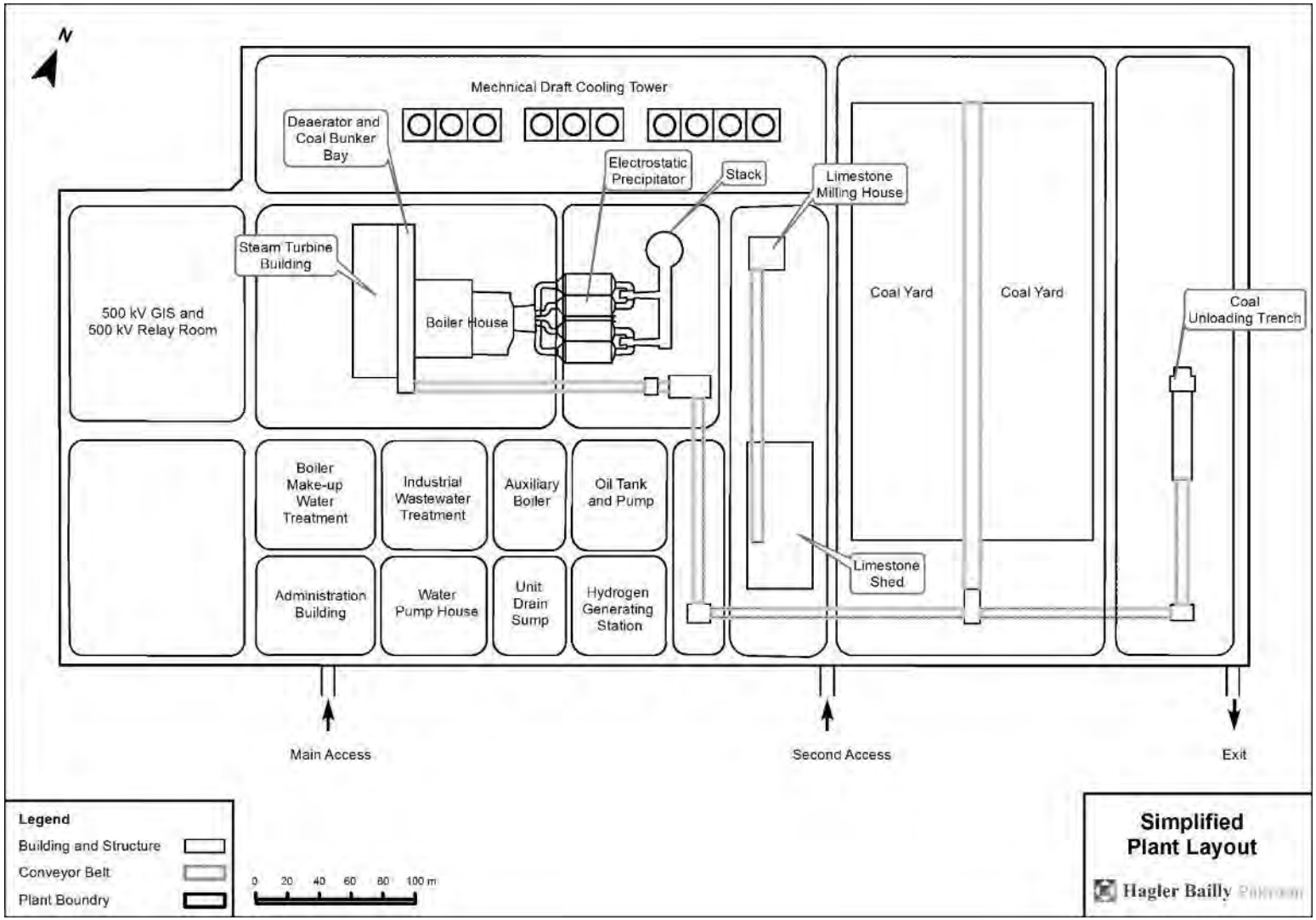


**Exhibit 3.5:** Simplified Plant Layout



## 3.3 Raw Material Inputs

The major inputs required for the proposed coal power plant Project are coal, limestone and water.

### 3.3.1 Coal

The main fuel for the power plant will be Thar Coal from Block II mine. The design specification of the fuel is given in **Exhibit 3.6**. Based on the lower heating value (LHV) of 2675 kcal/kg, net plant thermal efficiency of 37%, plant gross capacity of 1x330 MW, and 85% availability factor approximately 1.9 million tons per year of coal will be consumed.

Coal will be transported via truck to the Project site after preliminary crushing and storage at the mine stockyard which is less than 5 km from the Power Plant. Coal for the power plant will be received at the coal stockyard at the Project site. The coal yard within the project site will have a capacity of not more than 30 days of coal consumption. The height of the coal stockpile will be around 10 meters and the stockyard will be equipped with a wind breaker and water sprinkling system for coal dust suppression

**Exhibit 3.6:** Design Specification of the Fuel[18]

| *Coal Quality of Thar Block-II Lignite for Power Plant Design* | | *Design Coal* |
|---|---|---|
| **A** | **Calorific Value** | |
| i | Net calorific value, kcal/kg (kJ/kg) | 2,675 (11,198) |
| **B** | **Proximate Analysis** | |
| I | Moisture (a.r) | 49.5% |
| Ii | Ash (a.r) | 7.0% |
| Iii | Volatile matter (a.r) | 24.5% |
| Iv | Fixed carbon (a.r) | 19.0% |
| **C** | **Ultimate Analysis** | |
| I | C (a.r) | 30.89% |
| Ii | H (a.r) | 2.65% |
| Iii | N (a.r) | 0.44% |
| iv | O (a.r) | 8.35% |
| v | S.t (a.r) | 1.07% |
| **D** | **Ash analysis** | |
| i | Silica (as $SiO_2$) | 25.45 |
| ii | Alumina (as $Al_2O_3$) | 15.20 |
| iii | Titanium oxide (as $TiO_2$) | 1.81 |

[18] Hagler Bailly Pakistan. *Environmental Impact Assessment of Thar Coal Block II Power Plant Project*. Prepared for Thar Power Company. January 2014

| | *Coal Quality of Thar Block-II Lignite for Power Plant Design* | *Design Coal* |
|---|---|---|
| iv | Iron oxide (as $Fe_2O_3$) | 12.85 |
| v | Calcium oxide (as CaO) | 11.8 |
| vi | Magnesium oxide (as MgO) | 4.86 |
| vii | Sodium oxide (as $Na_2O$) | 3.85 |
| viii | Potassium oxide (as $K_2O$) | 0.41 |
| x | Sulphur oxide (as $SO_3$) | 11.59 |
| xi | Base / Acid Ratio | 0.84 |
| **E** | **Ash fusibility characteristic** | |
| i | Initial deformation temperature, ºC at reduced atm | 1,220 |
| ii | Softening temperature, ºC | 1,284 |
| iii | Fusion temperature, ºC at reduced atm | 1,412 |
| **F** | **Hardgrove grindability index (HGI)** | **75** |

a.r = as received

### 3.3.2 Water

The water source and requirements for the proposed coal power Project are discussed in this section.

#### *Water Source*

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD) [19] towards the Thar Coalfields. Water will be treated and stored at Nabisar station. The raw water storage at Nabisar will be of 15 days based on 100 cusec water flow and the treated water storage will be 30 days based on 35 cusec flow. From there it will be pumped through underground piping to Vejihar water reservoir where the water storage capacity is 15 days. From Vejihar the water will be pumped through underground piping to the Project site. The expected water quality is given below in Exhibit 3.7. An indicative route of the water channel from the LBOD to Thar Coalfield is shown in **Exhibit 3.8**.

[19] The LBOD is an environmental improvement project which was conceived in the 1960s as a response to the problem of rising water tables and resulting waterlogging and salinity. The project area includes some of the most hard-hit areas on the left side of the Indus River in the arid zones of Sindh Province. The project's primary function is to remove and safely convey saline water to the sea through a network of drains. The project provides for the integrated development of irrigation and drainage which include an outfall for saline drainage effluent to the Arabian Sea, phased construction of three drainage subareas in Nawabshah, Mirpurkhas and Sanghar, remodeling of the Nara/Jamrao Canal system, and watercourse improvement in the arid zones in Sindh Province.

The World Bank. "Left Bank Outfall Drain Project Tackling Pakistan's Waterlogging and Salinity Problems." Projects and Operations. http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20017537~menuPK:64282137~pagePK:41367~piPK:279616~theSitePK:40941,00.html (accessed October 15, 2014).

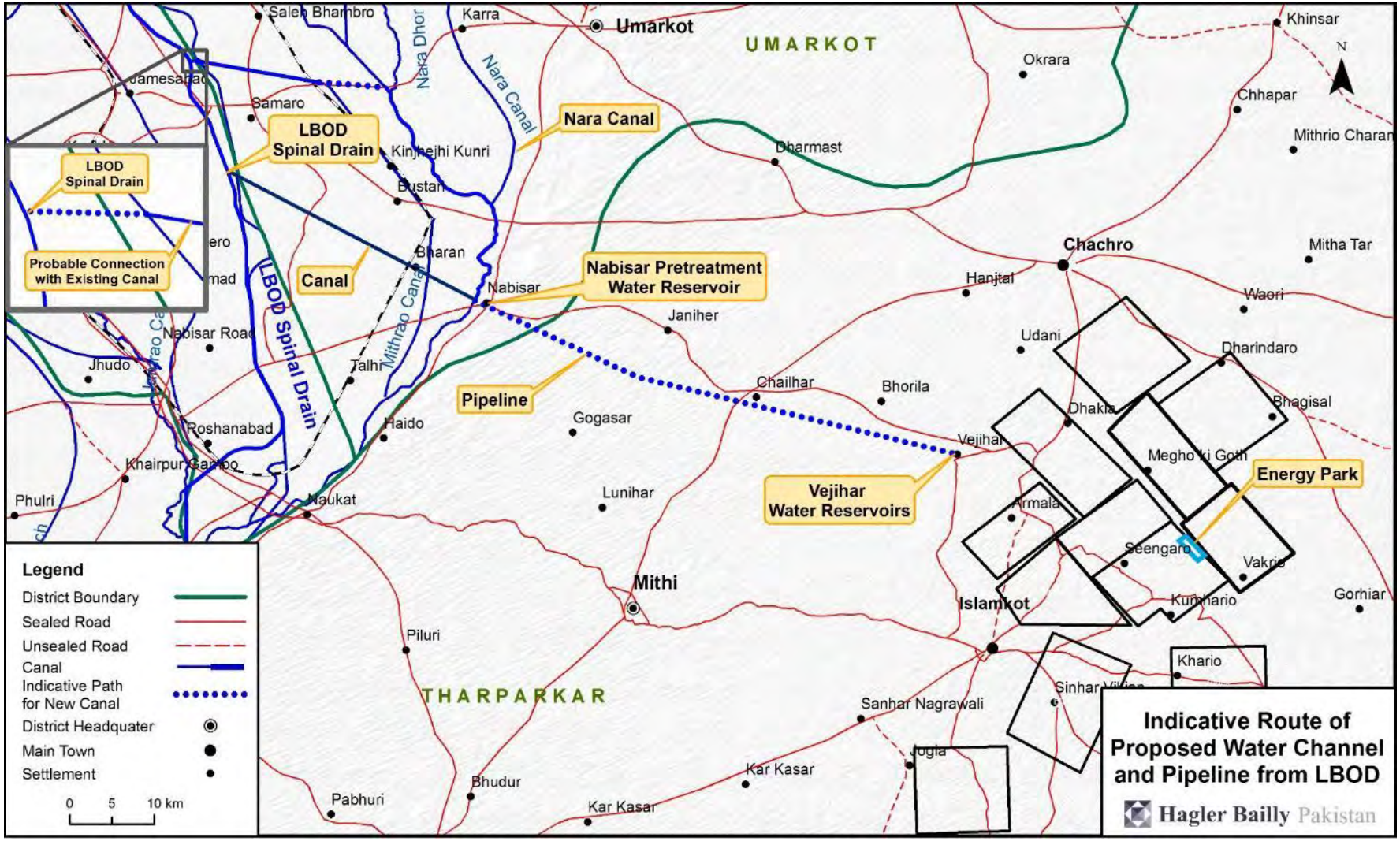
LBOD treated water of 8.75 cusec (892 $m^3$/hour) will be allocated as the main source of water supply to the project which based on preliminary water balance is sufficient to satisfy the needs of 1x330MW plant at all loads and in peak summers. To further reduce the plant water consumption (and reduce reject quantity) cooling tower blowdown treatment plant (Reverse Osmosis based) may be considered. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts are not evaluated as part of this ESIA.

Water from the mine dewatering of the Block II coal mine will primarily be used by the 2x330 MW EPTL coal power plant. If additional water from mine dewatering is available in sufficient quantity it may be used as a secondary water supply for the Project after necessary treatment. For this a mine water treatment plant (Reverse Osmosis based) may be considered. In this case about 1100 $m^3$/hour of mine water should be available before treatment to meet plant requirements.

**Exhibit 3.7:** Expected Water Quality from LBOD after Treatment

| *Design Parameter* | *Unit* | *Expected Value* |
|---|---|---|
| pH | | 4.8 |
| Color | H.U | <5.0 |
| Turbidity | NTU | 0.55 |
| Conductivity | µS/cm | 205 |
| Total Dissolved Solids (TDS) | mg/l | 98 |
| Total Suspended Solids (TSS) | mg/l | <0.1 |
| Total Alkalinity | mg/l | 20 |
| Total Hardness | mg/l | 50 |
| Nitrate | mg/l | 6.3 |
| Nitrite | mg/l | 0.005 |
| Ammonia | mg/l | 0.04 |
| Chloride | mg/l | 37 |

**Exhibit 3.8:** Indicative Route of the Proposed Water Channel from LBOD to Block II



***Water Demand Estimate***

The Project will require 740 $m^3$/h of water supply. The breakdown of water requirements are shown in **Exhibit 3.9**.

If water from mine dewatering is used an additional 304 $m^3$/h will be required due to losses in treatment of the mine water. The water balance of the power plant will remain the same and require 740 $m^3$/h for both sources of water supply.

**Exhibit 3.9:** Power Plant Water Demand (1x330 MW)

| *Item* | *Makeup water required ($m^3$/h)* |
|---|---|
| Evaporation loss (cooling tower) | 531 |
| Continuous blowdown | 60 |
| Wind loss (cooling tower) | 42 |
| Steam loss (boiler) | 36 |
| Tower Blowdown | 17 |
| Dual axle mixer water | 15 |
| Washing water (main block, precipitator, roads, dry ash) | 9 |
| Sanitary water | 3 |
| Make up water for HVAC | 1 |
| Dosing water | 1 |
| Contingency margin | 25 |
| **Total water demand** | **740** |

### 3.3.3 Limestone

Limestone is a key input to control $SO_2$ production. The project site will house a limestone preparation facility for feeding in CFB boiler. In plant limestone storage will have approximate capacity equivalent to 30 days and will be finalized based on lime stone supply.

## 3.4 Waste Materials

The major waste streams generated by the proposed coal power plant Project include ash, waste water and gaseous emissions.

### 3.4.1 Ash

Bottom ash is what remains after combustion in the furnace and consists of noncombustible matter in the inputs. The bottom ash will be evacuated from the bottom of the furnace. Fly ash is a product of combustion and is made of fine particles. The fly ash will be collected by means of an electrostatic precipitator (ESP). The ESP is installed downstream of the furnace.

Ash residue will be stored temporarily in the combined ash yard until it is transported to the mine area (see **Exhibit 3.1**) for final disposal. It will be used as backfill in the spent mine pit. The dumped ash in the temporary yard will be compacted, mixed with sand and given leaching protection by considering clay or geomembrane lining in the area. Lining selection will also be based on the geotechnical data and aquifer depth.

The mine area is at a distance of around 5 km. The ash residue transportation will be via truck.

### 3.4.2 Wastewater

The maximum possible water from the plants will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. A sewage treatment plant will treat sewage from the housing complex and construction camp. Wastewater from the sewage plant will be discharged or recycled in appropriate processing streams. The industrial wastewater treatment system will meet the requirement to treat the regeneration waters etc. The water after treatment from industrial wastewater unit will be re-used. Wastewater from the sanitary and industrial water treatment plants will meet SEQS limits for liquid effluents (see **Exhibit 2.5**).

Wastewater disposal of power plants developed in the Energy Park will be through a General Drainage System being developed by the Energy Park. It is likely that wastewater will be reinjected into the third ground water aquifer. As a backup, or in instances where concentrations of pollutants are high in the effluent, it will be disposed into an evaporation pond. The evaporation pond will have a capacity of approximately one month of effluent disposal. The wastewater disposal through the General Drainage System is an independent combined project and is not part of this Project, hence its impact are not evaluated in this ESIA.

## 3.5 Air Emissions

Main gaseous emissions of health concern from the coal power Project include sulfur dioxide ($SO_2$), oxides of nitrogen ($NO_x$) and particulate matter. A summary of key parameters related to air emissions, including stack specifications and emission rates, are presented **Exhibit 3.10**. The release and dispersion of these pollutants is discussed in **Chapter 6**. The dispersion modelling was performed at the emission rates based on Project limits. The expected values are

**Exhibit 3.10:** Estimated Air Emission Parameters (1 × 330MW)

| *Parameters* | *Value* | *Units* |
|---|---|---|
| **Stack Specifications** | | |
| Height | 180 | m |
| Inner diameter | 5.76 | m |
| **Flue Gas Specifications** | | |
| Exit velocity | 20.8 | m/s |
| Exit temperature | 170 | ºC |
| Flow rate | 543 | $m^3/s$ |
| **Emission Rates** | Modelling Rate (Expected Rate) | |
| $SO_2$ | 850 (584) | $mg/Nm^3$ |
| PM | 50 (23) | $mg/Nm^3$ |
| $NO_2$ | 510 (381) | $mg/Nm^3$ |

Modelling rate is at the proposed Project limits, expected rate is the expected emission rate of the Project.

# 4. Description of the Environment

This section describes the Study Area's existing environment including the physical, ecological and socioeconomic baseline conditions. The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic. The ecological baseline includes nearby protected areas, habitat types and ecological resources. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

## 4.1 Methodology for Developing the Baseline

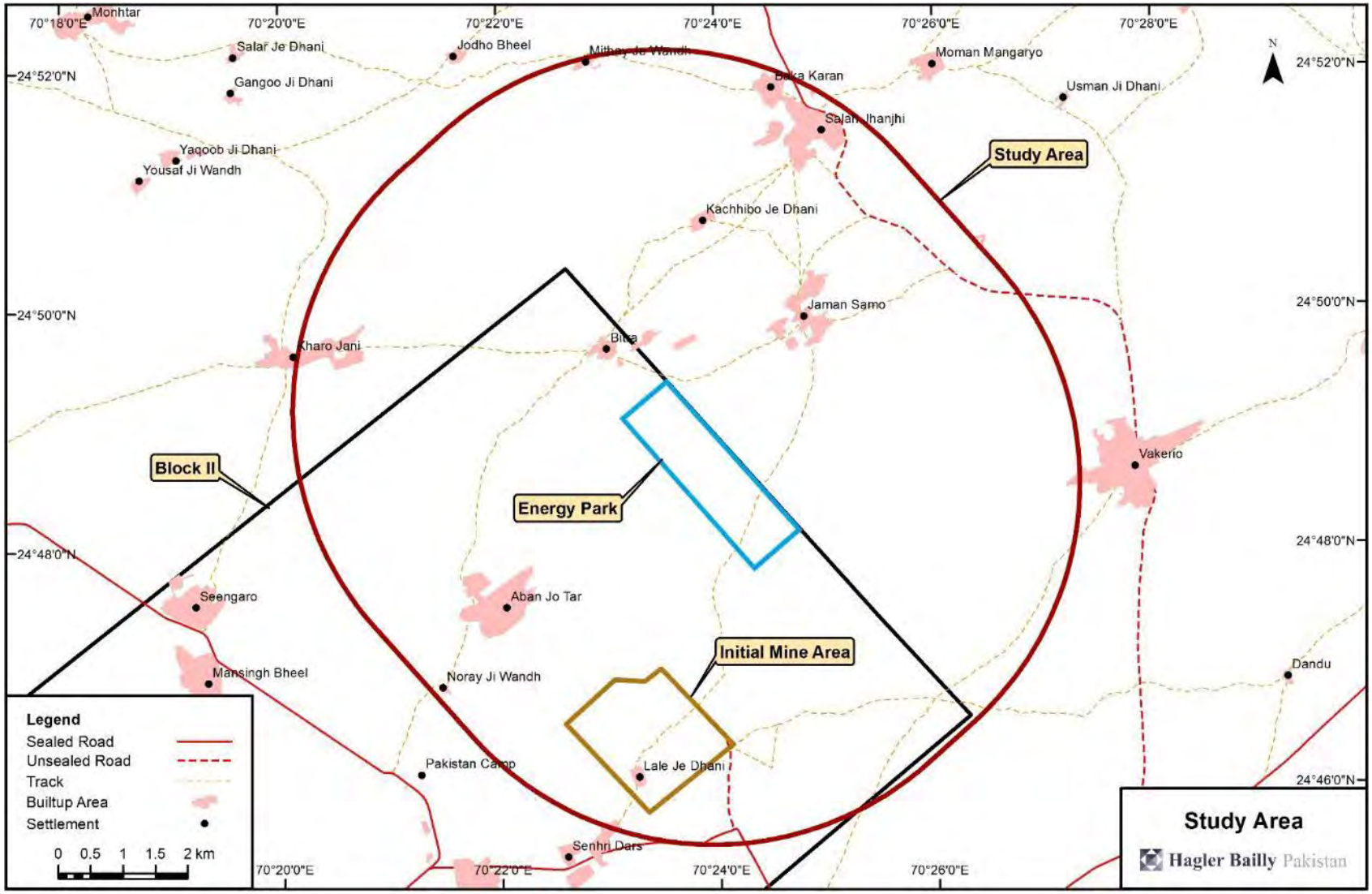
As a number of mining and power projects have been approved in the Thar area, the 'baseline' for the proposed Project takes into account the potential impact of these developments on the environment. This approach is especially used in developing air quality baseline.

## 4.2 Study Area

The Study Area selected for the ESIA includes sensitive receptors[20] that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it and is depicted in **Exhibit 4.1**.

[20] Sensitive receptors include, but are not limited to, residential areas, schools, places of worship, wetlands, and habitats. These are areas which are more susceptible to the adverse effects of an anthropogenic activity such as noise, air emissions, traffic influx, and privacy issues.

**Exhibit 4.1:** Study Area



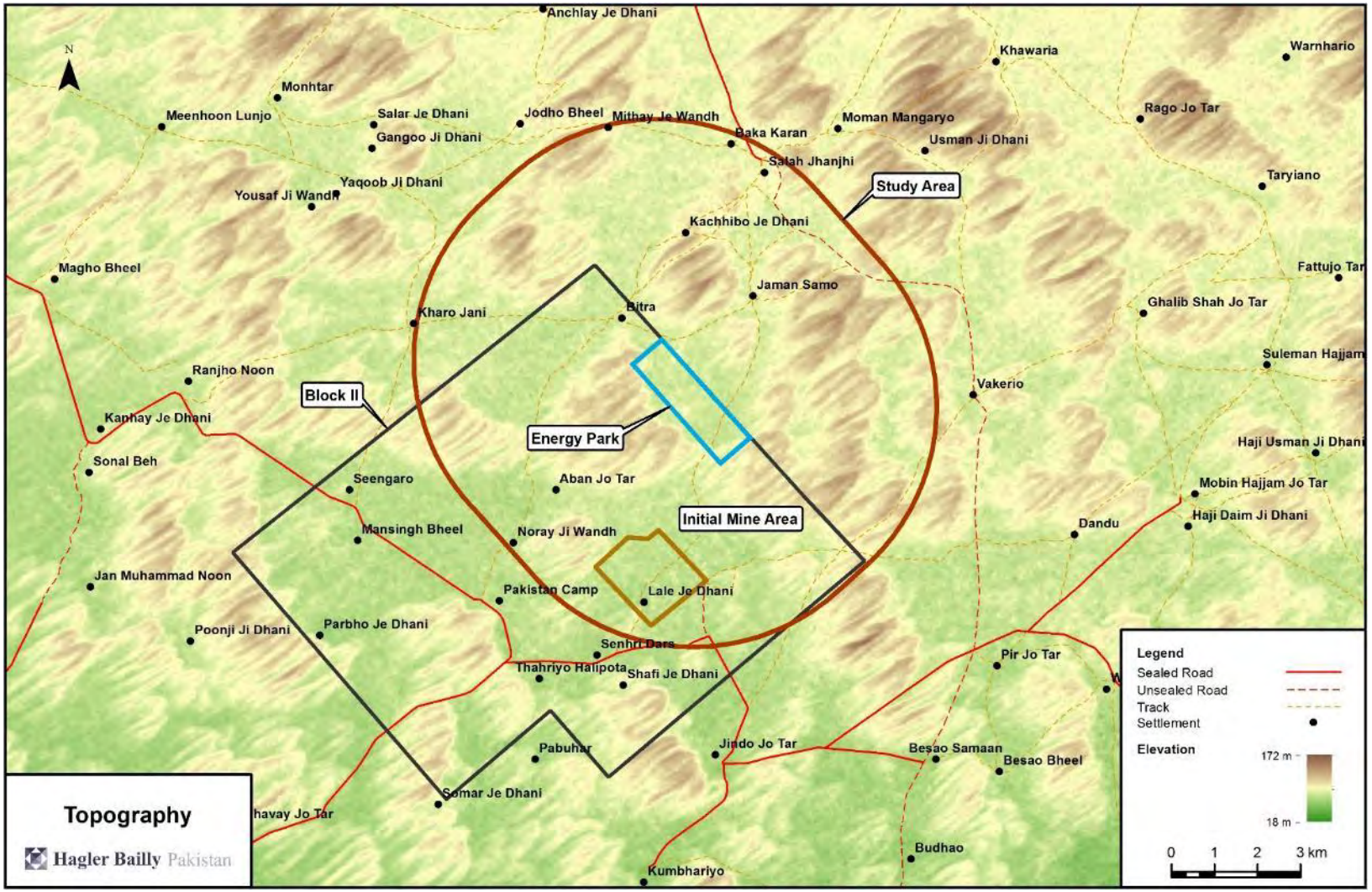
## 4.3 Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic.

### 4.3.1 Topography

The topography of the Study Area is typical of the Thar Desert. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. A topographical map of the Study Area is shown in **Exhibit** 4.2. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (amsl). Dunes are interspersed with areas of very flat plain being approximately 90 m amsl. There are no river courses close to the Study Area, although there are small ephemeral channels that capture run–off during and after large rainfall events. Significant temporary water bodies exist along the southern margins of the Thar Desert, particularly in the Great Rann of Kutch, approximately 30 km from the edge of the Study Area (see the Ecology Baseline in **Section 4.4**).

**Exhibit 4.2:** Topography



### 4.3.2 Visual Character

The visual baseline documents the current aesthetic and visual conditions of the proposed Project site as seen from the nearby receptors.

To document the visual baseline, a survey was conducted at the locations listed in **Exhibit** 4.3 and shown in **Exhibit 4.4**. The survey was conducted from April 25 to 27, 2016.

**Exhibit 4.3:** Visual Survey Locations

| *ID* | *Coordinates* | *Elevation (m amsl)* | *Location* | *Date of Survey* | *Direction of Image Center* | *Rationale* |
|---|---|---|---|---|---|---|
| V1 | 24° 49' 14.0" N<br>70° 24' 15.1" E | 100 | Near Jaman Samo | May 14, 2016 | Southwest | View of Project site area |
| V2 | 24° 49' 29.3" N<br>70° 23' 04.1"E | 139 | Bitra | May 13, 2016 | Southeast | View of Project site as seen from Bitra (village) |
| V3 | 24° 47' 41.1" N<br>70° 22' 18.6" E | 107 | Aban Jo Tar | May 13, 2016 | Northeast | View of Project site as seen from Aban Jo Tar (village) |

**Exhibit 4.4:** Visual Sampling Locations

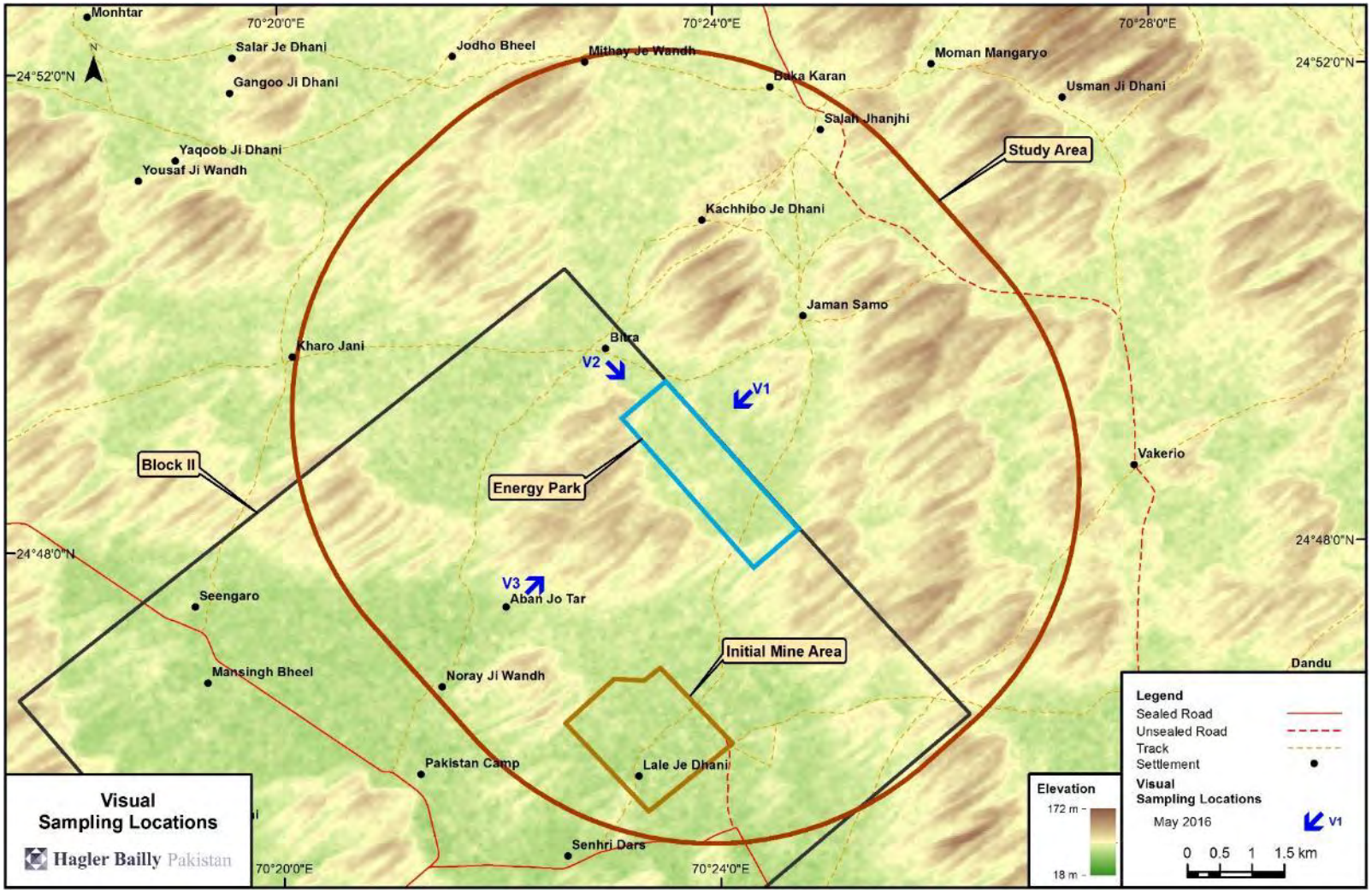


**Exhibit 4.5:** View of the Project Site from nearby Receptors

View from V1 (180 degree view, at 100 meters elevation, centered southwest). The undulating landscape and shrubs block visibility to the site.

View from V2 (180 degree view, at 139 meters elevation, centered southeast). Project site is visible on the plains at a distance.

View from V3 (180 degree view, at 107 meters elevation, centered northeast). Dunes block visibility of Project Site from Aban Jo Tar

### 4.3.3 Geology

The Thar Desert is covered by parabolic sand dunes and intervening playas[21].A map of the surface geology and the extent of the Thar Coalfields area is shown in **Exhibit 4.6**. The entire surface of the Study Area is covered by aeolian sands of the Quaternary.

Elongate parabolic dunes are dominant within the Study Area, often with small playas within their noses (**see Exhibit 4.7**)[22]. The entire Study Area is covered by these, with little to no outcrop of rock. The last major phase of extended aeolian accumulation of the higher dunes in Thar occurred about 13,000 years ago[23].

[21] Playa is a typically desert basin with no outlet which fills with water to form a temporary lake after rainfall.

[22] J. Laity, Deserts and Desert Environments (Wiley-Blackwell: 2008)

[23] Chawla, S., et al., "Thermoluminescence chronology of sand profiles in the Thar desert and their implications," *Quaternary Science Reviews* 11 (1992), 25–32

**Exhibit 4.6:** Surface Geology and Extent of Thar Coalfields

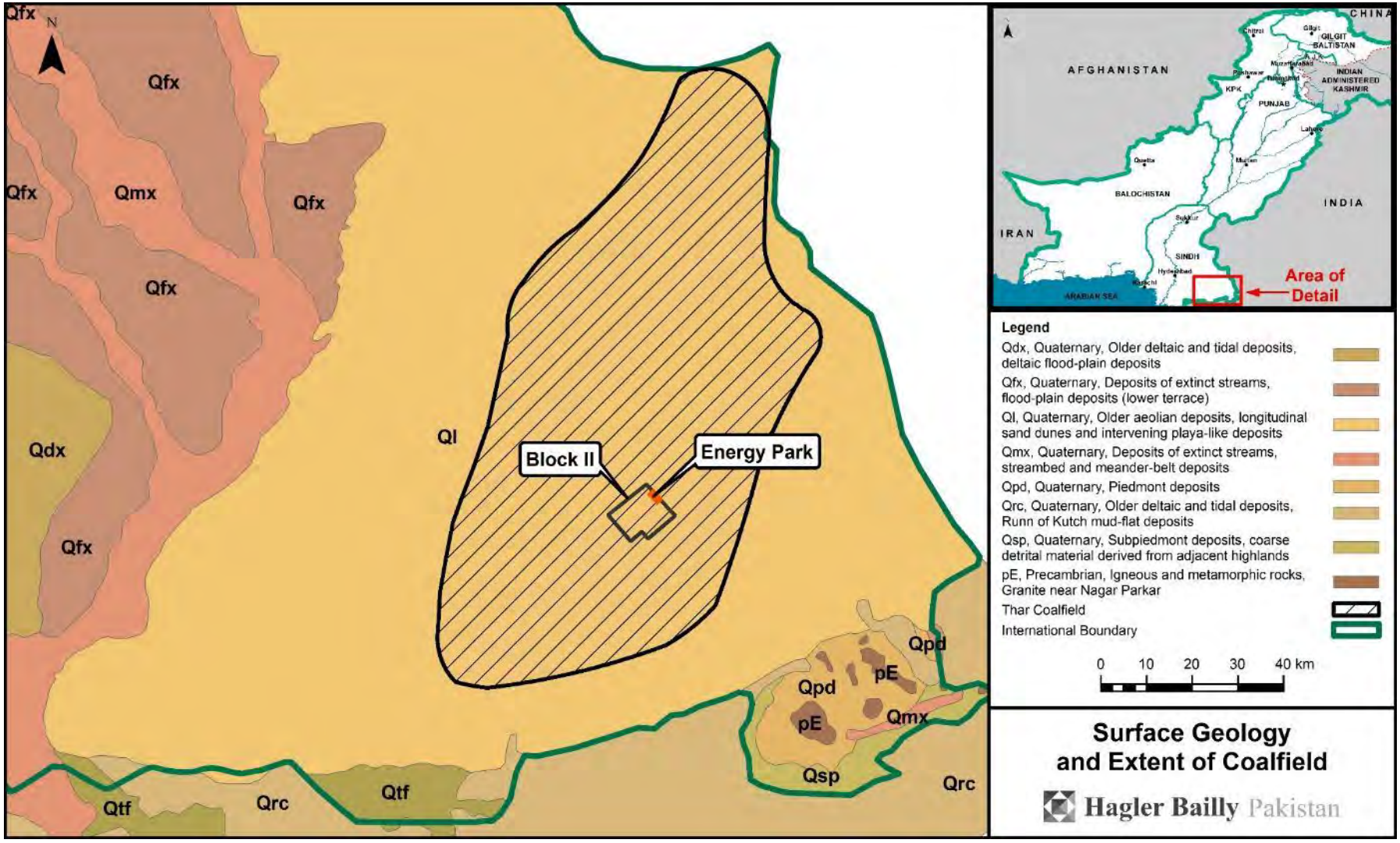


**Exhibit 4.7:** Characteristic Parabolic Sand Dunes in Study Area[24]

### 4.3.4 Tectonics, Earthquakes and Tsunamis

The Thar Desert lies at the north-western corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi (**Exhibit 4.8**).

Based on the Global Seismic Hazard Map Project (GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 $m/s^2$ (**Exhibit 4.9**).

The Rann of Kutch fault extends south of the India-Pakistan border. In 1819 an earthquake of 7.7 to 9.2 on the moment magnitude scale ($M_W$) and perceived Modified Mercalli Intensity (MMI) scale intensity of XI (extreme) occurred along the fault. This trigged a tsunami causing at over 1,500 deaths along the sparsely populated coastline of Kutch.

[24] Google Earth Imagery

**Exhibit 4.8:** Major Tectonics and Earthquakes of Southern Pakistan

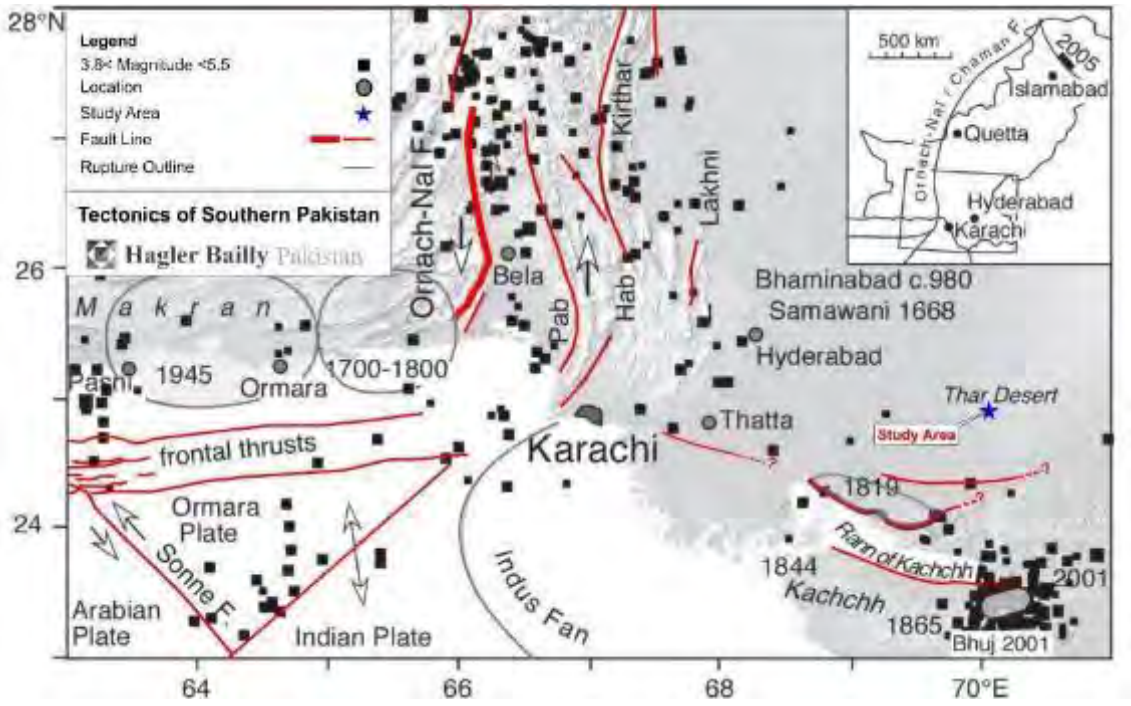
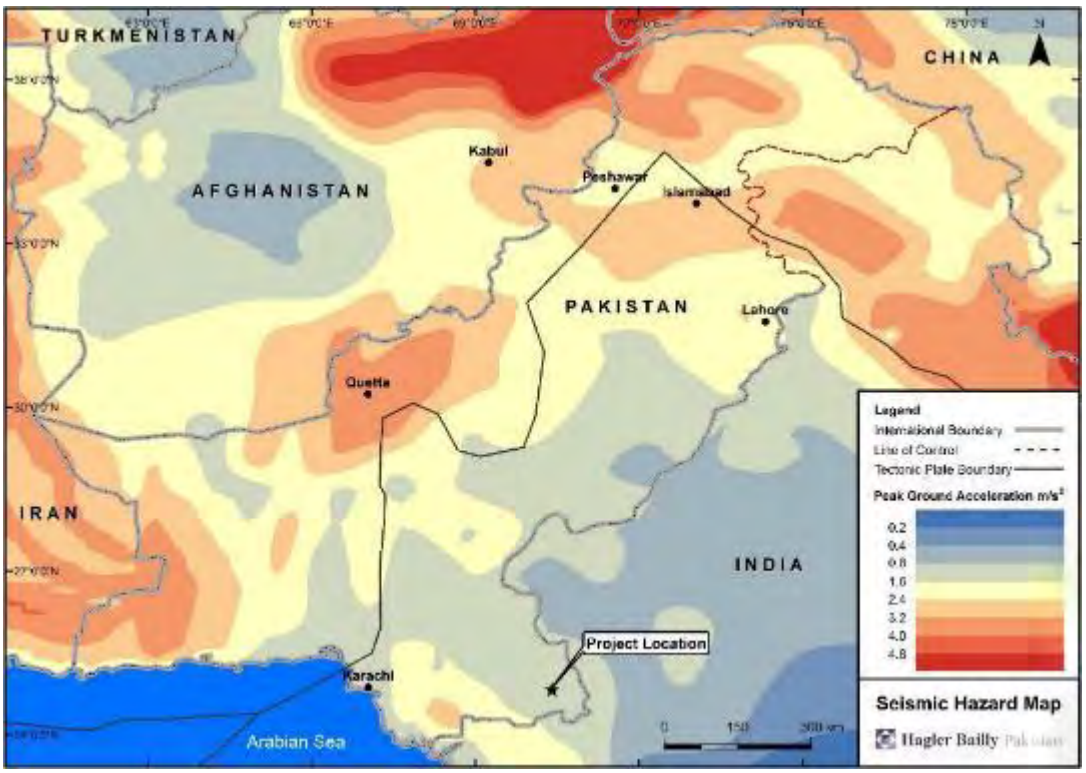



**Exhibit 4.9:** Seismic Hazard Map of Pakistan[25]




[25] Giardini, D., Grünthal, G., Shedlock, K. M. and Zhang, P.: The GSHAP Global Seismic Hazard Map. Annali di Geofisica 42 (6), 1225-1228, 1999.

### 4.3.5 Climate

A regional climate overview is established using the available data from nearby weather stations. The location of the stations, their distances from the Project site, and other relevant information is presented in **Exhibit 4.10**.

**Exhibit 4.10:** Summary of Weather Datasets

| | *Badin* | *Chor* | *Mithi* | *Synthetic* |
|---|---|---|---|---|
| World Meteorological Organization ID | 41785 | 41685 | 41786 | – |
| Established | 1929 | 1930 | 2004 | – |
| Coordinates | 24º 38' N<br>68º 54' E | 25º 31' N<br>69º 47' E | 24º 45' N<br>69º 48' E | 24°51' N<br>69°47' E |
| Distance from Site | 155 km east | 95 km northwest | 64 km east | 0 km |
| Data | 1961-1990<br>(30 years) | 1961-1990<br>(30 years) | 2004-2014<br>(11 years) | 2012-2014<br>(3 years) |
| Rationale of selection | While these are distant from the Study Area, data are available for 30 years, providing good long-term averages of regional climate, and good for generally verifying other datasets. | | Closest Pakistan Meteorological Department operated weather station from Project site, with relatively long term data record. | Synthetic data specific to Block III (relevant to air quality modelling) |

The monthly trends in weather parameters obtained from each weather station are tabulated and shown in **Exhibit 4.11** to **Exhibit 4.21**.

**Exhibit 4.11:** Mean Monthly Temperature Statistics

| *Month* | *Badin* | | *Chor* | | *Mithi* | | *Synthetic* |
|---|---|---|---|---|---|---|---|
| | *Max (°C)* | *Min (°C)* | *Max (°C)* | *Min (°C)* | *Max (°C)* | *Min (°C)* | *Average (°C)* |
| January | 25.8 | 8.7 | 26.5 | 5.4 | 27.1 | 5.8 | 16.4 |
| February | 28.6 | 11.6 | 29.2 | 8.7 | 30.6 | 9.9 | 18.8 |
| March | 34.0 | 16.8 | 34.5 | 14.3 | 36.4 | 16.2 | 24.1 |
| April | 38.4 | 21.8 | 39.1 | 20.1 | 40.0 | 21.6 | 28.5 |
| May | 39.8 | 25.5 | 41.5 | 24.5 | 41.1 | 25.4 | 30.9 |
| June | 38.0 | 27.5 | 39.7 | 27.2 | 39.7 | 27.1 | 32.1 |
| July | 35.1 | 27.0 | 36.2 | 26.8 | 37.1 | 26.7 | 31.7 |
| August | 33.6 | 26.1 | 34.5 | 25.7 | 35.0 | 25.3 | 30.1 |
| September | 34.4 | 24.9 | 35.7 | 23.9 | 35.8 | 24.3 | 29.7 |

| Month | Badin | | Chor | | Mithi | | Synthetic |
|---|---|---|---|---|---|---|---|
| | Max (°C) | Min (°C) | Max (°C) | Min (°C) | Max (°C) | Min (°C) | Average (°C) |
| October | 35.8 | 21.7 | 37.1 | 18.5 | 37.5 | 19.7 | 27.8 |
| November | 31.9 | 15.9 | 33.0 | 11.9 | 34.2 | 13.0 | 22.8 |
| December | 26.7 | 10.1 | 27.9 | 6.6 | 28.9 | 7.2 | 17.8 |

**Exhibit 4.12:** Monthly Temperature Profile

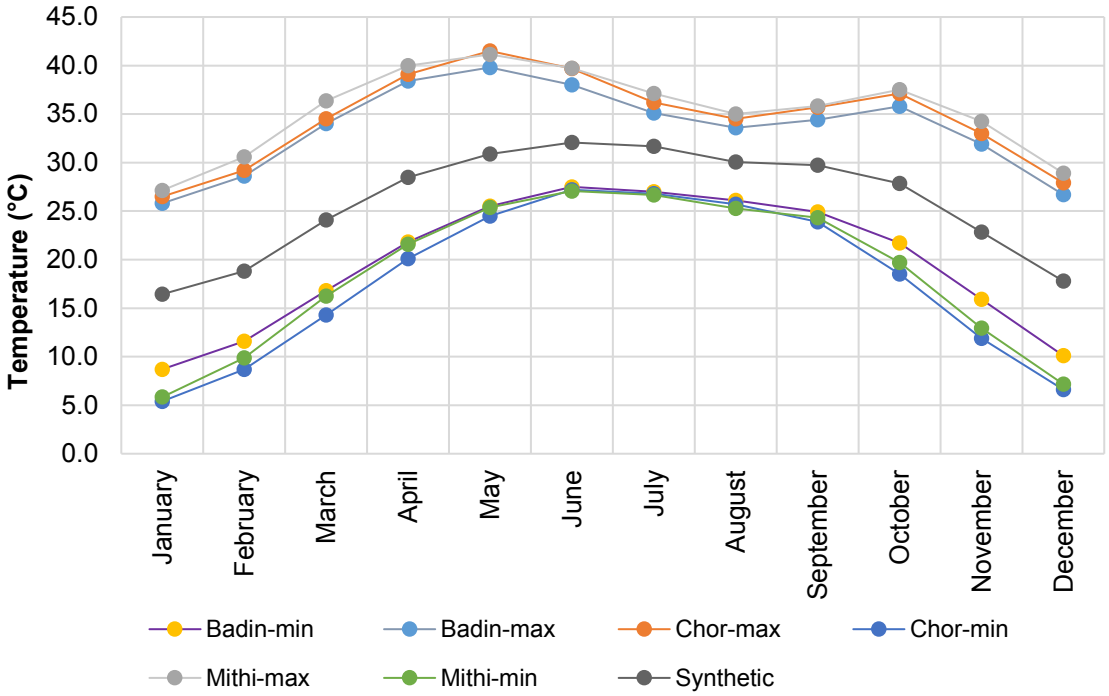



**Exhibit 4.13:** Mean Monthly Relative Humidity

| Month | Badin | | Chor | | Mithi | | Synthetic | |
|---|---|---|---|---|---|---|---|---|
| | (%) | | (%) | | (%) | | (%) | |
| | 5 AM | 5 PM | 5 AM | 5 PM | 5 AM | 5 PM | 5 AM | 5 PM |
| January | 73 | 31 | 71 | 27 | 70 | 27 | 57 | 32 |
| February | 71 | 28 | 71 | 27 | 69 | 21 | 59 | 29 |
| March | 77 | 25 | 70 | 23 | 71 | 18 | 67 | 26 |
| April | 79 | 25 | 72 | 21 | 74 | 19 | 85 | 25 |
| May | 80 | 33 | 78 | 25 | 77 | 29 | 93 | 22 |
| June | 80 | 47 | 81 | 40 | 78 | 40 | 91 | 30 |
| July | 84 | 59 | 84 | 56 | 80 | 49 | 92 | 34 |
| August | 85 | 63 | 86 | 59 | 84 | 56 | 93 | 36 |
| September | 87 | 55 | 87 | 49 | 83 | 50 | 89 | 32 |

| *Month* | *Badin* | | *Chor* | | *Mithi* | | *Synthetic* | |
|---|---|---|---|---|---|---|---|---|
| | *(%)* | | *(%)* | | *(%)* | | *(%)* | |
| | *5 AM* | *5 PM* | *5 AM* | *5 PM* | *5 AM* | *5 PM* | *5 AM* | *5 PM* |
| October | 84 | 38 | 79 | 33 | 75 | 27 | 63 | 25 |
| November | 77 | 35 | 72 | 30 | 69 | 25 | 59 | 32 |
| December | 74 | 34 | 72 | 30 | 70 | 24 | 59 | 35 |

**Exhibit 4.14:** Mean Monthly Relative Humidity

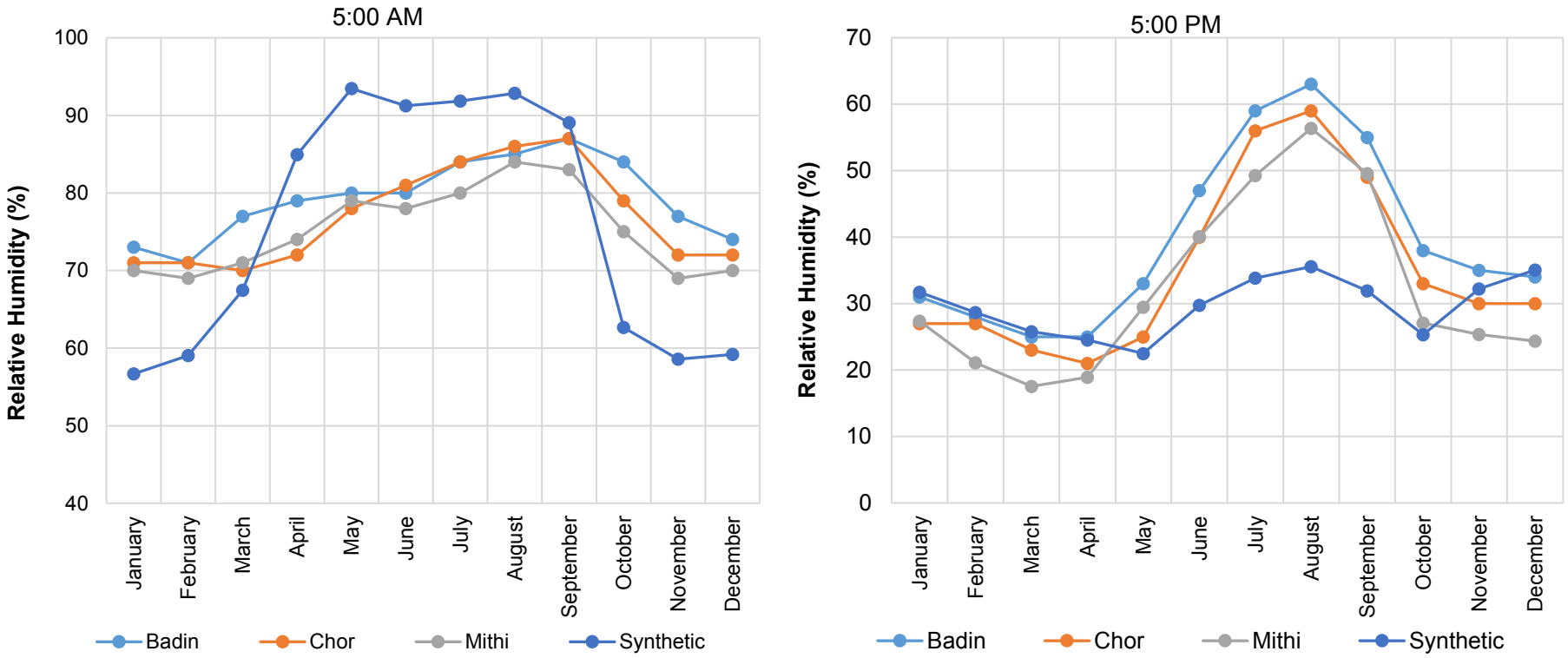
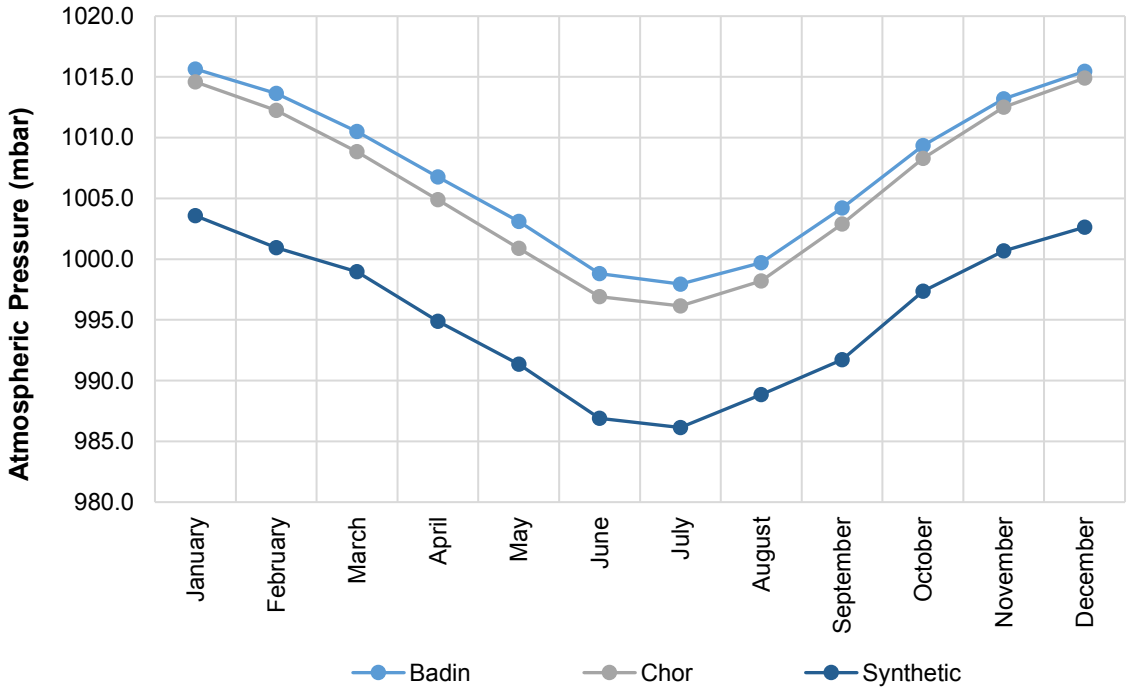


**Exhibit 4.15:** Mean Monthly Atmospheric Pressure

| *Month* | *Badin* | *Chor* | *Mithi*[26] | *Synthetic* |
|---|---|---|---|---|
| | *(mbar)* | *(mbar)* | *(mbar)* | *(mbar)* |
| January | 1015.65 | 1014.60 | – | 1003.57 |
| February | 1013.65 | 1012.25 | – | 1000.94 |
| March | 1010.50 | 1008.85 | – | 998.97 |
| April | 1006.75 | 1004.90 | – | 994.89 |
| May | 1003.10 | 1000.90 | – | 991.35 |
| June | 998.80 | 996.90 | – | 986.90 |
| July | 997.95 | 996.15 | – | 986.14 |
| August | 999.70 | 998.20 | – | 988.86 |
| September | 1004.20 | 1002.90 | – | 991.71 |
| October | 1009.35 | 1008.30 | – | 997.35 |
| November | 1013.20 | 1012.50 | – | 1000.68 |
| December | 1015.45 | 1014.90 | – | 1002.64 |

**Exhibit 4.16:** Mean Monthly Atmospheric Pressure




[26] Mithi Station atmospheric pressure data was not available.

**Exhibit 4.17:** Mean Monthly Total Clouds Cover

| *Month* | *Badin (Oktas)* | | *Cho (Oktas)* | | *Mithi (Oktas)* | | *Synthetic (Oktas)* | |
|---|---|---|---|---|---|---|---|---|
| | *5 AM* | *5 PM* | *5 AM* | *5 PM* | *5 AM* | *5 PM* | *5 AM* | *5 PM* |
| January | 0.5 | 1.0 | 0.8 | 1.4 | – | 1.6 | 2.2 | 2.2 |
| February | 0.8 | 1.4 | 1.0 | 1.7 | – | 1.3 | 2.1 | 2.2 |
| March | 0.7 | 1.3 | 1.1 | 2.1 | – | 1.3 | 2.1 | 2.1 |
| April | 0.8 | 1.2 | 1.1 | 1.8 | – | 1.3 | 2.1 | 2.1 |
| May | 1.1 | 0.3 | 1.1 | 0.8 | – | 0.8 | 2.0 | 2.1 |
| June | 1.9 | 1.7 | 2.3 | 1.7 | – | 2.7 | 2.1 | 2.5 |
| July | 3.7 | 4.5 | 3.9 | 4.3 | – | 4.6 | 2.4 | 2.8 |
| August | 3.6 | 4.7 | 3.7 | 4.2 | – | 5.1 | 2.6 | 2.9 |
| September | 1.4 | 2.3 | 1.6 | 2.3 | – | 3.7 | 2.4 | 2.5 |
| October | 0.8 | 0.4 | 0.6 | 0.8 | – | 1.2 | 2.1 | 2.2 |
| November | 0.4 | 0.7 | 0.4 | 1.0 | – | 1.0 | 2.2 | 2.4 |
| December | 0.5 | 1.0 | 0.7 | 1.4 | – | 1.1 | 2.2 | 2.3 |

Note "–"indicates that data was not available

**Exhibit 4.18:** Mean Monthly Total Clouds Cover

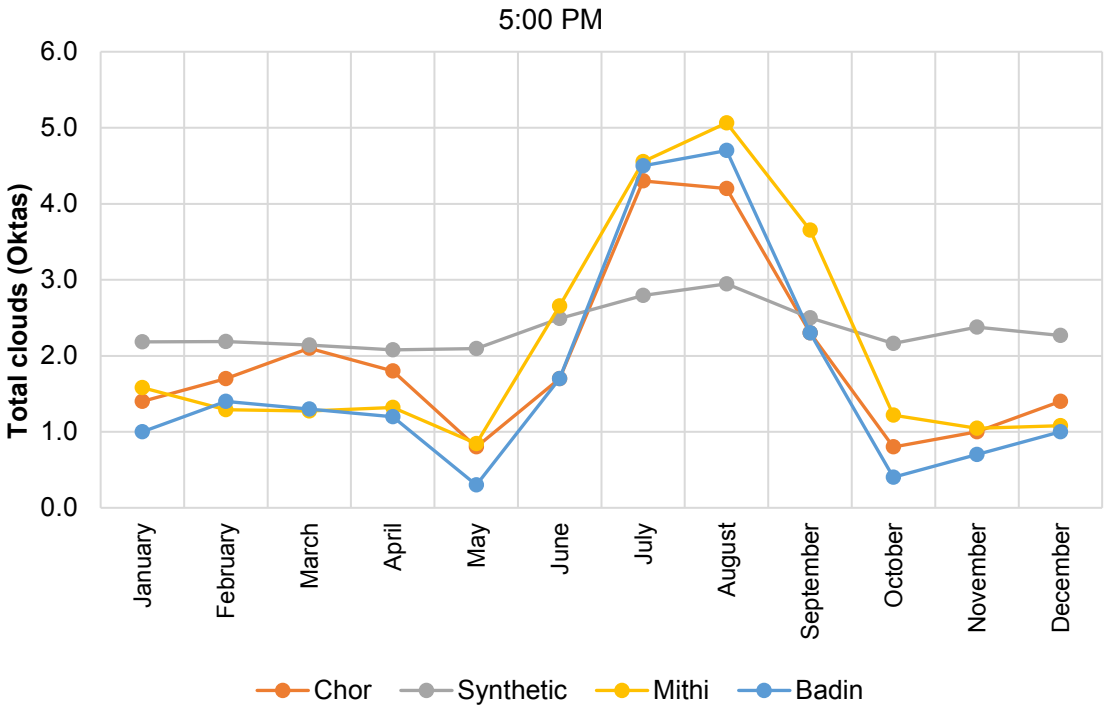
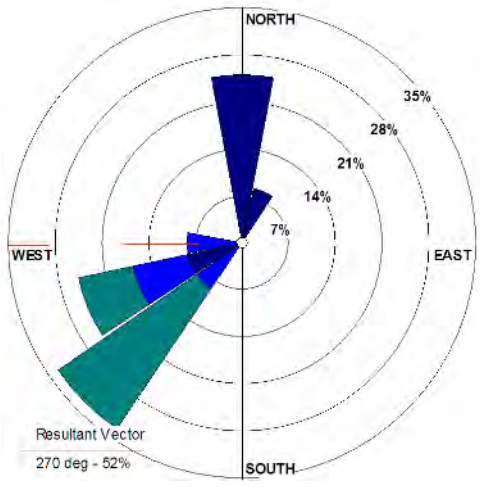


**Exhibit 4.19:** Mean Monthly Wind Speed and Wind Direction

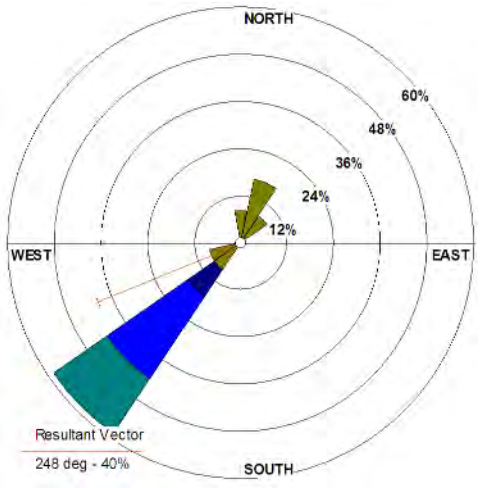
| *Month* | *Badin* | | *Chor* | | *Mithi** | | *Synthetic* | |
|---|---|---|---|---|---|---|---|---|
| | *WS (knots)* | *WD (degree)* | *WS (knots)* | *WD (degree)* | *WS (knots)* | *WD (degree)* | *WS (knots)* | *WD (degree)* |
| January | 4.20 | 9 | 2.60 | 21 | 6.10 | 281 | 5.73 | 185 |
| February | 4.90 | 349 | 2.80 | 2 | 6.47 | 311 | 6.25 | 351 |
| March | 6.00 | 273 | 3.70 | 248 | 6.75 | 251 | 5.45 | 283 |
| April | 9.10 | 254 | 6.10 | 228 | 9.45 | 224 | 7.13 | 264 |
| May | 13.00 | 244 | 10.30 | 224 | 14.21 | 234 | 9.30 | 239 |
| June | 12.00 | 229 | 9.70 | 221 | 13.14 | 231 | 9.89 | 221 |
| July | 11.50 | 231 | 9.00 | 222 | 11.89 | 231 | 9.10 | 229 |
| August | 11.10 | 233 | 7.30 | 222 | 9.48 | 224 | 8.34 | 238 |
| September | 9.50 | 234 | 4.40 | 222 | 7.18 | 206 | 7.43 | 242 |
| October | 5.10 | 257 | 2.60 | 220 | 4.87 | 251 | 4.68 | 319 |
| November | 4.50 | 357 | 2.00 | 34 | 3.62 | 276 | 4.47 | 354 |
| December | 3.80 | 14 | 2.00 | 31 | 5.13 | 284 | 6.01 | 180 |

* The readings were taken at 5:00 pm

**Exhibit 4.20:** Wind Rose




Badin




Chor

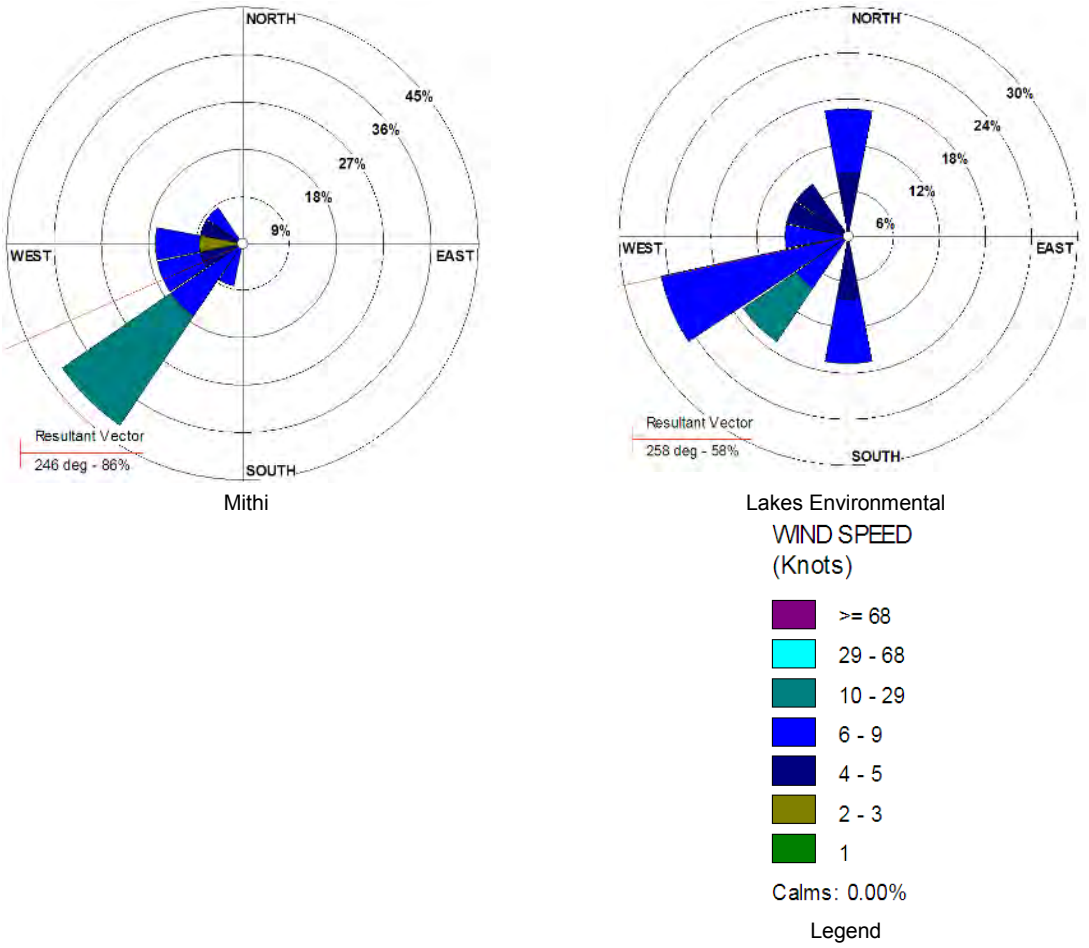



**Exhibit 4.21:** Mean Monthly Precipitation

| *Month* | *Badin* | *Chor* | *Mithi* | *Synthetic* |
|---|---|---|---|---|
| January | 1.0 | 0.6 | 1.3 | 0.0 |
| February | 3.6 | 2.0 | 2.5 | 3.5 |
| March | 2.3 | 4.5 | 2.2 | 4.3 |
| April | 2.5 | 3.5 | 3.0 | 13.7 |
| May | 0.7 | 3.0 | 1.8 | 24.7 |
| June | 10.8 | 19.7 | 22.1 | 78.3 |
| July | 70.5 | 79.0 | 58.6 | 45.7 |
| August | 89.9 | 74.5 | 162.0 | 64.3 |
| September | 34.4 | 22.9 | 129.5 | 98.7 |
| October | 3.7 | 2.1 | 14.0 | 10.7 |
| November | 1.7 | 3.6 | 3.0 | 1.7 |
| December | 1.1 | 0.9 | 1.0 | 0.0 |
| Annually | 222 | 216 | 398.5 | 345 |

### *Analysis*

The calendar season's spring, summer, autumn and winter cannot be used to characterize the climate in the Study Area. This is because the Study Area has mild winters and there is consistency of temperatures between the rest of the seasons. Considering the climate data presented above, the seasons in the Study Area are classified as:

- **Summer** (mid-March to mid-June): Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.
- **Summer Monsoon** (mid-June to mid-September): The summer Monsoon, hereafter referred to as the Monsoon, is characterized by high temperatures (milder than summers), high rainfalls with high atmospheric humidity and moderate speed-winds.
- **Post-Monsoon** Summer (mid-September to mid-November): Characterized by moderately high temperatures, low rainfalls and low speed-winds blowing from southwest towards northeast.
- **Winter** (mid-November to mid-March): Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

Season wise descriptions of the climate in the Study Area based on the data from the Mithi weather station are presented in **Exhibit 4.22.**

**Exhibit 4.22:** Summary Data for Study Area (based on Mithi Station)

| *Parameter Group* | *Statistic* | *Season* | *Value or Description* |
|---|---|---|---|
| Temperature | Maximum | Summer | 41°C |
| | | Summer Monsoon | 40°C |
| | | Post-Monsoon Summer | 38°C |
| | | Winter | 34°C |
| | Mean | Summer | 31°C |
| | | Summer Monsoon | 31°C |
| | | Post-Monsoon Summer | 27°C |
| | | Winter | 20°C |
| | Minimum | Summer | 16°C |
| | | Summer Monsoon | 24°C |
| | | Post-Monsoon Summer | 13°C |
| | | Winter | 6°C |
| Relative Humidity | 5 am (Mean) | Summer | 76 % |
| | | Summer Monsoon | 81 % |
| | | Post-Monsoon Summer | 76 % |

| *Parameter Group* | *Statistic* | *Season* | *Value or Description* |
|---|---|---|---|
| | | Winter | 70 % |
| | 5 pm (Mean) | Summer | 27% |
| | | Summer Monsoon | 49 % |
| | | Post-Monsoon Summer | 34 % |
| | | Winter | 25 % |
| Precipitation | Median (monthly) | Summer | 3 mm |
| | | Summer Monsoon | 94 mm |
| | | Post-Monsoon Summer | 14 mm |
| | | Winter | 2 mm |
| Cloud Cover | Mean (monthly) | Summer | 2 oktas |
| | | Summer Monsoon | 4 oktas |
| | | Post-Monsoon Summer | 2 oktas |
| | | Winter | 1 oktas |
| Wind Speed | Mean (monthly) | Summer | 11 knots |
| | | Summer Monsoon | 10 knots |
| | | Post-Monsoon Summer | 6 knots |
| | | Winter | 5 knots |
| Wind Direction | Monthly Average | Summer | Southwest to northeast |
| | | Summer Monsoon | Southwest to northeast |
| | | Post-Monsoon Summer | Southwest to northeast |
| | | Winter | Northwest to southeast |
| Extremes | Dry months in year | - | December and January |
| | Recent droughts | - | Recently declared drought years include 2013 and 2014. The associated annual rainfall at Mithi during these years was 190 mm and 207 mm respectively. |
| | Wettest month in year | - | August |
| | Recent high intensity rainfall and flooding. | - | High rainfall intensities in 2010, 2011 and 2015 were associated with flooding in the Thar region. The associated annual rainfall is also higher in these years. Flooding caused damage in the Study Area in 2015. |

### *Weather Extremes*

Extreme weather events at the Badin and Chor are given in **Exhibit** 4.23 and **Exhibit 4.24**.

**Exhibit 4.23:** Extreme Temperature Events at Badin and Chor (ºC)

| | *Highest Recorded* | | | | *Lowest Recorded* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Badin* | | *Chor* | | *Badin* | | *Chor* | |
| | *Value* | *Date* | *Value* | *Date* | *Value* | *Date* | *Val* | *Date* |
| January | 36.1 | 15/1965 | 36 | 27/1932 | -2 | 15/1935 | -2.8 | 12/1967 |
| February | 40 | 26/1943 | 42 | 14/1934 | 1 | 8/1974 | -2 | 5/1980 |
| March | 44 | 28/1945 | 43.5 | 31/1984 | 5 | (4)/1979 | -1.6 | 5/1984 |
| April | 46 | 18/1949 | 49 | 28/1983 | 11 | 2/1945 | 9 | 15/1955 |
| May | 49.4 | 22/1962 | 51 | 24/1932 | 17.5 | 5/1989 | 11.8 | 25/1989 |
| June | 49 | 15/1947 | 48.1 | 11/1988 | 21.1 | 20/1967 | 20 | 7/1976 |
| July | 44 | 2/1958 | 45.9 | 19/1989 | 22 | 31/1948 | 19.5 | 16/1987 |
| August | 44 | 5/1957 | 43 | 11/1981 | 22 | 13/1956 | 21 | 25/1932 |
| September | 44 | 30/1951 | 44 | 23/1981 | 20 | 10/1960 | 17.8 | 27/1972 |
| October | 43 | 4/1951 | 44 | 4/1941 | 9 | 30/1949 | 8.9 | 28/1964 |
| November | 40 | 2/1951 | 40 | 3/1977 | 4 | 29/1938 | 1.1 | 28/1966 |
| December | 35.6 | 1/1968 | 36 | 7/1934 | 2.5 | 14/1986 | -1.7 | 11/1964 |

**Exhibit 4.24:** Extreme Precipitation Events at Badin and Chor (mm)

| | *Badin* | | | | *Chor* | | | |
|---|---|---|---|---|---|---|---|---|
| | *1931-1960* | | *1961-1990* | | *1931-1960* | | *1961-1990* | |
| | *Value* | *Date* | *Value* | *Date* | *Value* | *Date* | *Value* | *Date* |
| January | 21.8 | 8/1945 | 13.3 | 14/1976 | 7.6 | 29/1935 | 4.6 | 9/1968 |
| February | 23.6 | 2/1940 | 58 | 27/1990 | 17.5 | 2/1940 | 14.5 | 1/1961 |
| March | 37.8 | 10/1960 | 11.2 | 7/1970 | 15.5 | 24/1933 | 61 | 6/1970 |
| April | 33 | 7/1957 | 21 | 14/1983 | 6.6 | 19/1959 | 57.4 | 10/1961 |
| May | 50.5 | 1/1933 | 15.7 | 31/1985 | 20.3 | 19/1957 | 21.1 | 29/1977 |
| June | 47.5 | 26/1934 | 55.7 | 1/1985 | 41.7 | 26/1956 | 97.6 | 2/1985 |
| July | 249.4 | 1/1936 | 111.5 | 25/1967 | 114.3 | 23/1937 | 119.9 | 1/1983 |
| August | 105.9 | 12/1933 | 241 | 13/1979 | 61.7 | 1/1931 | 214.6 | 7/1990 |
| September | 115.6 | 7/1954 | 159.3 | 3/1990 | 76.2 | 6/1959 | 80 | 2/1990 |
| October | 8.9 | 14/1959 | 3.4 | 17/1963 | 26.7 | 2/1956 | 22.2 | 3/1975 |
| November | 25.1 | 16/1936 | 21.2 | 12/1978 | 22.6 | 15/1936 | 38.6 | 3/1981 |
| December | 17 | 30/1937 | 15 | 22/1980 | 12.9 | 6/1956 | 15 | 12/1967 |

### 4.3.6 Air Quality

The objective of the air quality baseline was to collect data on air quality in the airshed, particularly the area likely to be affected by the Project.

The air quality baseline specifically assess the concentration of pollutants in the ambient air without the Project. The Project is assumed to become operational in 3 to 4 years. Other developments, such as the Block II and Block VI mines, are planned around the Project and are also likely to affect air quality. Therefore, the concentration of pollutants in the ambient air in, say, 2020 when the Project comes in operation, is likely to be different from the concentration at present.

The air quality baseline was developed using measured concentration and modeled concentration. The modeled concentration shows the expected impact of the proposed developments around the Project. The concentrations were modeled using air emission modelling.

The pollutants selected for evaluation, based on the expected emissions from the planned operations and the level of risk to human health posed by these pollutants, are as follows:

- Sulfur dioxide ($SO_2$)
- Nitrogen dioxide ($NO_2$)
- Particulate matter ($PM_{10}$ and $PM_{2.5}$)

#### *Measured Baseline*

The measured air quality baseline was developed using both primary and secondary data on ambient air quality in the Project area.

##### Primary Data

Air quality sampling was carried out at four different locations in the Study Area from May 24$^{th}$ to 31$^{st}$, 2016. As the results from the literature indicate low concentrations of $SO_2$ and $NO_2$. This low concentration was expected, as there were no major sources of these pollutants in the area other than cook stoves in villages that use wood as a fuel. However, previous sampling also indicates high concentrations of particulate matter ($PM_{10}$ and $PM_{2.5}$). This was largely due to the desert environment of the area that results in naturally high dust concentrations. Therefore, sampling for this study focused only on sampling particulate matter.

A description of sampling locations and the rationale of selection is given in **Exhibit 4.25**.

**Exhibit 4.25:** Air Quality Sampling Locations and Rationale of Selection

| *Sample ID* | *Coordinates* | *Location* | *Rationale* |
|---|---|---|---|
| A1 | 24° 45' 55.3" N<br>70° 23' 08.8" E | Lale Je Dhani | Engro activities influenced zone |
| A2 | 24° 48' 42.3" N<br>70° 28' 00.2" E | Vakerio | Receptor (large village) downwind of site |
| A3 | 24° 49' 58.3" N<br>70° 24' 46.1" E | Jaman Samo | Receptor (village) downwind of site |
| A4 | 24° 45' 15.1" N<br>70° 21' 43.9" E | Thahriyo Halipota | Receptor (village) on transport route |

At each location, $PM_{10}$ and $PM_{2.5}$ were sampled using a low volume sampler for 24 hours. Lab analysis was performed at the HBP Laboratory in Islamabad. Photographs of the particulate matter sampling sites are shown in **Exhibit 4.26**.

**Exhibit 4.26:** Particulate Matter Sampling Site Photographs

Low Volume Samplers at A1

Low Volume Samplers at A2

Low Volume Samplers at A3

Low Volume Samplers at A4

### Secondary Data

Additional data on ambient air quality in the Project area, available from previous EIAs conducted near the Study Area, is summarized in **Exhibit 4.27**. The current and previous sampling locations are shown in **Exhibit 4.28.**

**Exhibit 4.27:** Air Quality Sampling Locations in Literature

| *Sample ID* | *Coordinates* | *Dates of Survey* | *Description* | *Source* |
|---|---|---|---|---|
| THMA1 | 24°44' 14.56" N<br>70°13' 14.32" E | May, June, July 2010 | Mehari Bajeer | ESIA of Block II coal mine[27] |
| THMA2 | 24°51' 47.63" N<br>70°24' 54.39" E | May, June, July 2010 | Salah Jhanjhi | |
| THMA3 | 24°46' 11.39" N<br>70°21' 23.94" E | May, June, July 2010 | Pakistan Camp | |
| THMA4 | 24°45' 08.94" N<br>70°21' 25.76" E | May, June, July 2010 | Thario Halepota | |
| TCOA1 | 24°49' 12.19" N<br>70°17' 08.83" E | May, June 2012 | Ranjho Noon | ESIA of Block VI coal mine. (Oracle Coalfields Limited)[28] |
| TCOA2 | 24°53' 51.32" N<br>70°19' 04.57" E | May, June 2012 | Meghay Jo Tar | |
| TCOA3 | 24°51' 21.78" N<br>70°24' 45.21" E | May, June 2012 | Salah Jhanjhi | |
| SSRA1 | 24°39' 22.51" N<br>70°19' 01.10" E | November, 2011 | Open Field Tilwai | ESIA of Block I coal mine)[29] |
| SSRA2 | 24°40' 48.48" N<br>70°17' 56.62" E | November, 2011 | Open Field Varvai | |
| SSRA3 | 24°40' 11.39" N<br>70°22' 01.06" E | November, 2011 | Open Field Khario Ghulam Shah | |

### Results and Analysis

The results of the current sampling along with the results from literature are tabulated in **Exhibit 4.29.** The results were compared against Sindh Environmental Quality Standards (SEQS) and IFC EHS guidelines.

[27] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project. Prepared for Sindh Engro Coal Mining Company

[28] Hagler Bailly Pakistan, April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

[29] Environmental Management Consultants (EMC), May 2012, Environmental Impact Assessment of Thar Coal Mining Project, Sinhar Vikian Varvai, Block 1 for Sino-Sindh Resources

**Exhibit 4.28:** Air Quality Sampling Locations

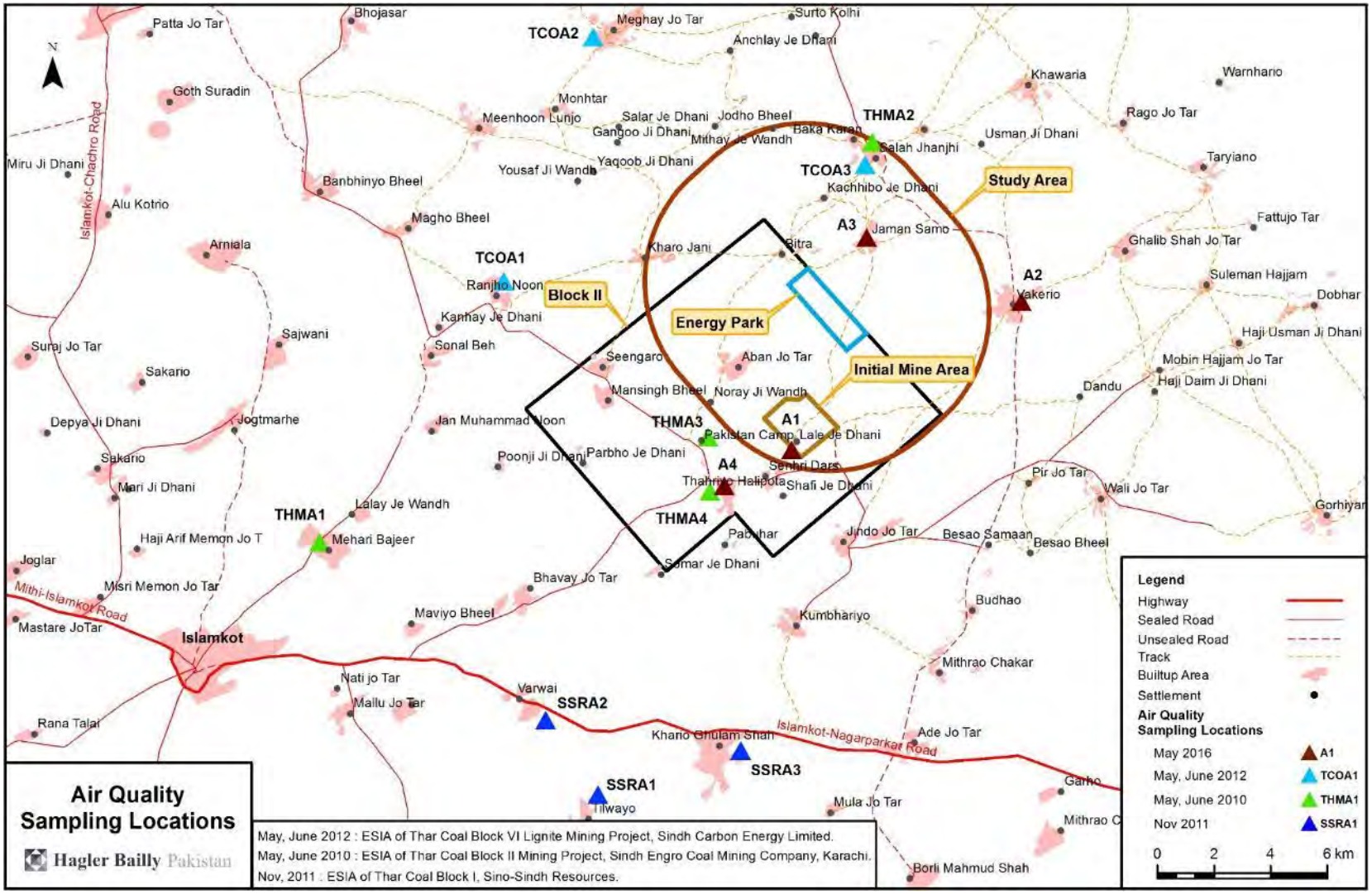


**Exhibit 4.29:** Results of Current and Previous Sampling (µg/m$^3$)

| *Sample ID* | *Date* | *$NO_2$* | *$SO_2$* | *$PM_{10}$* | *$PM_{2.5}$* |
|---|---|---|---|---|---|
| A1 | May, 2016 | – | – | 114.3 | 63.5 |
| A2 | | – | – | 109.3 | 68.3 |
| A3 | | – | – | 104.7 | 52.4 |
| A4 | | – | – | 84.6 | 36.3 |
| THMA1 | May, 2011 | 6.98 | 12.40 | – | – |
| THMA2 | | 4.65 | 9.14 | – | – |
| THMA3 | | 2.39 | 4.49 | – | – |
| THMA4 | | 3.23 | NA | – | – |
| THMA1 | June, 2011 | 2.95 | 5.83 | 138.9 | 13.9 |
| THMA2 | | 3.36 | 8.39 | 180.7 | 27.8 |
| THMA3 | | 2.81 | 2.18 | 166.7 | 27.8 |
| THMA4 | | 2.22 | 3.37 | 222.2 | 55.6 |
| TCOA1 | June, 2012 | – | 3.2 | 333 | 112 |
| TCOA2 | | – | 2.1 | 776 | 129 |
| TCOA3 | | – | 9.0 | 406 | 98 |
| THMA1 | July, 2011 | 3.31 | 2.99 | 83.3 | 13.9 |
| THMA2 | | 4.56 | 6.77 | 97.2 | 13.9 |
| THMA3 | | 2.66 | 8.12 | 97.2 | 13.9 |
| THMA4 | | 2.88 | 1.6 | 111.1 | 27.8 |
| SSRA1 | Nov, 2011 | 16.1 | 27.0 | 140.6 | 20.8 |
| SSRA2 | | 5.8 | 10.1 | 228.0 | 34.2 |
| SSRA3 | | 6.7 | 11.2 | 205.6 | 30.8 |
| **Median Value** | | **3.3** | **7.4** | **139.8** | **32.5** |
| SEQS (annual) | | 40 | 80 | 120 | 40 |
| SEQS (24-hour) | | 80 | 120 | 150 | 75 |
| IFC EHS (annual) | | 40 | - | 70 | 35 |
| IFC EHS (24-hour) | | - | 125 | 150 | 75 |

Note: – means the data was not available

From the measured values the following conclusions can be drawn:

- The median value of $SO_2$ concentration is 7.4 µg/m$^3$ which complies with SEQS (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded $SO_2$ in the area is 27.0 µg/m$^3$ which is also well below the SEQS and IFC EHS limits.
- The median value of $NO_2$ concentration is 3.3 µg/m$^3$ which complies with SEQS (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded $NO_2$ in the area is 16.1 µg/m$^3$ which is also well below the SEQS and IFC EHS limits.
- The median value of $PM_{10}$ and $PM_{2.5}$ concentrations are 139.8 µg/m$^3$ and 32.5 µg/m$^3$ respectively. The $PM_{2.5}$ concentration complies with SEQS (24 hour and annual) and is within IFC EHS guideline limits. The median value of $PM_{10}$ concentrations exceeds the annual limit but is within the 24-hour limits of the

SEQS and the IFC EHS guideline values. $PM_{10}$ concentrations from previous sampling exceeds the standards at 8 out of 14 locations. $PM_{2.5}$ concentrations from previous sampling exceeds the standards at 3 out of 14 locations. $PM_{10}$ and $PM_{2.5}$ concentrations from current sampling complies with the standards. Their concentrations are very high due to the natural background influence of the desert environment. Human sources of particulate matter (PM) include the use of wood as fuel and vehicular traffic on unpaved roads and dirt tracks. In this study the highest PM readings were recorded at A1 (Lale Je Dhani) and A2 (Vakerio).

Based on the above exercise, **Exhibit 4.30** presents the current pollutant levels of the Study Area that are established based on the rounded median of the measured results. These values are used for development of the modelled cumulative baseline. The error bars are of one standard deviation.

**Exhibit 4.30:** Baseline Ambient Air Quality in the Study Area (µg/m$^3$)

| | *$NO_2$* | *$SO_2$* | *$PM_{10}$* | *$PM_{2.5}$* |
|---|---|---|---|---|
| Baseline Levels | *3 ± 3* | *7 ± 6* | *140 ± 93*[30] | *30 ± 40* |
| SEQS (annual) | 40 | 80 | 120 | 40 |
| SEQS (24-hour) | 80 | 120 | 150 | 75 |
| IFC EHS (annual) | 40 | - | 70[a] | 35 |
| IFC EHS (24-hour) | - | 125 | 150 | 75 |

Even though the standard deviation of $NO_2$ and $SO_2$ is large the level of these pollutants are much lower than SEQS and IFC EHS limits. However, the PM readings are both high, but also have high variation, due the intense variation in background levels depending on the season.

### *Modeled Baseline*

Expected activities near the Study Area, that may influence the air quality baseline of the Project are summarized in **Exhibit 4.31** and locations shown in Exhibit 4.32.

**Exhibit 4.31:** Approved Developments near Study Area

| *Block No.* | *Coal Mine* | *Power Plant* | *Source* |
|---|---|---|---|
| Block II | up to 22 mtpa | 2x330 MW | ESIA of Block II Mining Project[31]<br>ESIA of Block II Power Plant Project[32] |
| Block VI | 2.5 mtpa | - | ESIA of Block VI Mining Project[33] |

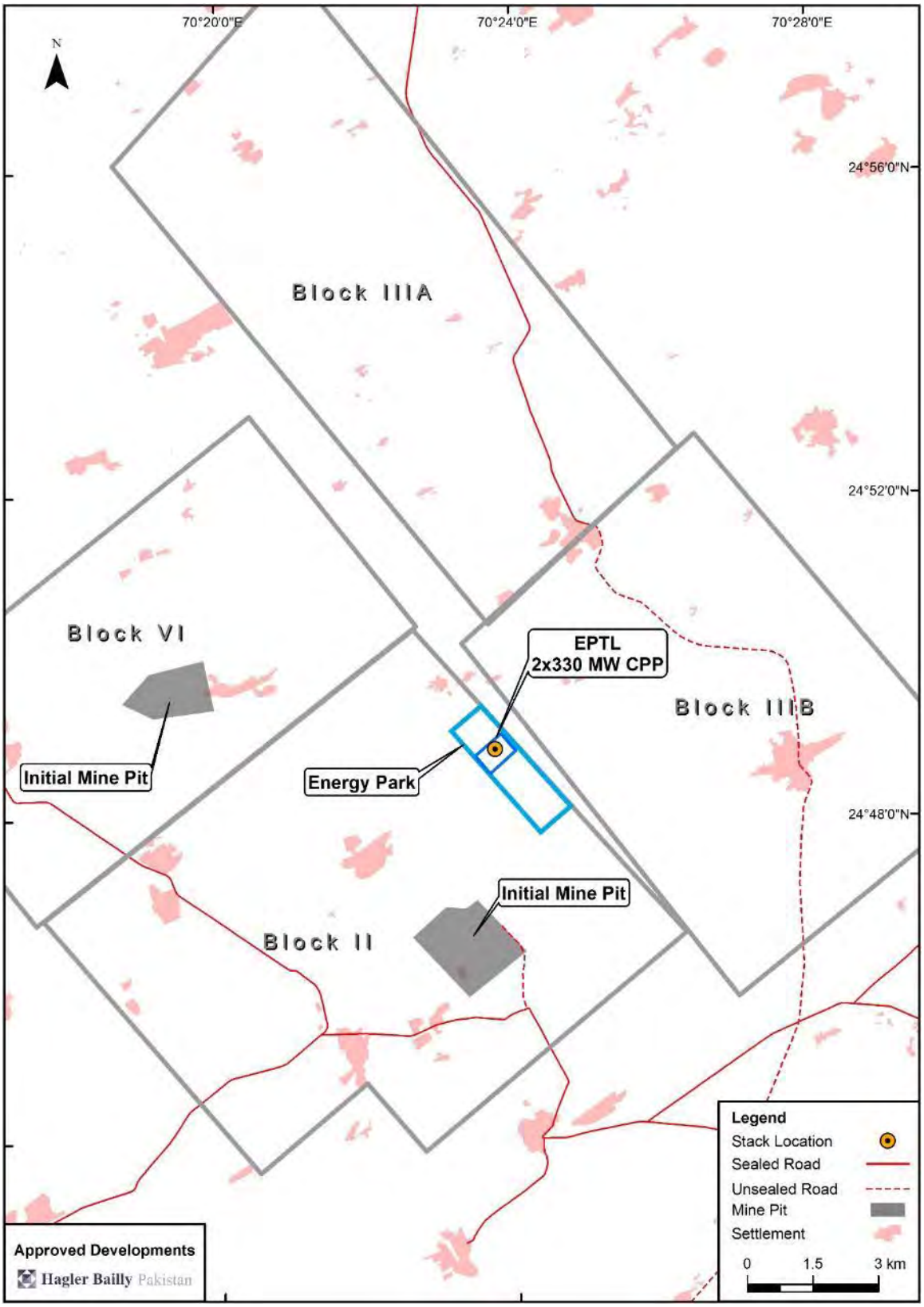
[30] The reading of 780 µg/m$^3$ is removed as it was 5 times the median value and is likely a low occurring outlier.

[31] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

[32] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

[33] Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

**Exhibit 4.32:** Approved Developments



### Modelling Area

The modeling area was defined as circle of radius 15 km centered at the center of the Energy Park. The area was taken considering the distance of receptors and expected impact of the Project. As Block I is farther than 15 km it was not included in the modelling exercise.

### Model Details

These activities were modeled using USEPA approved regulatory model AERMOD. AERMOD provides predicted pollutant concentrations for hourly, daily, monthly, and yearly averaging periods, and complies with the USEPA's guidelines on air quality models. Weather data from the Mithi weather station from 2012-2014 was used.

### Modeling Approach

There is a large variability in the natural dust concentrations. This can be observed from the large standard deviation in the particulate matter readings. This could be due to the following reasons:

- Seasonal influence such as the monsoons, that result in large amounts of greenery in the Thar Desert which suppress dust emissions to dry and windy dust storms that result in large dust emissions.
- Location of measurement with reference to sand dunes, which can both shade receptors from the wind but are also a source of dust emissions depending on whether the receptor location is upwind or downwind of the dune.

This natural spatial and temporal variability is not captured in the average value of 140 $\mu g/m^3$ for $PM_{10}$ and 30 $\mu g/m^3$ for $PM_{2.5}$.

Initial modelling using AP-42 methodology shows that under unmitigated mining operation, areas within 3 to 5 km of the active coal mine and waste dump will be dominated by the dust emissions from the mining activity. The mining activity is not included further in this assessment.

The EPTL power plant is modelled based on the parameters given in the ESIA of the project**.**

### *Combined Baseline*

The measured baseline was added to the modelled results to uniformly elevate the current modelled concentrations. It should be noted that the existing pollutant concentrations are not uniform and this is a simplifying assumption. Contour maps for dispersion of $SO_2$ and $NO_X$ are presented in **Exhibit 4.33** to **Exhibit 4.40**. The measured and modeled results are compiled in **Exhibit 4.41.** The results were compared against SEQS and IFC EHS limits and the values exceeding one of the standards are shaded.

**Exhibit 4.33:** Baseline $SO_2$ Concentration (Annual)

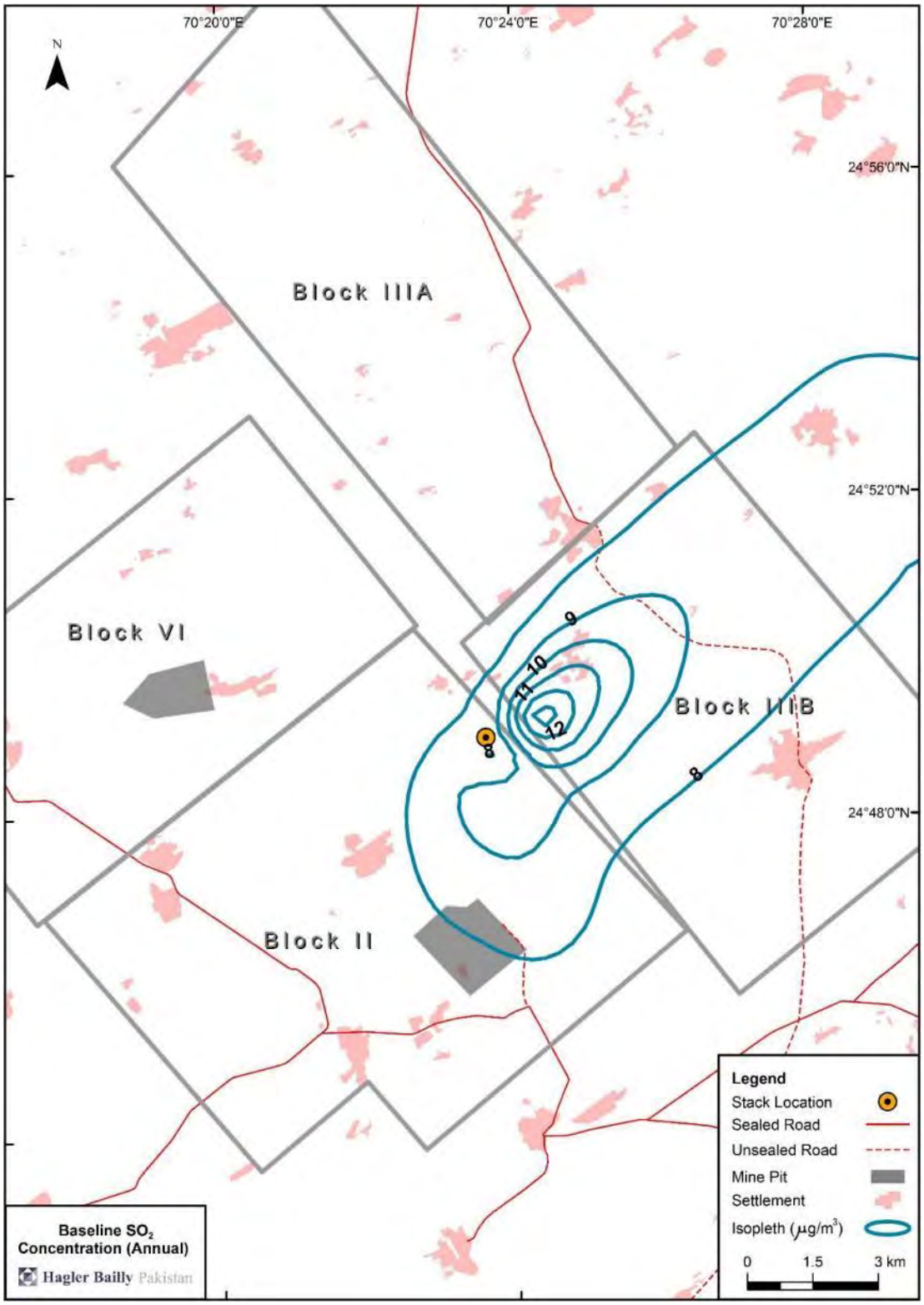


**Exhibit 4.34:** Baseline $SO_2$ Concentration (24 hour)

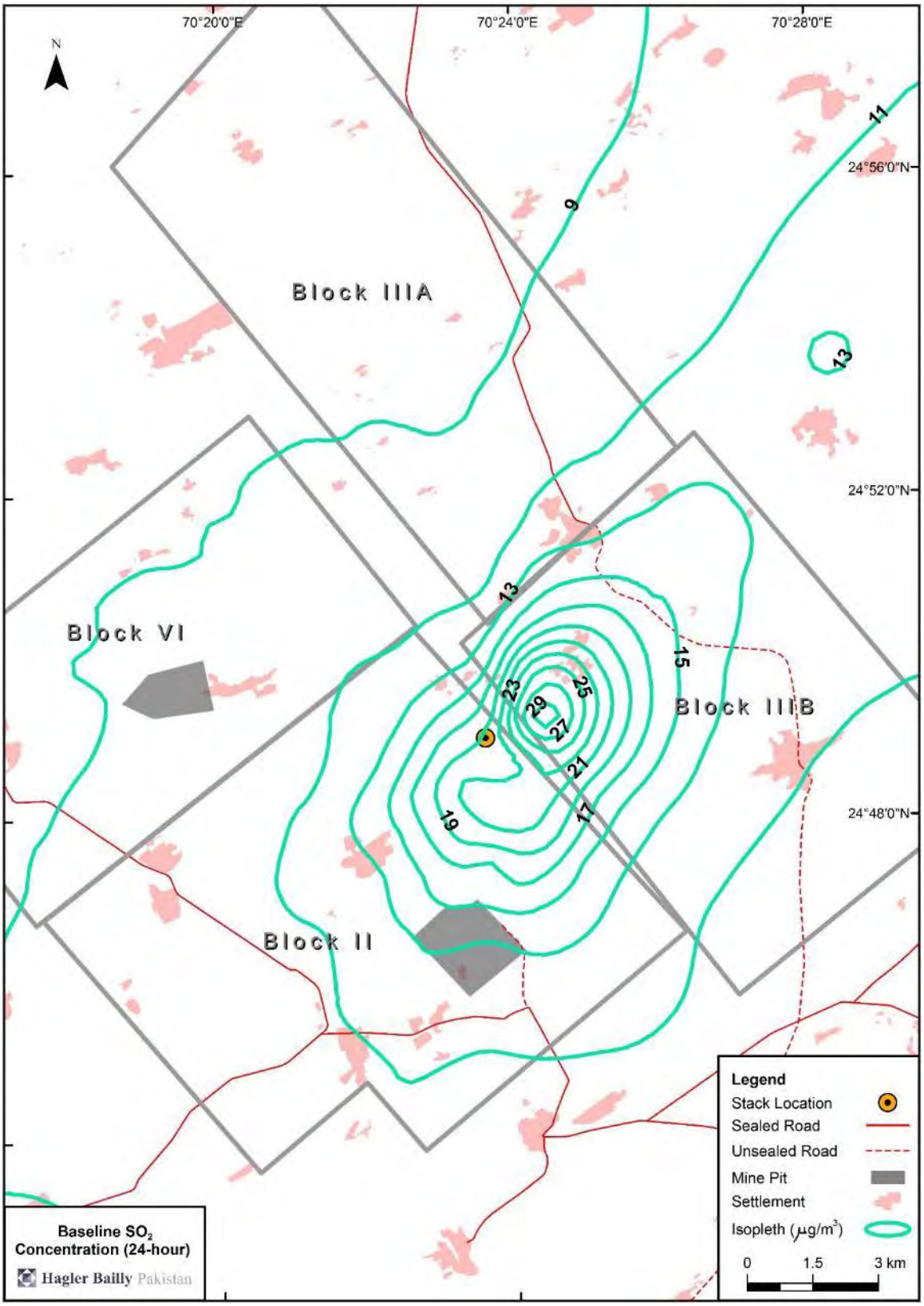


**Exhibit 4.35:** Baseline Concentration of $NO_2$ (Annual)

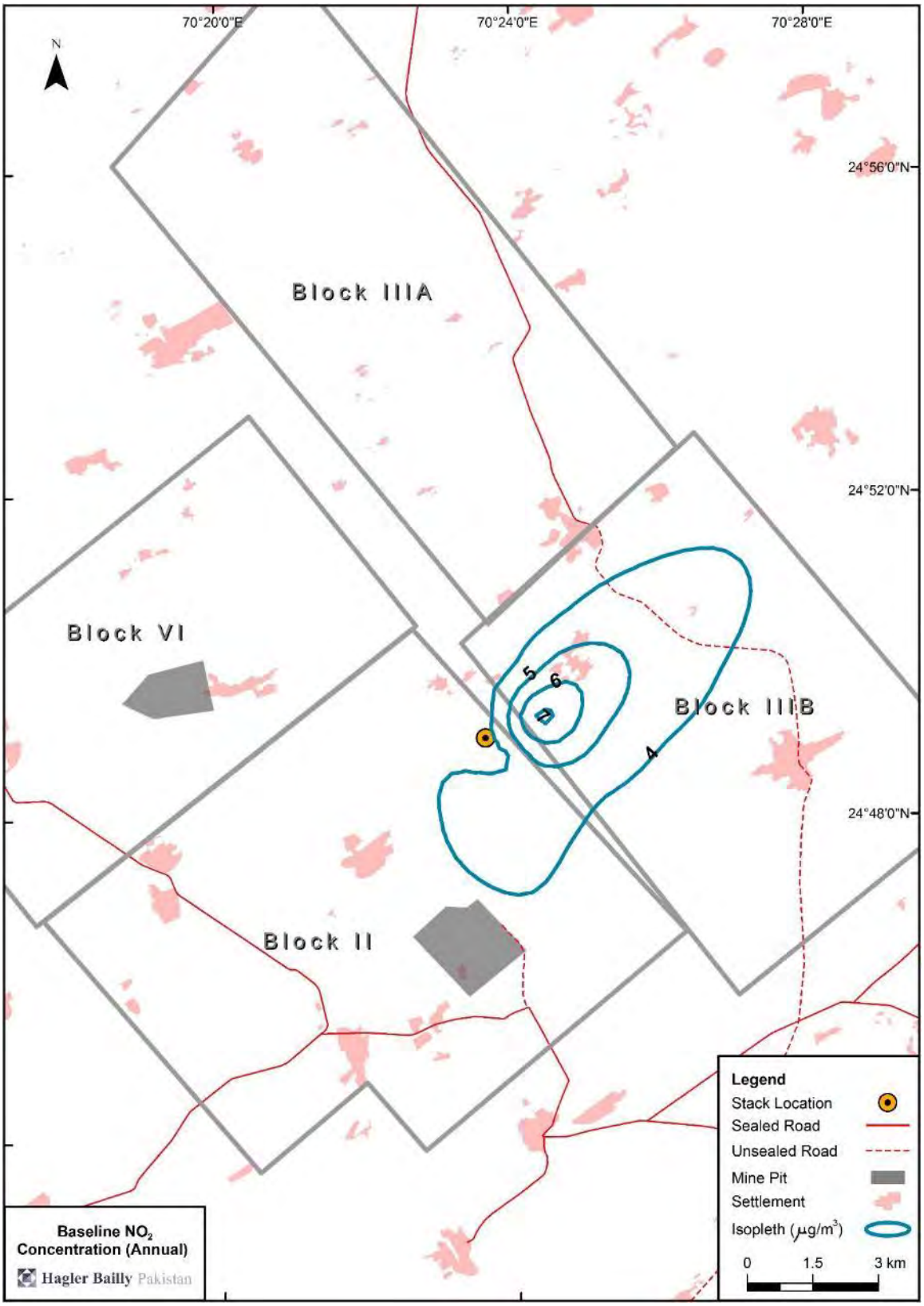


**Exhibit 4.36:** Baseline $NO_2$ Concentration (24 hour)

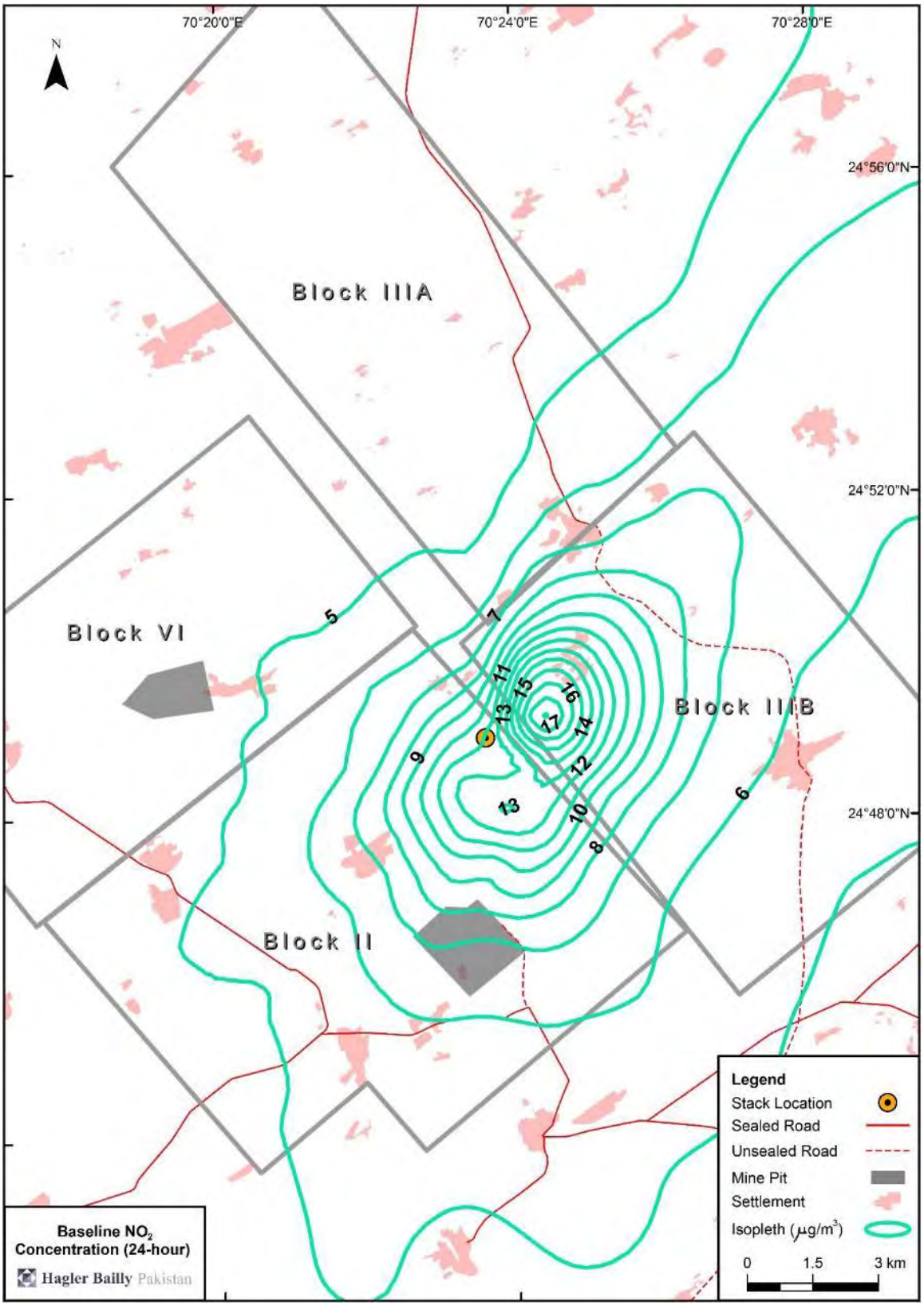


**Exhibit 4.37:** Baseline $PM_{10}$ Concentration (Annual)

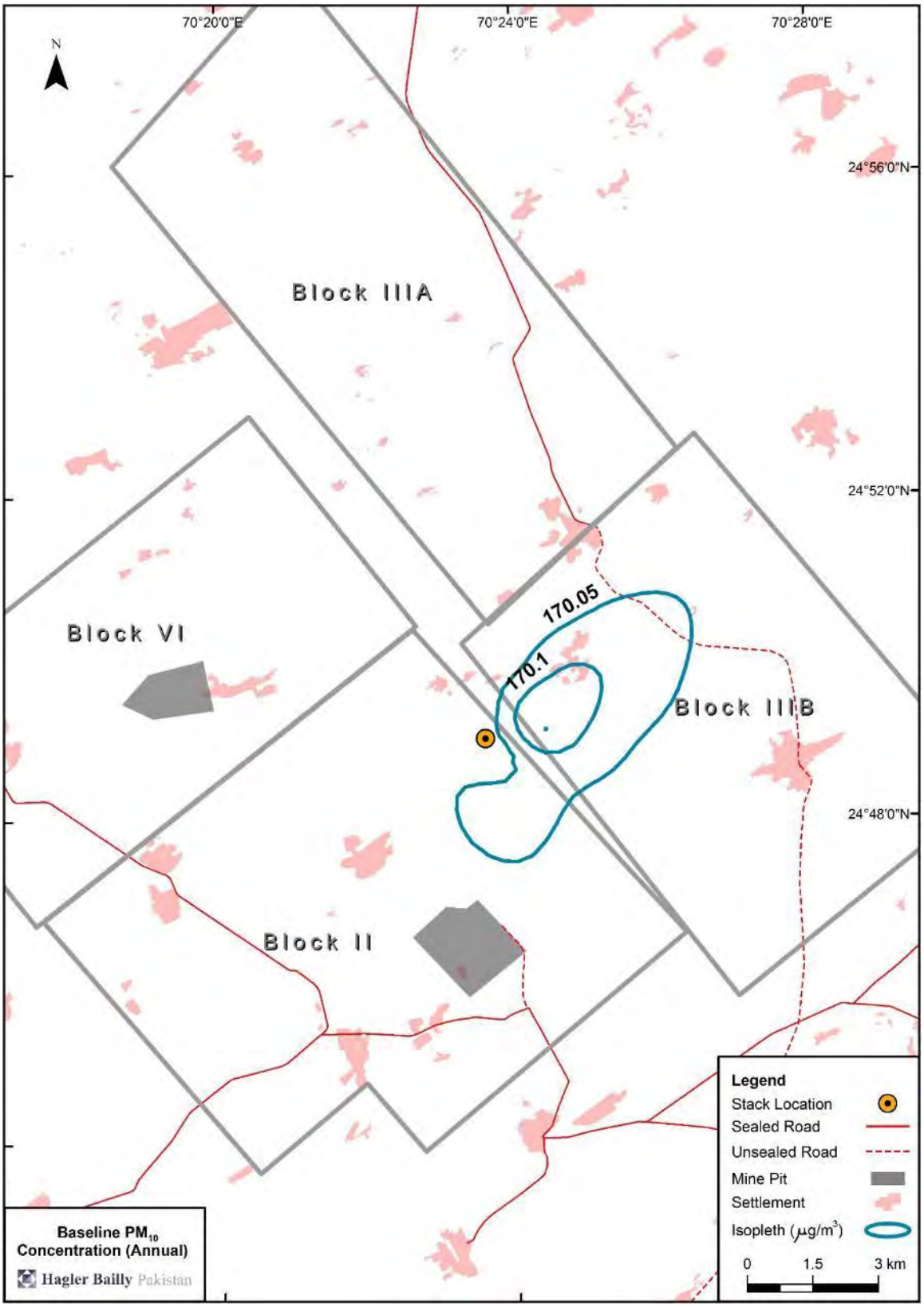


**Exhibit 4.38:** Baseline $PM_{10}$ Concentration (24-hour)

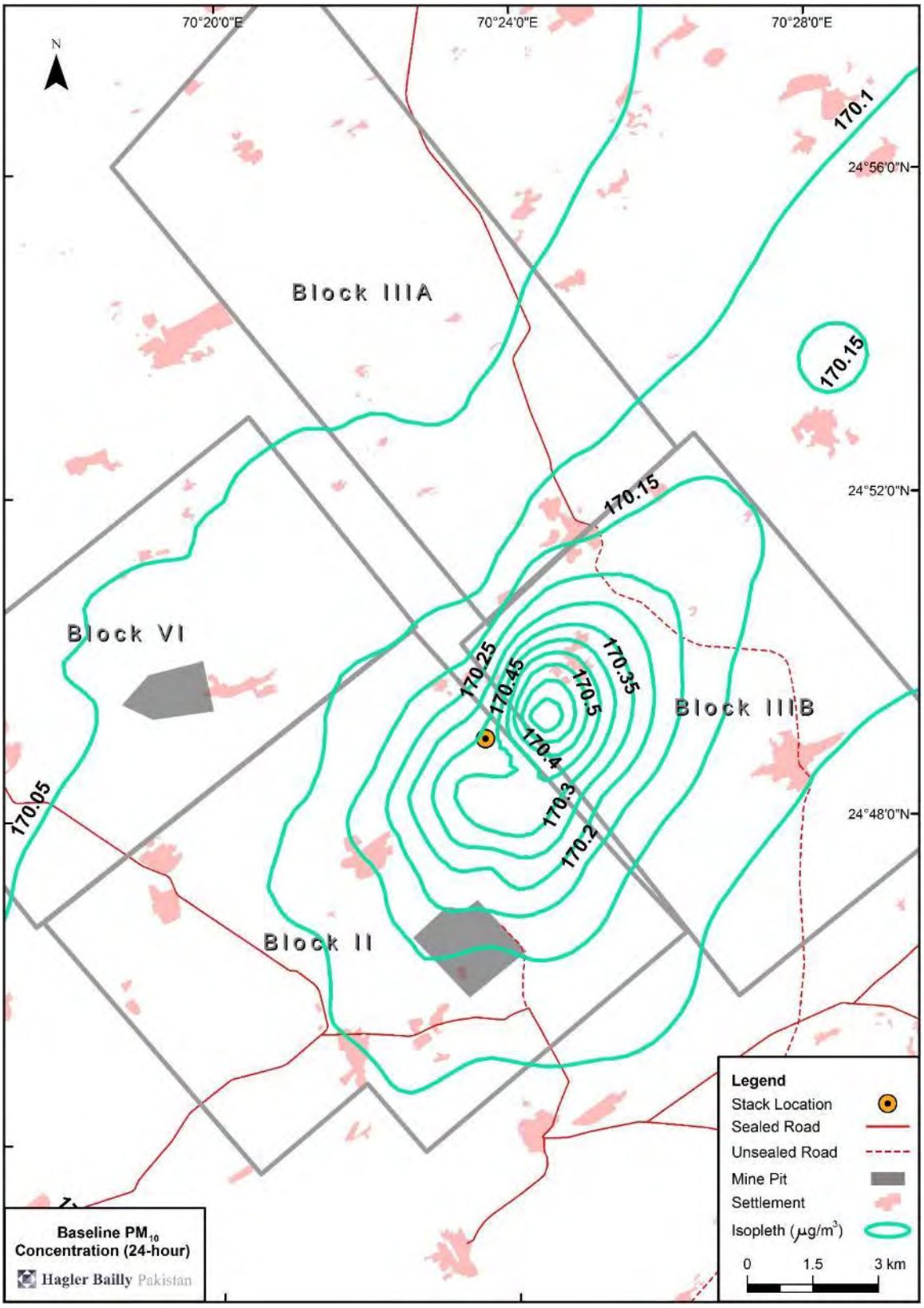


**Exhibit 4.39:** Baseline $PM_{2.5}$ Concentration (Annual)

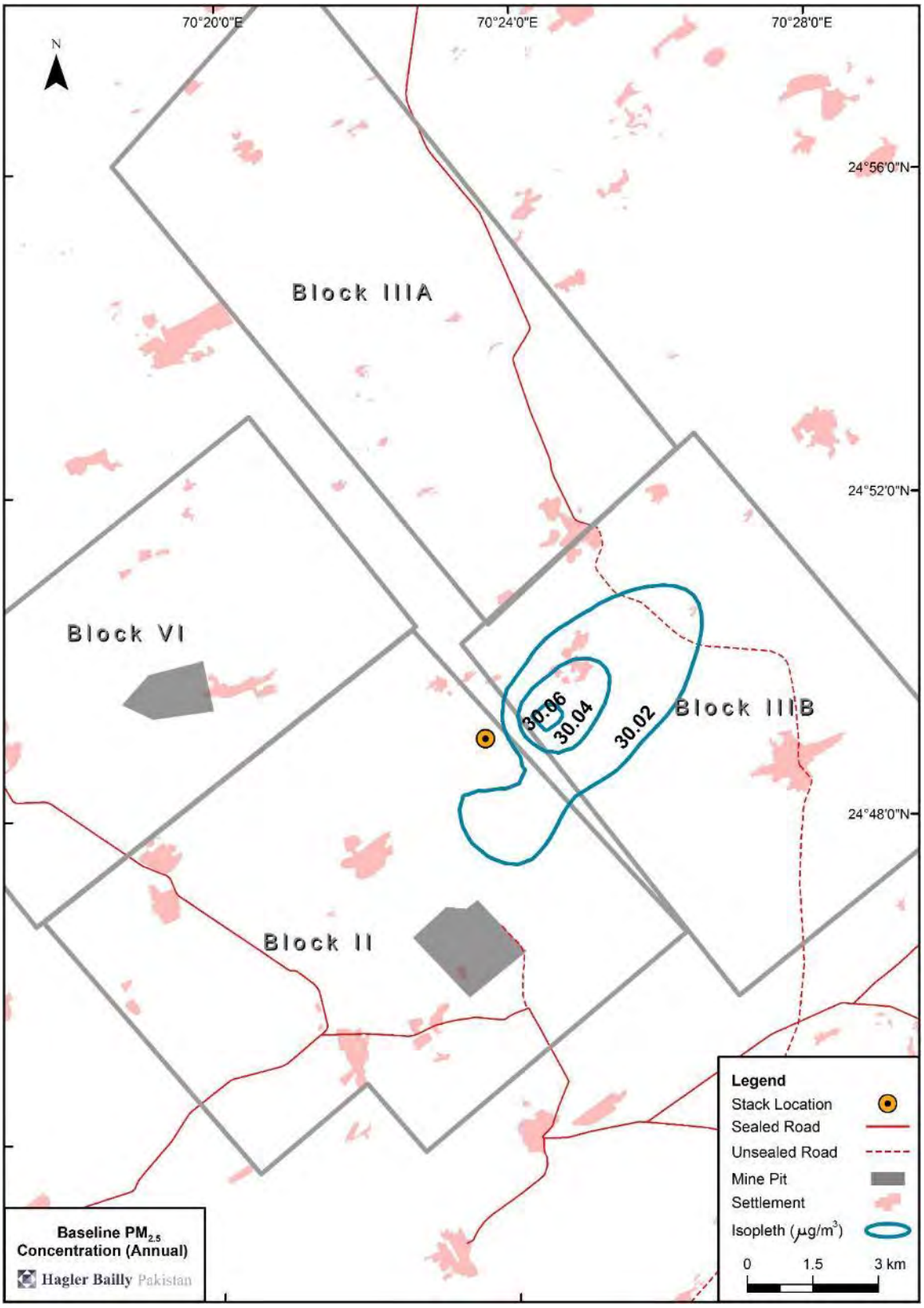


**Exhibit 4.40:** Baseline $PM_{2.5}$ Concentration (24-hour)

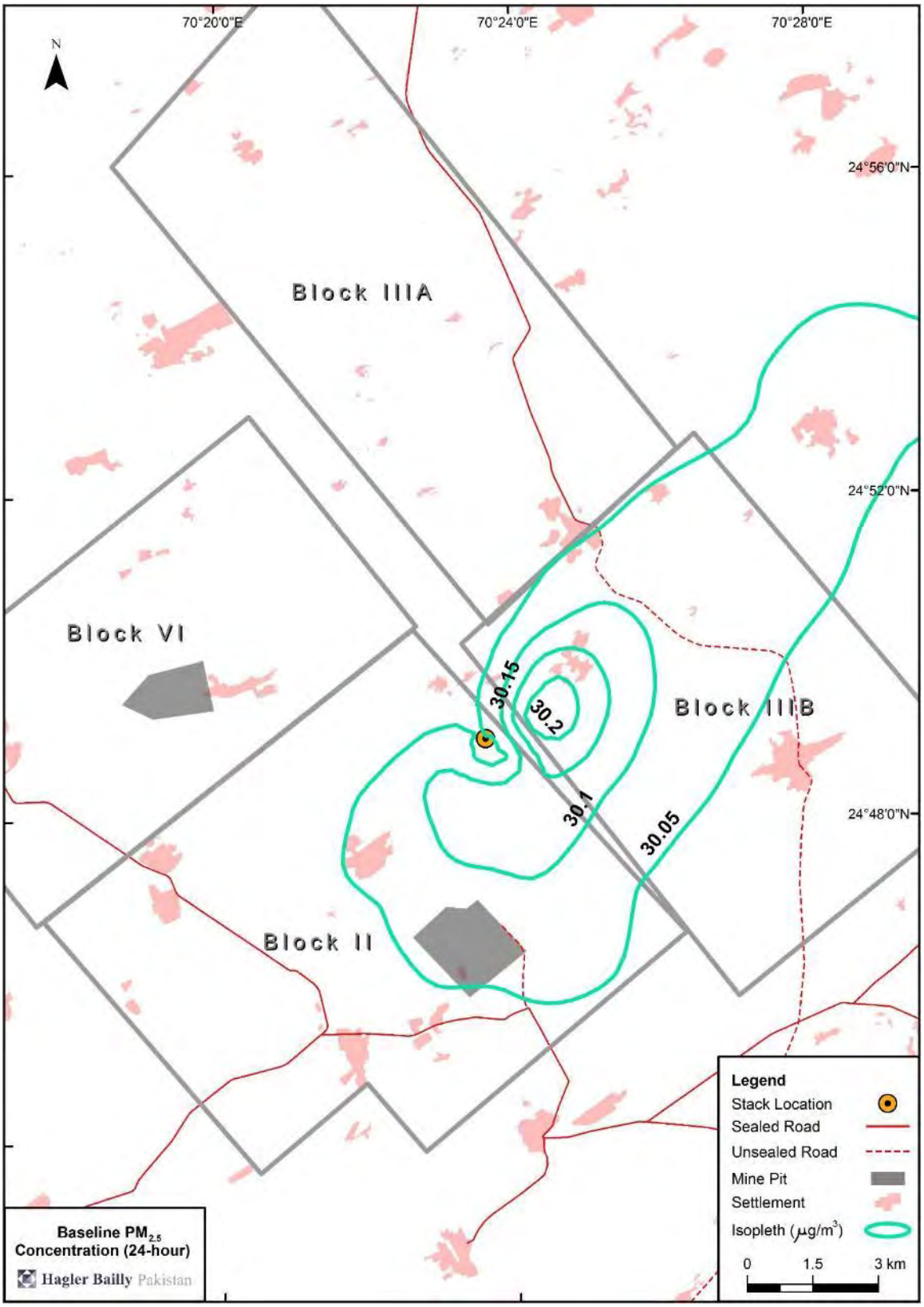


**Exhibit 4.41:** Combined Baseline Results (µg/m$^3$)

| *Pollutant* | *Averaging Period* | *Measured Baseline* | *Modeled Increment* | *Simulated Baseline* | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|
| $SO_2$ | 24-hour (98$^{th}$ percentile) | 7 | 23.8 | 30.8 | 120 | 125 |
| | Annual Avg. | | 7.1 | 14.1 | 80 | - |
| $NO_2$ | 24-hour (98$^{th}$ percentile) | 3 | 15.5 | 18.5 | 80 | - |
| | Annual Avg. | | 4.6 | 7.6 | 40 | 40 |
| $PM_{10}$ | 24-hour (98$^{th}$ percentile) | 140 | 0.6 | 140.6 | 150 | 150 |
| | Annual Avg. | | 0.2 | 140.2 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98$^{th}$ percentile) | 30 | 0.2 | 30.2 | 75 | 75 |
| | Annual Avg. | | 0.1 | 30.1 | 40 | 35 |

The following conclusions can be drawn:

- The 24-hour and annual concentrations of $SO_2$ complies with both SEQS and IFC EHS limits.
- The 24-hour and annual concentrations of $NO_2$ complies with both SEQS and IFC EHS limits.
- The 24-hour concentrations of $PM_{10}$ complies with SEQS and IFC EHS limits.
- The annual $PM_{10}$ concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average. The modelled annual $PM_{10}$ concentrations due to the developments are not a significant cause for exceedance. The background levels of $PM_{10}$ are high due to naturally dusty desert environment.
- The 24-hour $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits. The modeled 24-hour and annual concentrations complies with the standards.

### 4.3.7 Sound Levels

This section defines the baseline ambient sound levels in the Study Area in a manner that can be used for the assessment of the noise impact of the proposed Project.

#### Primary Data

To determine the baseline noise in the area, sound levels were measured at selected locations considered representative of the nearby receptors of possible noise pollution

from the Project. These locations are given in **Exhibit 4.42**. The survey was conducted from the May 11 to 15, 2016. Per second measurements were taken for 24 hours at each location.

**Exhibit 4.42:** Description of Sampling Sites

| *ID* | *Location* | *Coordinates* | *Dates of Survey* | *Rationale* |
|---|---|---|---|---|
| N1 | Bitra | 24° 49' 37.8" N<br>70° 22' 59.5" E | May 12, 2016 | Nearest receptor (village) |
| N2 | Jaman Samo | 24° 49' 19.4" N<br>70° 24' 19.1" E | May 14, 2016 | Background levels near the Project site |
| N3 | South of Energy Park | 24° 48' 12.2" N<br>70° 24' 24.8" E | May 15, 2016 | Background levels near the Project site |
| N4 | Thahriyo Halipota | 24° 45' 15.6" N<br>70° 21' 38.9" E | May 11, 2016 | Road sound levels |

The survey was conducted with Cirrus Research plc.'s sound level meter, Model CR:1720. The instrument meets the International standards IEC 61672-1:2002, IEC 660651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986, and ANSI S1.43-1997 where applicable. The instruments have a resolution of 0.1 dB.

The instrument was mounted on a tripod, to avoid interference from reflecting surfaces within the immediate neighborhood, and a wind shield was used in all measurements. Photographs of the sampling equipment setup are provided in **Exhibit 4.43**. Day time hours are considered to be from 6 am to 10 pm and night time hours are taken to be from 10 pm to 6 am as per SEQS standards for noise.

**Exhibit 4.43:** Sound Sampling Site Photographs

Sound meter at N1 (Bitra, village)

Sound meter at N2 (background levels)

Sound meter at N3 (background levels)

Sound meter at N4 (Thahriyo Halipota, village near road)

### Secondary Data

Additional data on sound levels in the Project area was available from previous ESIA[34]. The previous sampling locations along with the description of each is given in **Exhibit 4.44**.

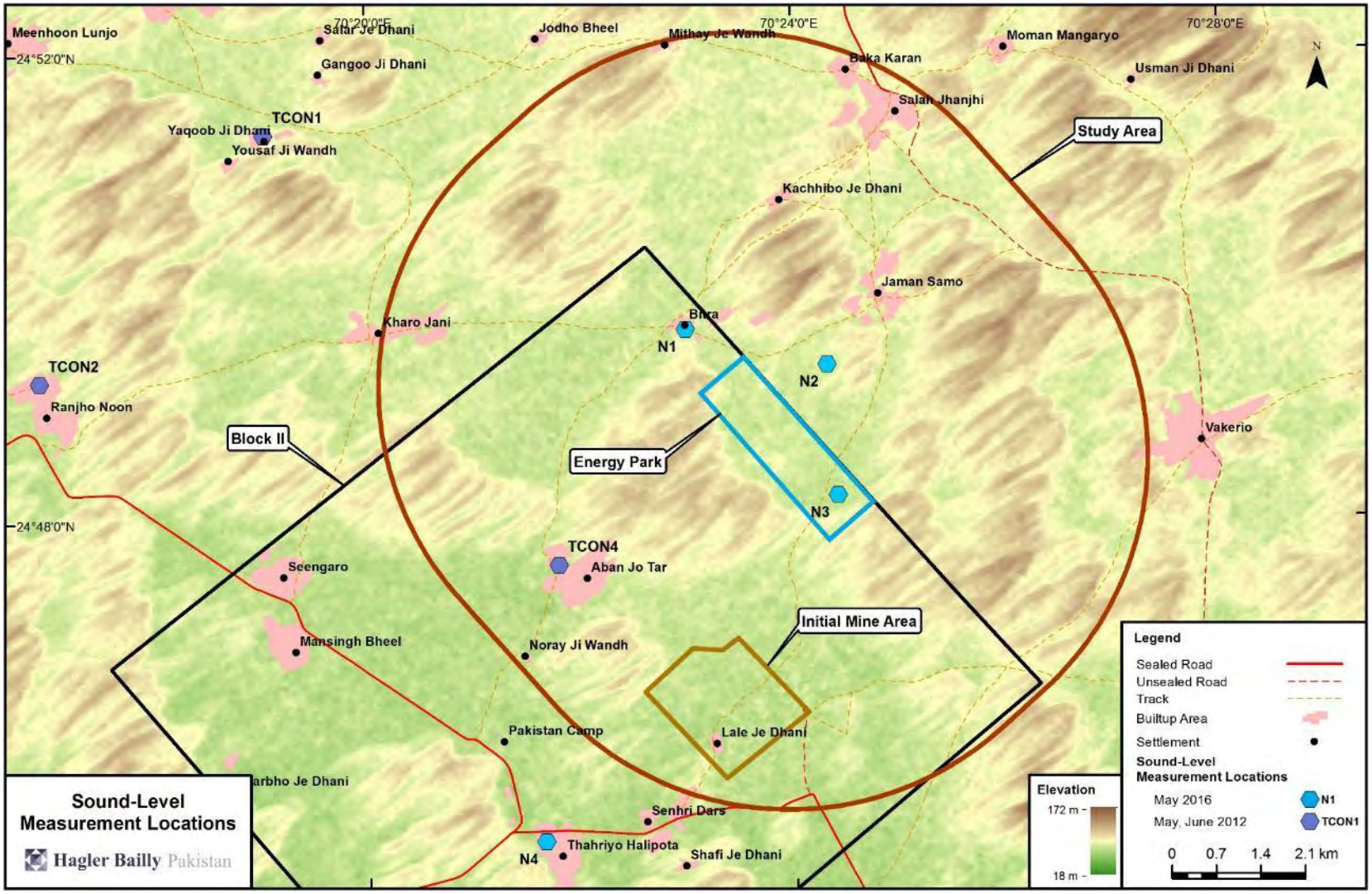
The current and previous sampling locations are shown in **Exhibit 4.45.**

**Exhibit 4.44:** Sound Level Sampling Locations in Literature

| *Sample ID* | *Coordinates* | *Dates of Survey* | *Description* |
|---|---|---|---|
| TCON1 | 24° 51' 18.9" N<br>70° 19' 02.8" E | October 2012 | Yaqoob Ji Dhani |
| TCON2 | 24° 49' 12.1" N<br>70° 16' 55.8" E | October 2012 | Ranjho Noon |
| TCON4 | 24°47' 37.5" N<br>70° 21' 47.3" E | October 2012 | Aban jo Tar |

[34] Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

**Exhibit 4.45:** Sound-Level Measurement Locations



### *Measurement Results and Analysis*

A summary of the results and SEQS for noise are provided in **Exhibit 4.46**. Reported results include:

- $L_{90}$ is the sound level exceeded 90% of the time. The $L_{90}$ is representative of the background sound level.
- $L_{10}$ is the sound level that is only exceeded 10% of the time (higher than $L_{90}$).
- $L_{eq}$ is the average of the total sound level in decibels.

Reported sound levels are on the A scale, which covers the full audible range and is relatable to human hearing.

**Exhibit 4.46:** Summary of Sound Levels during the Survey and from Literature

| *Point* | *Description* | *24 hour (dBA)* | | | *Daytime Averages (dBA)* | *Nighttime Averages (dBA)* |
|---|---|---|---|---|---|---|
| | | $L_{90}$ | $L_{10}$ | $L_{eq}$ | $L_{eq}$ | $L_{eq}$ |
| ***Current Study*** | | | | | | |
| N1 | Village (Bitra) | 31.8 | 52.4 | 51 | 51.8 | 46.0 |
| N2 | Background, no human presence | 35.8 | 46.8 | 45 | 46.2 | 43.0 |
| N3 | Background, no human presence | 29.0 | 41.1 | 40 | 41.9 | 34.2 |
| N4 | Road + Village | 36.0 | 50.2 | 50 | 49.8 | 50.1 |
| ***Literature*** | | | | | | |
| TCON1 | Village | 31.6 | 44.2 | 46.8 | 48.6 | 41.1 |
| TCON2 | Village | 25.8 | 44.5 | 43.9 | 45.5 | 38.6 |
| TCON4 | Village + Road | 34.0 | 55.5 | 52.4 | 53.7 | 46.2 |
| **SEQS** | | | | | **55.0** | **45.0** |

Conclusion

The sound levels of the primary and secondary data are averaged[35] to obtain the sound level baseline as presented in **Exhibit 4.47** and discussed below.

[35] dB cannot directly be averaged due to the log scale of the unit.

**Exhibit 4.47:** Sound Level Baseline of the Study Area

| *Location* | *Average $L_{eq}$ (dBA)* | |
|---|---|---|
| | *Daytime* | *Nighttime* |
| Desert Background | 44.6 | 40.5 |
| Village | 49.4 | 43.0 |
| Village & Road | 52.2 | 48.6 |
| **SEQS** | **55** | **45** |
| **IFC Limits**[36] | **55** | **45** |

The desert background, is very quiet and approximately 10 dBA below SEQS for both day and night time. Observed noise sources included passing livestock herds, braying donkeys, and birds.

Villages have slightly higher noise levels due to the limited village activities. These include a few vehicles that pass through the villages, livestock, and human activities.

Villages near major roads record the highest noise levels. This is because of the road traffic, which includes a large fraction of trucks, jeeps and busses. Moreover, villages near roads often have shops where passengers stop to rest. This has resulted in the exceedance of the nighttime SEQS.

### 4.3.8 Traffic

The traffic baseline was prepared to assess the current traffic conditions on the road route that could be used for Project related transportation of goods and services during construction and operation of the Project.

The selected transport route from Karachi to the Project site is shown in **Exhibit 4.48**. The route, is 366 km long and passes through the following towns:


| | | | | |
|---|---|---|---|---|
| National Highway N-5<br>75 km<br>Two lane<br>7.3 m wide | Provincial Highway<br>105 km<br>Two lane<br>6.1-6.7 m wide | Provincial Road<br>114 km<br>Two/One lane<br>4-6 m wide | Provincial Road<br>44 km<br>Two/One lane<br>4-6 m wide | Provincial Road<br>28 km<br>Two/One lane<br>4-6 m wide |

[36] For IFC EHS limits, daytime is from 7 am to 10 pm, whereas for SEQS daytime is from 6 am to 10 pm. Values in this study were calculated based on SEQS daytime classification. Furthermore, IFC requires hourly Leq to comply with the limit.

**Exhibit 4.48:** Transport Route and Traffic Count Survey Locations

Traffic counts are reported at five points as shown in **Exhibit 4.48**. A photograph of the surveyors and site location is given in **Exhibit 4.49**.

The data for four points (T1, T2, T3, and T4) are based on previous surveys[37]. The previous surveys were conducted between 2012 and 2014. To ascertain the present traffic condition, traffic counts from previous surveys were extrapolated using an annual growth rate of 2.58%[38]. The results are shown separately for each direction in **Exhibit 4.50**.

A traffic count for T5 was conducted for this ESIA on May 12, 2016, on the newly constructed road that will provide access to the Project Site.

**Exhibit 4.49:** Traffic Survey Location

[37] Hagler Bailly Pakistan, August 21, 2015, "Environmental Impact Assessment of 660 MW Coal Fired Power Plant Construction Project at Lakhra in Islamic Republic of Pakistan", GENCO Holding Company Limited, Pakistan.

[38] Pakistan Sustainable Project, "Principle policy guidelines for Sindh urban transport policy", December, 2014.

**Exhibit 4.50:** Traffic on the Transport Route (Karachi to Nagar Parkar Road) in both directions

| *Sub-segments* | *Location ID* | *Survey Date* | *M-cycles* | *Cars* | *Pickups* | *Buses* | *Trucks[a]* | *Trailers/ Trolleys* | ***Total*** | *% of Light Traffic Vehicle* | *% of Heavy Traffic Vehicle* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Karachi – Thatta | T1 | Jul 2012 | 1,862 | 3,405 | 941 | 892 | 1,289 | 20 | **8,409** | 74 | 26 |
| Thatta - Karachi | | | 2,613 | 4,477 | 1,022 | 799 | 1,247 | 11 | **10,169** | 80 | 20 |
| Thatta – Badin | T2 | May 2013 | 1,503 | 1,582 | 383 | 78 | 1,033 | NA | **4,579** | 76 | 24 |
| Badin - Thatta | | | 1,721 | 1,734 | 468 | 130 | 1,121 | NA | **5,174** | 76 | 24 |
| Badin – Mithi | T3 | Mar 2014 | 107 | 91 | 112 | 8 | 133 | 3 | **454** | 68 | 32 |
| Mithi - Badin | | | 127 | 106 | 116 | 12 | 109 | 6 | **476** | 73 | 27 |
| Mithi – Islamkot | T4 | Mar 2014 | 177 | 80 | 124 | 47 | 108 | 2 | **538** | 71 | 29 |
| Islamkot - Mithi | | | 230 | 87 | 144 | 52 | 120 | 1 | **634** | 73 | 27 |
| Islamkot – Project Site | T5 | May 2016 | 74 | 77 | 55 | 4 | 27 | 3 | **240** | 87 | 13 |
| Project Site – Islamkot | | | 74 | 78 | 49 | 3 | 31 | 1 | **236** | 87 | 13 |

Note: NA means data not available

a includes all truck categories from 2 axle to 5 axle.

### 4.3.9 Soil

The soils in Thar are generally coarse-textured, well drained and calcareous in nature. At varying depths a thick accumulation of lime may also be encountered. The soils usually overblown with sand due to severe wind erosion. In general, these are infertile soils.

There are seven main groups of soils found in the Thar. [39]These are:

- Desert soils
- Red desertic soils
- Sierozems (rowinsh gray soils)
- Red and yellow spoils of the foothills
- The saline soil of the depressions
- Lithosols (shallow, weathered soils)
- Rigosols (soft loose soils) found in the hills

### 4.3.10 Groundwater

There are no major rivers within the Thar Desert. Rainwater flows (mostly as sheet flow) to the nearest topographic low, and either evaporates there or infiltrates[40]. The inactive Nara River used to flow in the west of the Thar Desert. The old bed of the Nara River is now utilized as part of the Nara Canal.

Three main aquifers and two aquitards have been identified in the Thar region. These units comprise (from the surface downwards):

- upper aquifer (Top Aquifer), which is located in the base of the dune sands
- fine grained siltstone aquitard
- middle alluvial sand aquifer (Middle Aquifer) of sub-recent age
- claystone and lignite aquitard in the top part of the Bara Formation
- deep aquifer (Deep Aquifer or Bottom Aquifer) of marine sands belonging to the bottom part of the Bara Formation.

A groundwater census was carried out in the Study Area for a previous study[41]. The results are summarized below and the locations shown in **Exhibit 4.51**.

- The wells are open dug wells; no mechanically drilled boreholes were found in the Study Area. Most of the wells are brick-lined.

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[39] Ihsan H. Nadiem: Thar, the Great Pakistan Desert: Land, History, People. Sang-e-Meel Publications, Lahore. 2001

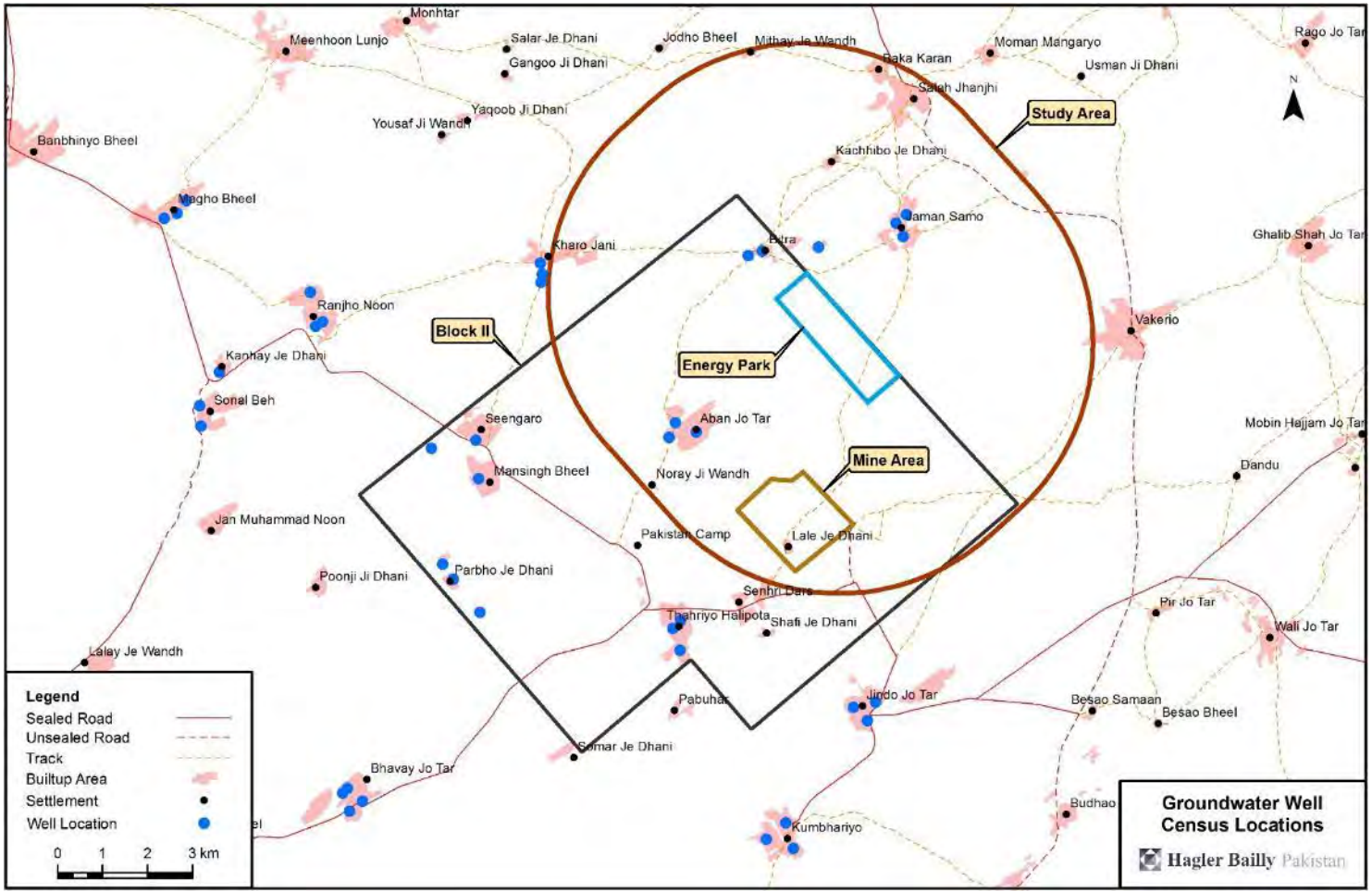
[40] Bender, 1995, Geology of Pakistan

[41] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

- The minimum, maximum and average depths of the well with respect to ground are 48.0 m, 86.4 m, and 60.9 m, respectively; 90% of the wells are between 50 and 70 m in depth.
- The minimum, maximum and average depths of the well with respect to mean sea level are –10.38 m, 31.43 m, and 19.26 m, respectively; 95% of the wells are between 10 and 30 m in depth.

Water quality samples were obtained from the 40 wells and were analyzed for common chemical parameters and heavy metals. The results indicate that in general the water is unfit for human consumption. Sodium, sulfate, chlorides, and hence the total dissolved solids (TDS), exceed the drinking water standards for almost all the wells. The results of these tests are presented in **Exhibit 4.52**.

**Exhibit 4.51:** Groundwater Well Census Locations[42]




[42] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

**Exhibit 4.52:** Water Quality in the Study Area[43]

| *Parameters* | *Unit* | *Min[a]* | *Max[b]* |
|---|---|---|---|
| pH | - | 7.48 | 8.42 |
| EC | µS/cm | 3,280 | 14,500 |
| Sodium | mg/l | 500 | 2,460 |
| Magnesium | mg/l | 10 | 240 |
| Calcium | mg/l | 11 | 320 |
| Potassium | mg/l | 9 | 58 |
| Sulfate | mg/l | 150 | 712 |
| Chloride | mg/l | 975 | 5,599 |
| Bicarbonate | mg/l | 185 | 729 |
| Silica Dioxide | mg/l | 11.2 | 15.4 |
| Hardness (as $CaCO_3$) | mg/l | 68 | 1,705 |
| Sulfide | mg/l | <1.00 | |
| Fluoride | mg/l | 0.495 | 1.14 |
| TDS | mg/l | 1,996 | 9,584 |
| Iron | mg/l | 0.05 | 0.675 |
| Aluminum | mg/l | 0.075 | 0.28 |
| Manganese | mg/l | 0.025 | 0.08 |
| Arsenic | mg/l | 0.005 | 0.01 |
| Copper | mg/l | 0 | 0 |
| Lead | mg/l | 0.02 | 0.1 |
| Zinc | mg/l | 0.025 | 0.05 |
| Cadmium | mg/l | 0 | 0 |
| Nickel | mg/l | 0.025 | 0.25 |
| Chromium | mg/l | 0 | 0 |
| Cobalt | mg/l | 0 | |
| Selenium | mg/l | 0 | 0 |
| Mercury | mg/l | 0 | 0 |

a Minimum value among the 40 wells
b Maximum value among the 40 wells

[43] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

## 4.4 Ecological Baseline

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

### 4.4.1 Protected Areas in the Vicinity of the Study Area

The Protected Area closest to the Study Area is the Rann of Kutch Wildlife Sanctuary. It is located 32 km from Study Area. The Rann of Kutch Ramsar Site is the only designated area of global conservation importance present in the vicinity of the Study Area, being a part of the 1.6 million hectares of wetlands of international importance stretching across the two countries of India and Pakistan.[44] The Rann of Kutch Ramsar Site information sheet provides a list of species present within the Ramsar Site which includes a total of 154 plant species, 26 mammal species, 14 reptile species (no amphibian species) and 107 bird species.[45] Based on these figures it can be concluded that the Rann of Kutch Ramsar Site is an area richer in biodiversity compared to the Study Area. The location of the Project relative to the Rann of Kutch Ramsar Site is shown in **Exhibit 4.53**.

[44] World Wildlife Fund (WWF). Desert wetlands, World Wildlife Fund Global, News and Stories (February 2003)

[45] Hussain Bux Bhaagat, Information Sheet Ramsar Wetlands, Sindh Wildlife Department, (September 2002). Available at <http://www.ramsar.org/>, accessed January 27, 2016

**Exhibit 4.53:** Rann of Kutch Ramsar Site and Project Location

### 4.4.2 Habitat Types in the Study Area

Habitats within the Study Area were classified relying primarily upon geomorphology and soil texture, with consideration of variations within habitat types. The Study Area was classified by geomorphological characteristics into Agricultural Fields, Sand Dunes with Agriculture, Sand Dunes, Plains and Settlements. The relative percentage of each habitat type has been provided in **Exhibit 4.54**.

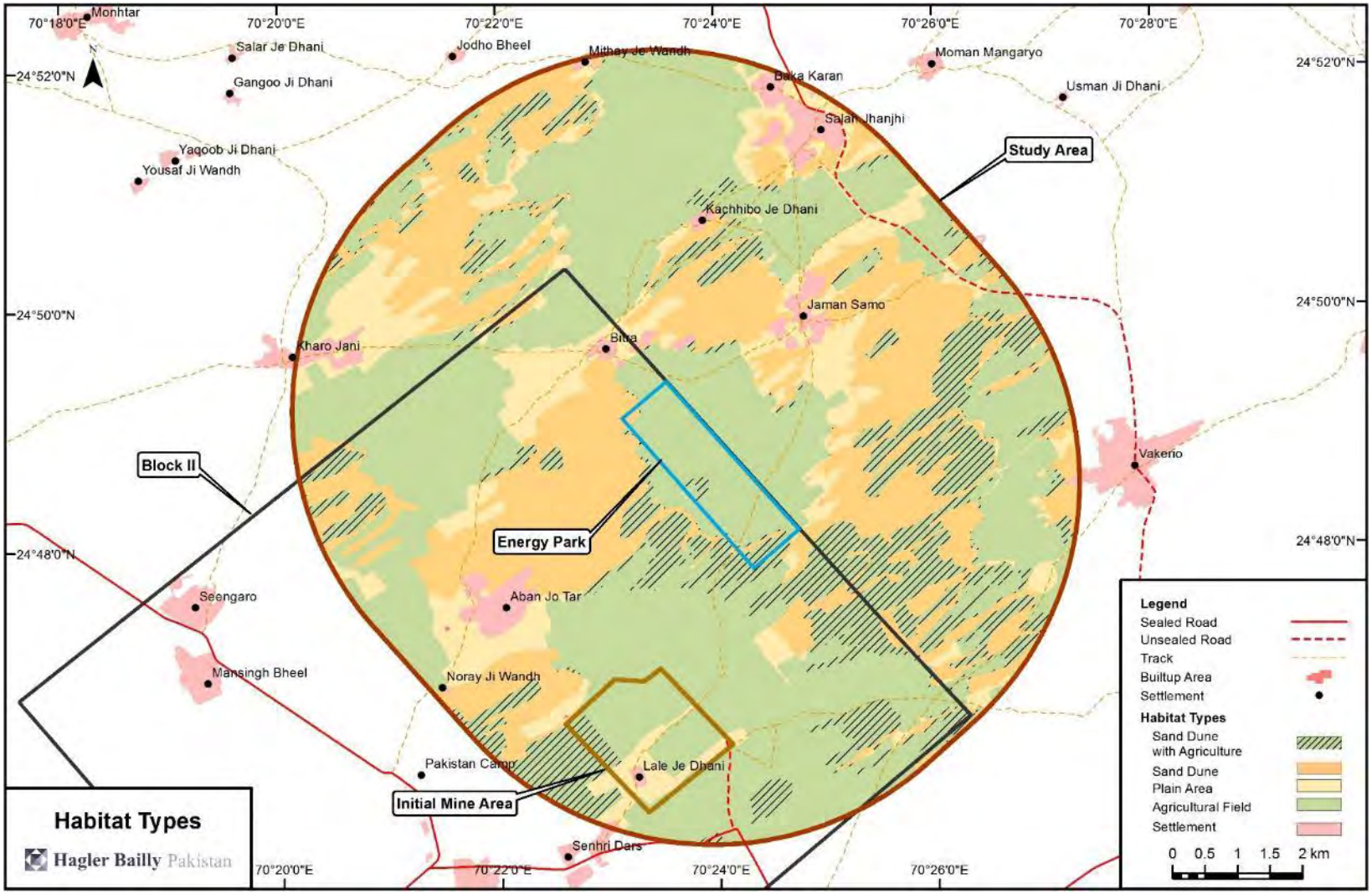
A map showing the distribution of the different habitat types has been shown in **Exhibit 4.55**.

**Exhibit 4.54:** Table giving Habitat type Percentages

| *Habitat Type* | *Percentage of Study Area (%)* |
|---|---|
| Agricultural Fields | 46 |
| Sand Dunes | 24 |
| Sand Dunes with Agriculture | 15 |
| Plain | 13 |
| Settlements | 2 |

Agriculture Fields are the dominant habitat, constituting 46% of habitats of the Study Area. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. Sand dunes are the second dominant habitat, constituting 24% of the total habitat. They vary in height, ranging from a few meters to over a hundred meters. Sand Dunes with Agriculture are the third most dominant type making up 15% of the Study Area with Plains constituting 13% and Settlements constituting 2%. An established tradition of preservation of trees contributes to maintaining the vegetation cover in the Thar Desert. Grazing pressure, however, is significant and the ground vegetation in terms of grasses, scrubs and bushes can be considered as uniformly degraded.

**Exhibit 4.55:** Habitat Types within the Study Area



### 4.4.3 Ecological Resources

Information about the ecological resources in the Study Area has been obtained from the surveys carried out as part of other studies done both within the Study Area as well as nearby areas. The following reports have been used to collect information about the flora and fauna present within the Study Area:

- Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Block VI Lignite Mining Project, Main Report for Sindh Carbon Energy Limited, April 2013
- Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012
- Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

#### *Vegetation*

The vegetation of the Thar Desert can be classified as Tropical Thorn Forest.[46] It comprises mainly scattered trees and bushes.[47] These are mainly thorny, drought resistant species and grasses. Following rains, lush green grasses sprout providing a rich source of fodder.[48] The vegetation is typical of arid regions with adaptations to survive the extreme conditions of the desert environment.[49]

A total of 137 plant species have been reported from the Tharparkar area. These plant species are the base for the animal and human life in the desert. The plants are used for a variety of purposes, including production of medicines, resins, dyes and fibers, and for construction, forage and fodder making. The habitat in the Thar Desert is influenced by the extreme climate. The vegetation consists of xerophilious grasslands of *Eragrostis sp*. *Aristida adscensionis, Cenchrus biflorus, Cympogon sp., Cyperus sp., Eleusine sp., Panicum turjidum, Lasiurus scindicus, Aeluropus lagopoides, and Sporobolus sp*. Scrub vegetation consists of low trees such as *Acacia nilotica, Prosopis cineraria, Prosois juliflora, Tamrix aphylla, Zizyphus mauritiana, Capparis decidua*, and shrubs such as *Calligonum polygonoides, Calotropis sp., Aerva sp., Crotalaria sp.. Haloxylon salicornicum* and *Haloxylon recurvum* are also present. The region comprises 9.1% of the total flora of Pakistan, making it poor in terms of floristic diversity.[50]

None of the plant species found during the survey is listed under either the IUCN Red List of Threatened Species or under the Pakistan legislation.

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[46] Nisar Ahmad Khan. Deserts in Pakistan. Pakistan Geographic, <http://pakistangeographic.com/deserts.html>, accessed December 17, 2015

[47] Ibid

[48] Ibid

[49] Chapter 1: Biological Adaptations to Aridity. Global Deserts Outlook, United Nations Environment Programme. Available at, <http://www.unep.org/geo/gdoutlook/028.asp>, accessed December 17, 2015.

[50] Nasir, Yasin J., and Rubina A. Rafiq. "Wild flowers of Pakistan." Karachi: Oxford University Press xxxiii, 298p. 104p.of plates-illus., col. illus.. ISBN195775848 (1995).

The only plant species included in the CITES Species List is Leafless Milk Hedge (Thor) *Euphorbia caducifolia* that is included in Appendix II.[51] It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[52]

The data for the vegetation survey carried out for the Thar Coal Block II Mining Project[53] has been provided in **Appendix G** along with information about their phytosociological attributes.

### *Mammals*

Thirty-five (35) mammalian species have been reported from the Tharparkar area, which includes large mammals from the Family Canidae (dog family), Felidae (cat family), Hyaenidae (hyena family), Mustelidae (e.g. badgers, weasels etc.), Bovidae (rumenant mammals such as gazelle), Equidae (such as wild ass) and Suidae (artiodactyl mammals such as boars, pigs etc.). Small mammals reported from the Study Area include members from the Family, Erinaceidae (e.g. hedgehogs), Soricidae (e.g. shrews), Herpestidae (e.g. mongoose), Rhinopomatidae (insectivorous bats), Vespertilionidae (e.g. Common Bat), Manidae (pangolins), Leporidae (rabbits and hares), Sciuridae (squirrels), Hystricidae (porcupines) and. Muridae (family of rodents).[54]

The mammal species observed during the surveys carried out as part of the environmental and social impact assessment of the Thar Coal Block II Mining Project[55] included both small and large mammal species. The small mammal species, the Balochistan gerbil *Gerbillus nanus* was found to be the most abundant followed by *Tatera indica* and Indian desert jird *Meriones hurrianae*. Common medium sized mammals included the Long-eared Desert Hedgehog *Hemiechinus collaris* and Five-striped Palm Squirrel *Funambulus pennantii.* The large mammal species, Fox *Vulpes sp.,* Indian Hare *Lepus nigricollis* and Indian Hedgehog *Paraechinus micropus* are the abundant species in the Study Area while the rest of the species are comparatively less common. The Striped Hyaena *Hyaena hyaena* is listed as Near Threatened in the IUCN Red List of Threatened Species. It was not sighted but signs (foot print) indicating its presence were seen during the April 2010 survey for the environmental and social impact assessment of the Thar Coal Block II Mining Project.[56] Dens of this species were not observed in the area. None of the mammalian species observed is exclusively found in the Study Area and the habitat of the species found is widespread across the Thar Desert.

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51 UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed November 20, 2015

52 LLifle, Encyclopedias of living forms, The Encyclopedia of Succulents, *Euphorbia caducifolia*, <http://www.llifle.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/28041/Euphorbia_caducifolia>, accessed December 18, 2015

53 Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

54 Khan, Abdul Aziz, Waseem Ahmad Khan, and Abdul Aleem Chaudhry. "Mammalian Diversity in Thar Desert Habitat of Tharparkar District, Sindh, Pakistan." Pakistan J. Zool 47, no. 5: 1205-1211, (2015)

55 Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

56 Ibid

The data for the mammal survey carried out for the Thar Coal Block II Mining Project[57] has been provided in **Appendix E** with information about their conservation status based on National Status, the IUCN Red List of Threatened Species and the CITES Appendices.

### *Avifauna*

There is no permanent wetland close to the Study Area; therefore avifauna of the area predominantly consists of terrestrial birds. During the surveys carried out for the environmental and social impact assessment of the Thar Coal Block II Mining Project[58] 50 bird species were observed of which 43 are classified as resident, five as passage migrants and irregular year round visitors, one as a summer breeder and one was an isolated or occasional breeder in the Study Area.

A total of seven nests of Egyptian Vultures *Neophron percnopterus* were identified in the Study Area during the surveys for the environmental and social impact assessment of the Thar Coal Block II Mining Project[59], of which five were empty and two were occupied. A further three empty nests were located on *Prosopis cineraria* trees, which are thought to be nests of either the White-backed Vulture *Gyps bengalensis* or the Egyptian Vulture *Neophron percnopterus*. One active nest of a Tawny Eagle *Aquila rapax*, one active nest of a Spotted Owlet *Athene brama* and a further 10 nests of unknown bird species were identified in the Study Area.

The subfamily *Aegypinae* contains 15 species of old world vultures, 8 of which are reported in Pakistan. Of the four belonging to the genus *Gyps*, three including Oriental White-backed Vulture *Gyps bengalensis,* are listed as Critically Endangered in the IUCN's Red List of Threatened Species. The Egyptian Vulture *Neophron percnopterus* is listed as Endangered (IUCN Red List of Threatened Species). The Greater Spotted Eagle *Clanga clanga* is listed as Vulnerable in the IUCN Red List of Threatened Species. It was seen in the Study Area in the April 2010 survey. The Laggar Falcon *Falco jugger* is listed as Near Threatened in the IUCN Red List of Threatened Species and was also seen in the Study Area during the April 2010 surveys.

The data for the avifauna survey carried out for the Thar Coal Block II Mining Project[60] has been provided in **Appendix G** along with information about their conservation status based on the IUCN Red List of Threatened Species and the CITES Appendices.

### *Herpetofauna*

Of the 32 species of reptiles reported in the literature and likely to be found in the area, 17 were observed during the surveys conducted in the Study Area for the environmental and social impact assessment of the Thar Coal Block II Mining Project.[61] Of these, common species were the Indian fringe-toed sand lizard *Acanthodactylus cantoris*, Three-toed snake skink *Ophiomorus tridactylus,* garden lizard *Calotes versicolor*, yellow-tailed

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57 Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

58 Ibid

59 Ibid

60 Ibid

61 Ibid

sand gecko *Crossobamon orientalis* and brilliant ground agama *Trapelus agilis*. The species found were evenly distributed across three habitats in the Study Area, namely, Agricultural Fields (including Sand Dunes with Agricultural Fields), Sand Dunes and Plains during the surveys carried out for the Thar Coal Block II Mining Project.[62]

The three species of amphibians known to occur in the Study Area include the Indus Valley toad *Duttaphrynus stomaticus*, the Common Skittering Frog *Euphlyctis cyanophlyctis* and the Indian Bullfrog *Hoplobatrachus tigerinus.*[63] None of these amphibian species are of conservation importance based on the IUCN Red List of Threatened Species,[64] however, the Indian Bullfrog is listed in Appendix II of the CITES Species List.[65]

None of the species observed or reported in the area are on the IUCN Red List of Threatened Species. However, according to one reference[66], three species are endemic to Pakistan which include the Red-throated Ground Agama *Trapelus rubrigularis*, the Sindhi Krait *Bungarus sindanus* and the Cholistan Desert Lacerta *Eremias cholistanica*. However, according to the Reptile Database online resource only the Cholistan Desert Lacerta is endemic.[67]

The data for the herpetofauna survey carried out for the Thar Coal Block II Mining Project[68] has been provided in **Appendix G** along with information about their conservation status based on Pakistani guidelines and CITES Appendices.

### 4.4.4 Conclusions

Vegetation – there are no plant species of conservation importance in the Study Area.

Mammals – none of the mammal species are of conservation importance based on the IUCN Red List of Threatened Species. However, according to Pakistan's National Red List, there are certain species which are of conservation importance, however, their distribution is widespread and not limited to the Study Area.

Herpetofauna – there is at least one endemic species and possibly three. However, their distribution is widespread and they are not restricted to any habitat type, therefore, there is no species of conservation importance in the Study Area amongst herpetofauna.

Birds – the main concern is with respect to vulture species and certain bird species such as the Laggar Falcon which are of conservation importance according to the IUCN Red List of Threatened Species.

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62 Ibid

63 Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

64 IUCN 2015. *The IUCN Red List of Threatened Species. Version 2015-4*. <http://www.iucnredlist.org>. accessed December 14, 2015

65 UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed 19th November 2015

66 Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

67 Uetz, P. (editor), The Reptile Database, http://www.reptile-database.org, accessed May 9, 2016

68 Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

The only protected area near the Study Area is the Rann of Kutch Wildlife Sanctuary. This is 32 km from the Study Area and will not be adversely affected by the Project.

## 4.5 Socioeconomic Baseline

The baseline was developed using a combination of secondary sources. The main data source was the ESIA Thar Coal Block II Power Plant Project, for which the Study Area covers the same villages as this study. Ground verification was performed during consultations with the villages in the Study Area.

Other key secondary sources of information for this baseline study include official statistics, such as maps, census reports and other available documentation on the history of the people and the area from a broad selection of recent and reliable sources, both published and unpublished. These sources of information include:

- Information collected from the Thardeep Rural Development Programme offices;
- Development Statistics of Sindh, 2006;
- Pakistan Social and Living Standards Measurement Survey (PSLM) 2006-07;
- District Census Reports, 1998, published by Population Census Organization, Government of Pakistan;
- Development statistics published by the Federal Bureau of Statistics, Government of Pakistan;
- Other published material from the private sector, including NGOs working in the Sindh province.

### 4.5.1 Governance and Administration

Thar Desert has been governed by various rulers of Sindh over the last millennium. In 1843, the British rulers merged it into the Kutch Political Agency. In 1882, the Thar Desert was upgraded to the Tharparkar District and made a part of the Hyderabad Collectorate. In December 1990, the district was bifurcated into two districts including Mirpurkhas, and Tharparkar with headquarters at Mithi.

The Study Area falls within the Tharparkar District of Sindh Province. The District lies between 24° 10' to 25°45' N latitudes and 69' 04' to 71°06' E longitudes. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*zila*) Council Chairman. The District administration comprises District offices including sub-offices at UC and town level (includes municipal and town committees).

The District is bounded on the east by India (Jaisalmer District), whereas the northern and western peripheries are bounded by the Mirpurkhas and Badin districts respectively. In the south of Tharparkar, there is an extensive marsh, known as Rann, and the Indian district of Kutch.

Tharparkar is administratively divided into six *talukas*, namely Mithi, Diplo, Nagarparkar and Chachro, Dhali and Islamkot. The taluka are further sub-divided into Union Councils, town committees and municipal committees. Each Union Council has villages (*dehs)* under its administration, while the municipal and town committees have municipal

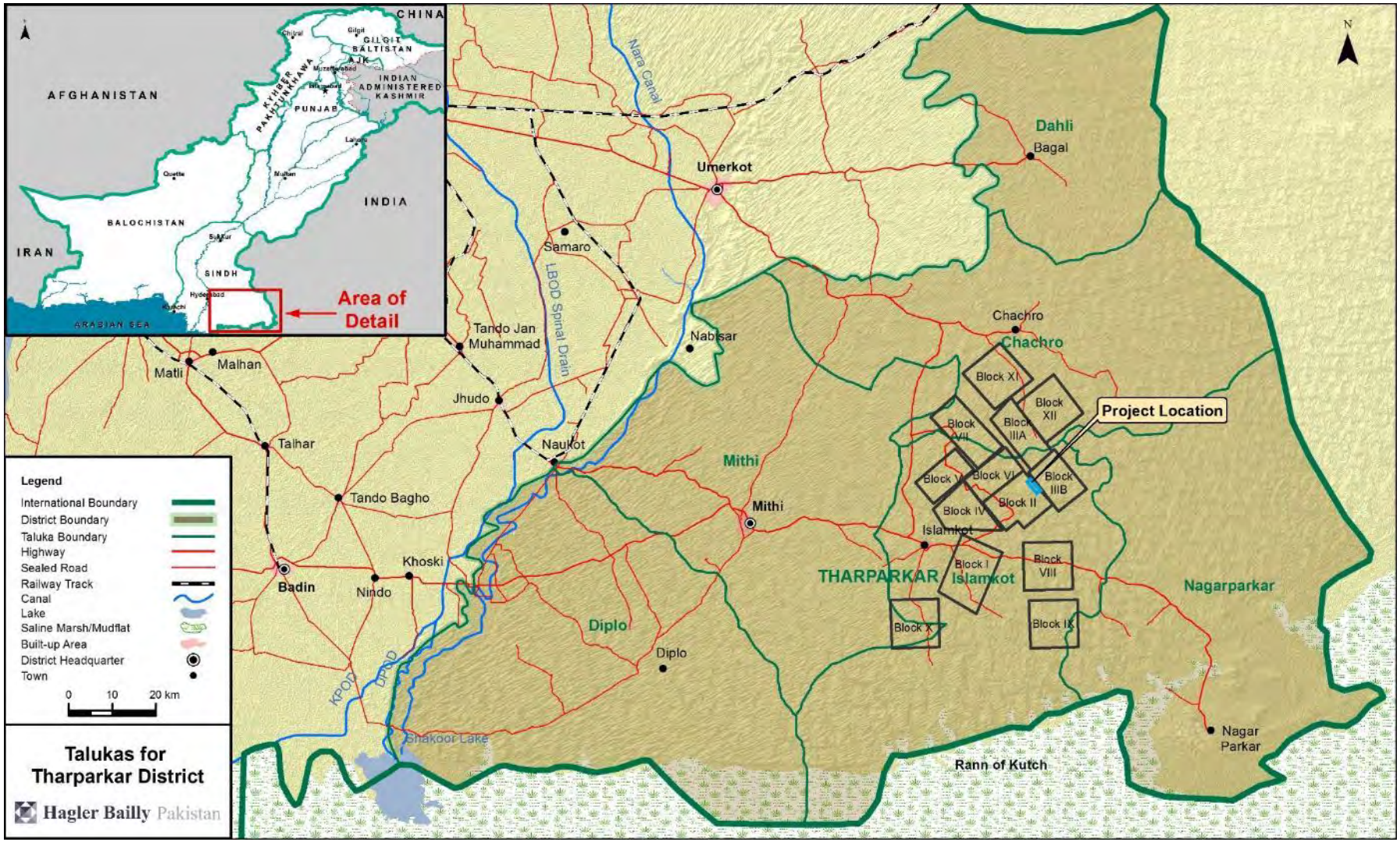
or town subdivisions called *wards*. The Energy Park falls within the Islamkot *taluka* as shown in **Exhibit 4.55**.

### *Social Organizations*

Civil society organizations have been active in Tharparkar District since the 1960s. Save the Children Fund, now transformed into Thardeep Rural Development Program (TRDP), is the largest NGO in Sindh. It has staff, offices and programs in all *talukas* of the Tharparkar district, and a field office in the town of Islamkot near Thar coal field. and Participatory Village Development Programme (PVDP) works mostly with the *Kolhi* and *Bheel* scheduled castes. Other NGOs working in Tharparkar include the Trust for Voluntary Organizations (TVO), Baanhn Beli (helping hands) organization and the Marooara Coordination Council. Civil society groups in the area include the Press Club Mithi, Press Club Islamkot and Sindhi Adabi Sungat among others.

The performance of these social and political organizations is perceived to be above average by the locals in the Study Area.

**Exhibit 4.56:** Talukas for Tharparkar District



### 4.5.2 Land Cover and Land Use

The Study Area covers 111 square km of which of sand dunes cover 43 km$^2$ (38%) and plains cover 69 km$^2$ (62%)[69]. Major land uses in the Study Area consists of settlements (2%), agricultural fields (61%) and grazing areas (37%). Sand dunes are permanent with significant vegetative cover and therefore are suitable for use as grazing lands. Once the crop is harvested livestock is also grazed on the agricultural fields. Photographs of different land uses are shown in **Exhibit 4.57**. The distribution of these uses is given in **Exhibit 4.58** and a land use map is shown in **Exhibit 4.59.**

**Exhibit 4.57:** Photographs of Different Land Uses in the Study Area

Sand Dunes are permanent with significant vegetation cover.

Uncultivated plains are used for grazing livestock.

A village on the plain, nestled between dunes

Agriculture field on the plains.

[69] As indicated by digitized Google Earth imagery dated April 10, 2013.

**Exhibit 4.58:** Land Cover and Land Use Distribution in the Study Area

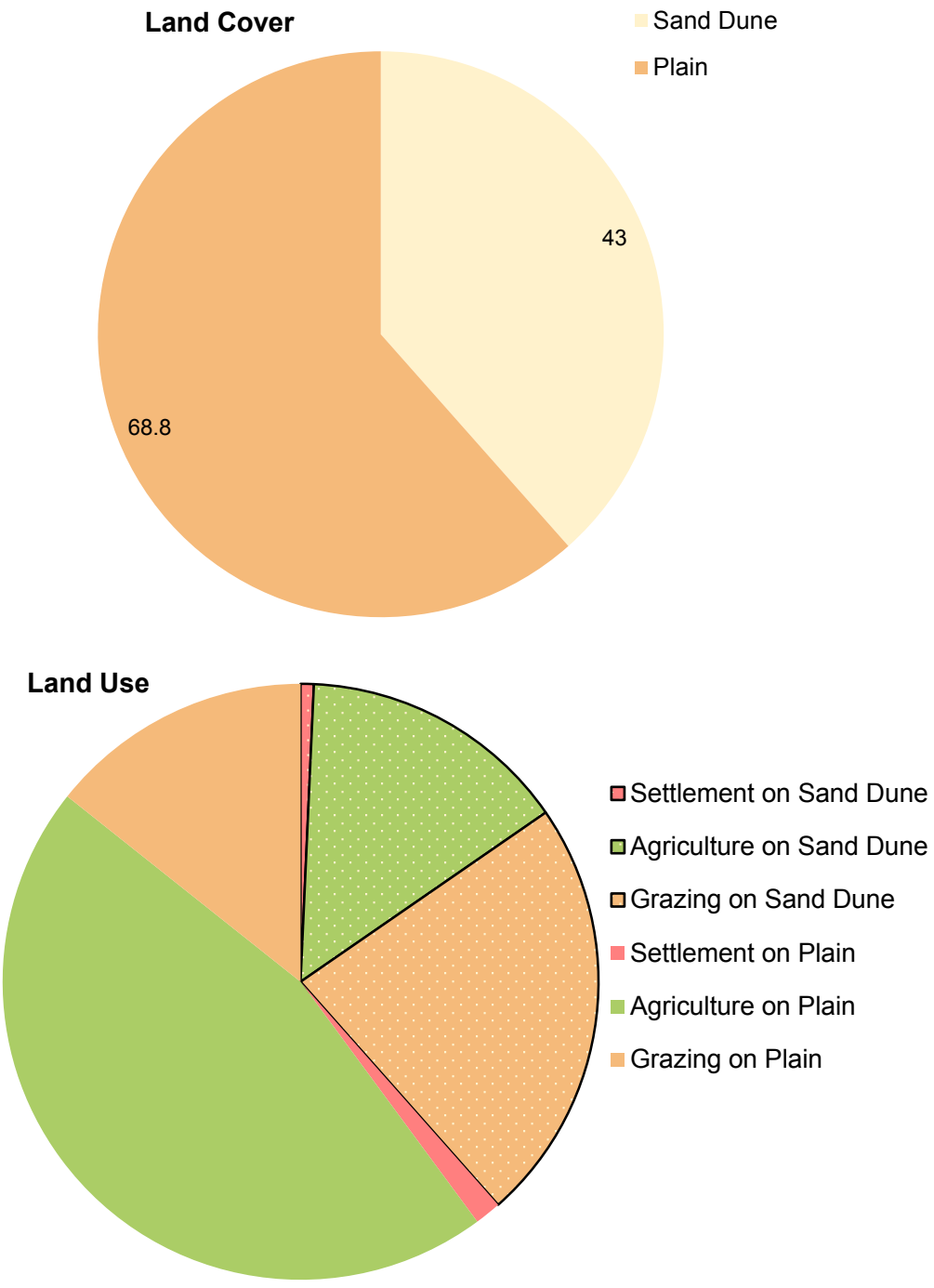
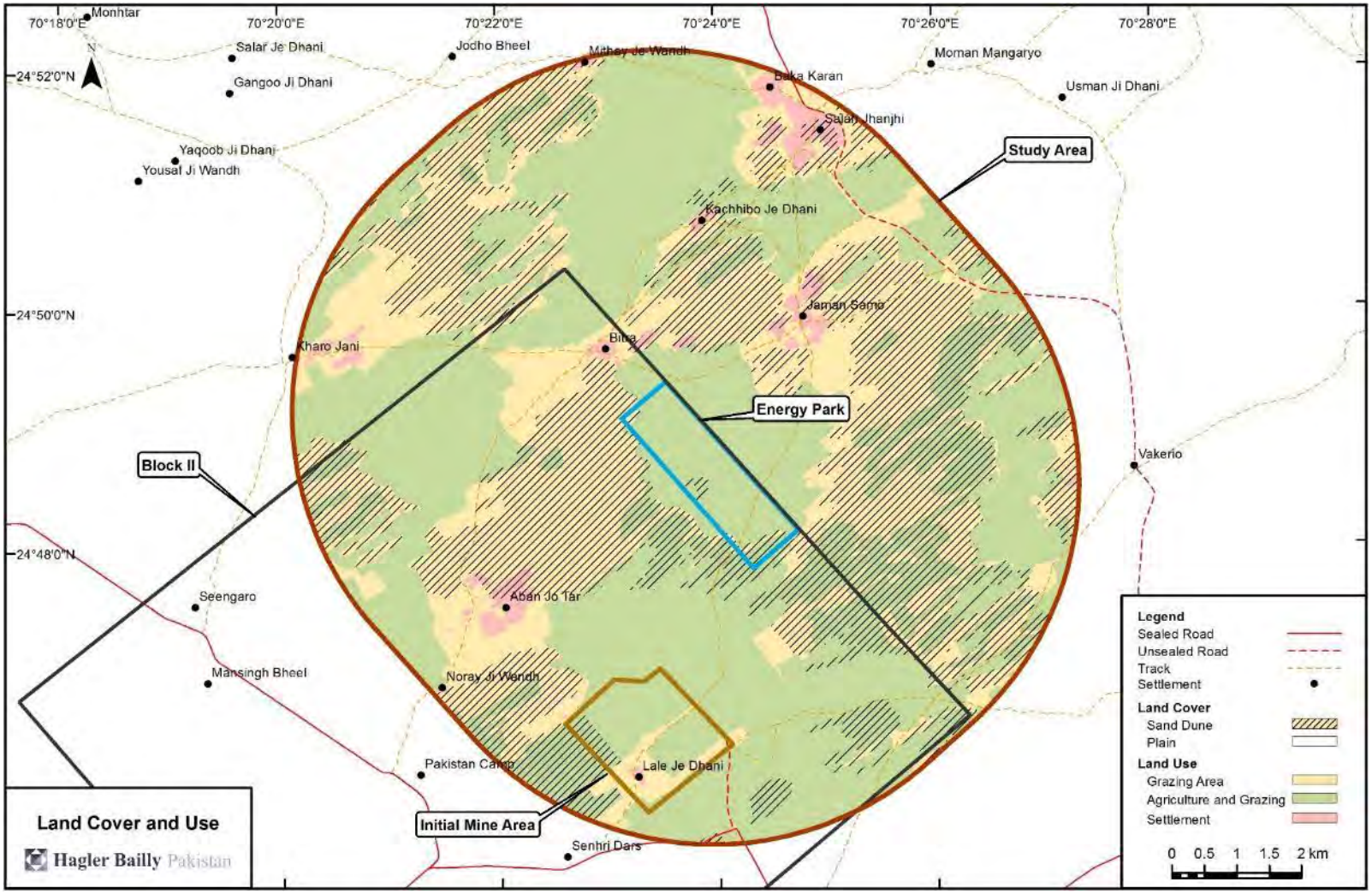


**Exhibit 4.59:** Land Cover and Land Use



### 4.5.3 Demography

The estimated population of the Tharparkar District ('District') as compared to Sindh and Pakistan is given in **Exhibit 4.60.** Although the Thar Desert is considered as one of the most densely populated deserts in the world, the population of Tharparkar District represents less than one percent of the country's population and three percent of Sindh's population. The population density of the District is low at 47 persons per square kilometer, nearly 6.7 times lower than the provincial average of 326 persons per square kilometer. However, the density is on the rise since 1998.

**Exhibit 4.60:** Population and Growth[70]

| | *Population, 000'* | | | | *Land Area* | | *Density (persons per sq. km)* | |
|---|---|---|---|---|---|---|---|---|
| | *1998* | *%* | *2015** | *%* | *sq. km* | *%* | *1998* | *2015** |
| Study Area | NA | NA | 6.2**[71] | | 112 | 0.01% | NA | 55 |
| Tharparkar (District) | 914* | 0.7% | 1,273 | 0.7% | 19,638 | 2.5% | 47 | 65 |
| Sindh | 30,440 | 23.0% | 45,988 | 24.0% | 140,914 | 17.7% | 216 | 326 |
| Pakistan | 132,352 | 100.0% | 191,708 | 100.0% | 796,096 | 100.0% | 166 | 241 |

Note: * 2010 for Tharparkar
** 2014 for Study Area

The Study Area, as with the majority of Tharparkar is rural, and contains ten villages with an average of approximately 600 persons per settlement. The distribution of the population by settlement is given in **Exhibit 4.61.**

**Exhibit 4.61:** Population of Settlements in the Study Area[72]

| *No* | *Village* | *Population* |
|---|---|---|
| 1 | Baka Karan | 500 |
| 2 | Salah Jhanjhi | 1,500 |
| 3 | Kachhibo Je Dhani | 210 |
| 4 | Jaman Samo | 900 |
| 5 | Bitra | 600 |
| 6 | Mithay Je Wandh | 120 |
| 7 | Kharo Jani | 1,200 |
| 8 | Aban Jo Tar | 1,100 |

[70] Ministry of Finance, Government of Pakistan, Statistical Appendices of Chapter 12, Population, Labour Force and Employment, Pakistan Economic Survey 2014-2015, (Government of Pakistan, 2015)

[71] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

[72] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

| *No* | *Village* | *Population* |
|---|---|---|
| 9 | Lale Je Dhani | 30 |
| 10 | Noray Ji Wandh | 60 |
| | **Total** | **6231** |

### *Size of Settlements and Households*

A comparison of village and household sizes as recorded in the Study Area with those recorded by the 1998 district statistics for Tharparkar is presented in **Exhibit 4.62** and **Exhibit 4.63** respectively. The population density map in **Exhibit 4.64**, shows the population of each village in the Study Area. Village sizes, in terms of population in the Study Area, range from 60 to 1,500 for the smallest and largest settlements respectively.

**Exhibit 4.62:** Average Population per Settlement in Tharparkar and Study Area[73]

| | *Number of Settlements* | *Total Population* | *Average Population per Settlement* |
|---|---|---|---|
| Study Area | 10 | 6231 | 623 |
| Tharparkar (1998) | 2000 | 914,291 | 4,57 |

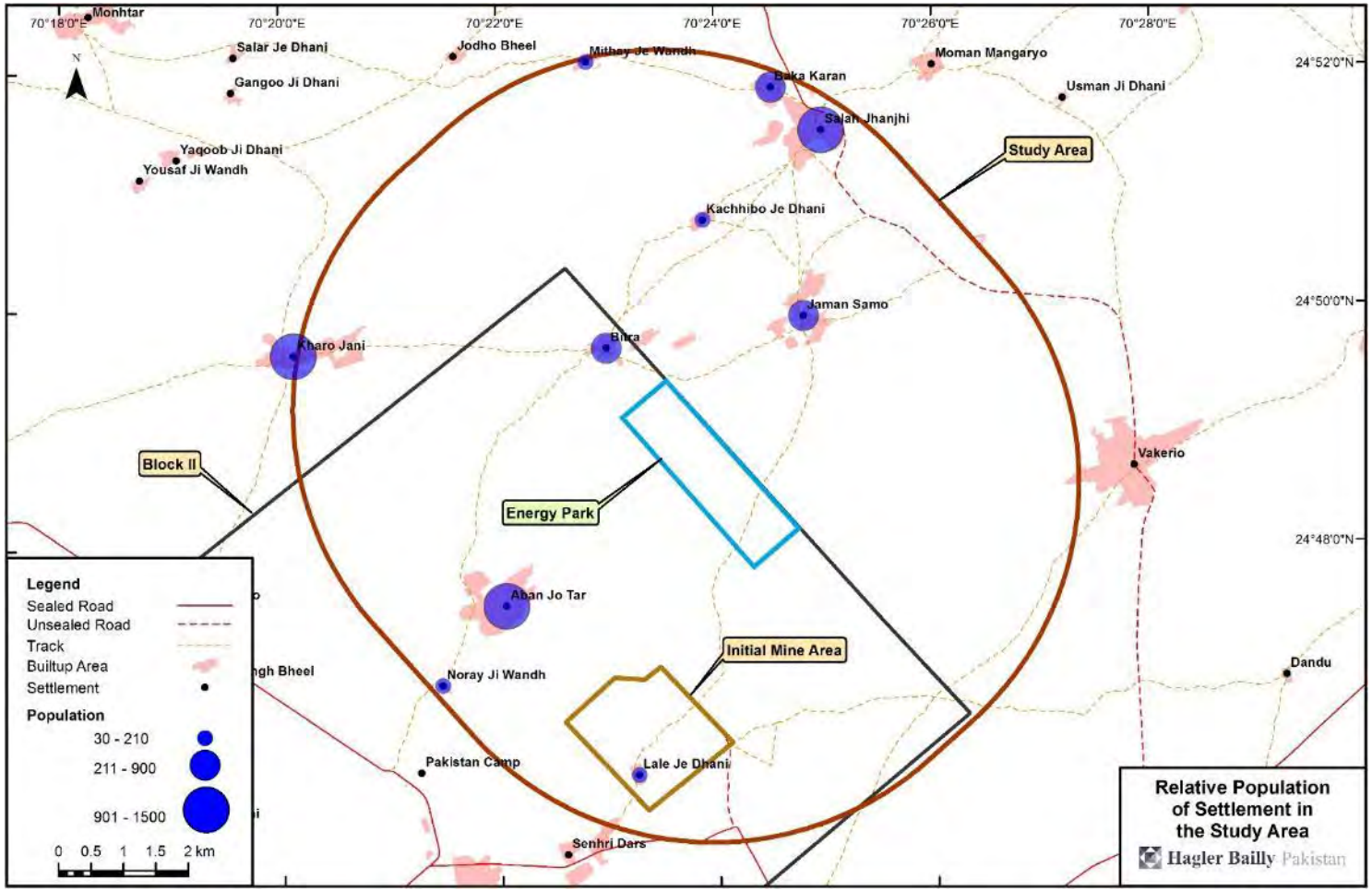
**Exhibit 4.63:** Average Household Size

| | *Sample Size* | *Average Household Size* |
|---|---|---|
| Previous Study[74] | 81 | 6.2 |
| Rural Tharparkar (1998) | 156,591 | 5.6 |
| Save the Children | 383 | 8.3 |

[73] Ibid

[74] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

**Exhibit 4.64:** Population Distribution in the Study Area [75]



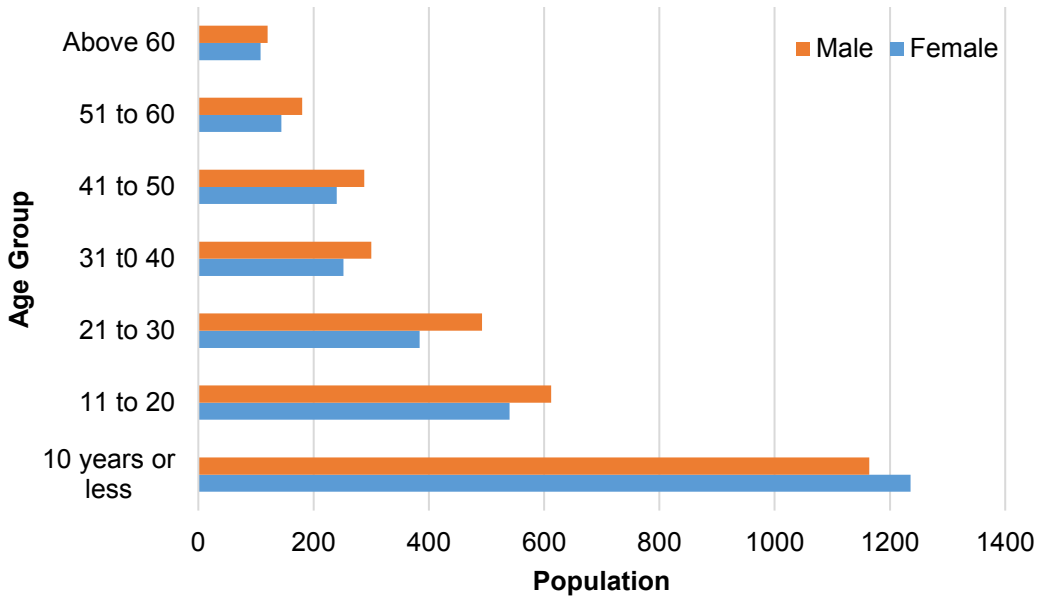

[75] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

***Gender and Age Profile.***

The population pyramid of the Study Area is shown in **Exhibit 4.65**. The population pyramid has a broad base with a relatively large number (40%) of children (10 years of age or less), which indicates high birth rates. The sharp decline of the pyramid signifies a low life expectancy amongst the population of the Study Area, as those above 60 years of age account for only 4% of the population. The structure also shows that more than half (around 60%) of the population is 20 years of age or younger.

While there are more female than male children 10 years or younger, this trend reverses for the other age brackets. This indicates a possible higher death rate for female children which could indicate a disparity in care or facilities available to the different sexes.

**Exhibit 4.65:** Age and Sex Composition of Study Area[76]




## 4.5.4 Ethnology and Religion

The inhabitants of the Study Area, as those of the larger Thar Desert, belong to different religions, sects and castes which gives the area a rich multifaceted culture.

***Religion***

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes. **Exhibit 4.66** provides the percentage distribution of population by main religious groups in Tharparkar District. Muslims are in the majority, forming 59.4% of the District's population. However, the ESIA of the Block II coal mine, which

[76] Based on Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

surveyed a larger but overlapping Study Area than this study, noted that the area has a Hindu majority (55.6.% Hindus as compared to 44.4% Muslims).[77]

**Exhibit 4.66:** Percentage of Tharparkar District Population by Religion, 1998

| *Religion* | *District wide* | *Rural* | *Urban* | *Study Area* |
|---|---|---|---|---|
| Muslim | 59.4% | 60.8% | 29.5% | 44.4% |
| Hindu | 40.5% | 39.1% | 69.6% | 55.6% |
| Others | 0.1% | 0.1% | 0.9% | 0.0 |

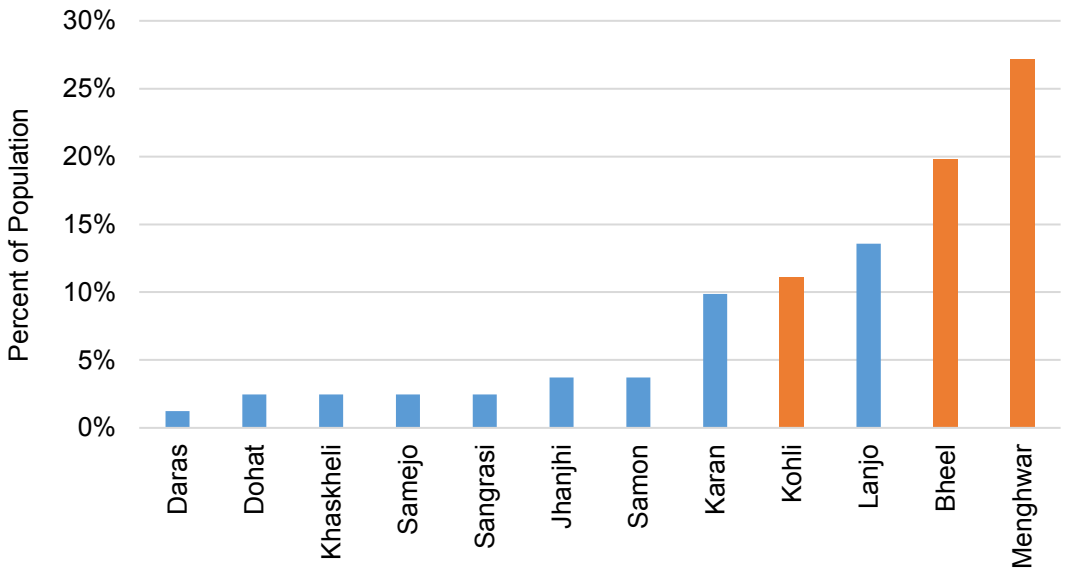
Source: District Census Report of Tharparkar, 1998, Population Census Organization, Statistics Division, Government of Pakistan

### *Castes*

A caste is a social class separated from others by distinctions of hereditary rank, profession, or wealth. In this study, the term caste has not been used in its strict definitional sense. It carries a different meaning for the Hindus and Muslims. Therefore, for the two ethnic groups, the term caste should be understood in light of the explanation provided in the statements to follow. The Hindu castes were established under the Hindu religion and not only on social grounds. On the other hand, the Muslim castes are not recognized by the religion, but are differentiated on religious, social or hereditary basis.

The distribution of the households in the Study Area by Hindu and Muslim castes is provided in **Exhibit 4.67**.

**Exhibit 4.67:** Distribution of Population in the Study Area by Castes[78]




[77] Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

[78] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

### *Language*

The main languages spoken in the Tharparkar District are Sindhi and Dhatki. In the Study Area, Muslims typically speak Sindhi and/or Dhatki as their primary language while Hindus primarily speak Dhatki only

## 4.5.5 Family Structure

The division of labor in the villages of Tharkparkar is gender based and clearly demarcated, as is the case with most traditional communities. A household usually contains two gender-based positions of authority: the first is the position of the head of the household. This position belongs to the oldest, able-bodied male member of a household. The second, which is subordinate to that of the household head, is the position of the senior woman.

**Exhibit 4.68:** People of the Study Area

*Village elders*

*Indigenous women*

## 4.5.6 Livelihoods and the Local Economy

### *Types of Occupations*

The majority (77%) of the employed population of the District was engaged in primary occupations such as agriculture and livestock according to the 1998 population census. Other occupations in the district include woodwork, wool-weaving, leather work, jewelry-making, cloth-dyeing, embroidery, and snake-charming. The number of artisans has increased over the last decade to meet the demand for handicrafts.

The Thar Desert is considered to be one of the greenest deserts in the world. The alluvial silt-mixed sands, relatively flat ground surface and summer monsoon rain (see **Section 4.1.6**) encourage agriculture and recharge groundwater for natural scrub vegetation thereon. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. About 27,000 hectares (60,000 acres) within the district are irrigated through the Thar Minor of Jamrao canal. Crops grown using irrigation include cotton, wheat, sugarcane, rice, chilies, fodder and vegetables. Crops grown in rain-fed lands include sorghum (*jowar*), millet (*bajra*), sesame, guar, moth beans, mung beans and sesame.[79]

[79] Development Statistics of Sindh, 2006

**Exhibit 4.69:** Average Annual Yield, Usage and Average Income from Crops Grown[80][81]

| *Type of Crop* | *Average Annual Yield kg/Acre* | *Consumed (%)* | *Sold (%)* | *Average Income (Rs/kg)* |
|---|---|---|---|---|
| Millet | 377 | 86% | 14% | 20 |
| Guar | 444 | 14% | 86% | 36 |
| Mung Beans | 150 | 10% | 90% | 49 |
| Moth Beans | 182 | 8% | 92% | 37 |

The natural scrub vegetation and harvested agricultural lands serve as grazing grounds for the large animal herds for most of the year. Dug wells are the major source of water for livestock. **Exhibit 4.70** shows images of livestock in the area. Due to recent droughts, which reduced ground water levels substantially, large numbers of livestock herds have moved from the desert to the canal fed lands to the west. An estimate of the population levels of livestock in Tharparkar is given in **Exhibit 4.71** and average livestock held by each household in **Exhibit 4.72**.

**Exhibit 4.70:** Typical images of Livestock

*Camels*

*Livestock use roads to access grazing areas.*

**Exhibit 4.71:** Livestock Population in Study Area

| *Type of Livestock* | *Livestock Population in Study Area[82]* | *Livestock Population in Tharparkar (2000) [83]* |
|---|---|---|
| Total Population | 10,559 | 3,806,000 |
| Goats and Sheep | 77% | 79% |

80 Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

81 Average income (Rs/kg) taken from Resettlement Study Sample Household Survey

82 Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

83 Development Statistics of Sindh, 2006

| *Type of Livestock* | *Livestock Population in Study Area*[82] | *Livestock Population in Tharparkar (2000)* [83] |
|---|---|---|
| Camels | 6% | 3% |
| Cows/Oxen | 13% | 14% |
| Donkeys | 4% | 4% |
| Horses | 0.03% | 0.26% |

**Exhibit 4.72:** Average Livestock Population and Average Price of Livestock[84]

| *Type of Livestock* | *Average Number/Household* | *Average Price (Rs/Animal)* |
|---|---|---|
| Goats and Sheep | 23 | 6,000 |
| Camels | 1 | 120,000 |
| Cows/Oxen | 2 | 43,333 |
| Donkeys | 2 | 4,000 |

Small businesses within the Study Area, shown in **Exhibit 4.73**, include shops that are located in larger settlements or on the roadsides.

**Exhibit 4.73:** Small Businesses within the Study Area

A village store

A roadside tea stall

An oil and air pump for bikes

A wheat mill and granary

[84] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

### *Income, Expenditure and Poverty*

Tharparkar has been consistently ranked as one of the most deprived districts provincially and nationally. The Annual Report on Poverty 2001 by the Social Policy Development Center (SPDC) ranked Tharparkar as the most deprived district in Sindh and 84th out of 98 districts in Pakistan in terms of depravation. A more recent analysis by SPDC in 2005 showed that the provincial ranking for Tharparkar improved marginally, with the district being ranked 15th out of 16 districts in Sindh[85]. National rankings for 2005 were unavailable. The same report by SPDC gives the predicted percentage of population below the poverty line at 30% for Tharparkar in 2005; 44% in urban areas and 24% in rural areas.

The estimated annual income per household in the Study Area, as reported in the literature is about Rs. 142,000[86]. For an average household of 6.2 this amounts to Rs. 1700 per person per month. The poverty line of Pakistan is based on a consumption of 2,350 calories per adult equivalent per day. The latest estimate of the inflation-adjusted poverty line for 2006 as reported in the FY 2008 Economic Survey of Pakistan[87] was Rs 944 per adult equivalent per month. Inflating this number for inflation estimates of 2007, 2008, 2009, 2010 and 2011, the poverty line of Pakistan in FY2011 has been calculated as Rs 1,755. Based on this estimate, the average household is just below the national poverty line.

Average annual household expenditure in the surveyed population was around Rs 119,000. Thus, on the average, the average annual income per household is around 19% above the average annual expenditure per household. Food expenditures contribute the most (over 50%) to the overall household expenditures. This is in line with the Pakistan Household Integrated Economic Survey 2010-11,[88] which indicates that food items contribute around 55% to total household expenditures in rural areas of the country. After food, farm related expenditures have the largest share in the overall household budget.[89]

The ratio of indebtedness in Tharparkar is reported as very high (more than 80%) due to droughts and poverty. Though borrowing from relatives is a preferred source of credit for many families, more than half of the loans are advanced by money lenders and shopkeepers. Because options are so limited, local money lenders tend to trap poor families in loans with interests ranging as high as 40% to 120%[90]. In recent years, microfinance loans by the TRDP and other Pakistan Poverty Alleviation Fund (PPAF) partners have been introduced as a way to reduce poverty.

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85 Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Center, Karachi

86 Ibid

87 Government of Pakistan, Economic Survey 2007-2008, Finance Division, Pakistan

88 Government of Pakistan, Pakistan Household Integrated Economic Survey 2010-11, Federal Bureau of Statistics, Islamabad.

89 Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

90 Reaching Out from Thar to Other Arid Zones of Sindh, Annual Report 2004-05; Thardeep Rural Development Programme (TRDP)

### 4.5.7 Physical Infrastructure and Services

The area has a weak infrastructure when compared to other districts provincially and nationally. It is discussed in this section.

#### *Roads and Communication*

The 1998 census reported that Tharparkar had 11 telephone exchanges. Cellular phones are the main mode of communication in the Study Area. Some homes, in larger villages connected to the electricity grid, receive television channels through satellite dish connections as shown in **Exhibit 4.74**.

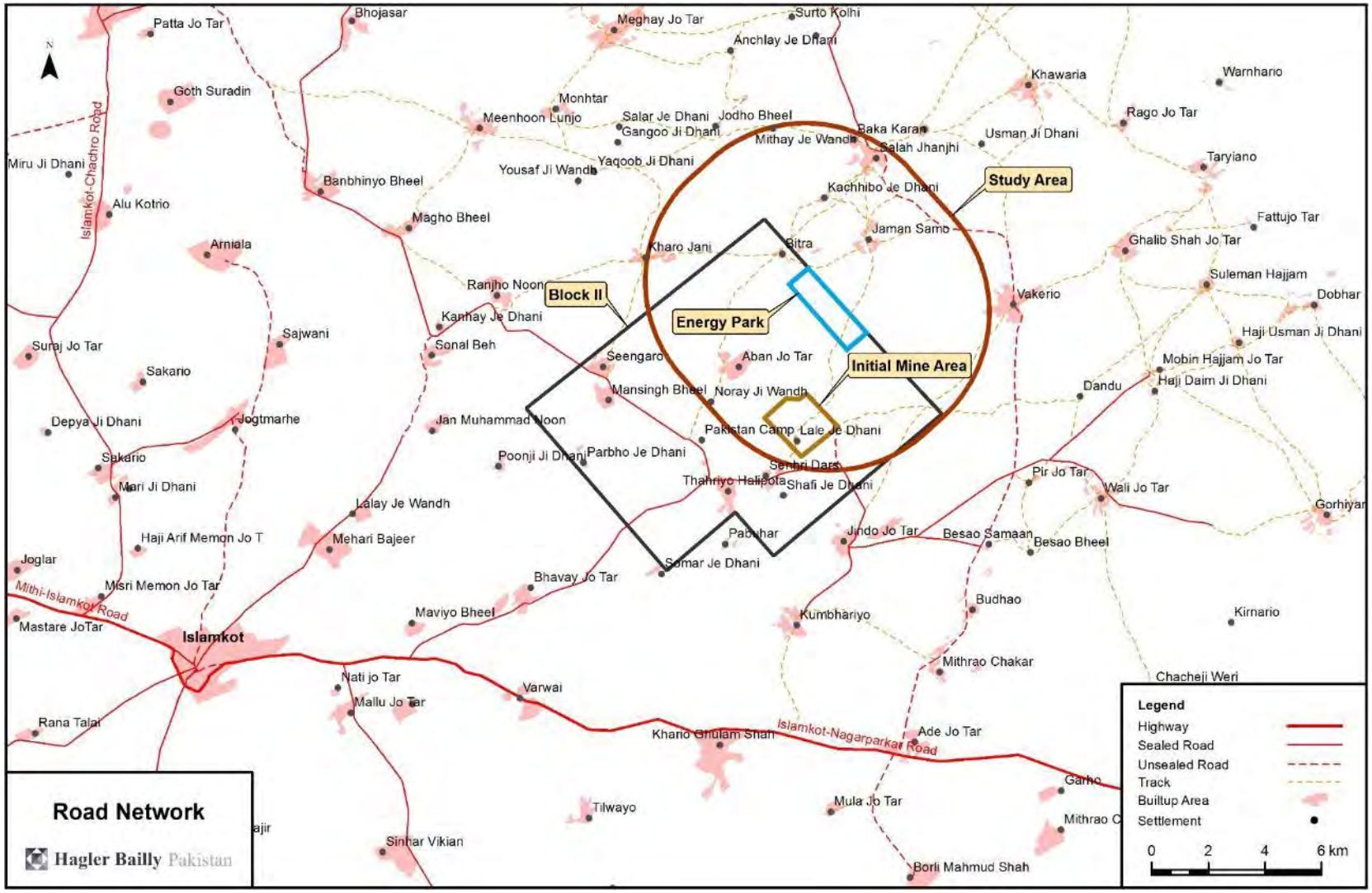
**Exhibit 4.74:** Satellite Dish Connections[91]


According to a 2006 report the District has a total of 737 km of roads, 529 km of which are of low quality[92]. Regular transport facilities to nearby towns in the form of private jeeps and buses is available at most villages. Road connectivity in the Study Area is mapped in **Exhibit 4.75**.

[91] Source: HBP Library

[92] Development Statistics of Sindh 2006

**Exhibit 4.75:** Road Network



### *Community Water Supply and Quality*

Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais,* and small underground tanks called *tankas*. There are also wells in lower lying areas that collect rainwater.

The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season. Water is extracted from dug wells, through ropes attached to pulleys pulled by a pair of donkeys or a camel. It is tedious two person job, where one person leads the animal and the other unloads the large container once it has been pulled up. The water from wells is emptied into ponds for use of livestock. Wells are mostly communal and villagers take turns extracting water.

Recently, solar powered reverse osmosis systems have been installed in larger villages. Types of water sources in the Study Area are illustrated in **Exhibit 4.76**.

**Exhibit 4.76:** Water Sources in the Study Area

*Taral*[93]

*Tanka*

*Dug Well*

*Collecting water in a pond for the livestock*

[93] Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan, April 30th 2013

### *Sanitation and Waste Disposal*

Pakistan Social and Living Standards Measurement Survey 2010-11 (PSLM 2010-11) reported that 43% of the households in rural Tharparkar had no toilet, while 53% had a non-flush toilet. Only 4% of the households in rural Tharparkar had a flush toilet.

Sewerage or storm water drainage systems were not reported in any of the villages in the Study Area, and only open air pit latrines were available which were mostly constructed to facilitate women. Villagers reporting that waste is normally disposed of into open spaces at some distance from houses due to the absence of any solid waste management system.[94]

### *Housing*

The main mode of construction in rural Tharparkar consists of huts called c*haunras* with pointed thatched roofs of shrubs and grasses they are built on mud plastered platforms. The 1998 population census reported that 85% of all housing units in rural Tharparkar were of *kacha* or adobe construction, while a mere 5% were of *pakka* or masonry construction. Examples of houses within the Study Area are shown in **Exhibit 4.77**.

**Exhibit 4.77:** Housing Structures in the Study Area[95]


A masonry or *pakka* house adjacent to the left of an adobe *chaunra*

### *Power and Fuel Supply*

The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar. Electricity usage in the urban areas was much higher at 68.38% of housing units, compared to only 4% in rural areas. An improvement in this number was seen with 44% of rural houses in Tharparkar using electricity in 2011.[96]

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94 Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

95 Source: HBP Library

96 Pakistan Social and Living Standards Measurement Survey 2010-11

Locals do not cut trees for fuelwood, rather harvest fast growing shrubs and bushes for cooking. There is no natural gas supply in the Study Area and most villages do not use of liquefied petroleum gas (LPG), kerosene or diesel to meet domestic fuel requirements.

### 4.5.8 Social Infrastructure

An overview of the health and education facilities that are available in the Tharparkar District are discussed.

#### *Health*

A high maternal mortality rate of 800 deaths per 100,000 live births in 1992, and a high infant mortality rate (IMR) of the district in 1992 at 150 (deaths per 1,000 live births) indicates a lack of health facilities in the area. These figures can be compared to the 8 times lower national IMR rate of 100 and that for Sindh at 98[97].

Health services are mainly provided through basic health units (BHUs), rural health centers (RHCs) and district head quarter hospitals that are equipped for primary health care services and to some extent comprehensive emergency obstetric care services[98]. **Exhibit 4.78** shows a comparison of the number of government health facilities present in Tharparkar in 1998 with the number of facilities present in 2005[99]. Rural health centers and basic health units have increased whereas other facilities have either declined in number or stayed constant. The number of private local clinics has, however, increased over the past decade.

**Exhibit 4.78:** Health Facilities in Tharparkar District

| *Health Facility* | *1998* | *2005* |
|---|---|---|
| Hospitals | 3 | 3 |
| Rural Health Centers | 3 | 10 |
| Basic Health Units | 21 | 32 |
| Dispensaries | 38 | 31 |
| Maternity and Child Welfare Centers | 2 | 1 |

As reported in a study conducted by Thardeep Rural Development Programme (TRDP)[100], the Thar coalfield area had just one BHU and four government dispensaries in 2003. The villagers mostly travel to the nearby towns of Mithi and Islamkot for health

[97] Thardeep Rural Development Programme (TRDP); Pakistan Economic Survey, Finance Division, Government of Pakistan; Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Centre

[98] Emergency obstetric care (**EmOC**) refers to the care of women and newborns during pregnancy, delivery and the time after delivery

[99] 1998 District Census Report of Tharparkar; Development Statistics of Sindh, 2006.

[100] Thardeep Rural Development Programme (TRDP), 'Socioeconomic and Environmental Aspects of Coal Mining in Tharparkar District' (2003)

facilities. Islamkot has a rural health center (RHC), while Mithi has a district hospital facility.

***Education***

Literacy[101] in Tharparkar district is low and shows high gender disparity. The 1998 population census reported the literacy rate of Tharparkar district at 18.32%; 28.3% for males and 6.9% for females. In rural areas, the literacy rate was 25.72% for males and a mere 4.8% for females.

There has, however, been a distinct upward trend of literacy in the district, as shown by literacy rates of rural localities in 2010-11 reported in the PSLM. Both male and female literacy have increased significantly in rural Tharparkar since 1998 and are now at par with the literacy rates in rural Sindh and rural Pakistan, although the overall literacy rate of Tharparkar (46%) remains below the overall literacy rates of Sindh (59%) and Pakistan (58%).

Adult literacy[102] was recorded at 57% for males and 13% for females in rural Tharparkar in 2011[103].

Tharparkar fares better nationally and provincially in terms of net primary enrollment rate, with PMDG 2006 ranking Tharparkar 51st out of 98 national districts, and 7th out of 16 provincial districts. A comparison of the net primary enrollment rate for 2010-11 for rural localities shows that Tharparkar now fares better than Sindh (**Exhibit 4.79**). The gender disparity in enrollment at the primary level, though present, is less pronounced.

**Exhibit 4.79:** Net Primary Enrollment Rate in Rural Localities, 2010-2011[104]

| | *Male* | *Female* | *Total* |
|---|---|---|---|
| Tharparkar | 70% | 54% | **63%** |
| Sindh | 63% | 43% | **54%** |
| **Pakistan** | **68%** | **56%** | **62%** |

Considering the gender imbalance in enrollment in educational institutions, community support programs should give attention to improving access to education for girls.

### 4.5.9 Cultural Heritage

There are a large number of religious, archeological and cultural sites of significance in the Thar area. These include temples, forts, and tombs.

The site closest to the Study Area is the Gad of Mirs (Talpurs) in Block II. It is located in the south of Seengaro Village about 10 km southeast of the Energy Park. The Gad of

[101] Literacy is defined as "all those persons ten years of age and above who could read and write in any language with understanding, as percentage of the population ten years and above."

[102] Literacy in population aged 15 years and above

[103] Pakistan Social and Living Standards Measurement Survey 2010-11

[104] Pakistan Social and Living Standards Measurement Survey 2010-11

Mirs (Talpurs), which belongs to the Talpur period (1784 to 1843),[105,106] had a square plan. It had four bastions with a main gate opening to the east and a well in the center of the fortress. Close to the northern ramparts there were a few buildings used as residence. The condition of the fortress is poor due to lack of proper maintenance.

The Gorri temple is said to be built around 1376 AD, in the golden era of the Sodhas. Images of the temple are shown in **Exhibit 4.80**. Other important cultural sites that are close to the Study Area are mapped in **Exhibit 4.81**.

Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. The Thakurs first cremate their dead and the ashes are buried.

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

**Exhibit 4.80:** Gorri Temple[107]

View of the Gorri Temple

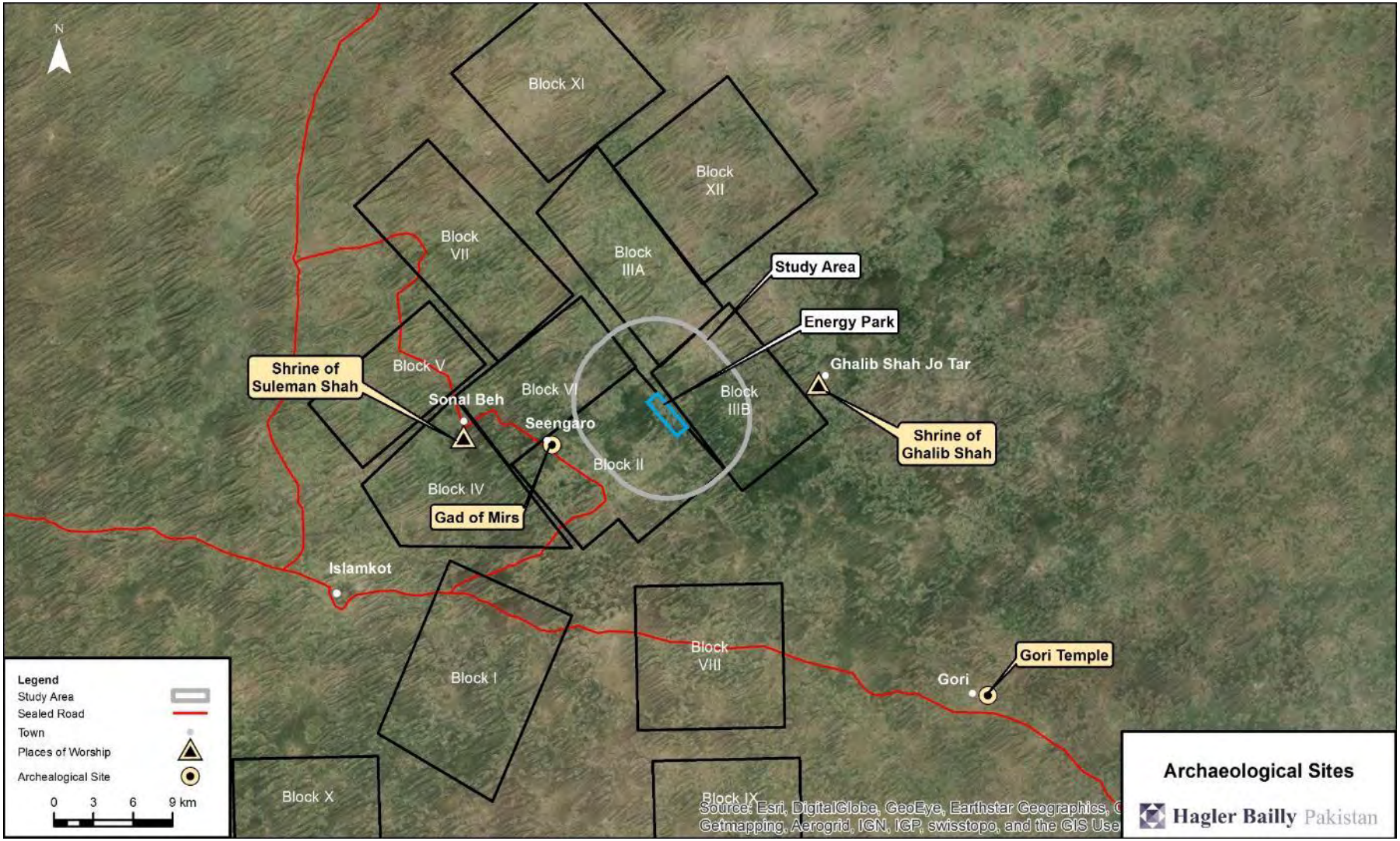
View of roof inscriptions inside the Gorri Temple

[105] Ursani, M.I., *Ser Registan (Travels into desert)* 2nd edition, Jamshoro, Sindhi Adabi Board (1995)

[106] Baloch, N.A., Sindh: Studies Historical, Jamshoro, University of Sindh ( 2003)

[107] Source: HBP Library

**Exhibit 4.81:** Archeological Sites and Major Places of Worship



# 5. Public Consultation and Disclosure

Stakeholders are groups and individuals that are affected by or can affect the outcome of a project. Stakeholder engagement is a broad, inclusive and continuous process between a company and its stakeholders. It encompasses a range of coherent activities and approaches, spanning the entire life cycle of a project. The objective of conducting stakeholder consultations during the ESIA process is to inform all the stakeholders about the Project, record and take into account their opinions, suggestions and concerns and establish confidence amongst the Project stakeholders that the Project is developed in a responsible way. This is achieved by informing the stakeholders in a timely manner about the proposed project and its potential consequences on the environment and by encouraging their feedback.

## 5.1 Consultation Methodology

The methodology adopted for consultations was in line with the legal framework adopted for the Project ESIA. It is summarized below.

### 5.1.1 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 for the Project is included as **Appendix C**. The consultation material was made available to the stakeholders in English and Sindhi (for communities in the Study Area), to suit their language preference.

### 5.1.2 Community Consultation Mechanism

The community consultations were conducted with the community members within their settlements to encourage and facilitate their participation. Separate consultation sessions were arranged for the community women. The list of communities consulted along with the dates when the consultations took place are shown in **Exhibit 5.1**. Photographic record of the consultations with the men from the communities are presented in **Exhibit 5.2**, whereas, photographs of consultations with the women of the community are not presented in consideration of local customs and traditions. Communities where stakeholder consultations were conducted are shown on a map in **Exhibit 5.3**. The meetings progressed in the following manner:

- An overview of the Project and ESIA process was provided to the community representatives. The main point of the BID was read out to them in Sindhi.
- Members of the communities 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 Communities Consulted

| *No* | *Stakeholder Group* | *Stakeholders* | *Date of Consultation* |
|---|---|---|---|
| 1. | Villages within the Study Area | 1. Baka Karan, | May 12, 2016 |
| | | 2. Salah Jhanjhi, | May 12, 2016 |
| | | 3. Kachhibo Je Dhani, | May 14, 2016 |
| | | 4. Jaman Samo, | May 12, 2016 |
| | | 5. Bitra, | May 13, 2016 |
| | | 6. Mithay Je Wandh, | May 13, 2016 |
| | | 7. Kharo Jani, | May 13, 2016 |
| | | 8. Aban Jo Tar, | May 13, 2016 |
| | | 9. Shafi Je Dhani[108] | May 13, 2016 |
| | | 10. Noray Ji Wandh | May 14, 2016 |
| | | 11. Lale Ji Dhani | May 25, 2016 |

**Exhibit 5.2:** Photographs of Community Consultations

Male consultation at village Aban jo Tar

Male consultation at village Kachhibo Je Dhani

Male consultation at village Baka Karan

Male consultation at village Jaman Samo

[108] Consulted as representative community on the access route of the Project.

Male consultation at village Noray Ji Wandh

Male consultation at village Mithay Ji Wandh

Male consultation at village Kharo Jani

Male consultation at village Salah Jhanjhi

Male consultation at village Shafi Je Dhani

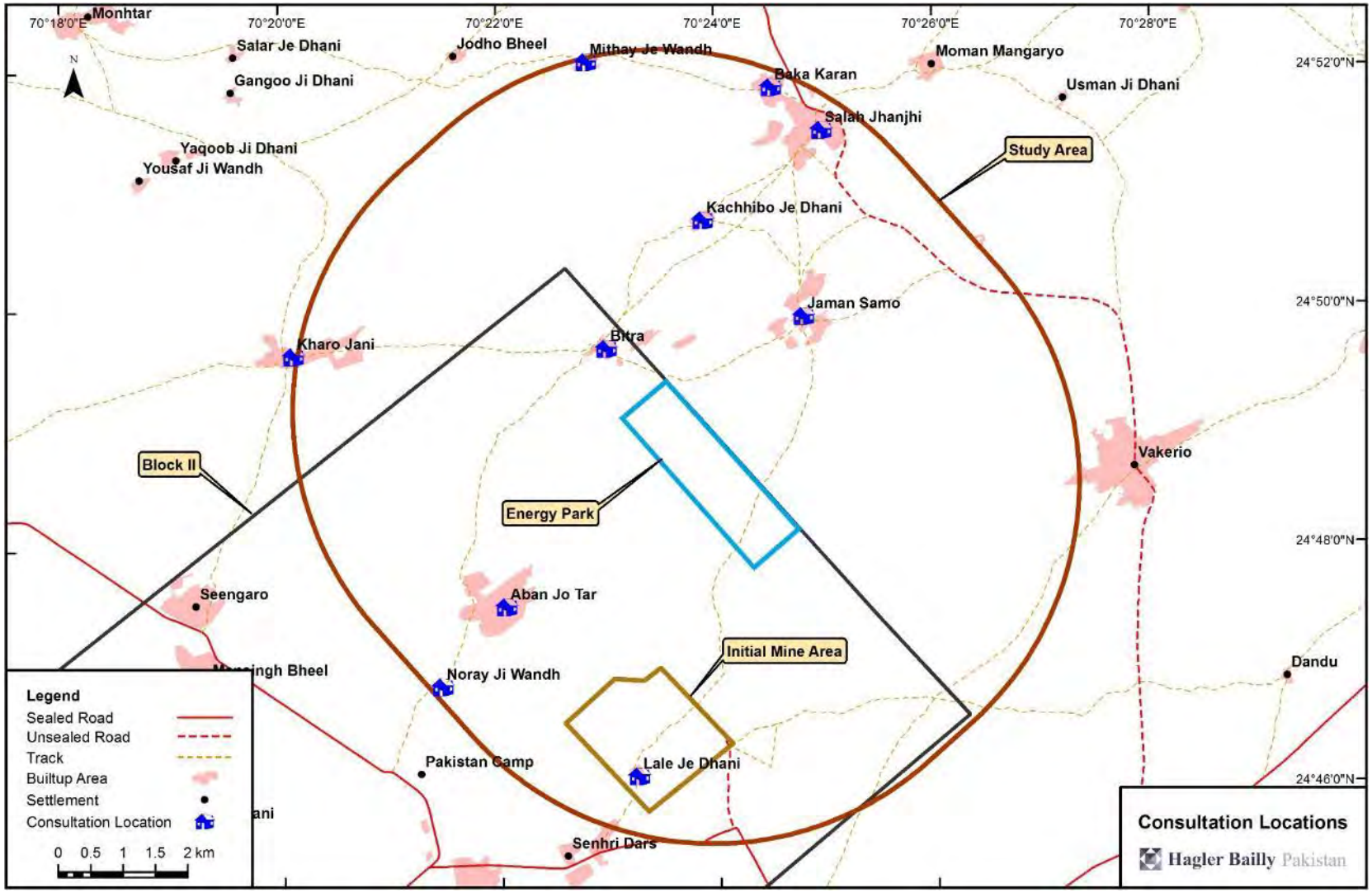
Male consultation at village Bitra

Male consultation at village Lale Je Dhani

Female consultation at village Kachhibo Je Dhani[109]

[109] Photographs of the remaining female consultations were not taken in respect of the local tradition of purdah or veil observance by women.

**Exhibit 5.3:** Locations of Community Stakeholder Consultations



### 5.1.3 Institutional Consultation Mechanism

Letters to inform the institutional and industrial stakeholders about the objective of the consultation process and to set up meetings with them were dispatched on May 20, 2016. The BID was enclosed with the letters containing information on the Project for the stakeholders. The list of the institutional stakeholders is provided in **Exhibit** 5.4 and photographs of the meetings provided in **Exhibit** 5.5. The meetings progressed in the following manner:

- Stakeholders were provided an overview of the Project description;
- The ESIA process that will be undertaken for the Project was briefly described and the structure of the ESIA report was presented to facilitate understanding of the process;
- Stakeholders were given the opportunity to raise queries or concerns regarding the Project. Queries were responded to and concerns were documented;

**Exhibit 5.4:** List of Institutional Stakeholders

| *No* | *Stakeholder Group* | *Stakeholder* | *Date of Consultation* |
|---|---|---|---|
| 1. | NGOs | 1. Participatory Village Development Programme (PVDP) | May 24, 2016 |
| | | 2. Baanhn Beli | May 24, 2016 |
| | | 3. Sukar Foundation | May 24, 2016 |
| | | 4. Social Welfare | May 25, 2016 |
| | | 5. National Commission For Human Development (NCHD) | May 25, 2016 |
| 2. | Government | 6. Assistant Commissioner, Islamkot | May 24, 2016 |
| 3 | Civil Society | 7. Press Club, Islamkot | May 25, 2016 |
| | | 8. Thar Coal Action Board | May 25, 2016 |
| 3. | Other Developers | 9. ThalNova Thar Power (Private) Limited (TNPTL) | May 27, 2016 |

**Exhibit 5.5:** Photographs of Institutional Consultations

Consultation with PVDP

Consultation with Baanhn Beli

Consultation with Sukar Foundation

Consultation with NCHD

Consultation with Assistant Commissioner, Islamkot


Consultation with Press Club Islamkot

Consultation with Thar Coal Action Board

Consultation with DO Social Welfare

## 5.2 Summary of Key Concerns Raised by Stakeholders

The main issues and concerns raised by communities and local businesses area summarized in **Exhibit 5.6**. The proposed mitigation is documented alongside each concern. The complete logs of the stakeholder consultations are presented in **Appendix E.**

**Exhibit 5.6:** Key Community Stakeholder Concerns and Expectations

| *Issue* | *Proposed Mitigation in ESIA* |
|---|---|
| **Environmental** | |
| Asthma and skin diseases may increase due to pollution from the project. There is no local access to treat these diseases and the villagers have to travel to Mithi or Islamkot for treatment. Most fail to do so and small instances of disease become very serious health concerns. | The most up to date and efficient equipment will be used to reduce gaseous emissions. Dust suppression techniques will be used. See **Section 7.3** for details. |
| In June and July there is a fast, hot wind (called *lukh)* and it is already very dusty and hot because of this which causes disease to the livestock and the locals. The impact of coal ash and dust from the power plant will exacerbate the impacts of this hot wind. | Impact assessment, including cumulative impact assessment is presented in **Chapter 6.** Emissions from the Project will comply with SEQS and IFC guidelines for emissions. |
| The construction of the effluent channel has exposed a large amount of sand previously covered by small trees and bushes. This and other construction activities are exposing sand which will be blown into the air and cause lung disease. | The effluent channel is being constructed by GoS and is beyond the scope of the Project. Mitigation measures to be undertaken during the Project construction are detailed in the Environmental Management Plan (EMP) in **Chapter 7**. |
| One tree can sustain 2-3 goats. If the trees die then incomes of the community will be effected. | The project does not involve any significant removal of vegetation. All impact of vegetation will be within the Project Site and no tree will be cut outside. |
| The cumulative impacts of all these developments will greatly impact the environment of the area. | Cumulative impact assessment is presented in **Section 6.4**. A joint strategy should be developed by all developers in the area to address cumulative impacts. |
| The accidents on the roads will increase as the traffic in the area increases. This includes accidents with pedestrians and livestock that use these roads to travel between villages and to grazing areas. | Techniques to reduce the noise will be employed. Road and traffic route will be planned to avoid disturbance to community. |
| The soils of the desert are very sensitive and excessive use of machinery or vehicles strips the small fertile layer, reducing their productivity. The locals are heavily dependent on their agricultural land for income. | The construction management plan outlined in **Chapter 7**. |

| *Issue* | *Proposed Mitigation in ESIA* |
|---|---|
| Drinking water is collected in large open rainwater harvesting ponds in many villages and is used for several months of the year. As these are open air ponds the water quality could be affected due to the ash and dust generated by the coal plant which may collect in these ponds and contaminate the fresh water. The dug wells may be impacted due to the mining activity hence, the already scarce water resources in the area will be further compromised. | As shown in the section on impact assessment, the increase in the dust due to the project will be marginal.<br>The impact of depletion of water in dug wells is evaluated in the mining ESIA. |
| **Socioeconomic** | |
| Employment should be given to local persons especially to those from villages within the study area. | Strategies for hire locals, and training and development programs will be developed. These are detailed in the (EMP) in **Chapter 7**. |
| Hiring for current projects is not being undertaken based on merit, rather land lords and influential people of the area have a say in who gets employed. | |
| Marginalized communities, such as the Kohli community, own no land and work as labor on the fields. The community will be very happy if provided employment at the project however fear that the hiring process will be prejudiced by those with influence such as local leaders, resulting in their further marginalization. The project should hire locals from this community. | |
| Poor and marginalized communities do not have access to education or training to have the skills required to work at the project. Training, education and scholarships should be provided to these communities. | |
| Livestock is scared by the increase in traffic and noise from machinery during Project construction and operation, which may cause stress and disease. The community is dependent on the livestock for income. | Techniques to reduce the noise will be employed. Road and traffic route will be planned to avoid disturbance to community. |
| **Cultural** | |
| The privacy of women will be affected due to the project. Women currently collect fuel wood, tend to livestock etc. and the family is not concerned about their safety. However, with the increase of outsiders this freedom of movement for women will be reduced. | Cultural emersion and sensitization training will be a part of the induction program for new employees. |
| The increase of outsiders is affecting the culture of the villages. As the area becomes more accessible the family structure is being influenced by the values of the incoming people. | |

| *Issue* | *Proposed Mitigation in ESIA* |
|---|---|
| Locals were provided compensation for land that was within Block II. However, many did not have any financial planning, as they were previously poor simple farmers, and some of them have ended up wasting a large amount of this money (such as through the purchase of cars, second weddings etc.) instead of investing it in income generating resources. Locals are concerned once this money ends, which is likely in a few years the locals will have no source of income which will create poverty and conflict within the communities. | |

## 5.3 Future Stakeholder Engagement

TEL will continue stakeholder engagement activities throughout the life of the Project. Further details of TEL's future stakeholder engagement activities are given in **Chapter 10**, Environmental Management Plan. Stakeholder engagement activities will include:

- ongoing reporting on progress on the implementation of environmental and social management measures identified during the ESIA process and recording of comments on the effectiveness of these measures;
- updating communities about new project developments and recording comments on these; and,
- ongoing operation of the grievance redress mechanism.

# 6. Project Impacts and Mitigation Measures

This chapter predicts the magnitude of the Project impacts, assesses their significance, and identifies mitigation measures to minimize the adverse impacts. Where possible impacts are quantified.

## 6.1 Identification of Significant Environmental Aspects

This section covers the assessment of potential environmental impact of the proposed power plant activities. The potential impacts are discussed in **Exhibit 6.1**. These are categorized into three categories as follows:

- High risk (H): Definite impact, major deterioration and/or long–term impact and/or large footprint
- Moderate Risk (M): Likely impact, medium magnitude, medium-term activity and/or relatively smaller footprint
- Low Risk (L): Low likelihood of impact, minor magnitude, generally reversible, and small footprint

Based on this categorization the potentially significant issues are identified according to anticipated risk to environment due to the Project activity. The significant issues are then further discussed in the following sections.

For the purpose of this discussion, impacts are defined where there is a plausible pathway[110] between the project aspects[111] and receptors.[112] The aspects, pathways and receptors are identified based on previous environmental or social studies; review of the evolving Project description to identify aspects; consideration of the area of influence to determine pathways and receptors; experience of the ESIA and Project specialists; consideration of issues raised by stakeholders; and findings of baseline investigations as they become available.

[110] Pathway is the mechanism by which the aspect affects the receptor (such as inhalation of air or drinking of water).

[111] Aspect is the mechanism by which project activities may cause impacts (for example, gaseous emissions to the atmosphere or effluent discharges to a water body).

[112] Receptor is a person, natural ecosystem, structure or infrastructure system that experiences the impact.

**Exhibit 6.1:** Potential Environmental and Socioeconomic Impacts of the Proposed Activities

| *Project Activity* | *Description* | *Impacts* | *Risk* | *Discussion* |
|---|---|---|---|---|
| ***Construction Phase*** | | | | |
| Land acquisition | The land for the Energy Park in which the power plant will be located will be acquired as part of the Block II mining project. The land will be purchased by the Project proponents from the developers of the mine. | Refer to ESIA of Block II mining project[113] | L | Land acquisition is not included in the scope of this study as the land will be acquired as part of the Block II coal mine project. However, all applicable laws will be followed as per regulation. |
| Transportation of equipment | The equipment for the power plant will be imported via Karachi Port or Port Qasim. It will then be moved to Thar via the highway (N-5), Thatta-Badin Road, and then Badin-Mithi Road). The load will comprise dozens of 40-feet (12.2 m) flat-bed trucks. In addition some large equipment will be carried on over-sized articulated trucks. | During the main phase of equipment transportation, the additional traffic generated on the road can potentially result in the following types of impact: road congestion and inconvenience to existing road users, additional noise and emissions and impact on the nearby community, and community safety issues.<br>For the over-sized consignments, it may be necessary to remove obstructions, such as toll plaza, and low level power and telephone lines, to allow the equipment to pass through. Further, the heavy load may also damage the road surface particularly the shoulders. | L | GoS is carrying out the improvement, development, widening of roads and building of bypasses on the mentioned route to facilitate the transport of heavy machinery to Thar. |
| Site construction activity | Construction activities include construction and operation of staff camp, storage of equipment, civil works, | Potential environmental impacts of construction activities include:<br>Camp waste disposal; disposal of camp wastewater; spills and leakages of oil and | L | Construction related impacts can be kept low if managed properly. A construction management plan (CMP) is included in the Environmental Management Plan (EMP) in **Chapter 7**. |

[113] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

| *Project Activity* | *Description* | *Impacts* | *Risk* | *Discussion* |
|---|---|---|---|---|
| | installation of equipment, and disposal of waste. | contamination of soil and potentially surface water; and noise and vibration | | |
| | | Industrial construction activities pose an occupational health and safety risk to the workers. Improper management of this aspect can lead to fatalities and health issues. | M | Requirements for occupational health and safety are discussed in relevant sections of **Chapter 7** |
| Socioeconomic impacts | Contribution of the project to the local livelihoods in the construction phase. | Additional employment opportunities, resulting in increased prosperity and wellbeing due to additional employment for local people. | M (Benefit) | The project will employ several thousand persons during the construction phase. |
| | Inflation may be caused by large amounts of cash entering the local economy through direct spending by Project developers or through salaries of employed locals. | Households which do not gain directly by employment at the Project or indirectly through increased sales of goods and services will be most affected and will not be able to afford basic goods and services. | M | |
| | Influx of outsiders into the area for project construction and management. | Women currently have easy mobility outside the village and collect fuel wood, tend to livestock etc. and the family is not concerned about their safety. As indicated during male consultations (see **Chapter 7**), with the increase of outsiders the freedom of movement for women will be reduced. | M | |
| Grievances of stakeholders due to construction activities | Unaddressed grievances of Project stakeholders due to absence of grievance redress mechanism | Ill will of local people and other stakeholders towards the Project | M | A formal system for addressing the grievances will be developed to ensure that closure on the issues are achieved expeditiously as a priority as construction related activities are likely to generate concerns and issues among the stakeholders. A Grievance Redress Mechanism to be followed in Project implementation is included in **Chapter 7**. |

| *Project Activity* | *Description* | *Impacts* | *Risk* | *Discussion* |
|---|---|---|---|---|
| ***Operations Phase*** | | | | |
| Emission from Power Plant | Emission of $SO_2$, NOx, $PM_{10}$, $PM_{2.5}$ and other pollutants | Health issues due to Project related pollution, resulting in increased health expenses and affecting deprived segments of the local populace. | M | Mitigation measures such as installation of control equipment on boilers have been incorporated in the plant design. |
| | Greenhouse Gas (GHG) Emissions | High levels of GHG emissions from coal based power generation leads to global warming causing climate change. | L | |
| Effluent discharge from the Power Plant | Discharge from the power plant includes cooling tower blowdown, boiler blowdown, washing effluent, sanitary waste, and some other effluents | Discharge can potentially pollute the soil and groundwater used by community | L | The waste generated by the different waste streams will be disposed through proper disposal and treatment systems. |
| Water consumption | Large quantities of water are required for power generation through the steam turbine as well as for coal dust suppression and other activities. | The area is water scarce and extensive use of local water can cause water shortages. | L | Water from the LBOD will be used for power generation. The maximum possible water from the plants will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. |
| Ash disposal | Large quantities of fly and bottom ash will be generated from the power plant. | Emission of dust particulates from ash handling activities at the ash disposal site. Leachates from rainwater runoffs contaminating water supplies. | L | Ash will be stored near the power plant site within Block II in the area designated for this purpose. The storage will be for about 2 years until it is transported to the mine area, when available, where it will be used as backfill in the spent mine pit. The dumped ash will be compacted, mixed with sand and ensuring leaching protection. |

| *Project Activity* | *Description* | *Impacts* | *Risk* | *Discussion* |
|---|---|---|---|---|
| Socioeconomic impacts | Contribution of the project to the local livelihoods and economy of the country. | Increased power generation due to the Project, reducing energy shortfall and reviving associated economy. | H (Benefit) | In the long-run the project will provide significant support to the local economy.<br>The power generated from the project will help in reducing power outages which are affecting growth of the economy and will also lower the average cost of power generation in the country by shifting the fuel mix in power generation from fuel oil to coal. |
| | Increase in local population due to in migration due to increased economic opportunity due to Project activities. | Stress on limited infrastructure due to increased population | M | The in-migrants are likely to be economically poor. The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing stock. The informal settlements developed in this manner would lack basic infrastructure and services, such as adequate sanitation systems and health facilities and put pressure on the limited existing infrastructure. |
| Ecological Impacts | Project activities will disrupt the natural setting of the area. | Project activities will cause direct loss of habitat due to site clearance and influence a broader zone due to noise air emissions and other activities. | M | Other than vultures, which are endangered, the impact on other flora and fauna will be limited. |

## 6.2 Construction Phase Impacts

Impacts, together with proposed mitigation measures, related to the construction phase are discussed in this section.

### 6.2.1 Impacts with Low Risk

Low risk impacts that arise during Project the construction phase, including land acquisition, transport of equipment and construction are discussed below.

#### *Land Acquisition*

Currently, the Project site is used for agriculture and grazing of livestock. No settlements will need to be replaced due to the Project footprint. The developers of Block II have drafted a Resettlement Action Plan (RAP) to cater to the communities that will need to be resettled.[114] The company is also in the process of engaging town planning and architect firm for the design of resettled villages & associated infrastructure.

#### *Transportation of Equipment*

The maximum traffic load is expected during the construction phase. Impacts of transportation of construction equipment and plant machinery to the Project site are:

- Incremental increase in the existing traffic on the road will affect the daily commuters.
- Traffic may cause a safety hazards especially for pedestrians and livestock.
- Emission and noise level will affect the air quality and cause nuisance to communities living alongside the route selected for transportation.
- Degradation of the existing roads.

Even at its peak, the estimated volume of traffic shall not be more than 20-30 trucks per day. This is low as compared to the existing traffic (see traffic baseline in **Chapter 4**) up till Thatta. However, it will be approximately a 20% increase in traffic at Mithi and Islamkot and a huge increase near the Project site which has very low levels of baseline traffic.

#### *Site Construction Activity*

Some of the environmental and social impacts of construction activities relate to activities at the construction site whereas others relate to the setting up and operation of the construction crew camp. Typical issues include:

- Site clearance leading to dust emission
- Removal of vegetation leading to loss of vegetation cover
- Erosion and sedimentation due to large scale earthwork
- Air quality impact from operation of construction machinery and earthwork
- Noise and vibration from machinery and construction work

[114] SECMC director's report, December 31, 2014

- Generation of waste and its disposal
- Off-site impacts such as those related to borrow pits
- Disposal of effluent from construction camp
- Cultural impact related to presence of non-local workers

Typically, the construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long-term residual impacts. To avoid adverse impact of the construction activities on the environment, following measures are proposed:

- To the extent possible, the camp of the construction contractor(s) will be located within the premises of Power Plant Site.
- The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the EMP (**Chapter 7**). The CMP will be submitted to the TPC for approval.

The CMP will clearly identify all areas that will be utilized during construction for various purposes using a site plan.

### 6.2.2 Socioeconomic Impacts during Construction

#### *Contribution to Local Livelihoods*

The Project will create additional job opportunities in the area. During construction period several thousand (typically 1,000- 2,000) people will be hired. To maximize the benefits to the local community the following mitigation, enhancement and good-practice measures are suggested:

- Preferentially recruit local candidates provided they have the required skills and qualifications for the announced positions;
- Coordinate efforts to recruit unskilled labor, if any are required under the Project, from the adjacent rural areas.
- Explain the recruitment process to local communities.
- Require contractors to prefer local candidates in the recruitment process provided they have the required skills and qualifications.
- Include an assessment of the contractor's demonstrated commitment to local procurement and local hiring in the tender evaluation process.
- Coordinate recruitment efforts related to non-skilled labor, including for non-skilled labor positions required by contractors.
- Maintain a recruitment database that contains information on local candidates and offer these candidates to contractors for consideration.
- Support the training of local people to increase their potential for indirect employment.

- Maximize the benefits of indirect and induced impacts to local communities and businesses by implementing the community development initiatives pertaining to education, training and skill development of the local people.
- Assist employees, local communities and vulnerable groups in improving basic personal financial life skills through training and awareness campaigns.
- Determine what is considered to be 'fair and transparent' in recruitment and in distribution of jobs between different community groups in consultation with local communities and their leaders.
- Set long-term (10 to 15 year) targets for local representation at the managerial level. Implement training and development to meet these targets.
- Promote mechanisms to increase the access of vulnerable groups to Project opportunities through small business development.

### *Inflation in the Local Economy*

Increased levels of income in the Study Area can result in inflation and economic inequality. This, in turn, can adversely affect those within the Study Area who are unable to benefit from the Project, as well as the vulnerable stratum of the population in the Study Area. Economic inequality can deepen social hierarchies and have an adverse impact on social relations as well as create conflict amongst different sections of the society

This is particularly relevant to the Study Area, where the greatest economic growth is expected to occur. Even a small increase in the cost of living, particularly food prices, can have a severe impact on the local community as around half of the households in the vicinity of the Study Area are below the national poverty line.

Proposed mitigation, enhancement and good-practice measures include:

- In association with the training measures indicated elsewhere, develop a training program targeted at local people living below the poverty line.
- In association with the community development measures, develop a program to create alternative employment creation initiatives aimed at local people living below the poverty line.
- Encourage government and NGOs to assist economically poor in strengthening their livelihood options.

### *Intrusion in Privacy due to the Influx of Outsiders*

The influx of workers in the Study Area can result in the deterioration of social values and an increase in social ills in the communities affected by the in-migration of workers and job-seekers. The increase in population and the associated economic inequality can result in increased crime, such as theft and robbery. Communities affected by the in-migration of workers can also witness a rise in drug abuse rates, which, in turn, can lead to increased violence, an increase in promiscuous sexual activities due to the presence of single males with disposable incomes, and the erosion of traditional cultural values. The society in Tharparkar is deeply rooted in various cultural ethics and values. Erosion of traditional cultural values can create conflict amongst the existing communities as well as

between communities and outsiders. The presence of outsiders can also restrict the movement of women, affecting the traditional division of labor.

The increase in social ills is expected to be more severe during the construction phase than the operational phase and can continue with reduced intensity in the operational phase. However, the magnitude, duration and scale of this impact are difficult to predict accurately as the Project may have little control over managing the complex social change processes associated with in-migration.

Proposed mitigation, enhancement and good-practice measures include:

- Require non-locals employed by the Project to adhere to a social 'code of conduct' in terms of relations with local communities.
- Provide employees and visitors to the site with cultural awareness training.

## 6.3 Operations Phase Impacts

Impacts and proposed mitigation measures that are expected in the operation phase are discussed in this section.

### 6.3.1 Impacts with Low Risk

#### *GHG Emissions*

The estimated greenhouse gas emission from the power plant is provided will be about 2.5 million tons per year. This estimate has been developed using the IPCC Tier 1 methodology that assumes a 101,000 kg of $CO_2$ emission per terajoule of heat input from lignite.

#### *Water consumption*

Water from the LBOD will be used for power generation. The maximum possible water from the plant will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping.

#### *Ash disposal*

The annual ash produced from the Project will be about 125,000 tons. The overburden generated by the production of coal at the Block II mine is estimated to be about 160 times the ash generated from the power plant.[115] Therefore, the ash produced from the power plant can easily be mixed with the overburden and disposed with it.

### 6.3.2 Air Emission from the Coal Power Plant

Air emission impacts were evaluated based on SEQS and IFC emission standards and ambient air quality standards.

#### *Combining the Air Quality Impacts*

As there are a number of existing, planned, and foreseeable gaseous emission sources in the area, it is essential to consider their impacts on the ambient air quality in appropriate

[115] Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

manner. This inventory of the sources and the scheme under which they are considered are discussed in **Exhibit 6.2**.

**Exhibit 6.2:** Gaseous Emission Sources and their Assessment

| *Additional Sources* | *Approach* | *Section* |
|---|---|---|
| **Existing**<br>Natural<br>Biomass Burning<br>Traffic | Measured Baseline<br>Measured | **Section 4.3.6** |
| **Planned Projects**<br>2x330 MW Plant, Block II | Simulated Baseline<br>Modelled + Measured | **Section 4.3.6** |
| **Proposed 330 MW Plant**<br>1x330 MW Plant, Block II | Impact of Proposed Plant<br>Incremental Impact of Proposed Plant + Simulated Baseline | **Section 6.3.2** |
| **Second 330 MW Plant being developed Simultaneously**<br>1x330 MW Plant, Block II | Impact of Second Plant<br>Incremental Impact of Second Plant + Impact of Proposed Plant | **Section 6.3.2** |

### *Emission Standards*

The emission rates discussed in **Chapter 3** are presented in **Exhibit 6.3** and compared to IFC EHS limits and SEQS stack emission standards. As national guidelines ambient $SO_2$ and $NO_x$ concentrations are not exceeded, the Study Area is considered a non-degraded air shed (NDA), see **Section 4.3.7.** The Project will be compliant with both SEQS and IFC guidelines for coal power plant emissions.

**Exhibit 6.3:** Compliance with SEQS and IFC Emission Standards for Coal Fired Power Plants[116]

| *Parameter* | *SEQS* | *IFC Guidelines* | *Project Emission Limits* | *Expected Project Emissions* | *Status* |
|---|---|---|---|---|---|
| Sulfur Dioxide | 500 tons per day | For NDA: 900-1500 mg/Nm$^3$<br>For DA: 400 mg/Nm$^3$ | 24.7 tons per day<br>850 mg/Nm$^3$ | 17 tons per day<br>584 mg/Nm$^3$ | Compliant |
| Oxides of Nitrogen | 260 ng/J of heat input | For NDA: 510 mg/Nm$^3$<br>For DA: 200 mg/Nm$^3$ | 168 ng/J of heat input<br>510mg/Nm$^3$ | 168 ng/J of heat input<br>381 mg/Nm$^3$ | Compliant |
| Particulate Matter | 500 mg/Nm$^3$ | For NDA: 50 mg/Nm$^3$<br>For DA: 30 mg/Nm$^3$ | 50 mg/Nm$^3$ | 23 mg/Nm$^3$ | Compliant |

[116] For NOx and SO2 the ambient values are much below the SEQS and recommended IFC EHS limits. Therefore it can be considered a NDA. However, the particulate matter is naturally high in the dusty desert environment. Measured $PM_{10}$ concentrations are 85% of the 24 hour SEQS and exceed the annual SEQS. Strictly speaking this falls into the category of a degraded airshed as national ambient air quality standards have been exceeded. However, since the particulate matter is naturally high with no major human sources of particulate matter in the area, this can also be considered an NDA

### *Ambient Air Quality Standards*

The air quality impact assessment was carried out to predict the impact of proposed Project plus the combined baseline concentration (see **Chapter 4**) on surroundings and compliance with the standards. To evaluate the impacts from proposed plant the modeling was carried out for approved developments and proposed plant as shown in **Exhibit 6.4**.

#### Modeling Parameters

The modeling was based on the plant parameters, emission control technologies and coal design specifications as discussed in **Chapter 2** and reproduced in **Exhibit 6.5.**

**Exhibit 6.4:** Approved Developments and Proposed Project

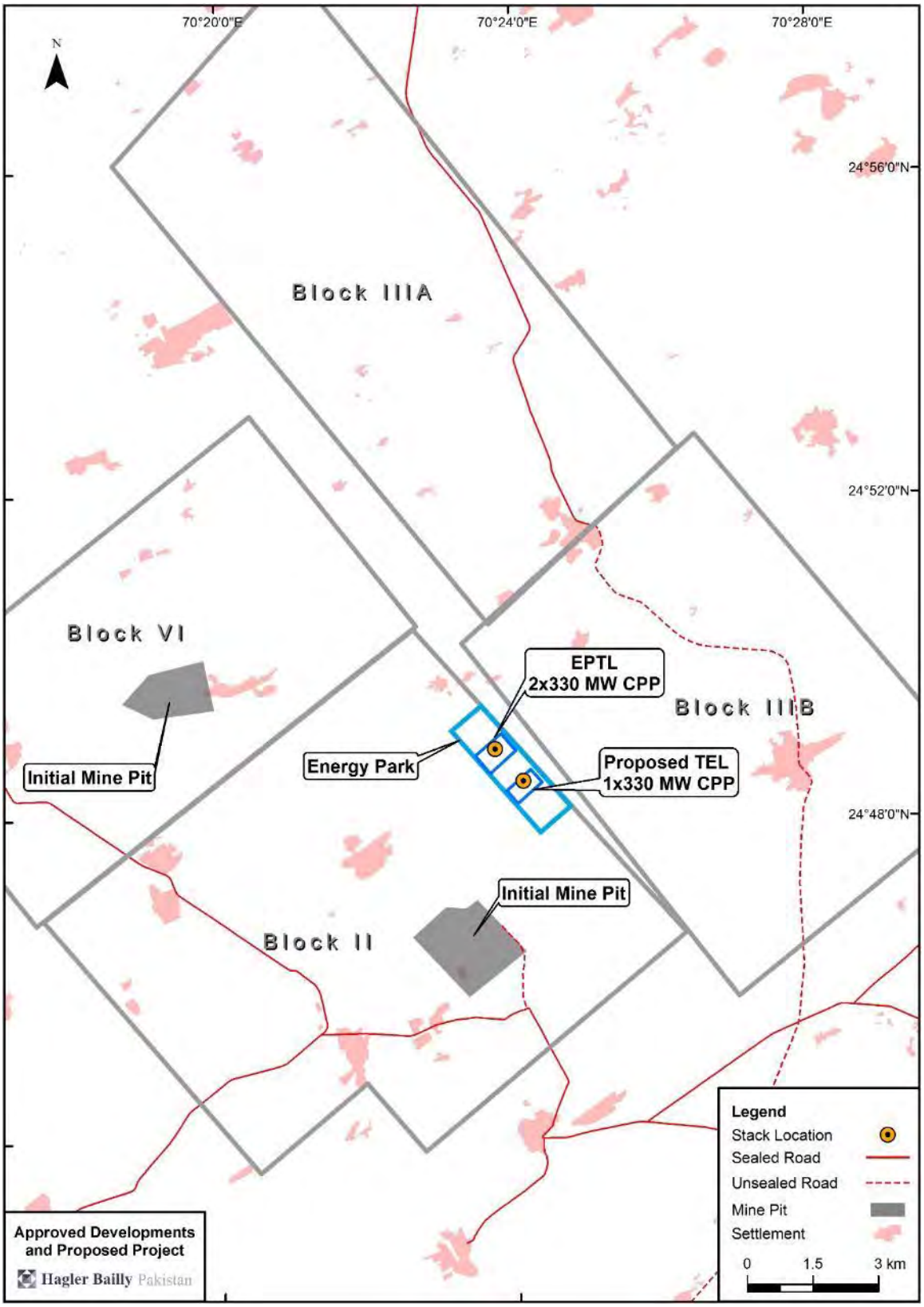


**Exhibit 6.5:** Modeling Parameters Based on Proposed Project Emission Limits (1 × 330MW)

| *Parameters* | *Value* | *Units* |
|---|---|---|
| **Stack Specifications** | | |
| Height | 180 | m |
| Inner diameter | 5.76 | m |
| **Flue Gas Specifications** | | |
| Exit velocity | 20.8 | m/s |
| Exit temperature | 170 | ºC |
| Flow rate | 543 | $m^3/s$ |
| **Emission Rates** [a] | | |
| $SO_2$ | 284 | g/s |
| $PM_{10}$ | 12.0 | g/s |
| $PM_{2.5}$ | 4.8 | g/s |
| $NO_2$ | 170 | g/s |

a: Based on proposed Project limits

### Modeling Area

The modeling area was defined as circle of radius 15 km centered at the center of the Energy Park. The area was taken considering the distance of receptors and expected impact of the Project. As Block I is farther than 15 km it was not included in the modelling exercise.

### Modeling Results and Discussion

Contour maps for dispersion of each pollutant are presented in **Exhibit 6.6** to **Exhibit 6.13.** Areas that exceed standards have been shaded as hotspots. The measured and modeled results are compiled in **Exhibit 6.14.** The results were compared against SEQS and IFC EHS limits. The pollutant concentrations exceeding one of the standards have been shaded in the table.

It should be noted that the table in **Exhibit 6.14** provides the highest value of the pollutants in the area of concern. While the maximum increment is small (as compared to the EPTL plant) the spatial extent of the increase in pollutant levels can be observed from the contour maps.

**Exhibit 6.6:** Sum of Baseline and Incremental $SO_2$ Concentration (Annual)

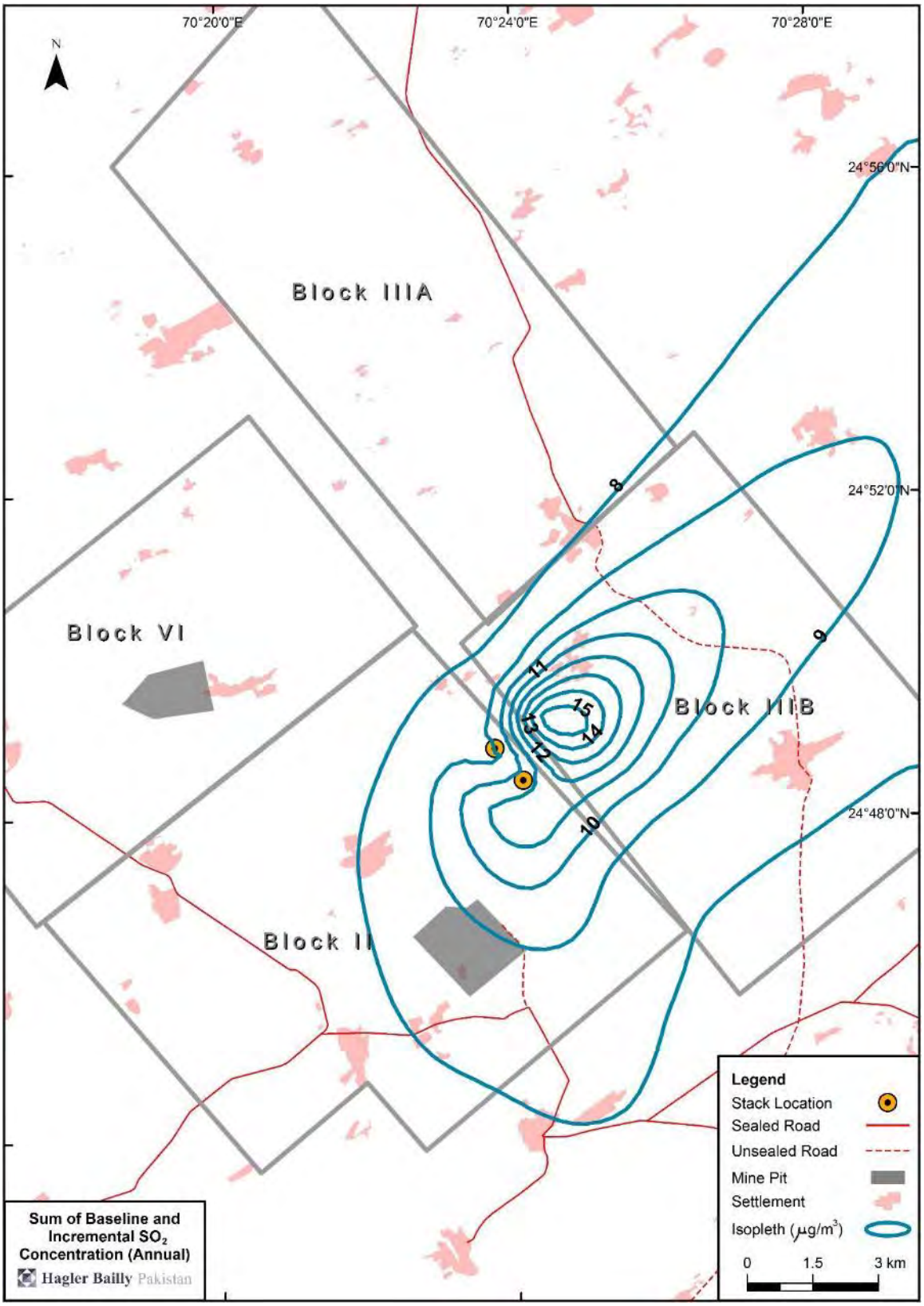


**Exhibit 6.7:** Sum of Baseline and Incremental $SO_2$ Concentration (24-hour)

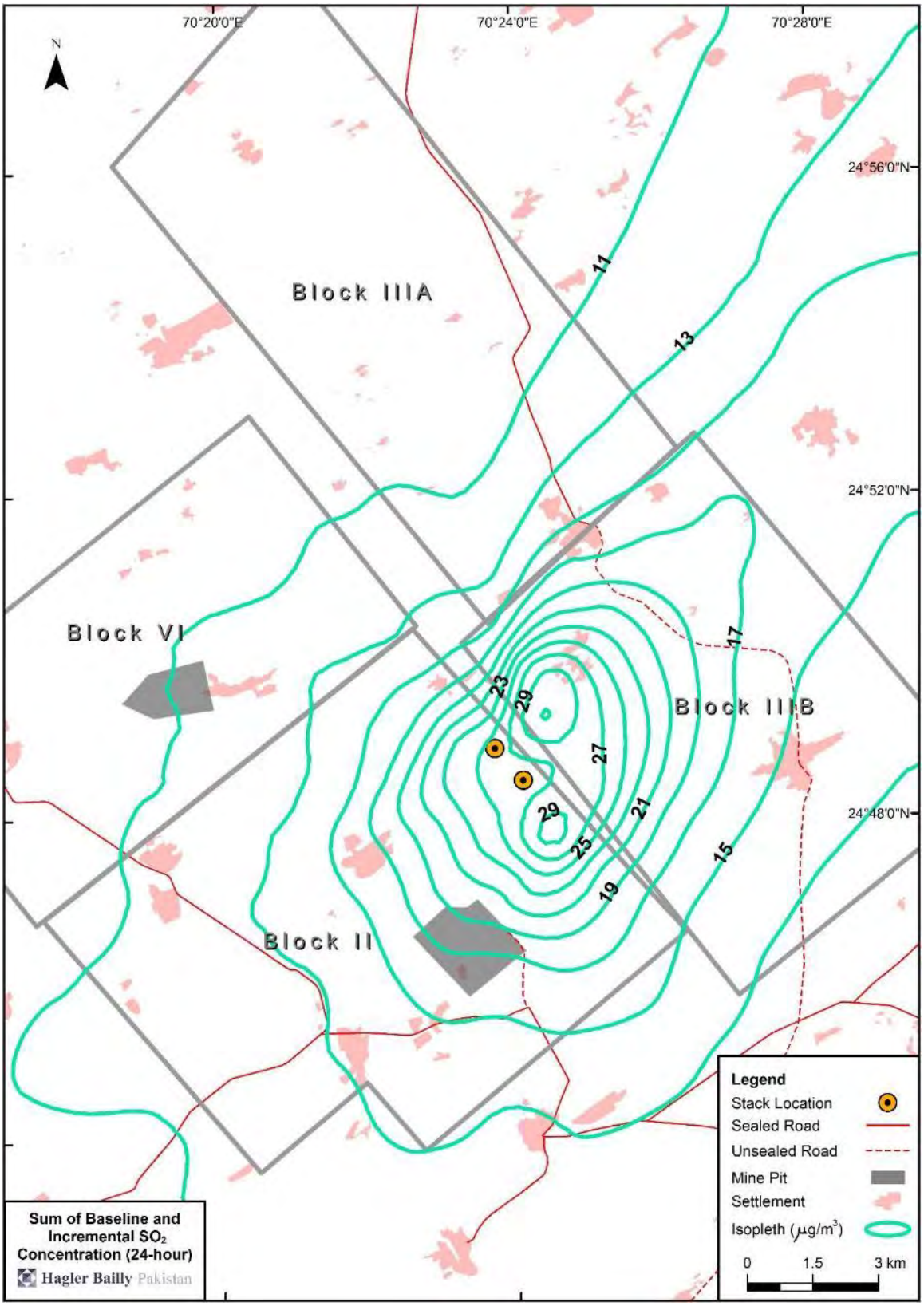


**Exhibit 6.8:** Sum of Baseline and Incremental $NO_2$ Concentration (Annual)

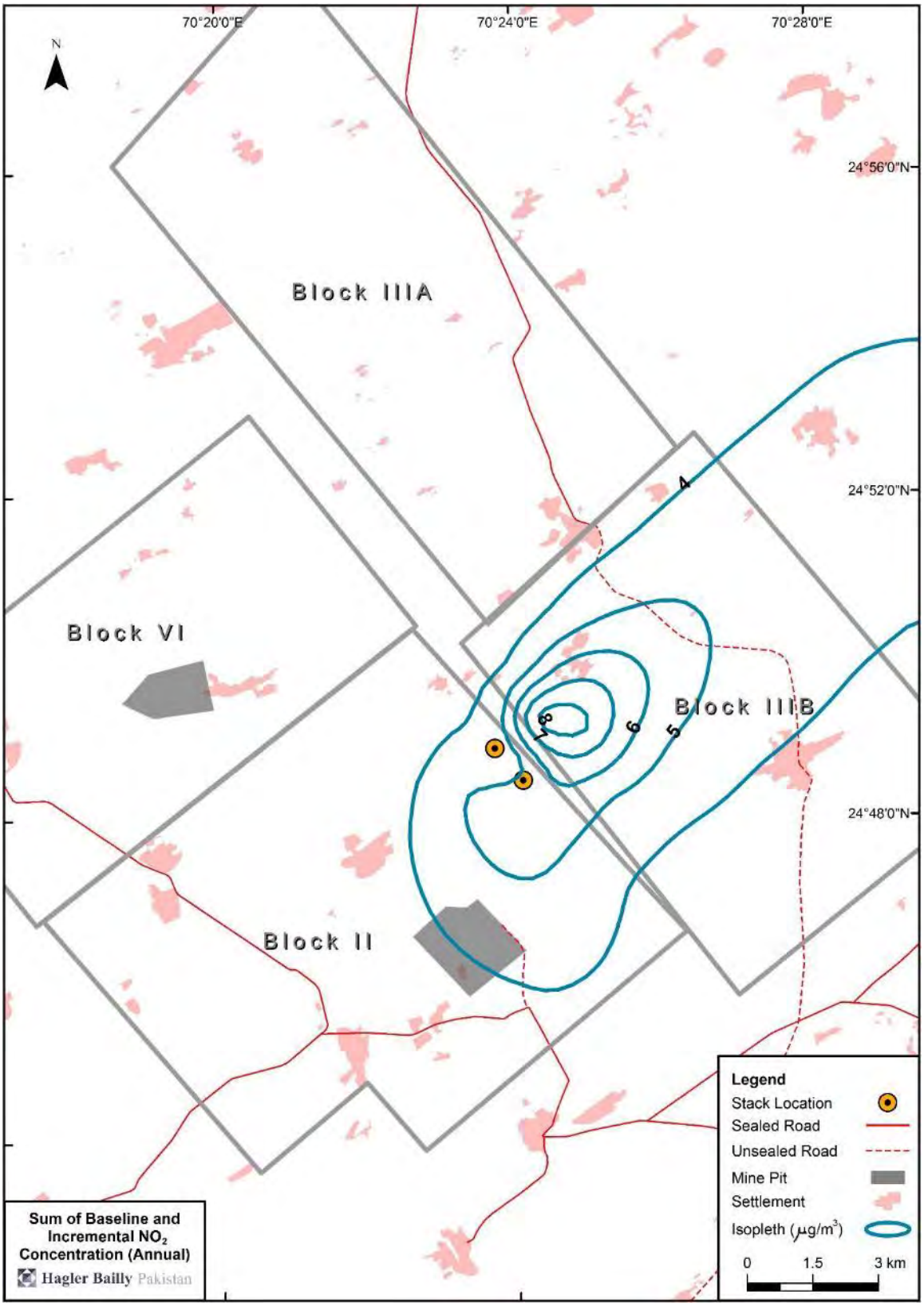


**Exhibit 6.9:** Sum of Baseline and Incremental $NO_2$ Concentration (24-hour)

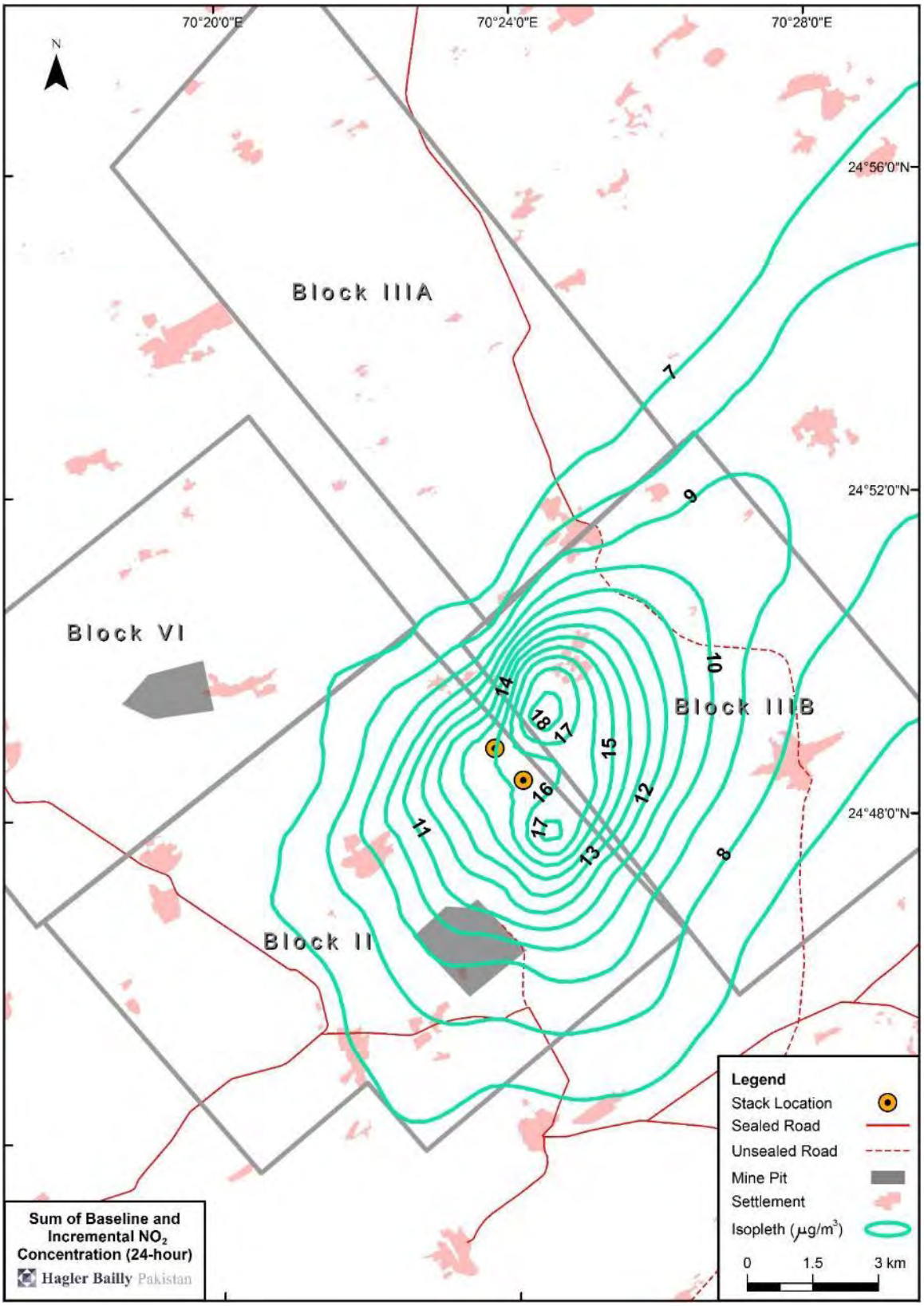


**Exhibit 6.10:** Sum of Baseline and Incremental $PM_{10}$ Concentration (Annual)

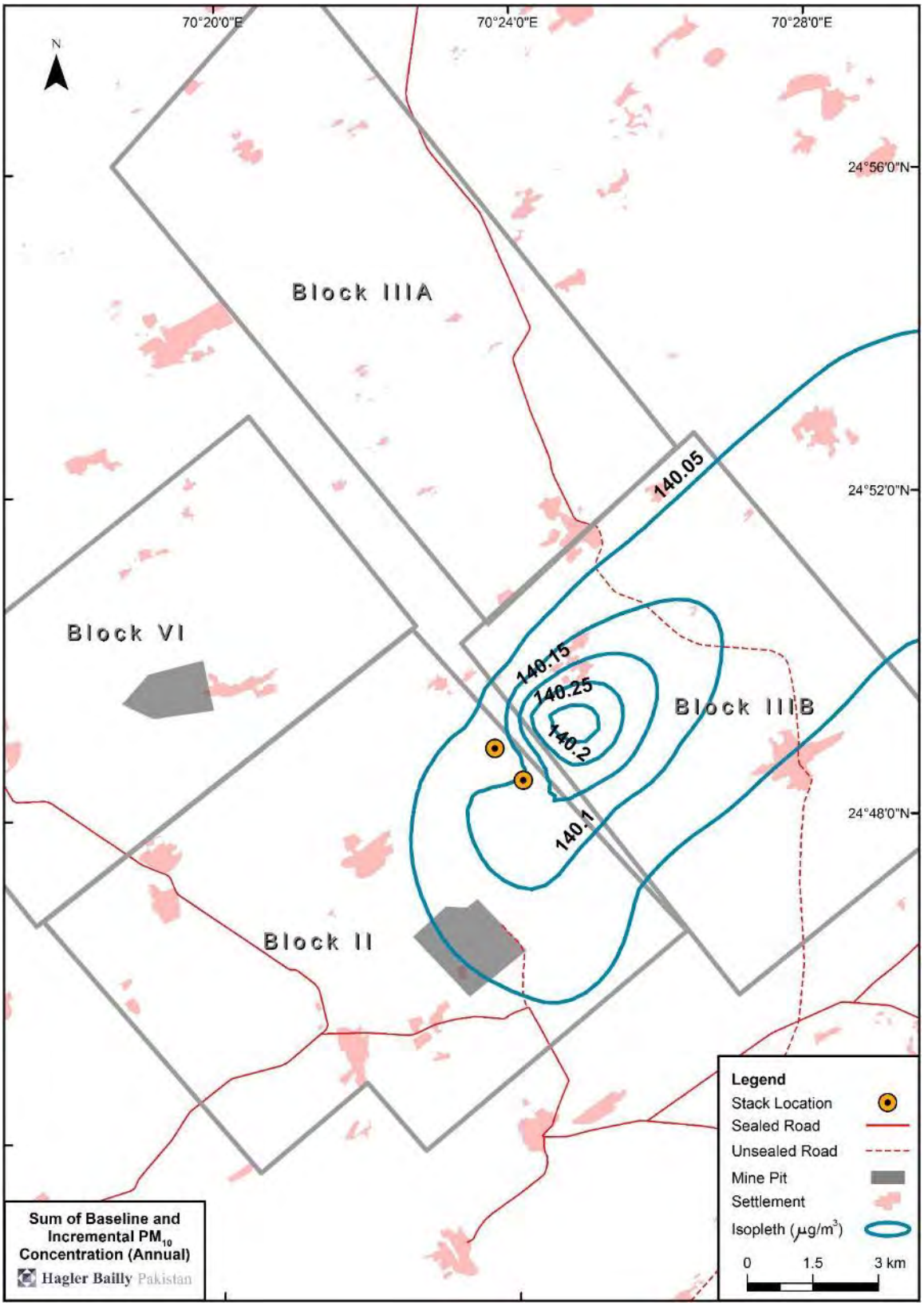


**Exhibit 6.11:** Sum of Baseline and Incremental $PM_{10}$ Concentration (24-hour)

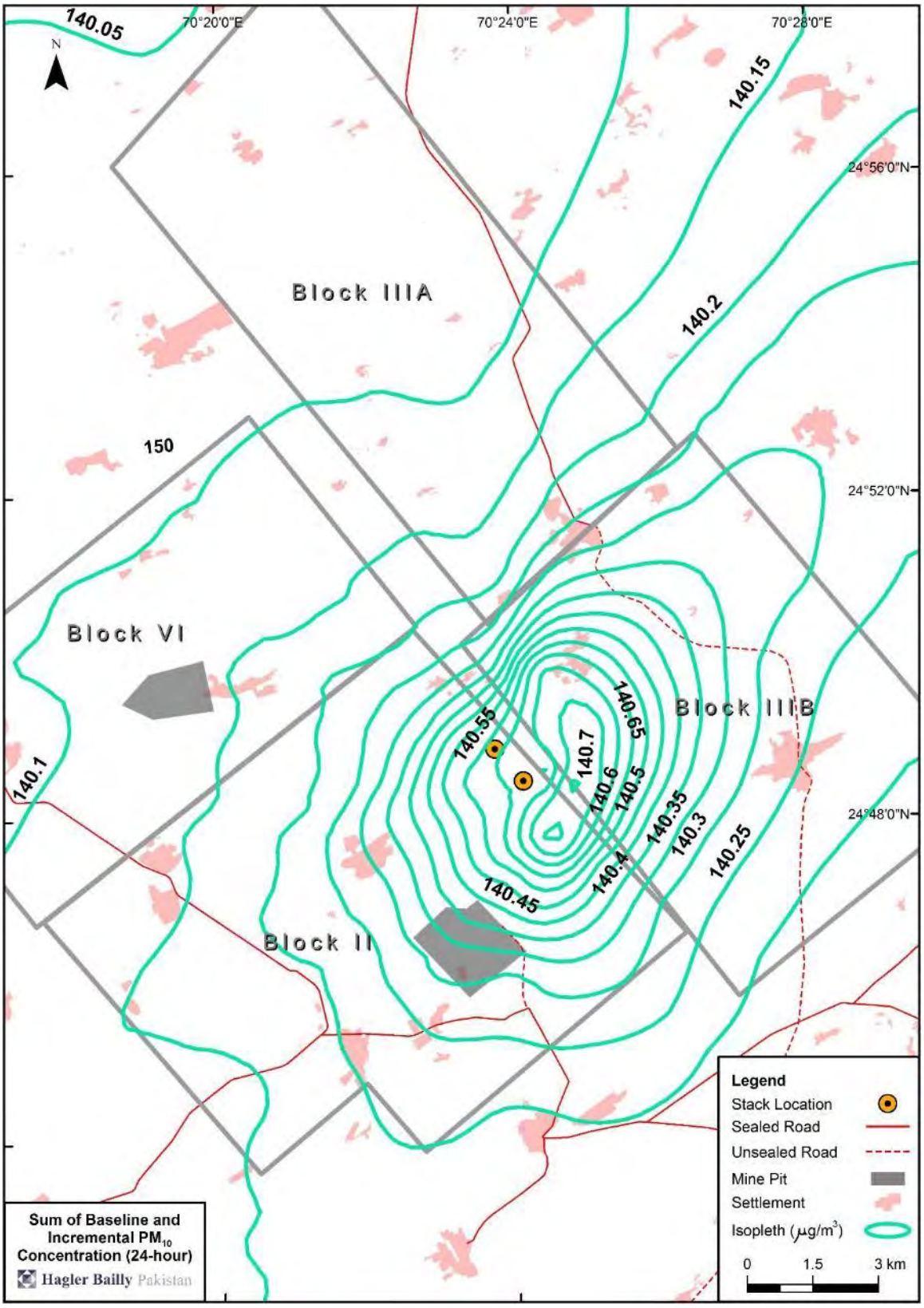


**Exhibit 6.12:** Sum of Baseline and Incremental $PM_{2.5}$ Concentration (Annual)

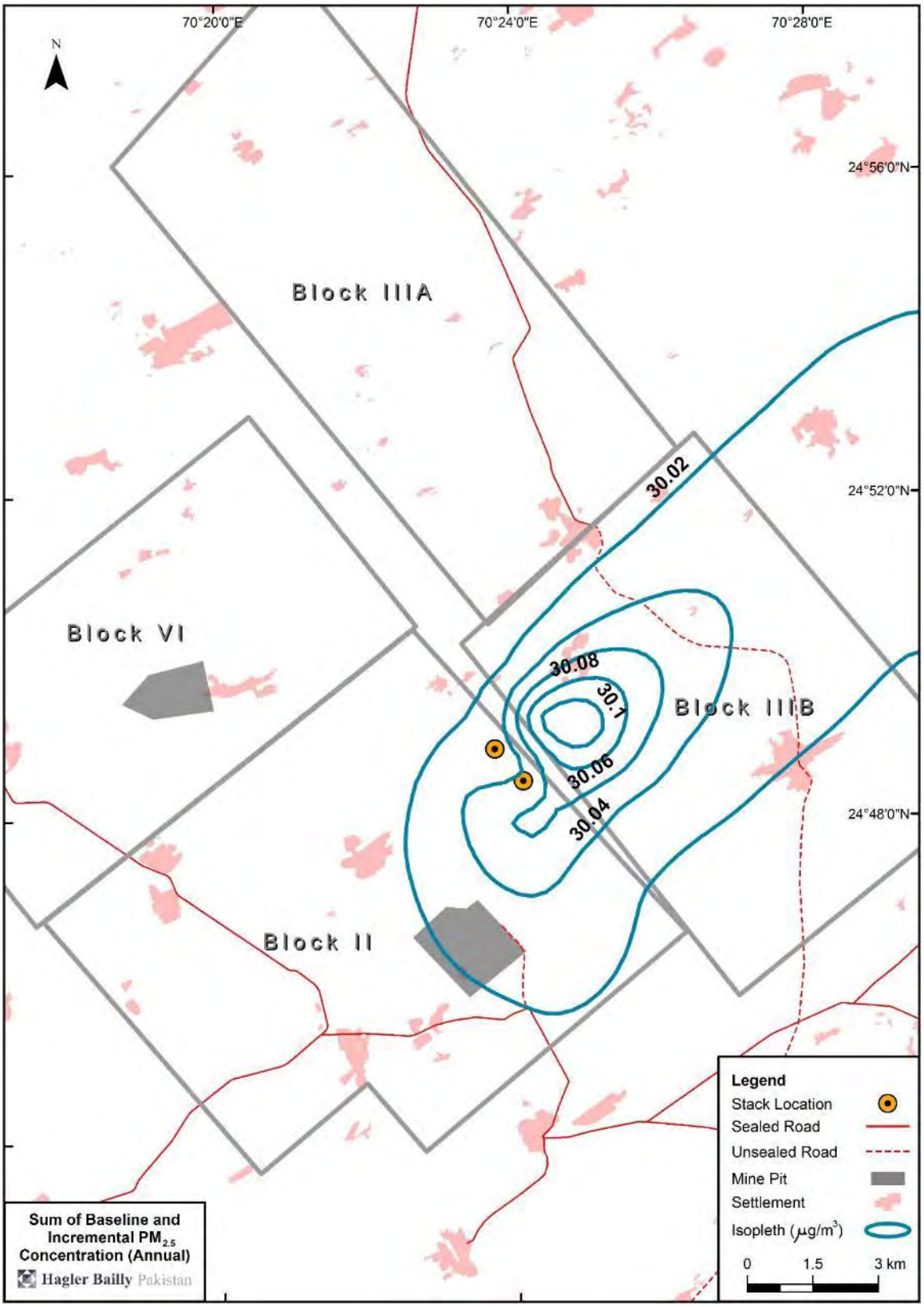


**Exhibit 6.13:** Sum of Baseline and Incremental $PM_{2.5}$ Concentration (24-hour)

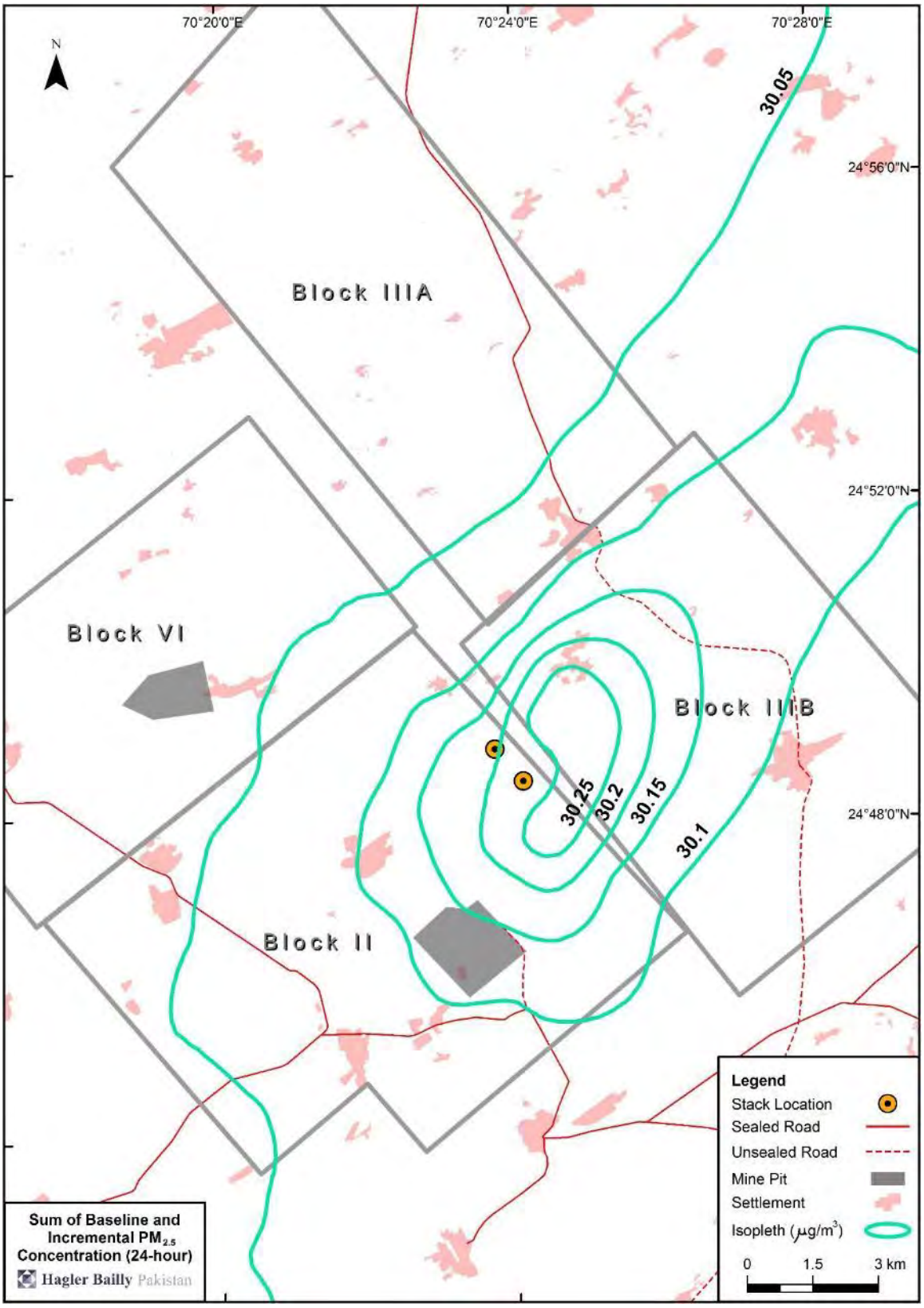


**Exhibit 6.14:** Impact of Proposed Plant (µg/m$^3$)

| *Pollutant* | *Averaging Period* | *Simulated Baseline* | *Impact of Proposed 1x330 MW Plant* | | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|
| | | | *Incremental* | *Ambient* | | |
| $SO_2$ | 24-hour (98$^{th}$ percentile) | 30.8 | 0.9 | 31.7 | 120 | 125 |
| | Annual Avg. | 14.1 | 1.7 | 15.8 | 80 | - |
| $NO_2$ | 24-hour (98$^{th}$ percentile) | 18.5 | 0.6 | 19.1 | 80 | - |
| | Annual Avg. | 7.6 | 0.9 | 8.6 | 40 | 40 |
| $PM_{10}$ | 24-hour (98$^{th}$ percentile) | 140.6 | 0.8 | 141.4 | 150 | 150 |
| | Annual Avg. | 140.2 | 0.3 | 140.5 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98$^{th}$ percentile) | 30.2 | 0.3 | 30.5 | 75 | 75 |
| | Annual Avg. | 30.1 | 0.1 | 30.2 | 40 | 35 |

### *Emission Controls*

There is no major incremental impact of the Project on the ambient air quality. Emission control technologies discussed in **Chapter 3** will significantly reduce the contribution of the Project on ambient air quality. Measures proposed in the Environmental Management Plan in **Chapter 7**, that deal with impacts during construction and operation of the Project will keep the impact of the Project to acceptable levels.

### *Impact of the Second 330 MW Power Plant*

Another 330 MW Power plant is planned to be constructed by ThalNova Power Thar (Private) Ltd. (TNPTL) in the Energy Park simultaneously with the Proposed Project. Although the impacts of the second plant are considered in the cumulative impacts, they are also considered here because unlike the anticipated projects, this plant will be developed simultaneously and will therefore will have its impact on the air quality when the proposed Project is commissioned.

The second plant is assumed to have the same modeling approach and parameters as of the EPTL power plant.

The results are shown in **Exhibit 6.15.** The location of the second plant is shown in **Exhibit 6.16**. It can be observed that there is an increase in the $SO_2$ and $NO_2$ concentrations due to the second power plant. The spatial distribution of this increase is shown in **Exhibit 6.16** to **Exhibit 6.20**, to identify sensitive receptors that will be impacted by the development.

No major impact of the second coal power plant on the particulate matter concentrations is observed. **Exhibit 6.10** to **Exhibit 6.13** can be referred to for the spatial distribution of particulate matter concentrations.

Although there is an increase in $SO_2$ and $NO_2$ concentrations they stay below limits. There is no visible impact on particulate matter concentrations and they are above the limits due to the baseline levels.

**Exhibit 6.15:** Impact of Second Plant ($\mu g/m^3$)

| *Pollutant* | *Averaging Period* | *Simulated Baseline* | *Air Quality After the Proposed Plant* | *Impact of Second 1x330 MW Plant* | | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|---|
| | | | | *Increment* | *Ambient* | | |
| $SO_2$ | 24-hour (98th percentile) | 30.8 | 31.7 | 2.0 | 33.7 | 120 | 125 |
| | Annual Avg. | 14.1 | 15.8 | 0.9 | 16.7 | 80 | - |
| $NO_2$ | 24-hour (98th percentile) | 18.5 | 19.1 | 0.7 | 19.8 | 80 | - |
| | Annual Avg. | 7.6 | 8.6 | 0.5 | 9.1 | 40 | 40 |
| $PM_{10}$ | 24-hour (98th percentile) | 140.6 | 141.4 | 0.9 | 141.5 | 150 | 150 |
| | Annual Avg. | 140.2 | 140.5 | 0.3 | 140.5 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98th percentile) | 30.2 | 30.5 | 0.3 | 30.5 | 75 | 75 |
| | Annual Avg. | 30.1 | 30.2 | 0.1 | 30.2 | 40 | 35 |

### *Conclusions*

*Incremental Impact of $SO_2$ and $NO_2$ Emission*

The 24-hour and annual concentrations of $SO_2$ and $NO_2$ will increase due to the proposed Plant (**Exhibit 6.15**). However, the increase will be less than 10 $\mu g/m^3$ in all cases ($SO_2$ and $NO_2$, annual and 24-hour). The impact of the second plant will be similar.

*$SO_2$ and $NO_2$ Concentration after the Proposed Plant*

The 24-hour and annual concentrations of $SO_2$ and $NO_2$ complies with both SEQS and IFC EHS limits. This is true for the proposed Plant as well the second Plant.

*Incremental impact on $PM_{10}$ and $PM_{2.5}$ Concentrations*

There is no significant impact of proposed plant on $PM_{10}$ and $PM_{2.5}$ concentrations. The reason is as the plant is using electrostatic precipitators with 99% efficiency that captures almost particulate matter of each size and leaves a minute amount of particulate matter in flue gas. As can be seen from **Exhibit 6.15**, the net increase even after both plant are operational will be less than 1 $\mu g/m^3$.

*$PM_{10}$ and $PM_{2.5}$ Concentration after the Proposed Plant*

There will be no measurable impact from the Project on particulate matter concentrations ($PM_{10}$ and $PM_{2.5}$). However, contributions from natural sources is high and an area of 3-5 km around the coal mines will be dominated by the coal mining activities.

The air quality management of an area is the responsibility of SEPA under the Sindh Act. It is proposed that SEPA, working with the developers in Thar Coalfields, develop an ambient air quality management plan to mitigate the high concentration of natural dust in the area.

**Exhibit 6.16:** Approved Developments and Proposed Projects

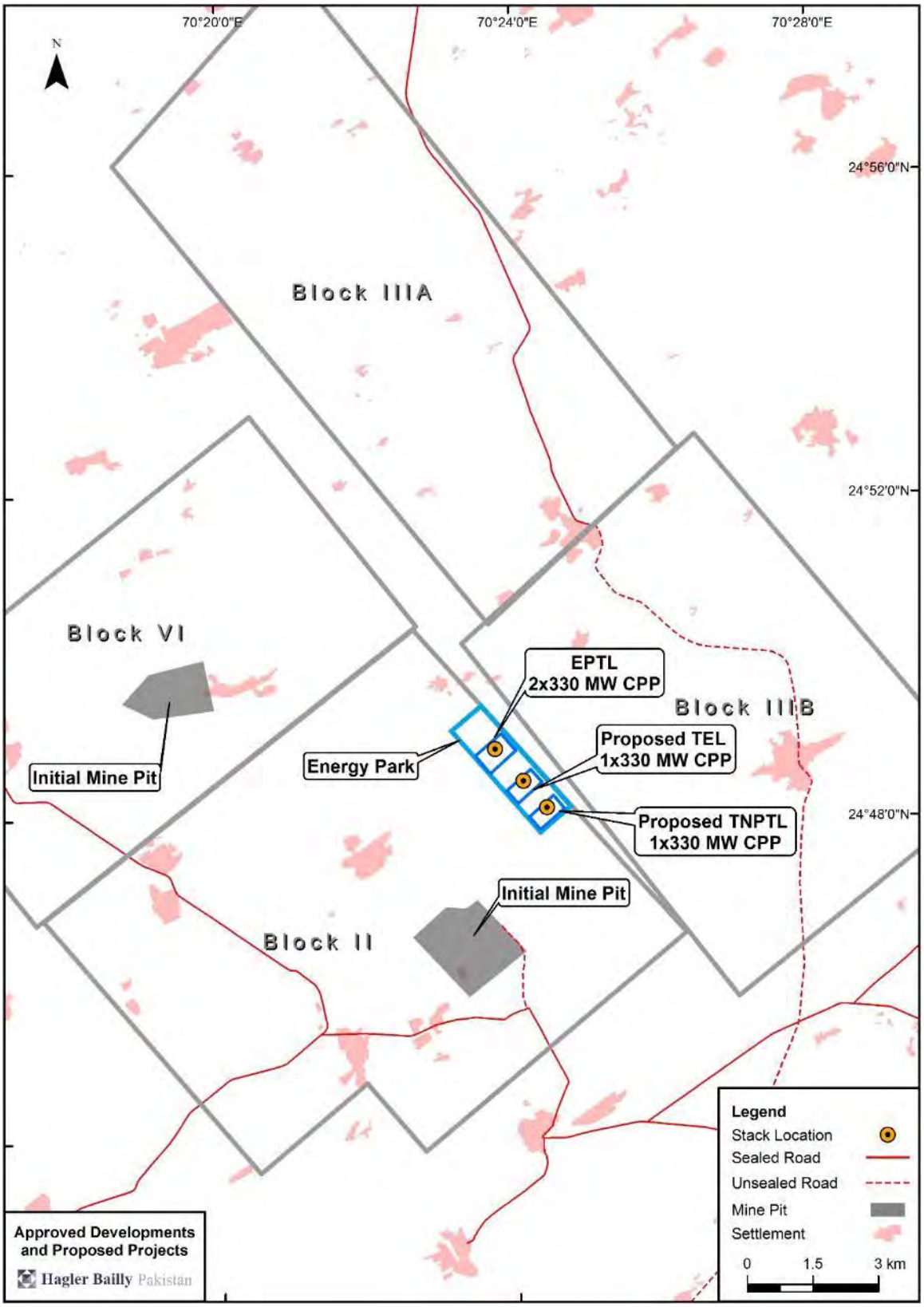


**Exhibit 6.17:** Sum of Baseline and Two Power Plants $SO_2$ concentration (Annual)

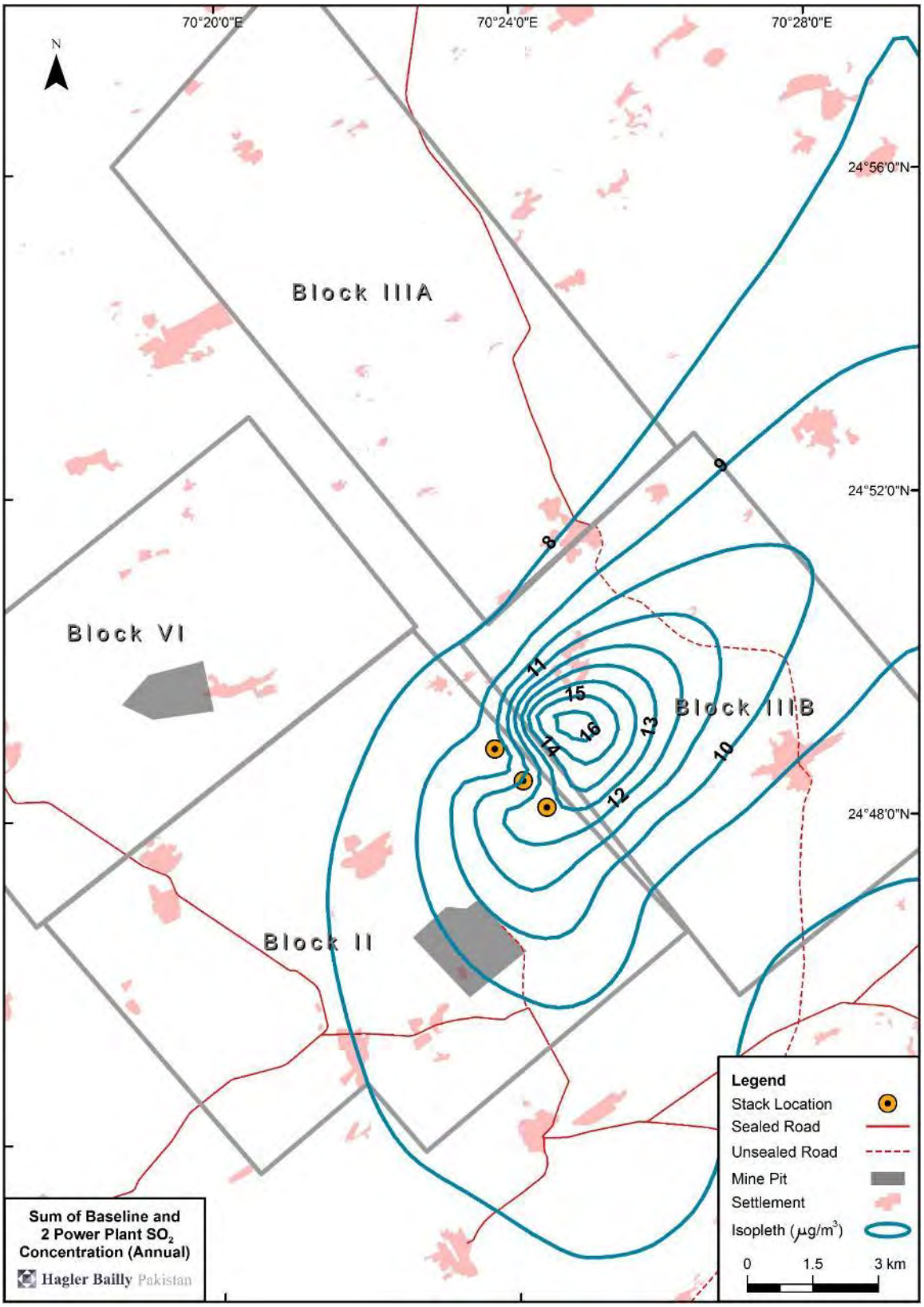


**Exhibit 6.18:** Sum of Baseline and Two Power Plants $SO_2$ concentration (24-hour)

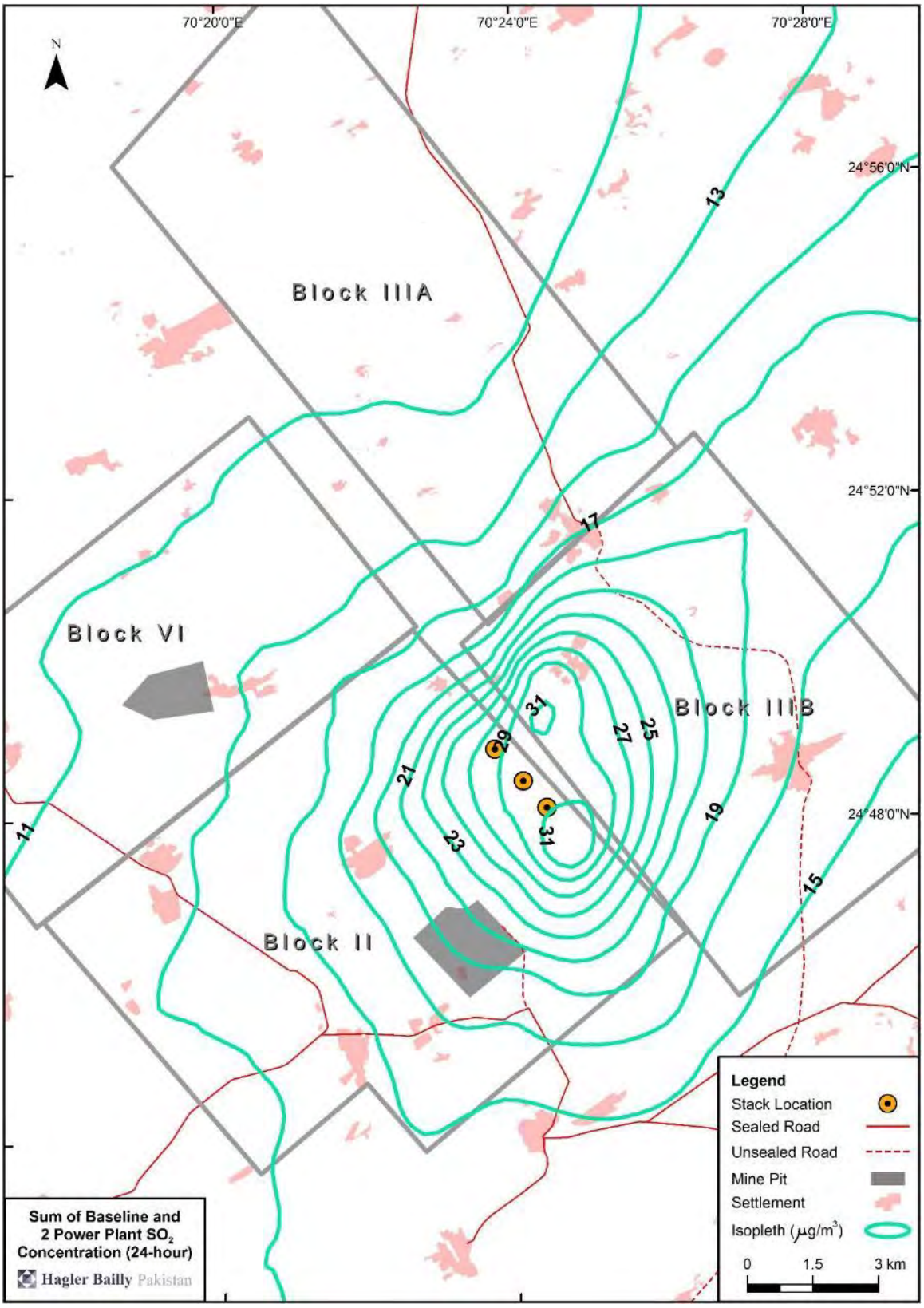


**Exhibit 6.19:** Sum of Baseline and Two Power Plants $NO_2$ concentration (Annual)

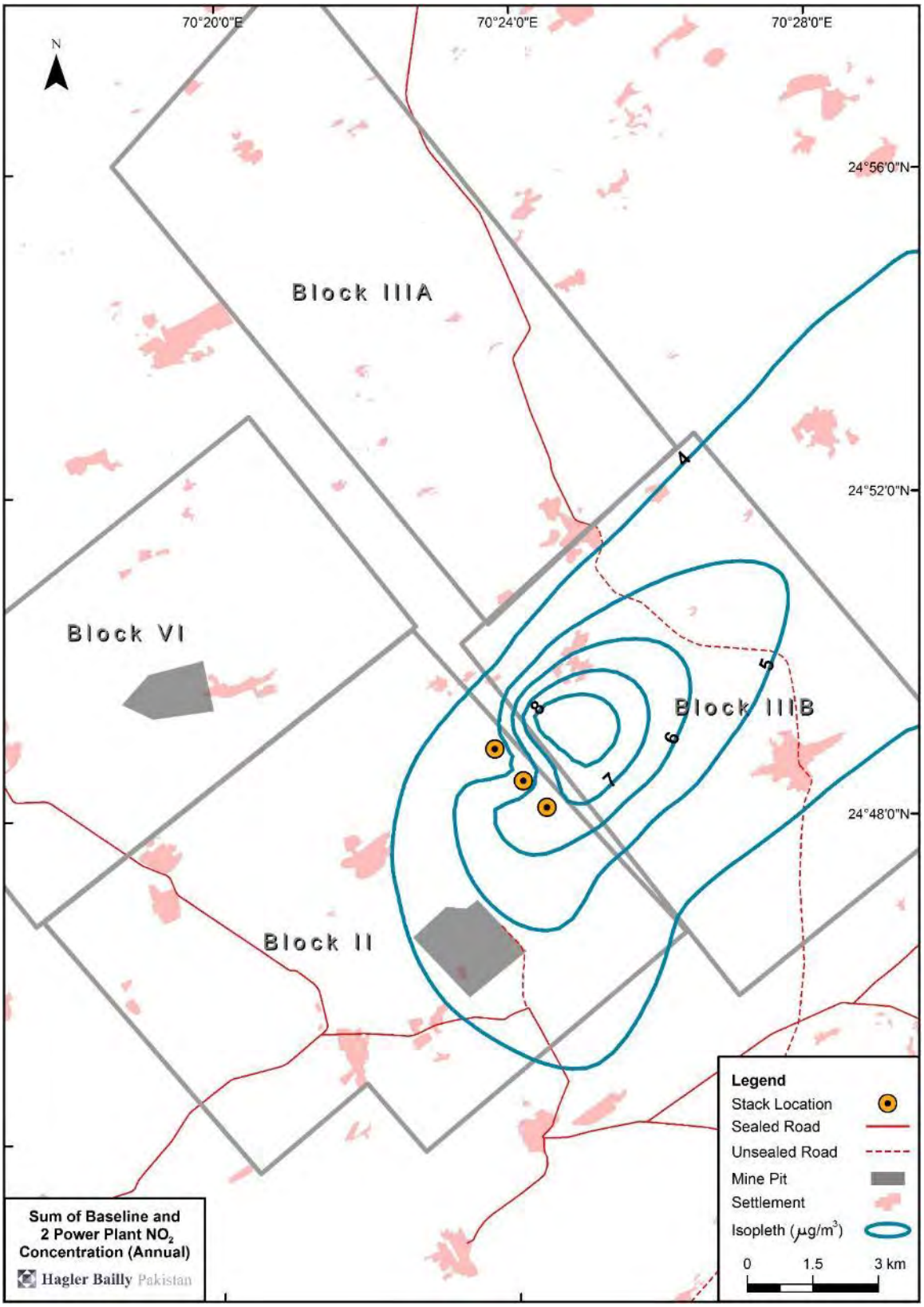
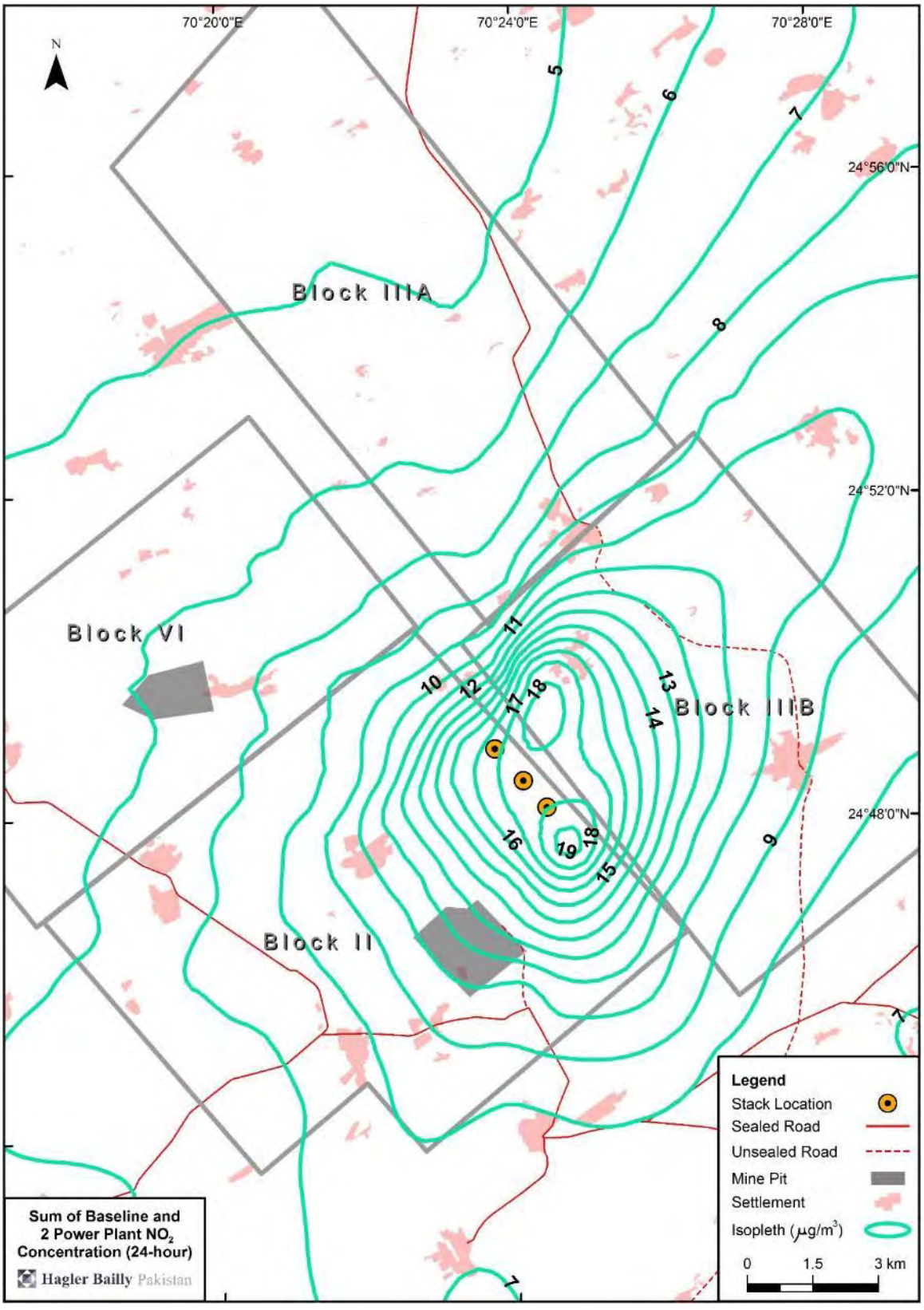


**Exhibit 6.20:** Sum of Baseline and Two Power Plants $NO_2$ concentration (24-hour)



### 6.3.3 Socioeconomic Impact during Project Operation

The major socioeconomic impact of the Project includes increased electricity generation capacity which will help alleviate Pakistan's energy crisis. Locally, the Project activities will stimulate the local economy thus creating jobs in the area.

#### *Employment Impact*

The Project will create additional job opportunities. It is expected that more than 100 staff positions will be created under the Project. Most of these positions will be skilled, having expertise in handling the new equipment and processes.

To maximize employment of people from within the Study Area in the operational phase of the Project, the Project will invest in training programs that focus on the Study Area. This investment will be needed to overcome the lack of education and skills in the labor force of the Study Area. The training programs will be implemented in time for local people to at least benefit from unskilled employment opportunities that are available during the construction phase of the Project. The proportion of locals in the workforce of the Project will increase over time as training programs are completed. Training and preparation of local people for jobs will also increase their access to indirect and induced employment opportunities.

#### *Increased Power Generation and Diversified Fuel Mix*

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, 300 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.

The power plant will also shift the generation mix of the country towards an indigenous fuel source of coal, thereby protecting the country from volatility in international oil prices.

#### *In-Migration*

The increased job opportunities offered by the Project and by service providers to the Project, in conjunction with the lack of opportunities available in the rest of Tharparkar District, will lead to an influx of job seekers in the Study Area. Some service providers to the Project may open new offices in the towns of Islamkot and Mithi, which are situated close to the Study Area. This will stimulate the local economy through a trickledown effect.

The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing facilities. The informal settlements developed in this manner would lack basic infrastructure and services, such as adequate sanitation systems and health facilities. Thus, in-migrants would rely on the existing infrastructure and services within the Study Area and in and around the towns of Islamkot and Mithi, which

would burden the existing infrastructure and services. This can possibly generate conflict between locals and the in-migrants. To avoid this, infrastructure and services would have to be scaled up in areas where there is in-migration. However, the district and tehsil administration of the Study Area do not possess the necessary resources for this. Conflict can also be caused if the in-migrants occupy land that the inhabitants of the Study Area consider as their own, which can give rise to disputes over the rightful ownership of the land. While TEL will not be able to address such conflicts by itself, TEL will report such cases to the local authorities as soon as they arise and work in collaboration with local authorities to resolve such disputes.

Proposed mitigation, enhancement and good-practice measures include:

- Limit employment of non-locals (persons from outside Tharparkar District). In support of this, establish and raise awareness of recruitment offices for 'non locals' in identified locations outside of Tharparkar District (such as Karachi). Support training of local people in getting the required skills to get employment in the power plant.
- In association with other community development programs, support local authorities in Mithi to increase their capacities to deliver services to an increased population. Determine the nature of support, which may include town planning, waste management and access to basic health care and education.
- Encourage local communities to use the grievance procedure for concerns related to deterioration of local services and conflicts over land ownership.
- Work with the concerned legal and traditional authorities to establish land ownership in the Study Area before commencement of construction.
- Support local government in the management of informal settlement.
- Support NGOs specializing in informal settlements to assist local government.

In-migration of people in the Study Area can result in deterioration in public health due to increased chances of exposure to communicable diseases such as tuberculosis, diarrhea, and malaria. The potential spread of communicable diseases can be exacerbated by factors associated with the development of informal settlements. Such factors would include unsanitary and congested living conditions in informal settlements, lack of potable water, malnutrition and lack of awareness about health prevention measures amongst in-migrants. The in-migration of people would also worsen public health conditions since it would burden the existing health facilities, which are not equipped to handle a large increase in population and thus, number of patients, in the Study Area.

Proposed mitigation, enhancement and good-practice measures include:

- Develop and implement management policies for tuberculosis, diarrhea, malaria and other communicable diseases, focusing on prevention, control, diagnosis and treatment in coordination with NGOs and local government.
- Provide health and hygiene education awareness programs to local communities, educational establishments and employees.
- Undertake health screening of employees.

### 6.3.4 Ecological Impacts

Any ecological impact from the Project will be incremental over the impact of the mining activities in Block II. In the ESIA for the Block II Coal Mine, it is stated that other than potential impact on the vulture habitat, no significant impact of the mining on the flora and fauna of the area are anticipated. No threatened mammals or reptiles are found in the Study Area. Although part of the Thar Desert in the project area is cultivated, the agricultural activity is not very intense. Thus the natural habitat is relatively intact. Site clearance for the power plant and related infrastructure will result in immediate and direct habitat loss, however the risk of direct killing of animals is minimal as the animals are likely to move away from the area once the clearance has started.

The habitat in the Thar Desert area is important for survival of vultures as one Endangered and three Critically Endangered species of vultures are breeding in the Thar Desert. Availability of nesting sites and food are principle factors that determine the population of vultures in an area. The vulture population in the Indian subcontinent is declining due to existing threat to the vulture population. The cause of this is presumably poisoning by the veterinary drug Diclofenac, probably combined with other causes (BirdLife International 2010)[117]. The birds feed on carcasses of animals treated with the veterinary drug.

Availability of nesting sites and food are principle factors that determine the population of vultures in an area. Clearing of land for power plant will reduce the potential habitat area of these vultures. While the trees for nesting and the feeding areas are widespread in the Thar Desert, a program for management of vulture population in the immediate vicinity and within Block II supported by the Project will be required to contribute to the ongoing efforts of the Sindh Wildlife Department and other conservation groups in preventing the extirpation of this species from the Thar area. Vultures prefer to make nests on *Prosopis cineraria* trees in the Thar Desert. *Prosopis cineraria* trees can be planted outside the area that will be directly impacted by Project operations so the vultures can have access to alternate nesting sites. Such plantation may be started early during the Project to minimize the potential impact of habitat loss during the construction period.

## 6.4 Cumulative Impact Assessment

The cumulative impacts of future developments that will affect the environment in the Study Area are discussed in this section. These include developments in Block II, Block VI and Block III A&B of the Thar coalfields.

### 6.4.1 Cumulative Impacts on Air Quality

As with time the Block II, VI and III A & B will be fully developed and generating electricity to their maximum capacity, they will cumulatively deteriorate air quality of the Study Area.

[117] BirdLife International 2010. Species factsheet: *Neophron percnopterus.* Downloaded from http://www.birdlife.org on 27/6/2010.

### *Future Developments*

The future developments in the adjacent blocks to the Energy Park are summarized in **Exhibit 4.31**. The expected location of these developments are shown in **Exhibit 6.22**.

**Exhibit 6.21:** Future Developments near Study Area

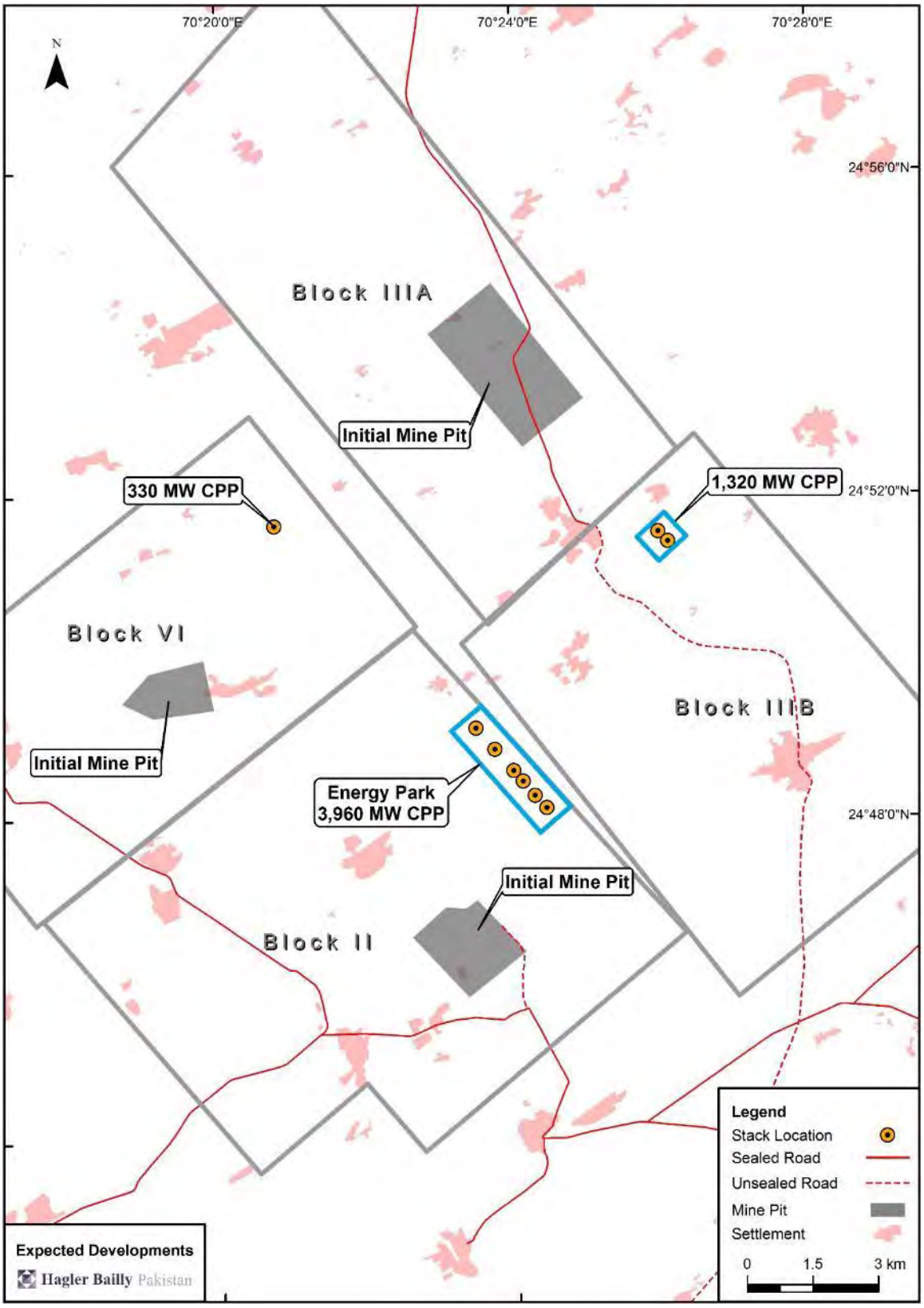
| *Block No.* | *Coal Mine* | *Power Plant* | *Source* |
|---|---|---|---|
| Block II | up to 22 mtpa | 3,960 MW | ESIA of Block II Mining and Power Project[118] |
| Block III A & B | 6.5 mtpa | 1,320 MW | Background information document for ESIA of Block III A & B Mining and Power Plant Project |
| Block VI | 2.5 mtpa | 330 MW | ESIA of Block VI Mining Project[119] |
| **Total** | **31.5 mtpa** | **5,610 MW** | |

The modelling method and approach discussed in **Section 6.3.2** was used. For simplicity it was assumed that all additional coal plants follow the same specification as the EPTL 2x330 MW power plant.

[118] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

[119] Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

**Exhibit 6.22:** Future Developments



### *Modeling Results and Discussion*

The results are compiled in **Exhibit XII.** The pollutant concentrations exceeding one of the standards have been shaded in the table. Contour maps for dispersion of each pollutant are presented in **Exhibit 6.24** to **Exhibit 6.31.** Areas that exceed standards have been shaded as hotspots.

**Exhibit 6.23:** Predicted Ambient Air Quality due to Cumulative Impacts ($\mu g/m^3$)

| *Pollutant* | *Averaging Period* | *Simulated Baseline* | *Impact of Proposed Plant* | *Impact of Second Plant* | *Cumulative Impact* | *SEQS* | *IFC EHS limits* |
|---|---|---|---|---|---|---|---|
| $SO_2$ | 24-hour (98th percentile) | 30.8 | 31.7 | 33.6 | 87.2 | 120 | 125 |
| | Annual Avg. | 14.1 | 15.8 | 16.7 | 36.7 | 80 | - |
| $NO_2$ | 24-hour (98th percentile) | 18.5 | 19.1 | 19.8 | 51.4 | 80 | - |
| | Annual Avg. | 7.6 | 8.6 | 9.1 | 21.1 | 40 | 40 |
| $PM_{10}$ | 24-hour (98th percentile) | 140.6 | 141.4 | 141.5 | 142.4 | 150 | 150 |
| | Annual Avg. | 140.2 | 140.5 | 140.5 | 140.9 | 120 | 70 |
| $PM_{2.5}$ | 24-hour (98th percentile) | 30.2 | 30.5 | 30.5 | 30.9 | 75 | 75 |
| | Annual Avg. | 30.1 | 30.2 | 30.2 | 30.4 | 40 | 35 |

The following conclusions can be drawn:

- The 24-hour and annual concentrations of $SO_2$ and $NO_2$ complies with both SEQS and IFC EHS limits. There is significant increment in $SO_2$ and $NO_2$ concentrations due to addition of more coal power plants. This leaves very narrow room for developments in other blocks.
- As the proposed plant has negligible impact on PM concentrations but when cumulated with whole developed Energy Park and Block III A & B power plant there is a noticeable increase in PM 24-hour concentrations.
- The annual $PM_{10}$ concentrations are above the SEQS and IFC EHS as the measured background concentrations is high.
- The 24-hour and annual $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits.

**Exhibit 6.24:** Predicted Cumulative $SO_2$ Concentration (Annual)

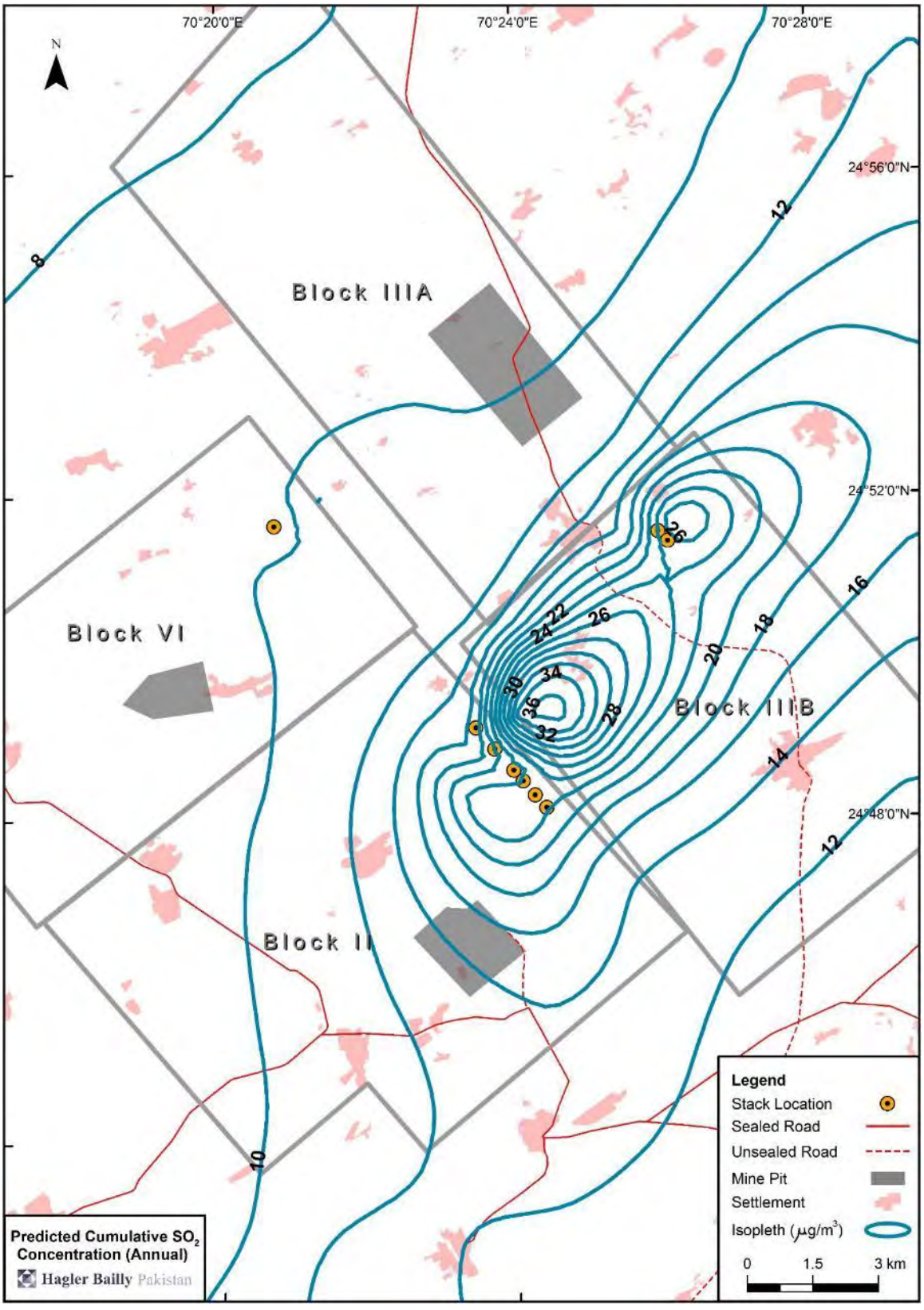


**Exhibit 6.25:** Predicted Cumulative $SO_2$ Concentration (24-hour)

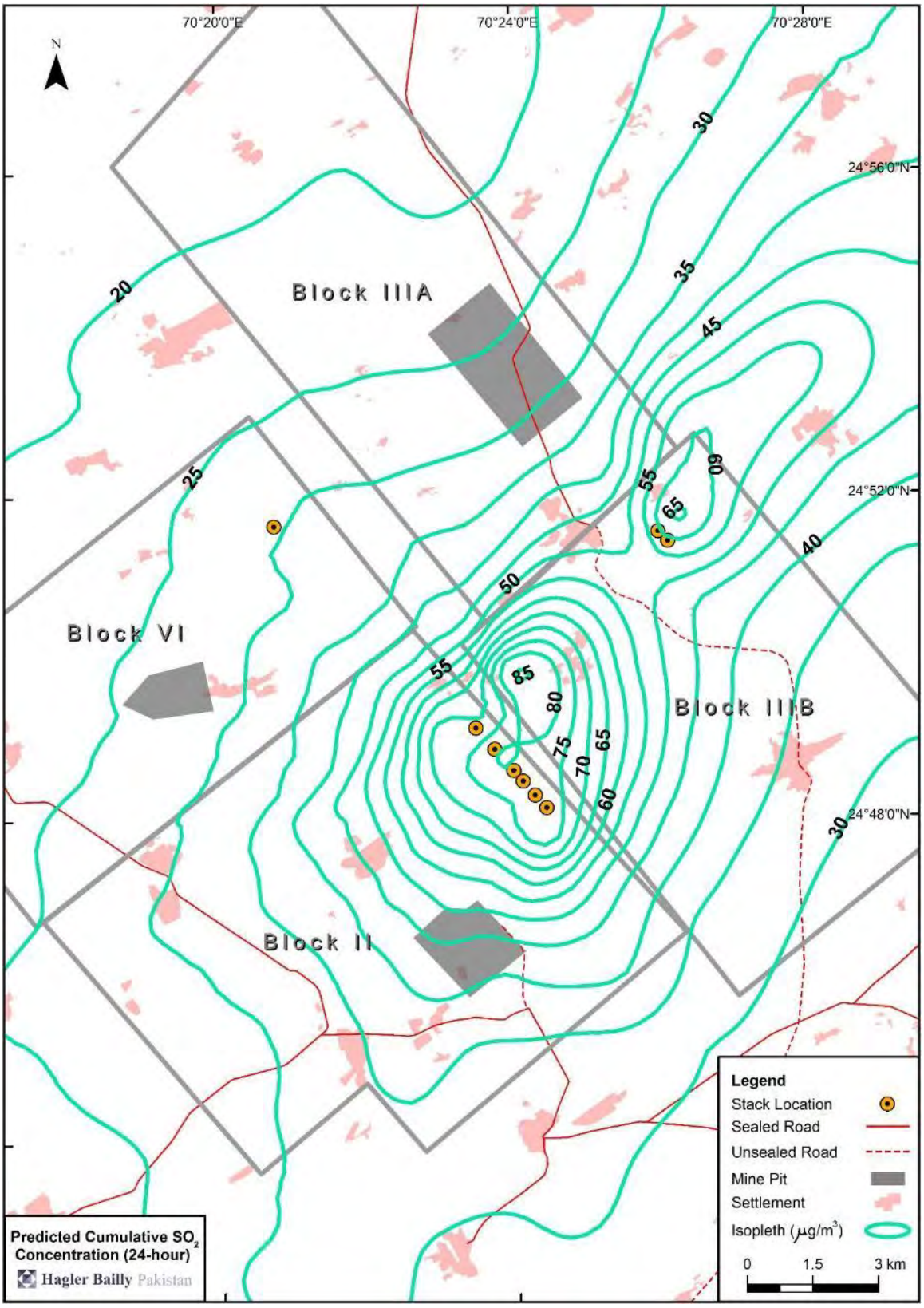


**Exhibit 6.26:** Predicted Cumulative $NO_2$ Concentration (Annual)

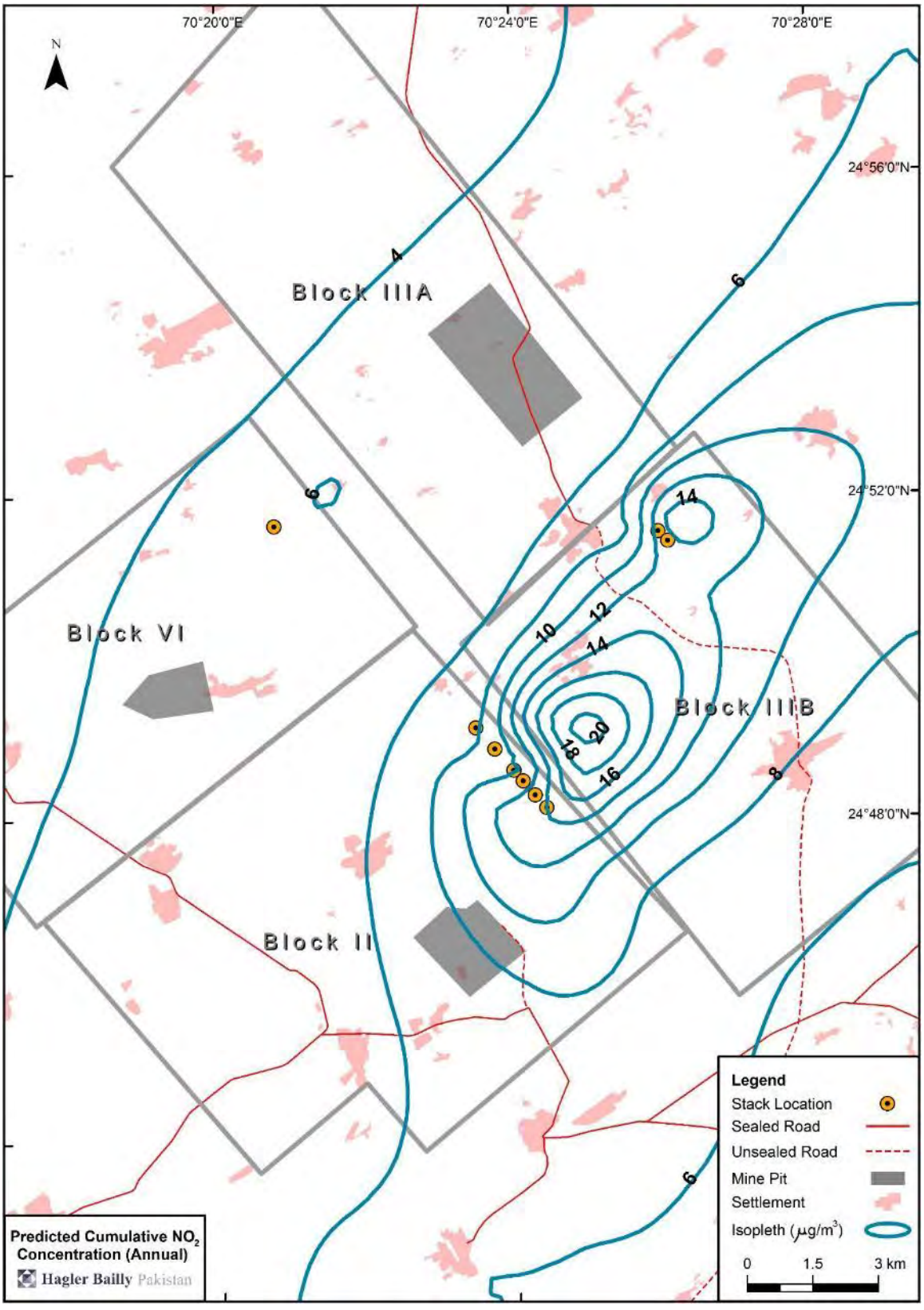


**Exhibit 6.27:** Predicted Cumulative $NO_2$ Concentration (24-hour)

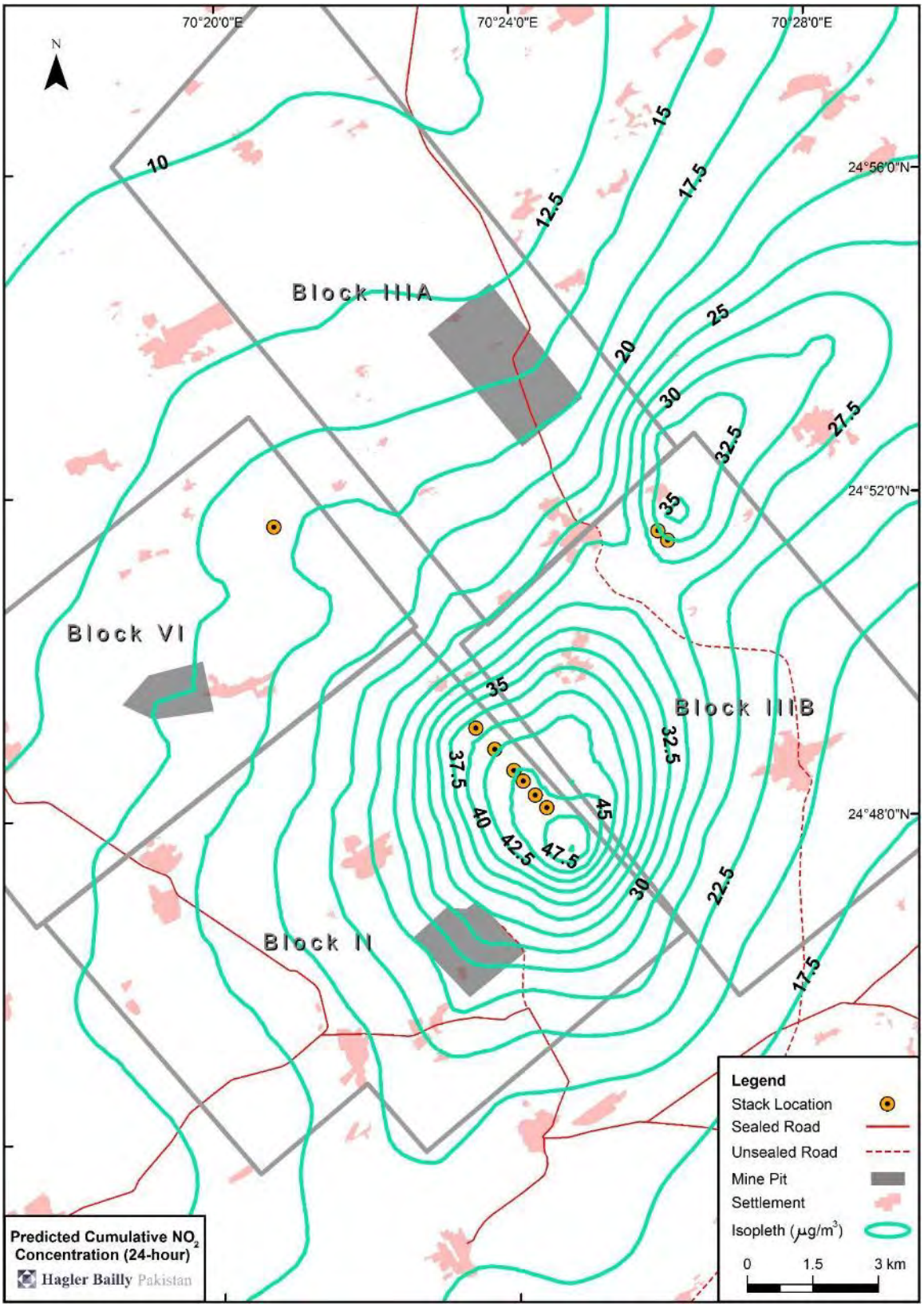


**Exhibit 6.28:** Predicted Cumulative $PM_{10}$ Concentration (Annual)

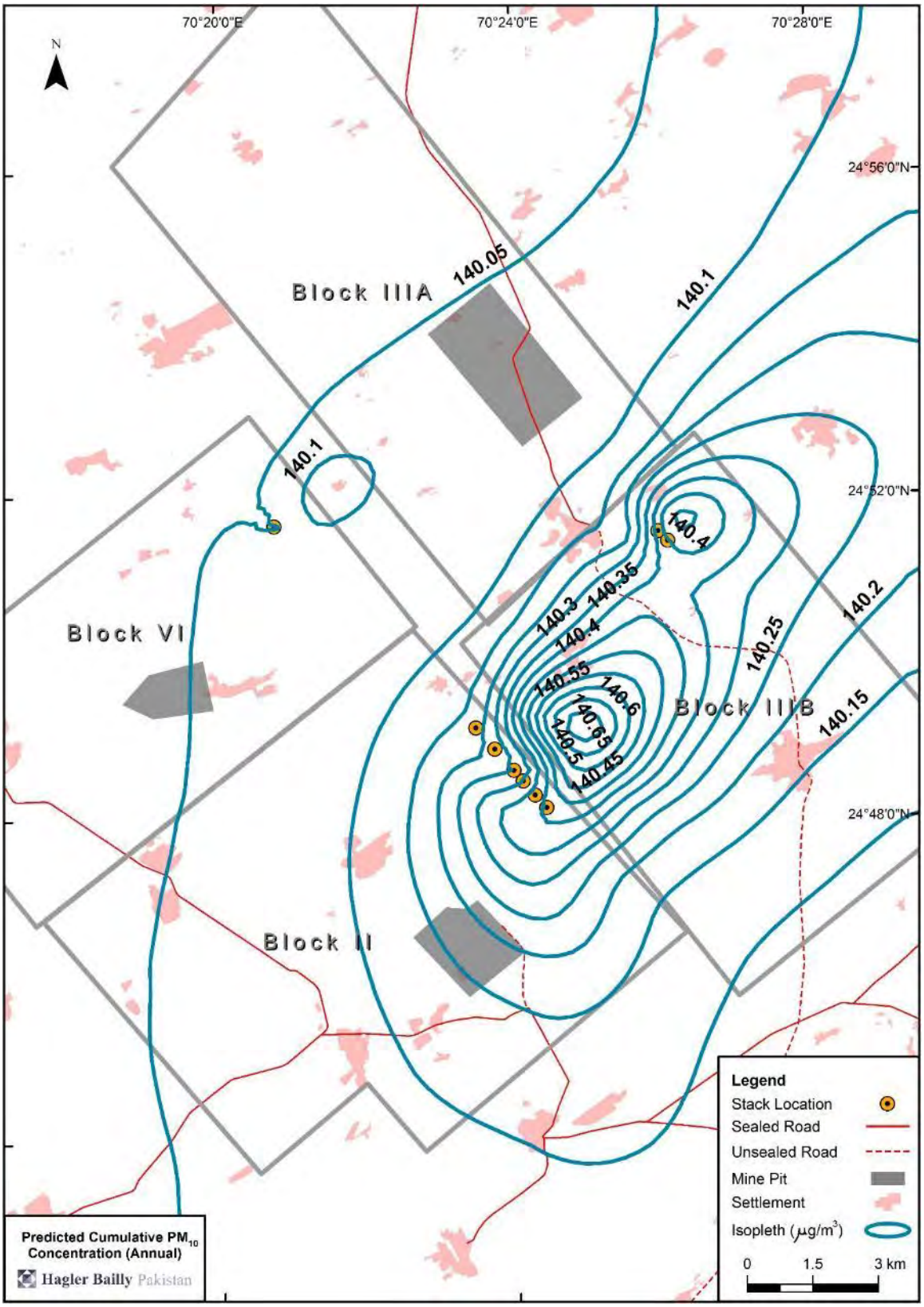


**Exhibit 6.29:** Predicted Cumulative $PM_{10}$ Concentration (24-hour)

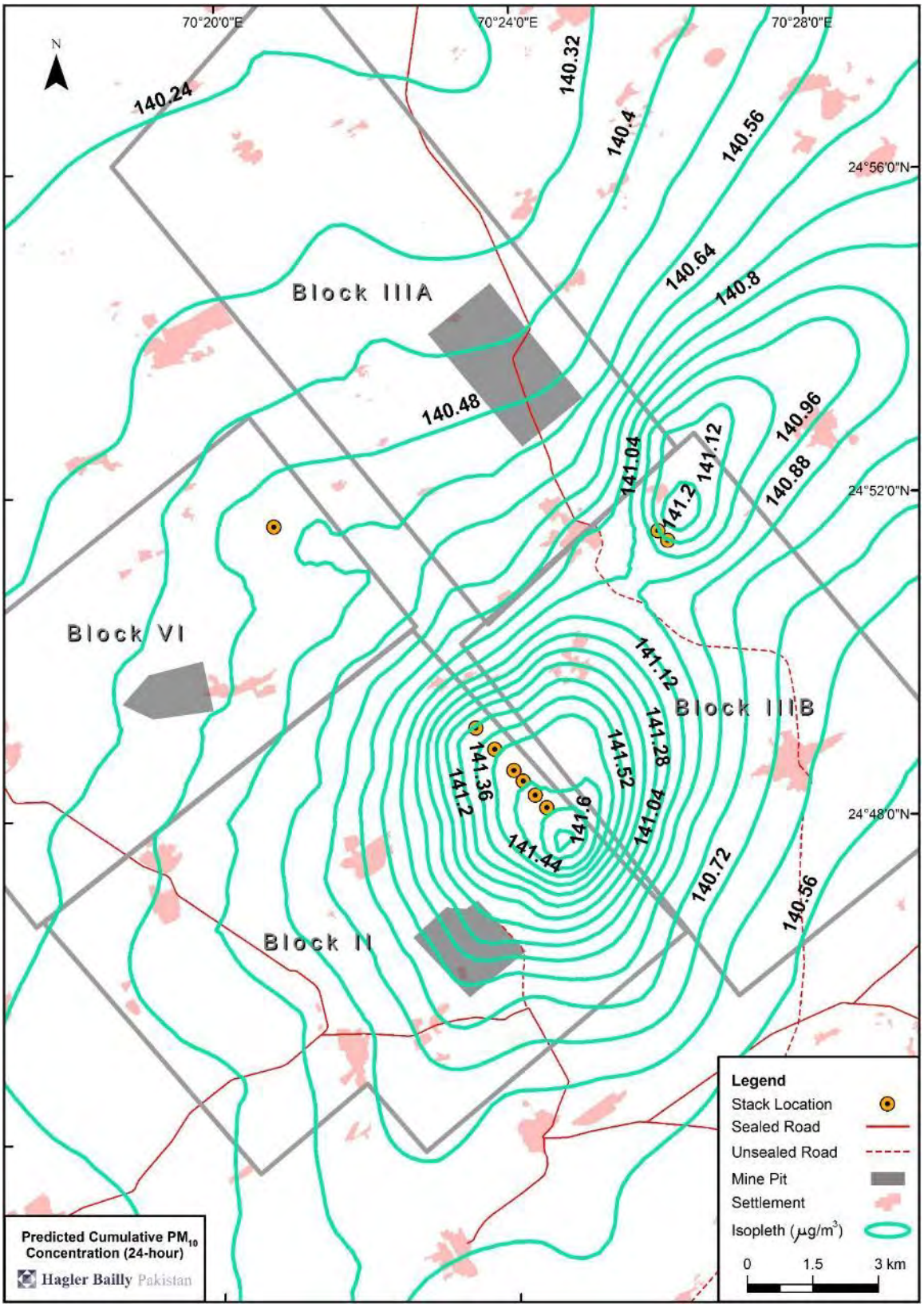


**Exhibit 6.30:** Predicted Cumulative $PM_{2.5}$ Concentration (Annual)

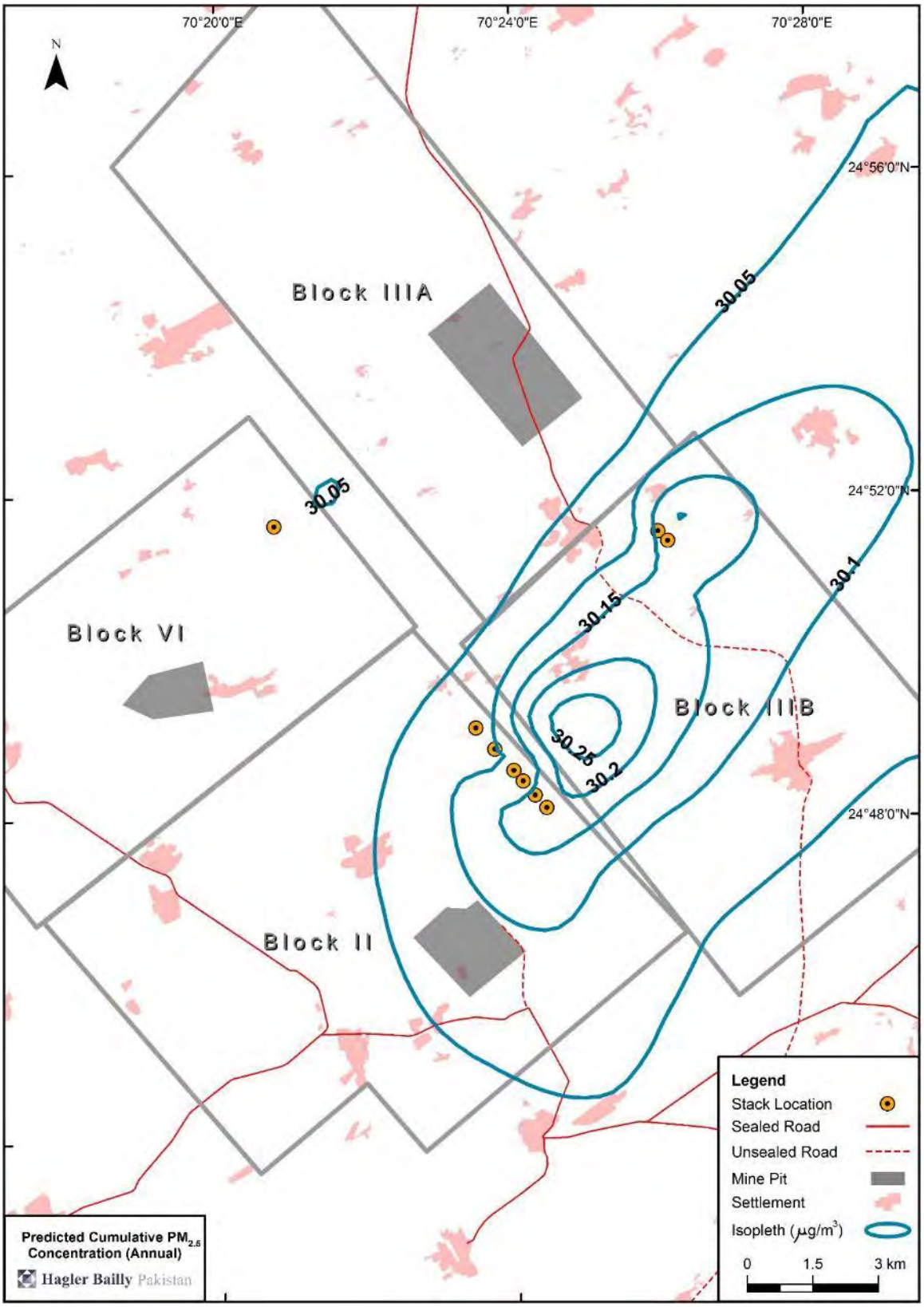
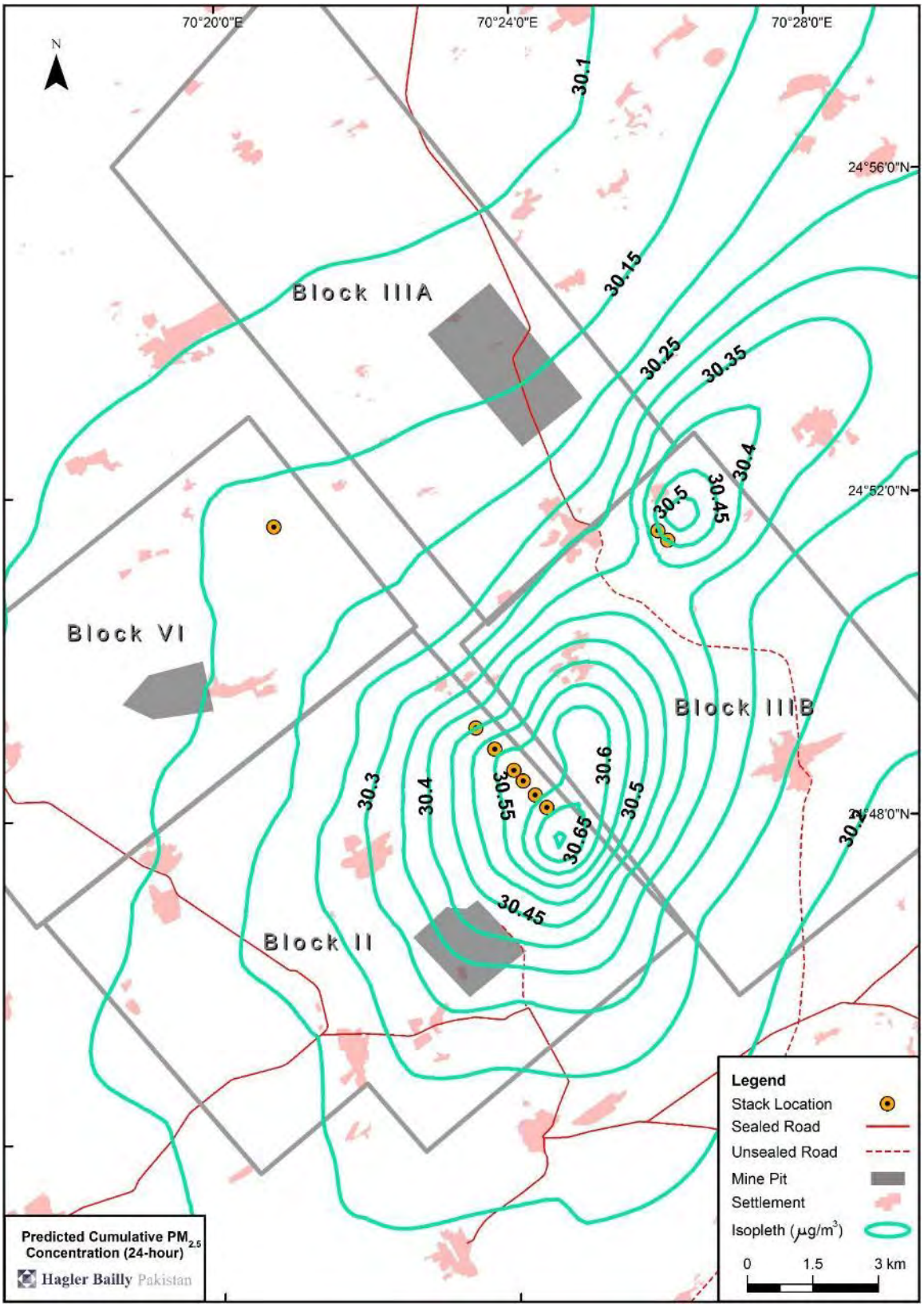


**Exhibit 6.31:** Predicted Cumulative $PM_{2.5}$ Concentration (24-hour)



### 6.4.2 Cumulative Impacts on Water Resources

The mining activities will result in ground water dewatering which will lower the ground water table in the area. The combined impacts are expected to be significant. However, as mining is beyond the scope of this Project, this impact is not quantified further. There should be a collective action plan developed between mine developers to quantify and address the potential impact on communities that a lowering of the ground water table will have as these communities depend heavily on ground water wells for water.

Water consumption for the proposed 330 MW power plant is expected to be between 1,200 to 1400 $m^3$/hr. Therefore the total water consumption for all power plants can be roughly estimated to be around 20,400 to 23,800 $m^3$/hr (200 – 233 cusecs). While the source of water for initial projects will be from the LBOD, it is likely that future projects utilize water from the dewatering of coal mines. Similarly, while initial projects will dispose water via the effluent channel to the Runn of Kutch it is likely future projects dispose water via re-injection of water into the Sub-Recent Aquifer. A synergistic plan should be adopted between various mine and power plant developers for the use and disposal of water to minimize the impact on the local water resources.

### 6.4.3 Cumulative Impacts on Employment

Employment in the construction and initial phases of the projects is expected to be the highest. However, the cumulative impact is assessed based on the operational phase of the projects.

The Proposed project is expected to employee 100 permanent staff positions. Therefore, it can be estimated that the combined employment generated by the power plants will be approximately 1700 persons. However, this figure may be lower due to efficiencies of scale once all plants are operational.

The ESIA of the Block VI mine estimates permanent positions for 340 people as the number of shovels and dump trucks are reduced in line with a reduction in overburden stripping and a move to conveyors.[120] This is 136 persons per mpa coal extracted for a total estimated 4284 staff for the future developments. As with the power plants economies of scale of larger mines may result in a lower number of persons employed.

The total direct permanent employment is therefore estimated at 6000 persons. There is expected to be significant indirect employment to provide services for the projects.

### 6.4.4 Cumulative Impacts on Traffic

The impacts of Thar coal development on the transport network could result from the transport of coal to the rest of the country, and the transport of goods and labor to and from the Thar coalfields.

#### *Coal Transport*

The export of coal from the Thar coalfields to the rest of the country could significantly impact the traffic situation of the area. Two proposed coal power plants (a 660 MW power plant in Lakhra and 1320 MW power plant in Jamshoro) are designed based on a

[120] Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan, April 30th 2013

coal mix of imported and Thar coal. However, it is unlikely that the coal will be transported to these power plants by road for the following reasons:

1. These projects are funded by the Asian Development Bank (ADB) which has stipulated that the Thar coal be transported by rail.
2. The design of these power plants is based on an 80% imported to 20% Thar coal mix. This reduces the requirement of transport for Thar coal.
3. Thar coal is of low quality and has a high moisture content, therefore transport over long distances is expensive.

Therefore, the transport of coal away from the Thar coalfields is not expected to have a major impact on traffic.

### *Project Activities*

Assuming that employees stationed at the mine and power plant are on a 21 day work 10 day leave schedule they will use transport on roads twice a month. This translates to 600 busses per month (with 20 person capacity) or 20 busses per day. Local roads should be able to handle this increase in traffic. Increase in traffic due to short trips, indirect increase in population, and transport of goods and services will also impact the traffic conditions.

# 7. Environmental Management Plan

The main objective of the Environmental Management Plan (EMP) is to identify mechanisms to implement the environmental mitigation measures discussed in **Chapter 6**. It is the fundamental tool that ensures that all mitigation measures are consolidated, their implementation responsibilities identified and the resources required to implement the measures are provided. Further, the EMP includes monitoring measures as a feedback mechanism on implementation and effectiveness of the mitigation measures.

EMP is prepared for all the identified environmental impacts during design, pre-construction, construction, operation, and closure stages. The methodology followed for preparing the EMP consists of the following steps:

- Identify mitigation and enhancement measures for each identified impacts and risks,
- Identifying the organization or person that would be responsible for implementing the measures, and
- Developing a mechanism for monitoring the proposed mitigation measures.

The EMP will be included in all bid documents of the Project and will become a part of the EPC works contract. The strict implementation of the EMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

The EMP contains the following elements:

- An institutional framework for effective implementation of the plan
- The Mitigation Plan which summarizes the mitigation measures to be implemented.
- A monitoring plan with guidelines on reporting and feedback
- Suggested training programs to build capacity for the implementation of the EMP
- A framework for the establishment of a grievance redress mechanism
- Guidelines for the development of supplementary, content specific plans including:
  - Construction Management Plan
  - Coal Dust Management Plan
  - Emergency Response Plan
  - Waste Management Plan
- Guidelines on how changes to the EMP and Project with be handled.

## 7.1 Institutional Framework for Implementation of EMP

Institutions responsible for executing and monitoring the environmental aspects of this Project are:

- The top management of TEL will be ultimately responsible to ensure that the EMP is implemented. For this purpose, TEL will develop and maintain internal institutional capacity for environmental management.
- Engineering, Procurement and Construction (EPC) and other contractors (the 'Contractors') will be primarily responsible for monitoring of the implementation of the EMP. EPC will monitor all activities of all contractors procured under the Project. As several contractors will be working simultaneously for timely and speedy implementation of the project, it is important that EPC has to effectively supervise and monitor the environmental activities being implemented in the field. The EPC is also responsible to update or make necessary changes to the EMP if required based on the revised designs and locations.
- Each contractor procured for this project will be responsible for implementation of the EMP to the extent that it applies to the contractor's area of work. Each contractor will be expected to have an environmental management system, preferably compliant with ISO 14001:2004 Environmental Management System (EMS) certification. The EPC contractor will be required to have one Environmental Specialist and one Occupational Health and Safety Specialist, who will be working in close coordination with the environmental staff of TEL.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 7.1**.

**Exhibit 7.1:** Roles and Responsibilities for Environmental Monitoring

| *Aspect* | *TEL's Responsibilities* | *Contractor's Responsibilities* | *Relevant Documentation* |
|---|---|---|---|
| Contracting | Ensuring that monitoring and mitigation requirements are included in the contract between TEL and the construction contractor(s). | Understanding the requirements and estimating the required resources | Contract between TEL and the contractor(s) |
| Monitoring plan | Ensuring finalization of monitoring plan and construction management plan before construction commences. | 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 | Job descriptions |

| *Aspect* | *TEL's Responsibilities* | *Contractor's Responsibilities* | *Relevant Documentation* |
|---|---|---|---|
| | | combined with health and safety) | |
| 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 and commissioning third party audits | Conducting periodic internal audits | Audit reports |
| 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 ESIA/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 |

## 7.2 Mitigation Plan

The environmental and social mitigation plan includes the following:

- The measures that are required to be implemented during the design, construction and implementation phases of the Project are identified
- For each mitigation measure the person responsible to implement and monitor the implementation is identified
- The timing to implement and the location to implement

**Exhibit 7.2:** Mitigation Plan for Design, Construction, Operation and Closure of the Project

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| **A. Design Phase** | | | | |
| Project Disclosure | Statutory compliance with Sindh Act 2014. | Submit EIA to Sindh EPA and obtain approval. | Before start of construction | TEL |
| Stack Emissions | $SO_2$, NOx and PM emissions from the stack | Ensure that the following equipment are included in the project design:<br>▶ ESP (High efficiency of at-least 99%) to limit the total PM emissions<br>▶ Dry low NOx burners to minimize NOx generation<br>▶ Limestone injection to limit $SO_2$ emission<br>▶ Continuous stack emission monitoring equipment<br>The equipment type and details may be changed as long as the objectives are met. | During design | Design Contractor, TEL |
| Plant Wastewater System | Pollution of soil and receiving water body; compliance with standards | Ensure that an appropriately sized evaporation pond is included in the design to receive all waste other than cooling water blowdown and reject of mine water treatment plant (if installed). However, for a shorter duration (to be finalized in design phase) both cooler tower blowdown and reject of RO treatment unit can be diverted to evaporation ponds. For third aquifer reinjection a separate study is to be done to meet the technical requirements. | During design | TEL |
| | | Ensure that the plant wastewater streams, in particular the cooling tower blowdown, boiler blowdown, floor washing, storm water runoff, and domestic waste, are designed in a manner that all waste streams can be segregated if required. | During design | Design Contractor, TEL |
| | | Ensure environmental friendly disposal of cooling tower blowdown RO treatment plant reject (if its installation considered) | During design | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| Hazardous waste | Unsafe handling of hazardous waste | Ensure that an appropriately sized hazardous waste handling facility is included in the power plant to handle low-volume hazardous waste such as batteries | During design | TEL |
| Land transformation | Surface disturbance for construction of infrastructure and topographic change | Avoid unnecessary disturbance of natural ground cover (e.g. prevent unnecessary off-road driving) and rehabilitate disturbed land (e.g. by rock cladding) as soon as possible to avoid erosion.<br>Incorporate wind and water erosion control measures and dune management where necessary into project design.<br>Require drainage facility designs to be adequately sized for expected storm events.<br>Ensure maintenance of drainage systems. | | |
| **B. Construction and Implementation Phase** | | | | |
| Construction management | Construction activities although temporary can potentially have adverse impact on the environment. | Ensure that a detailed Construction Management Plan (CMP) based on the skeleton plan included in **Section 7.6.1** is developed | Before construction | Contractor |
| | | Ensure that the CMP is implemented | During Construction | Contractor |
| **C. Operation and Maintenance Phase**<br>**Water and Effluent Waste** | | | | |
| Wastewater from plant | Pollution of receiving water bodies. | Complete segregation of wastewater streams to ensure that all streams the cooling tower blow down are routed to the evaporation pond<br>Recycle wastewater as much as possible to conserve water | During operation | TEL |
| Storm Water | Typically storm water runoff contains suspended sediments and may contain metals and petroleum | Route the runoff to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for dust suppression system. | During operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| | hydrocarbons, if it includes water from operation area | Separate storm water from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge<br>Install and maintain oil water separators and grease traps as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas.<br>Provide adequate storm drains along the boundary of the plant area and within the plant area to drain off the storm water during monsoon period.<br>Keep limestone and gypsum storage areas covered so that there will be no contaminated runoff | | |
| Wastewater from Housing Colony | Soil and receiving water body pollution | Treat the low-hazard colony wastewater (non-toilet wastewater or the gray water) and use it for sprinkling and for plantation purposes. | During operation | TEL |
| **Fugitive Emissions** | | | | |
| Coal Storage Areas | Dust emissions | Provide dust extraction/suppression system at transfer points of conveyor system and ventilation system to supply fresh air;<br>Roof extraction fans will be provided in essential areas like crusher house and boiler bunker floors.<br>Provide water sprinkling system at material handling and storage yard;<br>All roads with the plant shall be asphalted; and<br>Develop greenbelt around the plant to arrest the fugitive emissions. | During operation | TEL |
| | Fire hazards from auto generated combustion | Limit the coal stockpile height to 15 meters and compact coal to avoid air passages to prevent self-combustion of coal. | During operation | TEL |
| Emissions from fuel | | Periodically inspect mechanical seals in pumps;<br>Maintain valves, flanges, joints, roof vents of storage tanks; and<br>Ensure submerged filling of liquid fuel storage tanks. | During operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| **Ash Disposal** | | | | |
| Fly ash | Dust emissions | The following strategies will be adopted:<br>▶ TEL will initiate a study to assess the feasibility of promoting the manufacturing of cement and brick blocks as a local industry<br>▶ In case such industry is developed, TEL will provide incentives such as making ash available without any payment, to the local manufacturers.<br>▶ Basic technology, as well as initial expert advice for using fly ash in making bricks and cement blocks, will be provided to local brick and cement block makers free of charge.<br>▶ Where feasible, TEL will use fly ash building materials in future construction to instill confidence in local people regarding fly ash building materials.<br>▶ All ash that is not utilized for brick and cement block manufacturing will be disposed of with the coal mine overburden. | During operation | TEL |
| **Air and Noise pollution** | | | | |
| Air Pollution | Changes in ambient air quality due to stack emissions | Regularly monitor ambient air quality as recommended in the environmental monitoring plan (**Section 7.3.1**).<br>Continuous emission monitoring (CEM) of emission from stack of coal-fired boilers | During operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| Noise pollution | Noise from the equipment | The following strategies will be adopted:<br>▶ Occupational noise exposure to workers in the form of 8–hourly time weighted average will be maintained well within the applicable NEQS limits.<br>▶ Acoustic enclosures will be provided wherever required to control the noise level.<br>▶ Anywhere not possible technically to meet the required noise levels, personal protection equipment will be provided to the workers. | During operation | TEL |
| **Health and Safety** | | | | |
| Boilers | Higher exposure to electric and magnetic fields | The following strategies will be adopted:<br>▶ Train workers in the identification of occupational EMF/EMI levels and hazards.<br>▶ Establish and identify safety zones to differentiate between work areas with expected elevated EMF/EMI levels compared to those acceptable for public exposure, and limit access to properly trained workers.<br>▶ Implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non–Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE). Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials. | During operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| | | ▶ Identify potential exposure levels in the workplace, including surveys of exposure levels and the use of personal monitors during working activities. | | |
| | Heat Exposure | Provide adequate ventilation in work areas to reduce heat and humidity;<br>Reduce the time required for work in elevated temperature environments and ensure access to drinking water;<br>Regularly inspect and maintain pressure vessels and piping<br>Shield surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc.;<br>Use warning signs near high temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes. | During operation | TEL |
| **Socioeconomic Impacts** | | | | |
| Changes to society | Creation of job opportunities | The following strategies will be adopted:<br>▶ Develop policy and procedures for preferred employment for locals (from within the Study Area or within the Tharparkar District) and limiting employment of non-locals.<br>▶ In association with other community development programs, support local authorities in Mithi to increase their capacities to deliver services to an increased population. Determine the nature of support, which may include town planning, waste management and access to basic health care and education.<br>▶ Encourage local communities to use the grievance procedure for concerns related to deterioration of local services.<br>▶ Require the Project employment to be free of child and forced labor. | During design and planning and throughout construction and operation | TEL |
| Increase in local population | Unsanitary and congested living conditions in informal settlements | ▶ Develop and implement management policies for tuberculosis, diarrhea, malaria and other communicable | During design and planning and throughout | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| | Lack of potable water<br>Malnutrition<br>Lack of awareness about health prevention measures among in-migrants | diseases focusing on prevention, control, diagnosis and treatment in coordination with NGOs and local government.<br>▶ Provide health and hygiene education awareness programs to local communities, educational establishments and employees. | construction and operation | |
| Local culture | Increase in social ills in communities affected by in-migration of workers and job-seekers | ▶ Require non-locals employed by the Project to adhere to a social 'code of conduct' in terms of relations with local communities.<br>▶ Provide employees and visitors to the site with cultural awareness training.<br>▶ Establish local CBOs and NGOs relating to women's issues. | During design and planning and throughout construction and operation | TEL |
| Economic growth and inflation | Unequal empowerment and reduced resilience amongst the vulnerable groups due to Project related economic activities | ▶ Increase access to support equipment and training for specific jobs for disabled people.<br>▶ Increase access to support and training for specific jobs for vulnerable communities.<br>▶ Provide skill training for people lacking formal education either to access Project related jobs or to participate in alternative employment programs.<br>▶ Develop and implement a gender education program promoting participation of women in economic activities while protecting their dignity and culture.<br>▶ Through induction training, promote awareness of vulnerable groups and how they should be treated.<br>▶ Include provisions on a safe and enabling working environment for women workers in the human resource policies.<br>▶ In partnership with other developers in the area, develop a training program targeted at local people at or below the poverty line. | During design and planning and throughout construction and operation | TEL |
| | | | During design and planning and throughout construction and operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| | | ▶ Develop a program to create alternative employment initiatives aimed at local people at or below the poverty line.<br>▶ Encourage government and NGOs to assist economically poor in restoration and strengthening of their livelihood options. | | |
| Conflict | Project actions leading to tension and discord in local communities | ▶ Implement a local employment policy and community development program.<br>▶ Maintain regular communication with communities and other stakeholders to minimize tensions arising from Project activities.<br>▶ Establish a Grievance Redress Committee, and encourage and facilitate stakeholders to use the mechanism to express concerns.<br>▶ Provide sufficient resources to the community development program to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion.<br>▶ Establish a community based monitoring and evaluation strategy to monitor the potential impacts on communities, especially those to be relocated.<br>▶ Consider vulnerable groups for alternative livelihood opportunities arising due to the Project. | During construction and operation | TEL |
| Local employees | Skills development and capacity building of potential local employees | ▶ Establish a baseline to assess levels of literacy and skills and to determine local interest in literacy and vocational training to complement existing skills.<br>▶ Support the establishment of a 'feeder program' providing basic literacy, health & safety and personal life skills for potential candidates of unskilled positions.<br>▶ Prepare and implement a training and skills development plan for the Project workforce. | During detailed design and planning Throughout construction and operation | TEL |

| *Aspect or Concern* | *Potential Environmental Impact* | *Environmental Mitigation and Management Measures* | *When* | *Responsibility* |
|---|---|---|---|---|
| | | ▶ Support a 'vocational training program' to assist local people to qualify for semi-skilled positions.<br>▶ Create technical training opportunities/programs for local communities according to technological needs and provision of employment after completion of training. | | |

## 7.3 Monitoring, Reporting and Feedback

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.

### 7.3.1 Monitoring Plan

Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the EMP to safeguard the protection of environment. The objectives of the monitoring are to:

1. Monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions.
2. Manage environmental issues arising from construction works through closely monitoring the environmental compliances.

A monitoring mechanism is developed for each identified impact and it includes:

- Location of the monitoring (near the Project activity, sensitive receptors or within the Project influence area)
- Means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis)
- Frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity)

The monitoring program will also include regular monitoring of construction and operation activities for their compliance with the environmental requirements as per relevant standards, specifications and EMP. The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

The proposed monitoring plan is provided in **Exhibit 7.3**.

**Exhibit 7.3:** Environmental Monitoring Plan during Construction and Operation

| *Aspect* | *Location* | *What to monitor* | *Frequency* | *Responsibility* | *Trigger for Corrective Action* |
|---|---|---|---|---|---|
| Hydrocarbon and chemical spill | Construction camps and storage sites | Visual Inspection of storage facilities | Monthly | Contractor | Evidence of spills |
| Air Quality | Construction sites | Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place. | Daily | Contractor | Evidence of non-compliance |
| | Villages of Bitra, Saleh Jhanji, Jaman Samo and Aban Jo Tar and one reference site | Air quality monitoring (Total PM, $PM_{10}$, $PM_{2.5}$, $NO_X$, $SO_2$) | Annually, starting as early as possible before construction<br>One continuous monitoring station | TEL | NEQS (for gases) and baseline value as given in the EIA and any data collected before start of construction |
| Noise | Construction sites | Visual inspection to ensure good standard equipment are in use | Weekly | Contractor | Evidence of non-compliance |
| | Village of Bitra and one reference site | Hourly, day and night time noise levels (dB) monitoring using noise meters | Annually, starting as early as possible before construction | TEL | NEQS and baseline value based on data collected before start of construction |
| Waste Management | Construction camps and construction sites | Visual inspection that solid waste is disposed at designated site | Monthly | Contractor | Evidence of non-compliance |
| Drinking water and sanitation | In construction sites and construction camps | Ensure the construction workers are provided with safe water and sanitation facilities in the site | Monthly | Contractor | Evidence of non-compliance |
| Reinstatement of Work sites | All work sites | Visual Inspection | After completion of all works | TEL | Evidence of non-compliance |

| *Aspect* | *Location* | *What to monitor* | *Frequency* | *Responsibility* | *Trigger for Corrective Action* |
|---|---|---|---|---|---|
| Safety of workers | At work sites | Usage of Personal Protective equipment | Monthly | Contractor | Evidence of non-compliance |
| Wastewater | After waste water treatment and at the final disposal point | Parameters in NEQS (only those which are likely to exceed) | Annually | TEL | NEQS |
| Stack Emissions | Boiler stack | Continuous monitoring of SO2, NOx, and PM. | Continuous | TEL | NEQS to the extent applicable |
| Groundwater | All wells in the village of Bitra | Water level and TDS | Monthly | TEL | More than 10% change in water level or TDS as compared to seasonal average |
| Employment | All hiring undertaken directly by TEL or its contractors | Domicile, age, qualifications and salary of all employees in management, technical, skilled and unskilled category | Quarterly | TEL | Non-compliance with the employment policy |
| Grievance | Villages in the Study Area | Nature and frequency of grievances and time taken to address them | Quarterly | TEL | Increase in number of grievances or delay in addressing them |
| Hydrocarbon and chemical storage | Storage area | Visual Inspection of storage facilities | Monthly | Contractor and TEL | Spills and leakages |
| Traffic Safety | Haul Roads | Visual inspection to see whether proper traffic signs are placed and flagmen for traffic management are engaged | Monthly | Contractor and TEL | Lack of facilities |
| Coal and fly ash specifications | – | Heavy metals (Mainly As, Be, Cd, Cr, Pb, Hg, and Ni) | Quarterly | TEL through recognized laboratory | More than 10% increase over baseline |
| GHG emission | Stacks | Monitoring of flue gases flow and carbon content | Once in 6 months | TEL | – |

### 7.3.2 Reporting and Feedback Mechanism

The EPC Contractor will prepare a 'Construction Management Plan' (CMP) demonstrating the manner in which they will comply with the requirements of mitigation measures proposed in the EMP of the ESIA Report. The CMP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non–compliance leading to the corrections or otherwise imposing penalty on the contractors

EPC Contractor, through the environmental specialist on the team, will prepare periodic (not more once every three months) status reports on the EMP implementation. Such reports will carry information on the main types of activities carried out within the reporting period, status of any clearances/permits/licenses which are required for carrying out such activities, mitigation measures applied, and any environmental issues emerged in relations with suppliers, local authorities, affected communities.

The EPC Contractor's reports will be based on reports prepared by various subcontractors and their own monitoring and supervision. EPC Contractor shall assess how accurate is the factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by subcontractor. EPC Contractor must highlight any cases of incompliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

After completion of EPC Contractor's contract, TEL will be in charge of the operation and maintenance of the Project. HSE Department of TEL will be responsible for compliance with the monitoring plan during operations.

Feedback and adjustment will be carried out in two tiers. Upon request for EMP modification by the Subcontractor, EPC Contractor and TEL will review the proposals in detail and consider their acceptance or rejection. Primarily, only those modifications will be considered, which do not contravene the conditions of the environmental approval from SEPA. TEL will consider the recommendations of the EPC Contractor but it will be the final authority on approval of the change. It may decide to undertake studies before approval of the change.

### 7.3.3 Meetings

An effective mechanism to communicate and record environmental information during the Project is an essential requirement of an EMP.

Two kinds of environmental meetings will take place during the project:

- Kick-off meetings
- Fortnightly meetings

The purpose of the kick-off meeting will be to present the EMP to project staff and discuss its implementation.

A fortnightly 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.

### 7.3.4 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.

## 7.4 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. TEL will initiate a training program to ensure that its employees and that of its contractors have the required knowledge and skill to manage the environmental aspects of their respective jobs. The proposed environmental trainings listed in **Exhibit 7.4**, which will be finalized before the commencement of the project.

**Exhibit 7.4:** Proposed Environmental Trainings

| | Type of Training | Personnel to be Trained | Training Description |
|---|---|---|---|
| 1 | Occupational Health and Safety | EHS Manager<br>Plant managers and supervisors | Awareness to conform to safety codes.<br>Mandatory use of PPE by the senior administration during all plant visits |
| 2 | Occupational Health and Safety | Workers<br>Staff | Health, safety and hygiene<br>Proper usage of personnel protective gear<br>Precautions to be taken for working in confined areas. |
| 3 | Health, Safety and Environmental Auditing | Staff responsible for inspection/audits | Procedures to carry out Health, Safety and Environmental Audits<br>Reporting requirements |
| 4 | Waste Disposal and Handling | Relevant Workers<br>Relevant Staff | Segregation, identification of hazardous waste, use of PPEs, waste handling |
| 5 | Social & Environmental laws & regulations, norms, procedures and guidelines of Government | EHS staff<br>Plant managers and supervisors | Environmental standards and their compliance |
| 6 | Implementation of environmental management and monitoring plant | EHS staff<br>Responsible supervisory staff<br>Management | Concepts of environmental management and monitoring plan |
| 7 | Defensive driving | All drivers and their supervisors | Safe driving and handling of equipment |

## 7.5 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 include primarily the villages in the Study Area, which are described in **Chapter 4**. However, it can extend other stakeholders. The potential impacts of the Project are described in **Chapter 6**.

### 7.5.1 Regulatory Requirement for Grievance Redress Mechanism

The Pakistan EPA, 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 ensure a stable relationship between the project management and the community.

### 7.5.2 Framework for Grievance Redress Mechanism

Under the Project the following will be established or appointed to ensure timely and effective handling of grievances:

- A Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints; and,
- Grievance Focal Points (GFPs), which will be educated people from each community that can be approached by the community members for their grievances against the Project. The GFPs will be provided training by the Project in facilitating grievance redress.

PCU will be set up under TEL corporate structure. A senior official with experience in community and public liaison will lead the unit. Two assistants, one male and one female will be responsible for coordinating correspondence and preparing documentation work and will assist the senior official. The senior official will be responsible to review all documentation.

The PCU will be responsible to receive, log, and resolve grievances. Given that the female community members have restricted mobility outside of their villages and homes, the female PCU staff will be required to undertake visits to the local communities. The frequency of visits will depend on the nature and magnitude of activity in an area and the frequency of grievances.

The GFPs will be literate people from each community that will facilitate their community members in reporting grievances from the Project. The GFPs will be provided training by the Project in facilitating grievance redress. Each community will have a male and female GFP appointed for this purpose.

### 7.5.3 Operating Principles for PCU

The PCU will operate on the principles of transparency, approachability and accountability. To achieve these, the PCU will be required to:

- Be equipped to handle grievances in the local languages;
- Be equipped to work through all possible modes of communication, such as, emails, by-post and face-to-face meetings at plant site or requiring visits;
- Employ female staff, preferably from the nearby communities, to oversee complaints and issues of the female community members.
- Maintain a log of all grievances, with record of the date and time of the complaint logged and stakeholder information, such as, name, designation and contact details;
- Provide opportunity to the stakeholder to revert with their comments on the proposed plan of action;
- Keep the stakeholder informed of the progress in grievance resolution;
- Obtain stakeholder consent on the mechanism proposed to redress the grievance and document consent; and,
- Maintain confidentiality of the stakeholder, if requested so.

### 7.5.4 Stakeholder Awareness

The stakeholders will be informed of the establishment of the PCU through an awareness campaign. Under the awareness campaign, the proponent will share:

- Objective, function and the responsibilities of the PCU;
- Means of accessing the PCU and the mechanics of registering a grievance at the PCU;
- Operating principles of the PCU; and,
- Contact details.

Additional awareness campaigns may be organized, if necessary.

## 7.6 Guidelines for Supporting Plans

Specific management plans, for areas of concern, will be developed by TEL or contractors as specified. The framework, outline and requirements for each plan is discussed in this section.

### 7.6.1 Construction Management Plan

Every contractor will develop a specific construction management plan (CMP) based on the conceptual CMP shown in the **Exhibit 7.5**. The CMP will be submitted to the TEL for approval before start of construction activities.

**Exhibit 7.5:** Construction Environmental Management Plan

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| Planning | Clearly identify all areas that will be utilized during construction | Clearly identify all areas that will be utilized during construction. These include, but are not limited to the camp site, storage areas for raw material and equipment, waste yard, storage areas for potentially hazardous material such as oil, parking area, loading and unloading of material, septic tanks, housing and construction camp, fuel storage and pipelines, and access routes |
| Vegetation clearance | Minimize vegetation clearance and felling of trees | ▶ Removal of trees should be restricted to the development footprint.<br>▶ Construction activities shall minimize the loss or disturbance of vegetation<br>▶ Use clear areas to avoid felling of trees<br>▶ A procedure shall be prepared to manage vegetation removal, clearance and reuse<br>▶ Inform the plant management before clearing trees<br>▶ Cleared areas will be re-vegetated |
| Poaching | Avoid illegal poaching | ▶ Contractual obligation to avoid illegal poaching<br>▶ Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching |
| Discharge from construction sites | • Minimize surface and ground water contamination<br>• 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<br>▶ Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot<br>▶ 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.<br>▶ Reduce length of slope of runoff<br>▶ Construct temporary cutoff drains across excavated area<br>▶ Setup check dams along catch drains in order to slow flow and capture sediment |

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| | | ▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust.<br>▶ Increase the watering frequency during periods of high risk (e.g. high winds)<br>▶ All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover). |
| Excavation, earth works, and construction yards | Proper drainage of rainwater and wastewater to avoid water and soil contamination. | ▶ Prepare a program to prevent standing waters, which TEL will verify in advance and confirm during implementation<br>▶ 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<br>▶ Discard all the storage containers that are capable of storing of water, after use or store them in inverted position<br>▶ Reinstate relief and landscape. |
| Storage of hazardous and toxic chemicals | Prevent spillage of hazardous and toxic chemicals | ▶ Implement waste management plans<br>▶ Construct appropriate spill containment facilities for all fuel storage areas<br>▶ 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 2 m and with a slope of 1:2<br>▶ Spread the topsoil to maintain the physio–chemical and biological activity of the soil.<br>▶ The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites<br>▶ Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions will include:<br>▷ Anaerobic conditions – turning the stockpile or creating ventilation holes through the stockpile;<br>▷ Erosion – temporary protective silt fencing will be erected; |

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| | 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;<br>▶ Reinstate the natural landscape of the ancillary construction sites after completion of works |
| Construction vehicular traffic | Control vehicle exhaust emissions and combustion of fuels. | ▶ Use vehicles with appropriate exhaust systems and emission control devices.<br>▶ Establish and enforce vehicle speed limits to minimize dust generation<br>▶ Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site<br>▶ Level loads of haul trucks travelling to and from the site to avoid spillage<br>▶ Use of defined haulage routes and reduce vehicle speed where required.<br>▶ Transport materials to site in off peak hours.<br>▶ Regular maintenance of all vehicles<br>▶ 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<br>▶ Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc. |
| | Avoid impact on existing traffic conditions | ▶ Prepare and submit a traffic management plan<br>▶ Restrict the transport of oversize loads.<br>▶ 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.<br>▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions.<br>▶ Design and implement safety measures and an emergency response plan to contain damages from accidental spills.<br>▶ Designate special routes for hazardous materials transport. |

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| Construction machinery | Prevent impact on air quality from emissions | ▶ Use machinery with appropriate exhaust systems and emission control devices.<br>▶ Regular maintenance of all construction machinery<br>▶ 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 |
| | Reduce impact of noise and vibration on the surrounding | ▶ Appropriately site all noise generating activities to avoid noise pollution to local residents.<br>▶ Ensure all equipment is in good repair and operated in correct manner.<br>▶ Install high efficiency mufflers to construction equipment.<br>▶ Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment<br>▶ The project shall include reasonable actions to ensure that construction works do not result in vibration that could damage property adjacent to the works. |
| Construction activities | Minimize dust generation | ▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust.<br>▶ Increase the watering frequency during periods of high risk (e.g. high winds).<br>▶ Stored materials such as gravel and sand should be covered and confined<br>▶ Locate stockpiles away from sensitive receptors |
| | Reduce impact of noise and vibration on the surrounding | ▶ Notify adjacent landholders or residents prior to noise events during night hours<br>▶ Install temporary noise control barriers where appropriate<br>▶ Avoid working during 21:00 to 06:00 within 500m from residences. |
| | Minimize 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.<br>▶ Prepare an Emergency Spills Contingency Plan shall be prepared. |

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| Siting and location of construction camps | Minimize impact from construction footprint | ▶ Arrange accommodation in local towns for small workforce<br>▶ Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view. |
| Construction Camp Facilities | Minimize pressure on local services | ▶ Adequate housing for all workers<br>▶ Safe and reliable water supply.<br>▶ Hygienic sanitary facilities and sewerage system.<br>▶ Treatment facilities for sewerage of toilet and domestic wastes<br>▶ Storm water drainage facilities.<br>▶ 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<br>▶ Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector.<br>▶ Establish waste collection, transportation and disposal systems<br>▶ Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site.<br>▶ 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<br>▶ Conduct awareness campaigns to educate workers on preserving the protecting 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 | ▶ Restore the site to its condition prior to commencement of the works |

| *Aspect* | *Objective* | *Mitigation and Management Measure* |
|---|---|---|
| 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.<br>▶ It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management.<br>▶ Maintain appropriate behavior with all construction workers especially women and elderly people<br>▶ Resolve cultural issues in consultation with local leaders and supervision consultants |
| Best practices | Minimize health and safety risks | ▶ Implement suitable safety standards for all workers and site visitors which should not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations,<br>▶ 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,<br>▶ Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full–face eye shields, and ear protection.<br>▶ Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. |
| Water and sanitation facilities at the construction sites | Improve workers' personal hygiene | ▶ Provide portable toilets at the construction sites and drinking water facilities.<br>▶ Portable toilets should be cleaned once a day.<br>▶ All the sewerage should be pumped from the collection tank once a day into the common septic tank for further treatment. |

### 7.6.2 Coal Dust Management Plan

The coal dust suppression system will be designed during detail design stage. The following is a general description of the system.

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 plants and cooling water blow down will be the primary source of water to the sprinkler system.

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, spaced every 50 m. 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 addition coal dust extraction system may also be employed. In this system, dust is extracted from operations area that generates dust in large quantities such as screening, loading and unloading.

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.

### 7.6.3 Emergency Response Plans

TEL will prepare an emergency response for natural and human-made emergencies.

#### *Spill Prevention and Mitigation Plan*

Liquid waste spills that are not appropriately managed have the potential to harm the environment. By taking certain actions, the likelihood of spills can be reduced and their effect minimized.

To avoid spills and to help the cleanup process of any spills, the EPC contractors and the management and staff of TEL 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. A plan will also be developed for specific areas during plant operation. These plans 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.

#### *Fire Emergency Response Plan*

A firefighting system will be installed with a standard operating procedure considering the potential fire from the sparks in coal storage and handling.

#### *Other Emergencies*

Response plans for other emergencies, including but not limited to the following, will also be developed:

- Vehicle accident
- Earthquake
- Heavy downpour and consequent flooding
- Electrical hazards
- Equipment Failure

## 7.7 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.

**First Order:** 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 Sindh EPA for approval.

**Second Order:** 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 Sindh EPA, at least a month before undertaking the change

**Third Order:** 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.

To illustrate the magnitude of changes within these orders, examples are presented in **Exhibit 7.6**. The types of changes presented encompass a range of scenarios for illustration purposes only, and by no means reflect any intention on the part of TEL to make these changes. The list is also not meant to be comprehensive, ie, inclusive of all possible changes that may potentially take place in the design or operation of the plant as described in the ESIA. For any change not described in **Exhibit 7.6**, the definition of the first, second, and third order changes will be used to determine its category.

**Exhibit 7.6:** Generic Examples of Changes in the Project Design

| *Change* | *First Order* | *Second Order* | *Third Order* |
|---|---|---|---|
| Power plant location | Relocated such that the villages in the area of influence change | Relocated such that the villages in the area of influence do not change | |
| Power plant capacity | If increased significantly (for example, by more than 33%) from the proposed capacity. | If increased but not significantly (for example, by more than 20% but less than 33%) from the proposed capacity. | If increased by a small amount (for example, by less than 20%) from the proposed capacity. |
| Technology | A different technology or process for power generation resulting in altogether different environmental impacts. | A different technology or process for power generation, resulting in environmental impacts of similar nature or magnitude. | |

### 7.7.1 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 TEL 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 TEL and the contractor
- All relevant project personnel will be informed of the change

# 8. Analysis of Alternatives

This section considers the alternatives available to the current proposed Project. The different facets of the Project that were looked into for an analysis of alternatives are as follows:

- No project alternative
- Coal-source
- Boiler technology
- Particulate matter emission control
- Transport route

## 8.1 No Project Alternative

The no project alternative will have the following economic and environmental consequences:

- Pakistan is going through an acute power shortage. The gap between supply and demand has crossed 6,000 MW. In the absence of this project, the gap in power supply and demand will continue to grow.
- The power plant will provide a market for the coal mined at Block II and aid in the development of the Thar Coalfields, thereby helping develop Pakistan's indigenous energy reserves.
- This Project will contribute to the job creation for the surrounding communities, the people of Sindh in particular and people of Pakistan in general in skilled, technical and administrative categories during construction and operation. These opportunities would contribute towards improving the economic conditions of the communities.

Therefore, unless economically, socioeconomically and environmentally more viable options can be found, the 'no project' option will have a negative impact on the economy

## 8.2 Location of Project Site

Two sites were considered namely:

- **Thar Coalfield:** Power Plant located next to the Coal Mine providing a readily available fuel supply with minimum coal supply complexities
- **Port Qasim, Karachi:** Power Plant located next to a readily available water source (sea water) and other infrastructure.

### *Availability of Adequate Land*

Availability of land for the installation of the Project at lower cost is the primary factor for site selection, along with the provision for future expansion. Adequate land is available at Thar near the mine, which appears to be more favorable. Land for potential

plant site along with future expansion has already been marked and termed as Energy Park by SECMC. The acquisition/lease of land will be relatively easy and economical for this Project. At Port Qasim, land would be available at higher cost with constraints on future expansion.

### *Fuel Supply*

Guaranteed fuel supply and ease of the supply are the most important factors in the site selection criteria. Having a mine mouth power plant ensures that the fuel supply is ensured with minimum complexity. Installation of a power plant away from the mine site would mean that the coal has to be transported a considerable distance. This would lead to a number of issues:

- **Coal Drying**: Thar lignite consists of about 48% moisture. In order to make transportation of lignite economically feasible, the lignite will have to be dried. However, this would lead to increasing the scope of the Project and increase in the energy cost of the lignite. Coal drying process usually utilizes low pressure steam to evaporate water from finely ground coal. This would require additional installation of crusher, power generating system and boilers which burn lignite to produce steam. This results in increasing the initial cost and final energy price of lignite by 6 – 7%.
- **Spontaneous Combustion**: Thar lignite is susceptible to spontaneous combustion posing a risk during the long transportation. If such coal is to be transported to long distances, after drying the lignite powder is usually converted into briquettes to decrease its surface area and make it less susceptible to combustion during transportation. Moreover, arrangements to reduce the contact with excess oxygen would also be required.
- **Transportation Cost**: Currently there is no functioning railway network close to the mine site. Until a proper railway network is established coal will have to be transported by trucks. It is estimated that truck transportation cost may result in increase in the lignite energy price by about 20% - 25% and higher if the distance between mine and power plant increases as in case of Thar coal mine to Port Qasim.
- **Project Risk**: Transportation of coal to long distances would increase the Project susceptibility to external variables including quality of road network, traffic conditions, accidents, strikes and many other variables.

### *Water Availability*

Thar coalfields are located in a remote region with no surface water supply. Underground water is available in three layers of aquafers but is very brackish in nature. It needs to be treated by Reverse Osmosis (RO) to decrease its salinity to an acceptable level. During mining activities large quantities of groundwater will be pumped out to keep mine dry. This water can be used after treatment by the power plant but its quantity available for the 1x330 MW project will depend on scheme finalized with SECMC and EPTL in design phase. This water however cannot be regarded as the primary source of water supply for this project and shall be backup source of variable supply

The main supply for water for this 1x330 MW will be the LBOD water after treatment and an allocation of at-least 8.75 cusec out of 35 cusec of RO treated water shall be done by SECMC for this project, for which the construction is underway and is expected to be completed by year 2017.

The power plant water demand can be significantly reduced if project uses Air Cooling instead of Wet Cooling Tower. However, employing air cooling in the hot climate will result in decreased net efficiency as well as net output of the power plant (due to increase in auxiliary load). This will be further discussed under the section talking about the selection of cooling system.

Installation of the power plant at Port Qasim may ensure constant supply of seawater, which can be use directly for power plant cooling (once through cooling). Moreover, such a system allows energy savings and increased efficiency of the power plant. The outfall flow and temperature of once through cooling water at Port Qasim may be of concern due to already high flows of water coming from various industrial units in the vicinity.

### *Equipment Transportation*

Thar coalfield is located about 400 km from the port city of Karachi. The road network in the Thar district is significantly improved and further construction and maintenance plan is in place to ensure suitable transportation conditions for heavy power plant equipment. The cost of transportation of equipment and manpower mobilization is the significant part of project cost and need to be optimized in case Thar is selected as the project site

Installation of the power plant at Port Qasim will allow savings in transportation cost of equipment; reduce the risk related to heavy equipment transportation and susceptibility to external conditions.

### *Power Evacuation*

Currently no power grid is available at the mine site. However, NTDC has guaranteed the evacuation of 330 MW of power generated from this project to National Grid. In-time completion and connectivity / stability of the grid, keeping in view the other high capacity plants coming up in various parts of the country, may be a challenge. Load Flow study is being done for 1x330 MW power evacuation to ensure the safe and reliable project power evacuation in all conditions throughout the year.

Port Qasim area is relatively industrialized which means that connection to the grid may not be a major issue. A Load Flow study would still have to be considered in this case.

### *Air Emissions*

Major air pollutants from a coal power plant are $SO_2$, NOx and PM. Technologies are available which can control the air emissions in stack to keep the parameters limits within SEQS and to keep the Project impact on ambient air quality parameters to the minimum.

For $SO_2$ reduction, installation of lime-FGD in case of PC technology and direct lime dosing in case of CFB boiler can help meeting the $SO_2$ limits. For NOx reduction the PC boiler will utilize low-NOx burners and in case of CFB the combustion section temperatures are low enough to control NOx levels within SEQS and even within more stringent limit, if defined for the Project.

In Thar the PM level is high because of sandy area and frequent dust storms which require special focus on the equipment selection and stack height for control of PM and also for PM control during coal and ash handling activities.

The Thar Coalfield is located in a sparsely populated area with no industries present. For this reason the dispersion of the emissions is less likely to have an impact on the population.

The Port Qasim region already consists of functioning industries. It will have to be ensured that the emissions dispersion is away from the population area. This may require very high stack and thorough baseline data compilation.

#### *Waste Disposal*

Quantity and nature of the solid waste (ash) produced from the coal power plant depends on the boiler technology employed. With CFB boiler, the ash is produced as ash-gypsum residue and the product can be used as landfill or to some extent for road construction.

Coal mining in the Thar coalfield will involve removal of large quantities of overburden (earth material above coal). Ash or Ash-gypsum residue produced from the power plant can be used for mine refilling after overlay removal. An intermediate ash yard for ash residue storage may be required for few initial years of plant operation until a significant mine area becomes available for dumping the incoming ash into the mine cavity.

Ash disposal site selection can be a major issue at Port Qasim and the ash-gypsum reside will have no sale potential and.

#### *Conclusion*

Based on the factors discussed above constructing a mine mouth power plant, located within Block II, will be the most suitable option for utilizing of Thar Lignite.

## 8.3 Coal Source for the Project

The following coal sources can be used for a coal based power plant in Pakistan

1. Imported coal. This is generally high quality (low ash, low sulfur, and high calorific values) sub-bituminous coal imported from coal exporting countries as Australia, Indonesia and South Africa.
2. Local coal. Thar lignite deposits are of low quality (high ash, high sulfur, and low calorific values). These reserves are estimated at 175 billion tonnes.

A comparison of the quality of Thar lignite with that of the imported bituminous coal is summarized in **Exhibit 8.1**.

**Exhibit 8.1:** Comparison of Local Thar Lignite with Imported Bituminous Coal

| *Coal Properties* | *Sub-bituminous Coal* | | *Lignite Coal* |
|---|---|---|---|
| | *Australia* | *Indonesia* | *Thar* |
| Moisture (ar %) | 4-16 | 4-26 | 45-50 |
| Coal Ash Content (ar. %) | 4-16 | 3.0-22.0 | 14-15 |
| Volatile Matter (ar %) | 18-32 | 18-38 | 21-29 |
| Sulfur Content (ar %) | 0.4-0.9 | 0.2-0.94 | 0.2-2.7 |
| Coal Net Calorific Value (kcal/kg) | 4,000-6,900 | 3,105-6,900 | 2,500-3,700 |

Despite the difference in coal quality, Thar lignite is preferred for the following reasons:

1. The use of imported coal entails large environmental impacts of coal transport, which includes, unloading and transport through the densely populated city of Karachi which will be avoided.
2. To minimize transport distance, plants based on imported coal are usually situated near the port of import (Karachi). This deteriorates the already polluted airshed of the city.
3. The use of Thar coal, development of Project and ancillary facilities will help develop the Thar Coalfields, contributing to energy independence for Pakistan
4. The use of Thar coal will stimulate the local economy of the region.

Environmental controls to minimize pollutant release are discussed in **Chapter 7**.

## 8.4 Boiler Technology

Boiler technologies that can be considered for the Project are:

- Various advanced pulverized coal (PC) combustion technologies (subcritical, supercritical, ultra-supercritical)
- Fluidized bed combustion (FBC) technologies (atmospheric, circulating and pressurized).

FBC combustion uses the same thermodynamic cycle as a PC system. Thus, its power generation efficiency is in the same range as PC, but with a lower capital cost. This is due to its' ability to effectively control gaseous emission without the need to install additional $SO_2$ treatment system. In addition, FBC combustion has significantly lower power consumption compared to PF system. Of FBC systems, circulating FBC is most suitable for high ash, variable quality, high moisture and high sulfur fuels, which makes it ideal for a Thar lignite based power plant. Therefore, the selected combustion technology is the best available technology for the proposed Project.

## 8.5 Particulate Matter Emission Control

Particulate matter treatment technologies are electrostatic precipitators (ESP), fabric filters, cyclones and wet scrubbers. ESP were selected as the PM emission control technology for the following reasons:

1. High efficiency, compared to wet scrubbers and cyclones. The background particulate matter is already very high and hence a high efficiency technology is required.
2. Low maintenance requirements as compared to fabric filters. Although fabric filters also have high efficiency they require expensive and regular maintenance for said performance.

**Exhibit 8.2** presents a detailed comparison among the technologies in terms of efficiencies, advantages and disadvantages.

**Exhibit 8.2:** Particulate Matter Control Technologies

| *Control Technology* | *Description* | *Control Efficiency* | *Advantages* | *Disadvantages* |
|---|---|---|---|---|
| Electrostatic precipitator (ESP) | The ESP applies high-voltage fields to particles moving through the exhaust. The particulates are charged and move towards 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.<br>Continuous operation with minimum maintenance.<br>Relatively low operation costs.<br>Operation capability at high temperature (up to 700 °C) and high pressure (up to 10 atm)<br>Capability to handle relatively large gas flow rates. (up to 50,000 $m^3$/min) | High capital cost<br>High sensitivity to fluctuations in gas stream (flow rates, temperature, particulate and gas composition, and particulate loadings)<br>Difficulties with the collection of particles with extremely high or low resistivity.<br>High space requirement for installation<br>Highly trained maintenance personnel required. |
| Fabric filters or bag houses | 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.<br>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%).<br>Relative insensitivity to gas stream fluctuations and large changes in inlet dust loadings (for continuously cleaned filters).<br>Recirculation of filter outlet air.<br>Dry recovery of collected material for subsequent processing and disposal.<br>No corrosion problems.<br>Simple maintenance, flammable dust collection in the absence of high voltage<br>Various configurations and dimensions of filter collectors<br>Relatively simple operation | Requirement of costly refractory mineral or metallic fabric at temperatures in excess of 290 °C.<br>Need for fabric treatment to remove collected dust and reduce seepage of certain dusts.<br>Relatively high maintenance requirements<br>Shortened fabric life at elevated temperatures and in the presence of acid or alkaline particulate.<br>Respiratory protection requirement for fabric replacement. |

| *Control Technology* | *Description* | *Control Efficiency* | *Advantages* | *Disadvantages* |
|---|---|---|---|---|
| Wet scrubber | 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.<br>Ability to collect gases, as well as "sticky" particulates.<br>Ability to handle high-temperature, high-humidity gas streams<br>Low capital cost (if wastewater treatment system is not required)<br>High collection efficiency of fine particulates (95-99%). | Potential water disposal/effluent treatment problem.<br>Corrosion problems (more severe than with dry systems).<br>Potentially objectionable steam plume opacity or droplet entrainment<br>Potentially high pressure drop.<br>Potential problem of solid buildup at the wet-dry interface<br>Relatively high maintenance costs |
| Cyclone or multi-cyclone | The flue gas enters the vessel tangentially and sets up a rotary motion whirling in a circular or conical path. The particles are hit against the walls by centrifugal force of the flue gas motion where they impinge and eventually settle into hoppers.<br>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% | Relatively small space requirements<br>Low capital cost.<br>Relative simplicity and few maintenance problems.<br>Relatively low operating pressure drop.<br>Temperature and pressure limitations imposed only by the materials of construction used<br>Dry collection and disposal. | Relatively low overall particulate collection efficiencies especially for particulate sizes below 10 micron (PM10).<br>Inability to handle sticky materials. |

## 8.6 Transport Route

There are two transport routes from Karachi to the Project site shown in **Exhibit 8.3**.

1. The shorter of the routes is 366 km long and passes through the following towns:


| | | | | |
|---|---|---|---|---|
| National Highway N-5<br>75 km<br>Two lane<br>7.3 m wide | Provincial Highway<br>105 km<br>Two lane<br>6.1-6.7 m wide | Provincial Road<br>114 km<br>Two/One lane<br>4-6 m wide | Provincial Road<br>44 km<br>Two/One lane<br>4-6 m wide | Provincial Road<br>28 km<br>Two/One lane<br>4-6 m wide |

2. The alternate route is 425 km long and passes through the following towns:


The first route is selected as the alternate route is 22% or 59 km longer.

**Exhibit 8.3:** Alternate Transport Routes

# 9. Conclusion

The proposed Project entails the construction of a 330 MW coal power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

The findings of the study indicate that the Project will have positive impacts on the socioeconomic environment through increased electricity generation, direct and in-direct employment generation; and, increased business opportunities.

Major potential impacts of the Project are associated with air quality and changes to the socioeconomic environment. However, if the field activities, including the implementation of all mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (**Chapter 7**), are carried out as described in this report, the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Chapter 2** of this report.

A cumulative impact assessment of expected projects near the Project area is also presented. Cumulative impacts should be addressed collectively by all developers in the area.