ENVIRONMENTAL IMPACT ASSESSMENT

2 x 350 MW SUPER CRITICAL COAL POWER PLANT AT PORT QASIM, KARACHI

EMC Pakistan
Private Limited
Environmental Impact Assessment (EIA)

2 x 350 MW Coal Power Project

Final Report
April 2016
Ref: EIA/ 03/ 04/ 16

EMC PAKISTAN PVT. LTD.
Phones: 9221-34311466, 34324680, Fax: 9221-34311467.
E-mail: mail@emc.com.pk, info@emc.com.pk
Website: www.emc.com.pk
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Executive Summary

In order to contribute toward meeting Karachi’s growing electricity demand, Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited proposes constructing a coal fired power station at 250 acres land available in the Eastern Industrial Zone (EIZ) of Port Qasim Authority – PQA (Figure 1). The project aims at installation of 2 x 350 MW Coal based supercritical thermal power plant to reduce the dependency on expensive high sulphur fuel oil and to introduce cheaper alternative fuel for power generation, increase the efficiency and provide reliable low cost power to the Karachi City.

The project shall:
- Respond to the urgent need to close the yawning gap between power generation & demand,
- Provide an economically viable and environmentally acceptable power generation system to make the coal available for use in power production, in view of the wide gap between supplies of fossil fuel and demand,
- Ensure stable power production system for the Karachi City, and
- Respond to the need of improvement in quality of life through Sustainable Energy Resource development.

The proposed 2x350 MW coal power plant shall adopt supercritical boiler technology. The major systems of the power project include:
- Coal Jetty
- Super-critical boiler
- Pulverised Coal (PC) generation plant
- An open coal storage area surrounded by wind shield
- Coal handling covered conveyors
- Water supply and waste water system
- Ash handling system
- Emission control system
- Flue Gas Desulfurization (FGD) system
- Dust prevention, and fire monitoring and prevention facilities.

Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited is an entity incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (SPV) and develop a 2 x 350 MW imported Coal Power Project at Port Qasim Karachi, sponsored by China Datang Overseas Investment Co. Ltd. (CDTO), China Machinery Engineering Corporation (CMEC) and K-Electric Limited (KE).

51% of the equity stake in the Project is owned by CDTO, a wholly owned subsidiary of China Datang Corporation, a power generation giant based in China with assets of more than 120,000 MW under its ownership. 25% of the equity stake in the Project is owned by CMEC, an international conglomerate and the first Engineering and Trade Company in China, and was listed in the Hong Kong Stock Exchange in 2012. The remaining 24% of the equity stake in the Project is owned by KE.

The co-sponsors have signed a Joint Development Agreement in September 2015 and a Shareholders Agreement on 20 May 2016 to jointly establish a 700 MW imported coal fired power plant using supercritical technology with a dedicated Jetty at Port Qasim Karachi.
Figure EX-1: Location of DPKPG 2 x 350 MW Coal Power Plant
DPKPG appointed EMC Pakistan Private Limited for conducting the Environmental Impact Assessment study of the Proposed Project to assess the likely environmental and social impacts that may result from Project activities and to identify measures to mitigate negative impacts, if any. EMC formulated the following team of officials and experts for conducting the EIA study and preparing the report:

<table>
<thead>
<tr>
<th>S. #</th>
<th>Name</th>
<th>Position in Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Syed Nadeem Arif</td>
<td>Project Director</td>
</tr>
<tr>
<td>2</td>
<td>Saquib Ejaz Hussain</td>
<td>Project Manager / Expert on Air Dispersion Modeling</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Mirza Arshad Ali Beg</td>
<td>Senior Environmentalist / Project Team Leader</td>
</tr>
<tr>
<td>4</td>
<td>Dr. Shahid Amjad</td>
<td>Marine Biologist</td>
</tr>
<tr>
<td>5</td>
<td>Dr. Syed Ali Ghalib</td>
<td>Expert on Fauna</td>
</tr>
<tr>
<td>6</td>
<td>Mr. Khurram Shams Khan</td>
<td>Social Development Specialist</td>
</tr>
<tr>
<td>7</td>
<td>Ms. Zulekha Soorma</td>
<td>Health &amp; Safety Specialist</td>
</tr>
<tr>
<td>8</td>
<td>Ashar H. Lodi</td>
<td>Transportation Specialist</td>
</tr>
<tr>
<td>9</td>
<td>Mr. S.M. Zaman</td>
<td>Geologist</td>
</tr>
</tbody>
</table>

The EIA study of proposed DPKPG – CPP Project responds to the Section 17 of Sindh Environmental Protection Act (SEPA) 2014 which requires that every new development project in Pakistan has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) depending on the nature and severity of impacts anticipated on commissioning of the project.

The plant design is based on imported coal with the capability to burn local coal in the future. To satisfy the fuel requirements of the proposed 2 × 350 MW coal-fired power plant, approximately, 2.5 million tons per annum coal will be imported from Indonesia, South Africa or Australia, with expected calorific value of 20.14 MJ/kg and brought to the plant via Panamax-type shipping vessels. These vessels will unload coal at a dedicated Coal Jetty at the southern edge of the proposed plant. The ash content is expected to be 8-14%. The expected sulfur content is <1%. Ash generated during Project operation will be ultimately sold to cement plants. Main parameters of the design coal and check coal determined based on the coal quality data are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Symbol</th>
<th>Unit</th>
<th>Design coal</th>
<th>Check coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Total moisture</td>
<td>Mt</td>
<td>%</td>
<td>22.4</td>
<td>26</td>
</tr>
<tr>
<td>2</td>
<td>Air-dried moisture</td>
<td>Mad</td>
<td>%</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Ash content on as-received basis</td>
<td>Aar</td>
<td>%</td>
<td>8.57</td>
<td>14.44</td>
</tr>
<tr>
<td>4</td>
<td>Volatile content on dry ash-free basis</td>
<td>Vdaf</td>
<td>%</td>
<td>51.63</td>
<td>48.48</td>
</tr>
<tr>
<td>5</td>
<td>Coal on as- received basis</td>
<td>Car</td>
<td>%</td>
<td>52.88</td>
<td>44.08</td>
</tr>
<tr>
<td>6</td>
<td>Hydrogen on as- received basis</td>
<td>Har</td>
<td>%</td>
<td>3.81</td>
<td>2.98</td>
</tr>
<tr>
<td>7</td>
<td>Nitrogen on as- received basis</td>
<td>Nar</td>
<td>%</td>
<td>0.79</td>
<td>1.07</td>
</tr>
<tr>
<td>8</td>
<td>Oxygen on as- received basis</td>
<td>Oar</td>
<td>%</td>
<td>11.04</td>
<td>10.84</td>
</tr>
<tr>
<td>9</td>
<td>Total sulphur</td>
<td>St,ar</td>
<td>%</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>Net calorific power on as- received basis</td>
<td>Qnet,v,ar</td>
<td>MJ/kg</td>
<td>20.14</td>
<td>16.25</td>
</tr>
</tbody>
</table>
Coal consumption of boilers in the whole plant is as follows:

<table>
<thead>
<tr>
<th>Table EX-3: Coal Consumption</th>
<th>Design Coal</th>
<th>Check Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRL</td>
<td>BMCR</td>
<td>BRL</td>
</tr>
<tr>
<td>Hourly coal consumption (t/h)</td>
<td>293.72</td>
<td>308.82</td>
</tr>
<tr>
<td>Daily coal consumption (t/d)</td>
<td>5991.9</td>
<td>6299.9</td>
</tr>
<tr>
<td>Annual coal consumption (×10⁴t/a)</td>
<td>218.70</td>
<td>229.95</td>
</tr>
</tbody>
</table>

Note:
1. BRL working condition corresponds to the steam turbine’s TMCR working condition; BMCR working condition corresponds to the steam turbine’s VWO working condition.
2. The annual utility hours is counted by 7446 hours. The equivalent hours for one day is 20.4 hours.

Highest reliability & availability, convenience of operation and maintenance, neat and orderly arrangement, are of utmost importance. The functional requirements of the various systems and the pleasing physical appearance of the completed Plant shall also be taken into account. Due care shall be undertaken concerning the environmental impact due to plant operations and sufficient protective measures shall be incorporated in the design of the Plant for environmental protection especially on air pollution, water pollution and noise. The environment protection measures shall be undertaken in accordance with the Environment Protection Guidelines of World Bank / IFC and Environmental Protection and Emission Control Standards of SEPA.

Coal will be transported through sea. 50,000 DWT capacity Ship will be unloaded at project site with single berthing, Double Unloader and 12.5 m Draft Jetty. For this 1.5 km strip of Channel with average draft of 8 m will be dredged to 12.5 meters corresponding to a dredged material quantity of 1.5 million meter³. The dredged material will be dumped to reclaim the land to the east of Plant site and submerged portion of Project site.

Surface water resources in the macroenvironment of the ecosystem are limited to the catchment area of Ghaggar, Pipri and Badal Nalas, which run from the north and passing through the Bin Qasim Town fall in the Gharo Creek. On the west of the shoreline the Nalas are not prominent; while the Lyari which brings freshwater only during the monsoon season is grossly polluted with industrial as well as sewage effluent. The Pipri and Badal Nala remain dry during the dry season. During wet season there is flooding along the banks due to heavy rain. Pipri Nala and Badal Nala have an extensive catchment area starting from the far northern edge of Port Qasim industrial zone to the shoreline in the south at Arabian Sea.
Both Nalas merge near the Engro Asahi plant. The physical examination indicates that municipal as well as industrial wastewater is being discharged into the stream and is polluting it.

The marine ecology that exist in the mudflats and along the shoreline up to the tide lines in the neighborhood of the proposed DPKPG Power Plant site in Kadiro - Gharo Creek system consists of a unique and diverse ecosystem of birds, plants, fishes and benthic flora and fauna. The most notable aspects of marine fauna and flora are Mangroves and Aquatic birds. A survey was conducted in the microenvironment of project site to establish the baseline of the birds in the project area. 13 species of birds were recorded which include mostly the resident species such as Black Kite, Red Wattled Lapwing, Blue Rock Pigeon, Little Brown Dove, Crested Lark, Black Drongo, Indian Myna, House Crow and House Sparrow. The migratory birds recorded include: Common Sandpiper, Collared Sand Martin, Variable Wheatear and Desert Wheatear.

In the microenvironment of project area the most dominant species of flora is Avicenna marina that also grows on the northern and southern banks of the Phitti Creek. The Mangrove population of Avicenna marina is highly dense near project site. The density of mangrove trees is estimated at between 50-60/100 m². The height of the individual tree within the established Avicenna marina habitat is greater than ~3 m. The mangrove trees growing 200-300 m away from the creek (seawater) in the landward direction show an overall decline in the height of the mangrove plantations.

The Shannon Weiner Biodiversity Index was undertaken which shows that the species diversity and the species richness are relatively poor. The species diversity ranges from 0.69 to 0.90 (the normal range is 3.0) whereas the species richness i.e. number of species in each of the community measured between 0.07 at sample 3 to 0.188 at station 1 [species richness ranges from 0.01 (low) to (1.0) high].

The seismic risk factor of 0.2 is advisable and will need to be incorporated in the design for constructions and installations in the coastal zone, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-VI to VIII).

Dredging along the terminal piled bridge structure will be accomplished utilizing a bucket dredge that allows transfer of excavated material to the spoil storage area in large clumps, minimizing soil dispersion and siltation. Guidance of the London Convention recommends that consideration should be given to the environmental characteristics of the marine disposal site. The site for disposal of dredged material will be as per the advice from Port Qasim Authority (PQA).

The dredging activity will have impact on the benthic ecology. Most studies on the impact of dredging on marine benthos show that dredging can result in a 30 to 70% reduction in species variety; some 40 to 95% reduction in the number of individual species and a similar reduction in biomass in dredged areas (Newell et al., 1998). Re-colonization and recovery of species is a complex process involving initial colonization by fast growing animals (opportunistic) species. In stable environments these are replaced and supplemented by a wider species diversity of slow-growing (equilibrium) species after cessation of dredging. In more disturbed habitats the community is dominated by opportunistic species, which do not move towards an equilibrium community of repeated environmental disturbance.

EMC Pakistan undertook a baseline air quality monitoring survey at the proposed power plant site. The survey helped characterize the existing air quality in the air shed of the proposed power plant site. The measured minimum, maximum and mean concentrations for CO, NOx, SO2, O3 SPM, PM2.5 and PM10 are summarized and compared to the Sindh Ambient Air Quality Standards in the table below.
The level of all air pollutants were well within the prescribed limits of Sindh EQS.

### Table EX-4: Ambient Air Quality of the Project Area

<table>
<thead>
<tr>
<th>Site ID</th>
<th>Sulfur Dioxide (SO$_2$) (µg/Nm$^3$)</th>
<th>Nitrogen Dioxide (NO$_2$) (µg/Nm$^3$)</th>
<th>Nitrogen Oxide (NO) (µg/Nm$^3$)</th>
<th>Particulate Matter Suspended Particulate Matter (SPM) (µg/Nm$^3$)</th>
<th>Less than 10 Microns (PM$_{10}$) (µg/Nm$^3$)</th>
<th>Less than 2.5 Microns (PM$_{2.5}$) (µg/Nm$^3$)</th>
<th>Carbon Monoxide (CO) (mg/Nm$^3$)</th>
<th>Ozone (O$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>16.0</td>
<td>12.9</td>
<td>8.9</td>
<td>183</td>
<td>80.4</td>
<td>18.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-2</td>
<td>11.8</td>
<td>10.1</td>
<td>6.1</td>
<td>216.2</td>
<td>88.9</td>
<td>20.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-3</td>
<td>13.4</td>
<td>9.3</td>
<td>6.4</td>
<td>199.6</td>
<td>81.1</td>
<td>18.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-4</td>
<td>11.8</td>
<td>10.1</td>
<td>6.1</td>
<td>216.9</td>
<td>88.9</td>
<td>20.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-5</td>
<td>13.6</td>
<td>13.3</td>
<td>9.1</td>
<td>-</td>
<td>87.6</td>
<td>23.5</td>
<td>0.9</td>
<td>14.8</td>
</tr>
<tr>
<td>A-6</td>
<td>9.5</td>
<td>11.1</td>
<td>5.8</td>
<td>-</td>
<td>79.8</td>
<td>18.7</td>
<td>0.6</td>
<td>8.7</td>
</tr>
<tr>
<td>A-7</td>
<td>26</td>
<td>9.7</td>
<td>9.6</td>
<td>-</td>
<td>83.7</td>
<td>32.2</td>
<td>2.8</td>
<td>-</td>
</tr>
<tr>
<td>A-8</td>
<td>17.4</td>
<td>10.0</td>
<td>13.5</td>
<td>386</td>
<td>51</td>
<td>26.4</td>
<td>2.16</td>
<td>12.0</td>
</tr>
<tr>
<td>A-9</td>
<td>12.5</td>
<td>8.7</td>
<td>14.5</td>
<td>419</td>
<td>131</td>
<td>22.2</td>
<td>0.8</td>
<td>12.2</td>
</tr>
<tr>
<td>Avg.</td>
<td>14.7</td>
<td>10.6</td>
<td>8.9</td>
<td>270.1</td>
<td>85.8</td>
<td>22.4</td>
<td>1.5</td>
<td>11.9</td>
</tr>
<tr>
<td>SEQS</td>
<td>120</td>
<td>80</td>
<td>40</td>
<td>500</td>
<td>150</td>
<td>75</td>
<td>10</td>
<td>130</td>
</tr>
</tbody>
</table>

The worst incremental 24 hourly average GLC value of SO$_2$, NOx, PM10 and PM2.5 from the project at full operating load with 200 m high stack will be 17.6µg/m$^3$, 32.6µg/m$^3$, 2.0µg/m$^3$ and 1.3µg/m$^3$ respectively in the downwind ENE direction at a distance of 2 km from the plant site. The worst incremental annual average GLC vale of SO$_2$, NOx, PM10 and PM2.5 from the project at full operating load will be 3.9 µg/m$^3$, 7.3 µg/m$^3$, 0.6 µg/m$^3$ and 0.3 µg/m$^3$ respectively in the downwind ENE direction at a distance of 2 km from the plant site. The 24-Hr. maximum incremental GLC is superimposed over the maximum baseline ambient air level. Apparently all the emissions are getting dispersed at the designed height of 200 m. The 200 m tall stack heights with high momentum and buoyancy takes the plume above the highest mixing height. 99.98%. PM emissions are controlled using ESP, SO$_2$ by FGD and NOx by Low NOx burners. This results in lowest ground level concentration of air pollutants in the study area.

The values of the emissions at the fallout distance are within the Sindh Environmental Quality Standards (SEQS). The value of PM10 & PM2.5 which is the parameter of concern in coal fired power plants is much within the limits suggested by SEQS. As such introduction of mitigation measures will entail emissions that will be within all standards and guidelines.

The effluents from the plant include the boiler blow down, cooling water and waste water from the plant. A water treatment plant will be constructed at the plant site which will ensure the effluents meet the SEQS limits. While developing the water system for the project, utmost care has been taken to maximise the recycle/reuse of effluents and minimize effluent quantity. All major water systems of the plant (cooling water system, service water system, coal handling water system and bottom ash handling system) have recirculatory systems.

There are no designated protected areas in the vicinity of the project area. Similarly, this EIA study has not found any antiquity artifact in the microenvironment of area concerned. No sites of cultural heritage are known to exist at or in the immediate vicinity of the DPKPG -CPP project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites. Therefore, there will be no impacts from the construction and operation of the facilities; as such, no mitigation will be required.

The annual ash produced from the coal boilers could be several hundred thousand ton based on the ash content of the coal. ASTM C618 defines two types of ash: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The
chemical properties of the fly ash are largely influenced by the chemical content of the coal burned, anthracite, bituminous and lignite.

The use of fly ash as building material allows energy savings and the reduction of CO$_2$ emissions as one tonne of fly ash replacing cement saves one tonne of CO$_2$. Coal fly ash can also be processed to give a material used for landfill cover and isolating lining that has better technical and environmental characteristics than most natural clays. Coal fly ash has also been proven to improve the yield from agricultural land and can be used as a pollution control agent, particularly for soil decontamination, sludge and effluent treatment and in hazardous waste stabilisation.

There are a number of potential users of ash produced by the project in the vicinity of DPKPG -CPP. These include cement plants are located at a distance of 100-150 km from the plant mostly on the main highway M-9 linking Hyderabad to Karachi. Production of cement concrete blocks where bottom ash can be used as an aggregate is also common and widespread in the Karachi area.

EMP specifies various technological measures for pollution prevention, waste minimization, end-of-pipe treatment, attenuation etc. proposed to be undertaken to mitigate the environmental impacts on each sector of environment during each phase of the project, i.e. construction phase and operation phase. The responsibility for implementation for all mitigatory measures rests with DPKPG.

The environmental management will require specific approach in order to handle the issues effectively. Manager HSE will assign the roles and responsibilities to be performed during the construction and operations stages of DPKPG – Coal Power Plant Project. It is expected that a certain degree of redundancy is inevitable across all management levels, but should be in the order to ensure that compliance with the environmental management plan can be cross-checked.

Frequent round/surveillance of the area is to be conducted by the Independent Monitoring Consultant (IMC) for in-time detection of pollutants/polluter and remedial measures. IMC should also ensure compliance with procedures that are part of mitigating measures, such as low-speed, no engine-idling and no-horn disciplines on the access road.

The objective of post project monitoring will be to determine the level of residual impacts of the project activities on physical, biological and socio-economic receptors in the project area. The monitoring will start one month after the termination of all project-related activities in the project area. As a part of the post-project monitoring, restoration of sites will also be checked.

<table>
<thead>
<tr>
<th>Mitigation Measures</th>
<th>Mode of Implementation</th>
<th>Allocation of Financial Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Efficiency ESPs</td>
<td>Integral Part of Main Plant Package</td>
<td>Rs. 916.34 Million</td>
</tr>
<tr>
<td>Stack</td>
<td>Civil Construction Package</td>
<td>Rs. 1118.69 Million</td>
</tr>
<tr>
<td>Coal Dust Extraction and Suppression Systems</td>
<td>Integral Part of Main Plant Package</td>
<td>Rs. 32.89 Million</td>
</tr>
<tr>
<td>Reclamation of ash pond</td>
<td>Part of O&amp;M System</td>
<td>Rs. 449.95 Million</td>
</tr>
<tr>
<td><strong>Water Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling water discharge channel</td>
<td>Part of Main Plant Package</td>
<td>Rs. 2275.43 Million</td>
</tr>
<tr>
<td>Main Plant Effluent Treatment Plant – ETP</td>
<td>Part of Main Plant Package</td>
<td>Rs. 381.98 Million</td>
</tr>
<tr>
<td>Sewage Treatment Plant</td>
<td>Separate package</td>
<td>Rs. 22.87 Million</td>
</tr>
<tr>
<td><strong>Noise Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of equipment</td>
<td>Included in Technical Specification</td>
<td>Rs. 195.77 Million</td>
</tr>
</tbody>
</table>
This EIA Study finds that the proposed Project would fulfil the requirements of sustainable development by being socially equitable, and economically viable in improving the quality of life for all citizens of Karachi, without altering the balance in the resources of the ecosystem of the region.

The Study therefore recommends that the EIA should be approved with the condition that all mitigation measures recommended in EIA report, suggestions of stakeholders and recommendations of experts committee will be adhered to by Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited and the legal requirements as well as the Environmental Management & Monitoring Plan shall be implemented in letter & Spirit.
# TABLE OF CONTENTS

## 1.0 Introduction & Objectives  
1 of 11

1.1 Project Proponent  
2 of 11
1.2 The Project  
3 of 11
1.3 Environmental Impact Assessment  
5 of 11
   1.3.1 Environmental Protection Philosophy  
5 of 11
   1.3.2 Need for EIA  
6 of 11
   1.3.3 Methodology Adopted For EIA  
6 of 11
1.4 Organization of the EIA Report  
11 of 11
1.5 EIA Consultant  
11 of 11

## 2.0 Policy, Legal & Regulatory Framework  
1 of 24

2.1 The 18th Amendment in Constitution of Pakistan  
2 of 24
2.2 Sindh Environmental Protection Act, 2014  
2 of 24
2.3 Relevant Organization  
4 of 24
2.4 Sindh EPA Review of IEE and EIA Regulations 2014  
5 of 24
2.5 Guidelines for Public Consultation  
8 of 24
2.6 Sindh Environmental Quality Standards  
9 of 24
2.7 Self-Monitoring and Reporting By Industry Rules 2014  
11 of 24
2.8 The Hazardous Substances Rules 2014  
12 of 24
2.9 Sindh Wildlife Protection Ordinance 1972  
12 of 24
2.10 Sindh Fisheries Ordinance 1980  
13 of 24
2.11 Sindh Forest Act 1927  
13 of 24
2.12 The Factories Act 1934  
13 of 24
2.13 Land Acquisition Act (LAA) 1984  
14 of 24
2.14 Port Qasim Authority Act 1973 (Amendments 2002)  
15 of 24
2.15 Pakistan Penal Code  
15 of 24
2.16 Sindh Antiquities Act 1974  
15 of 24
2.17 Sindh Cultural Heritage (Preservation) Act 1994  
16 of 24
2.18 The Boilers Act 1923  
16 of 24
2.19 Guidelines for Coal Fired Thermal Power Plants – NIAP (2014)  
16 of 24
2.20 IFC Guidelines for Thermal Power Plants  
16 of 24
2.21 IFC General EHS Guidelines  
17 of 24
2.22 Requirement of the Equator Principles  
18 of 24
2.23 IFC Performance Standards 2012  
18 of 24
2.24 IMO Conventions Marpol 73/78 & OPRC 90  
20 of 24
2.25 London Convention 1972  
21 of 24
21 of 24
2.27 Convention on Conservation of Migratory Species, 1979  
22 of 24
2.28 Convention of International Trade in Endangered Species (CITES) 1973  
22 of 24
2.29 Convention on Wetlands of International Importance, Ramsar Convention 1971  
22 of 24
2.30 IUCN Red List  
23 of 24
2.31 International Convention on Biodiversity 1992  
23 of 24
2.32 Kyoto Protocol (1992) And United Nation’s Climate Change Convention 24 of 24

3.0 Description of Project 1 of 28

3.1 Main Principles of Design 1 of 28
3.2 Fuel Supply 3 of 28
  3.2.1 Coal Quality and Consumption 3 of 28
  3.2.2 Coal Transportation 4 of 28
3.3 Technical Specifications of Main Equipment 7 of 28
  3.3.1 Boiler 7 of 28
  3.3.2 Steam Turbine 8 of 28
  3.3.4 Thermo-Economic Indexes 9 of 28
3.4 Thermodynamic System 9 of 28
  3.4.1 Thermodynamic System Configuration 9 of 28
  3.4.2 Coal Pulverizing System 15 of 28
  3.4.3 Flue Gas and Air System 15 of 28
  3.4.4 Coal Handling System 15 of 28
  3.4.5 Ash & Slag Handling System 16 of 28
  3.4.6 Flue Gas Desulfurization and Denitrification 18 of 28
  3.4.7 Chemical Water Treatment System 18 of 28
  3.4.8 Water Supply and Drainage System and Cooling Facilities 19 of 28
  3.4.9 Fresh Water Makeup System 21 of 28
  3.4.10 Raw Seawater Pretreatment 22 of 28
  3.4.11 Structural Design of Hydraulic Buildings and Structures 23 of 28
  3.4.12 Layout of Ash and Slag Storage Yard 26 of 28
  3.4.13 HVAC & Dust Removal 26 of 28
  3.4.14 Instrumentation and Control Automation 27 of 28
3.5 Implementation Outline Schedule 28 of 28

4.0 Environmental & Social Baseline 1 of 55

4.1 Introduction 1 of 55
4.2 Physical Environment 1 of 55
  4.2.1 Climate 2 of 55
  4.2.2 Ambient Air & Noise Quality 11 of 55
  4.2.3 Site Geotechnical Characteristics 15 of 55
  4.2.4 Soil Quality 20 of 55
  4.2.5 Bathymetry of the Channel 21 of 55
  4.2.6 Seismicity 26 of 55
  4.2.7 Tsunamis 27 of 55
  4.2.8 Cyclones & Storms 27 of 55
  4.2.9 Waves 29 of 55
  4.2.10 Tides 30 of 55
  4.2.11 Seawater Currents 31 of 55
  4.2.12 Air & Seawater Temperature 31 of 55
  4.2.13 Water Resources 31 of 55
4.3 Biological Environment 39 of 55
  4.3.1 Coastal Ecology 39 of 55
4.3.2 Coastal Belt and Intertidal Zone
4.3.3 Mangroves
4.3.4 Phytoplankton
4.3.5 Vegetation
4.3.6 Pelagic Fish Community
4.3.7 Marine Benthic Flora And Fauna
4.3.8 Mammals
4.3.9 Avi Fauna (Birds)
4.3.10 Reptiles

4.4 Socioeconomic Environment
4.4.1 Coastal Communities
4.4.2 Historical Background
4.4.3 Demography of Bin Qasim Town
4.4.4 Livelihood
4.4.5 Gender
4.4.6 Community Life
4.4.7 Cultural and Archeological Resources

5.0 Screening of Alternatives, Potential Impacts & Proposed Mitigation Measures

5.1 No Project Alternative
5.2 Site Alternatives
5.3 Technology Alternatives
5.4 Coal Transportation Alternatives
5.5 Cooling Water Alternatives
5.6 Screening of Potential Environmental Impacts
  5.6.1 Evaluation of Structural Stability
  5.6.2 Dredging & Disposal of Dredged Spoil
  5.6.3 Impact on Ambient Air Quality and Noise
5.7 Impact on Soil & Water Quality
  5.7.1 Impact on Navigation and Hydraulics of Channel
  5.7.2 Impacts on Ecology
  5.7.3 Protected Areas
  5.7.4 Worker’s Health and Safety
  5.7.5 Fire and explosion protection
  5.7.6 Disposal of Waste
  5.7.7 Ash Handling & Disposal
  5.7.8 Socioeconomic Impacts
  5.7.9 Impacts Rating

6.0 Consultation & Information Disclosure

6.1 Objectives
6.2 Consultation Framework
6.3 Consultation Process
6.4 Community Engagement Responsibilities
6.5 Training on Community Relations
6.6 Stakeholder Engagement Plan Framework
6.6.1 Objectives and Principles
6.6.2 Principles of Stakeholder Engagement
6.6.3 Implementation Plan
6.6.4 Grievance Management
6.6.5 Commitment Register
6.6.6 Roles and Responsibilities
6.6.7 Community Development
6.6.8 Monitoring and Evaluation
6.6.9 Performance Indicators

7.0 Environmental Management And Monitoring Plan
7.1 Introduction
7.2 Objectives & Scope Of EMP
7.3 EMP Process
7.4 Project Background
7.5 Management Approach
7.6 Roles & Responsibilities
7.7 Implementation Stages Of EMP
7.7.1 Planning and Design Of Coal Power Plant Project
7.7.2 Construction and Operation Phase
7.7.3 Closure and Decommissioning Phase
7.8 Changes to the EMP
7.8.1 Change in Operations
7.9 Mitigation Plan
7.10 Monitoring Plan
7.10.1 Objectives of Monitoring Plan
7.10.2 Performance Indicators
7.11 Construction Management Plan (Draft)
7.12 Grievance Redress Mechanism
7.12.1 Framework for Grievance Redress Mechanism
7.12.2 Guidelines for Public Consultation, 1997
7.12.3 Outline of Mechanism for Grievance Redress
7.13 Environmentally Sound & Safe Working Procedures
7.14 Waste Management Plan
7.15 Spill Management
7.15.1 Avoiding Spills
7.15.2 Spill Kits
7.15.3 Responding To Spills
7.16 Afforestation and Green Belt Development
7.17 Emergency Response Plan
7.18 Disaster Management Plan
7.18.1 Definition of Disaster/ Emergency
7.18.2 Objectives of Disaster Management Plan
7.18.3 Classification of Disaster
7.18.4 Possible Disasters in Thermal Power Plant
7.18.5 Sections Prone To Emergencies
7.18.6 Components of Disaster Management Plan
7.18.7 Roles & Responsibilities

8.0 Conclusion

ANNEXURES
1.0 **Introduction & Objectives**

Pakistan is in the middle of a major socio-economic crisis because of the non-availability of electricity on a sustained and affordable basis. The crisis is basically caused by major supply side constraints, as well as suppression of demand. Inefficiency in generation, transmission and distribution system is exacerbated by thefts, leading to higher prices for those who pay their bills.

The clear example of this state of affairs is reflected in the so called “circular Debt” which crossed Rs. 872 billion in 2012. Tariff differential subsidies, and mismanagement and confusion caused by the ‘unbundling’ of the earlier monolith, WAPDA, have all contributed to the present crisis. This widening demand supply gap has resulted in regular load shedding of eight to ten hours in urban areas and eighteen to twenty hours in rural areas [FODP (2010)]. Rapid growth in demand, high system losses, and inadequate generation capacity are among the major reasons for this huge gap. Seasonal reduction in the availability of hydropower, reduction in the indigenous gas resources and too much reliance on imported fuel oil for power generation are primarily responsible for the current crisis. The unavailability of this fuel oil given the mounting circular debt problem (a major cause of fluctuating available power generation capacity) has further accentuated the energy crisis. The persistent shortage of electricity in the country has adversely affected the national economy. Industrial production has been severely hit; and also triggered social unrest which sometimes turns violent thus, creating law and order problems in many urban centres in the country. According to one estimate power shortages have resulted in an annual loss of about 2 percent of GDP [Abbasi (2011)]. Another study reports total industrial output loss in the range of 12 percent to 37 percent due to power outages [Siddiqui, et al. (2011)].

According to the Planning Commission of Pakistan, the peak power sector demand during fiscal year 2012-13 increased at 2,100 MW. Therefore, supply fell short and the supply demand gap remained between 4,500-6,000 MW. The electrical load pattern in the country varies from season to season; during summer season there is an increase in the inductive load.

In the summers of 2013, power shortfall varied from 6,500 MW to 8,500 MW while the entire country had to face daily blackouts of 8-22 hrs. These acute power shortages are forcing the industrial sector to work at underproduction level and are badly threatening the export performance of the country.

![Figure 1.1 - Energy Supply & Demand in Pakistan (2002-2030)](image-source-url)
The problem started after year 2005, when the energy supply fell short by 200 MW in the following year. The supply-demand gap has increased ever since and is projected to go up to 23,700 MW by 2030. If the supply and demand would have increased in the same pattern as it did before year 2005, Pakistan would not have faced any power shortfalls. The UK, which has less than half the population than Pakistan, was generating 70,000 MW in 1970 whereas Pakistan is generating merely 22,000 MW at present. Hence, the problem lies at the supply end.

The National Energy Policy 2013 requires development of strategy to i) ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coal (Thar coal) and hydel power, ii) address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan, and iii) shift Pakistan’s energy mix towards cheaper fuel and conservation of gas for power.

In order to contribute toward meeting Karachi’s growing electricity demand, Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited proposes constructing a coal fired power station at 250 acres land available in the Eastern Industrial Zone of Port Qasim Authority. The project aims at installation of 2x350 MW Coal based supercritical thermal power plant to reduce the dependency on expensive high Sulphur fuel oil and to introduce cheaper alternative fuel for power generation, increase the efficiency and provide reliable low cost power to the Karachi City.

The main objective of the proposed Project is to respond to the Energy Policy 2013 which has set the goals at:

- Ensuring the generation of inexpensive & affordable electricity for domestic, commercial, and industrial use,
- Adopt such strategy that meets this goal and also focuses on shifting Pakistan’s energy mix towards cheaper fuel and conservation of gas for power, and
- Utilize coal for power generation and thus provide energy security to the Country.

The project shall:

- Respond to the urgent need to close the yawning gap between power generation and demand,
- Provide an economically viable and environmentally acceptable power generation system to make the coal available for use in power production, in view of the wide gap between supplies of fossil fuel and demand,
- Ensure stable power production system for the Country, and
- Respond to the need of improvement in quality of life through Sustainable Energy Resource development.

### 1.1 Project Proponent

Executing organization of the proposed 2x350 MW Coal Power Plant (the ‘Project’) is Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited which would be responsible for the construction, maintenance and operation of the facility. Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited is an entity incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (SPV) and develop a 2 x 350 MW imported Coal Power Project at Port Qasim Karachi, sponsored by China Datang Overseas Investment Co. Ltd. (CDTO), China Machinery Engineering Corporation (CMEC) and K-Electric Limited (KE).

51% of the equity stake in the Project is owned by CDTO, a wholly owned subsidiary of China Datang Corporation, a power generation giant based in China with assets of more than 120,000 MW under its ownership. 25% of the equity stake in the Project is owned by CMEC, an international conglomerate and
the first Engineering and Trade Company in China, and was listed in the Hong Kong Stock Exchange in 2012. The remaining 24% of the equity stake in the Project is owned by KE.

The co-sponsors have signed a Joint Development Agreement in September 2015 and a Shareholders Agreement on 20 May 2016 to jointly establish a 700 MW imported coal fired power plant using supercritical technology with a dedicated Jetty at Port Qasim Karachi.

1.2 The Project

DPKPG intends to establish a 2 x 350 MW coal fired power plant in the Eastern Industrial Zone of Port Qasim, Karachi. The Project site is located on the north-western edge of the Indus delta system, which is characterized by long and narrow creeks, mud flats and the mangroves forest ecosystems. Overall the area comprises of barren land with industrial units towards the north of the proposed site of the plant. The site for proposed Siddiqsons Coal Power Plant is located immediately to the west, and the ASG Metals Limited and Lotte Pakistan is located immediately to the north of the Project site. The general elevation of the area is less than 4 m above Mean Sea Level (MSL) (Fig 1.1).

The proposed 2 x 350 MW coal power plant shall adopt supercritical boiler technology. The major systems of the power project include:

- Coal Jetty
- Super-critical boiler
- Pulverised Coal (PC) generation plant
- An open coal storage area surrounded by wind shield
- Coal handling covered conveyors
- Water supply and waste water system
- Ash handling system
- Emission control system
- Flue Gas Desulfurization (FGD) system
- Dust prevention, and fire monitoring and prevention facilities.

The plant design is based on imported coal with the capability to burn local coal in the future. To satisfy the fuel requirements of the proposed 2 x 350 MW coal-fired power plant, approximately, 2.5 million tons of coal per annum will be imported from Indonesia, South Africa or Australia, with expected calorific value of 20.14 MJ/kg and brought to the plant via Panamax-type shipping vessels. These vessels will unload coal at a dedicated Coal Jetty at the southern edge of the proposed plant. The ash content is expected to be 8-14%. The expected sulphur content is <1%. Ash generated during Project operation will be ultimately sold to cement plants.

Highest reliability & availability, convenience of operation and maintenance, neat and orderly arrangement, are of utmost importance. The functional requirements of the various systems and the pleasing physical appearance of the completed Plant shall also be taken into account. Due care shall be undertaken concerning the environmental impact due to plant operations and sufficient protective measures shall be incorporated in the design of the Plant for environmental protection especially on air pollution, water pollution and noise. The environment protection measures shall be undertaken in accordance with the Environment Protection Guidelines of World Bank / IFC and Environmental Protection and Emission Control Standards of Sindh EPA.
Figure 1.2 — Map showing DPKPG -CPP Site
1.3 Environmental Impact Assessment

1.3.1 Environmental Protection Philosophy

Environmental Protection Philosophy is all about preservation and conservation of natural settings within the project area. But the first priority of such a philosophy is about figuring out the alternatives and mitigation solutions for any potential disturbances or damages towards natural atmosphere, water bodies, native wildlife as well as economic, health and cultural disturbance to the people especially residing within or in the near surroundings of the project area due to project interventions. There could be number of ways to either save the environment totally or at least minimize the significance of the negative impacts on nature. The most internationally acceptable and leading protection tool is to prepare and conduct the Environmental Assessments (EAs) of the project. The assessment should be based primarily on the following principles.

- Impact assessment to be designed as a preventive measure;
- It should give environmental considerations equal weight with technical and economic aspects;
- Environmental considerations should be introduced early on in the planning processes; and
- Broad and public participation should ensure wide acceptance of projects implemented.

If above is not considered in an early planning stage or phase of the project, it is impossible to envisage that people who will be involved in development or upgradation activities in a project life cycle will readily engage themselves in environmental management planning and mitigation measures for the betterment and improvement of their surroundings and environmental setup. This could also be due to their lack of knowledge and required skills on the gravity of environmental degradation issue and often widespread common illiteracy leading to ignorance of such vital assets.
The basic methodology of an Environmental Protection Philosophy intends to provide fundamental information and guidelines on Environmental Issues in order to enhance and better understand the project's environmental impacts and their mitigation measures. There must be a commitment to compulsory actions, transparency of all such actions to be implemented, legal and other requirements binding the proponent or the contractor to execute the obligatory plans and procedures in accordance with the outlined National and International safety guidelines.

All of the above information must be based upon field survey experiences, background investigations of project area, potential environmental impacts during construction and operations and stakeholder's complaints, concerns and suggestions regarding pre- and post-construction and operational phases of DPKPG - Coal Power Plant (CPP) Project. An essential part of this philosophy is to check and examine the project activities during construction and operation stages i.e. Audits, Inspection and monitoring of performance against the Key performance Indicators (environmental, ecological, social etc.).

To cover the above, an EIA study has to be conducted, which has already been identified during the scoping stage of the DPKPG - CPP Project when the Terms of Reference (ToR) were under preparation. To safeguard the existing environment, a detailed methodology has been prepared for undertaking the EIA and provided in coming sections of this chapter. The overall protection philosophy contains the documentation of baseline footprint of the project, identification of relevant national and international environmental laws, impact assessment and proposal of mitigation measures along with preparation of Environmental Management and Monitoring Plan.

A proper understanding of Environmental Protection Philosophy can be an important means to enhance quality of socioeconomic conditions and livelihood opportunities of project area as well. By incorporating an EMMP for a project; involving the environmental and social principles helps project managers, staff and relevant agencies to develop a sense of ownership amongst all the stakeholders. This can also be applied as a useful instrument for the participation of immediate stakeholders in project related activities—especially women—by means of providing trainings, income generating programs, awareness initiatives & competence measures for community benefits.

### 1.3.2 Need For EIA

The EIA study of proposed DPKPG – CPP Project responds to:

- Section 17 of Sindh Environmental Protection Act (SEPA) 2014 which requires that every new development project in Pakistan has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) depending on the nature and severity of impacts anticipated on commissioning of the project.

- SEPA 2014, which requires the Project Proponents to follow the procedures set out in Sindh Environmental Protection Agency (Review of IEE and EIA) Regulations 2014.

### 1.3.3 Methodology Adopted For EIA

This study has covered all major areas of concern as per regulatory requirements. Scope of the EIA study included collection of data from different sources, development of baseline of the current physical, ecological and social baseline of the area through surveys. In general, the study has been conducted in accordance with the Sindh Environmental Protection Agency Review of EIA and IEE Regulations, 2014 & guidelines provided therein. Following screening of potential environmental impacts, the requirement for mitigation measures to address the adverse impacts is presented. The Report includes the Monitoring Program that will be implemented during the construction and operation phase. This environmental impact assessment was conducted in the following manner:
1.3.3.1 Scoping

A scoping exercise was undertaken to identify the potential issues that are to be considered in the environmental impact assessment. The scoping exercise included the following tasks:

**Data Compilation:** A generic description of the proposed activities relevant to this environmental assessment was compiled with the help of the Project proponent.

**Review of Published literature:** All available published and unpublished information pertaining to the micro and macro environment of the study area was obtained and reviewed. It included the earlier studies conducted in the study area, environmental and social baseline and impact assessment studies conducted by different consultants in past. Secondary data was very helpful in understanding the issues that were identified by other consultants.

**Review of applicable Legislation:** Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled.

**Identification of potential impacts:** The information collected in the above procedures was reviewed and potential environmental issues identified.

**Initial site visit:** An initial site visit was conducted to get an overview of site conditions and the surrounding areas.

**Stakeholder consultation:** Stakeholder consultation was undertaken to document the concerns of the local community and other stakeholders, and to identify issues that may require additional assessment in order to address these concerns. Stakeholder consultation was conducted during the survey with following objectives:

- To inform the Stakeholders and Communities about the project
- To gather feedback from primary and secondary stakeholders on proposed project
- To identify relevant potential environmental issues, including the socioeconomic impact of the project, and corresponding mitigation measures.
1.3.3.2 Review Of Legislation And Guidelines

National & Provincial legislations, international agreements, environmental guidelines, and best industry practices were reviewed to set environmental standards that DPKPG will be required to follow during different stages of the project.

Review of legislations included but not limited to the following:

- Policies and Legislation relevant to Coal Power Projects.
- Complementary legislation applicable to project for sustainable management of the environment covering land, water resources & water quality, solid waste management, atmospheric emissions.
- Administration: identification of relevant organization with its role and responsibility and make clear the approval process with its average time schedule though visit to relevant organization and reviewing documents.

The SEPA 2014 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. A number of rules and regulations have been promulgated under the SEPA 2014. These are:

- Environmental Samples Rules, 2014
- Pollution Charge for Industry (Calculation and Collection) Rules, 2014
- Provincial Sustainable Development Fund Board (Procedure) Rules
- The Sindh Environmental Quality Standard (Self-Monitoring and Reporting by Industry) Rule, 2014
- Sindh Environmental Protection Agency (Review of IEE and EIA), Regulations 2014
- Sindh Environmental Quality Standards.
There is a long list of legislation that falls in the category of or is relevant to environmental law. Some of the more important ones are:

- Sindh Wildlife Protection Ordinance, 1972
- The Antiquities Act, 1975
- Sindh Cultural Heritage (Preservation) Act, 1994
- Land Acquisition Act, 1894
- Factories Act, 1934
- Electricity Act, 1910
- Boilers Act, 1923

### 1.3.3.3 Baseline Data Collection

Detailed environmental baseline surveys were conducted to collect primary data on the Project Area to help identify sensitive receptors. The primary data were examined and compared with secondary data available from earlier environmental studies in the region. The scope of survey included collection of information on following key aspects:

1. (1) To confirm baseline data including Biophysical of the Project Area including the following items with their seasonal variability:
   - Climate and Rainfall
   - Air Quality
   - Noise Quality
   - Topography
   - Soil
   - Geomorphology
   - Geology
   - Hydrology
   - Vegetation
   - Agriculture
   - Livestock
   - Fauna

2. (2) To confirm baseline data including Socio Economic Environment of the Project Area including the following items with their seasonal variability
   - Administrative Division
   - Demography and Settlement
   - Socio-Economic Activities
   - Land use and National Resources Management in the Project area
   - Existing Infrastructure and Social Services
   - Current Resettlement Issues

![Figure 1.6 – Baseline survey for field data collection](image)
1.3.3.4 Identification Of Aspects

Identification of environmental aspects and their significance is fundamentally important for determination of severity of incidence of impacts at different stages of the project. This step is aimed at obtaining an inventory of the aspects. The aspects identified during this step cover all activities during construction, installation and operation, in order to determine those which have or can have significant impact on the environment.

1.3.3.5 Impact Assessment & EMP

Environmental experts at EMC analyzed and assessed the anticipated impacts that are likely to arise due to the identified aspects. Each of the potential impacts identified during the scoping session was evaluated using the environmental, socioeconomic, and project information collected. Air quality Modeling was undertaken to forecast the impact of gaseous emissions. In general, the impact assessment discussion covers the following aspects:

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

An environmental management plan (EMP) was developed to oversee the environmental performance of the project and adoption of proposed mitigation measures. A monitoring plan has also been incorporated in the EMP to monitor impact of all activities and performance of mitigation measures and to identify the residual impact if any, and also the positive / negative changes in the physical, and socioeconomic environment.

![EIA Methodology](image-url)

Figure 1.7 – EIA Methodology
1.3.3.6 Documentation & Review

This is the final step of the EIA study. The data generated during and for the study are compiled and examined by experts of the respective field. Sections of this report were prepared as the study progressed, by EMC office staff in consultation with experts. The report was finally reviewed by Team Leader, who analyzed the information, assessed the potential environmental impacts in the light of national and international guidelines, examined the alternatives in the light of observations on the field as well as meetings with the stakeholders, before organizing the Report in the present form.

1.4 Organization Of The EIA Report

Section 2 (Project Description) describes the proposed Project.

Section 3 (Policy, Statutory & Institutional Framework) briefly discusses existing national policy and resulting legislation for sustainable development and environmental protection, and then presents the legislative requirements that need to be followed while conducting the EIA.

Section 4 (Environmental & Social Baseline) documents in detail the existing physical, biological, and socioeconomic conditions at the microenvironment and macroenvironment of the Power Plant and coal handling facility, besides the transport routes.

Section 5 (Screening of Alternatives, Potential Impacts and Mitigation Measures) presents the project alternatives that were considered, and the reasons for their selection or rejection highlighted. It also presents an assessment of the Potential Environmental Impacts on the physical, biological, and socioeconomic environment, besides the measures required to mitigate the negative impacts.

Section 6 (Stakeholder Interaction) presents the objectives and outcomes of the public stakeholder consultation that was conducted during the present study.

Section 7 (Environmental Management Plan) presents the measures proposed for implementation of the environmental mitigation measures, and

Section 8 (Conclusions) presents the conclusions of this EIA Study

1.5 EIA Consultant

DPKPG appointed EMC Pakistan Private Limited for conducting the Environmental Impact Assessment (EIA) study of the Proposed Project to assess the likely environmental and social impacts that may result from Project activities and to identify measures to mitigate negative impacts, if any. EMC formulated the following team of officials and experts for conducting the EIA study and preparing the report:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name</th>
<th>Position in Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Syed Nadeem Arif</td>
<td>Project Director</td>
</tr>
<tr>
<td>2</td>
<td>Saquib Ejaz Hussain</td>
<td>Project Manager / Expert on Air Dispersion Modeling</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Mirza Arshad Ali Beg</td>
<td>Senior Environmentalist / Project Team Leader</td>
</tr>
<tr>
<td>4</td>
<td>Dr. Shahid Amjad</td>
<td>Marine Biologist</td>
</tr>
<tr>
<td>5</td>
<td>Dr. Syed Ali Ghalib</td>
<td>Expert on Fauna</td>
</tr>
<tr>
<td>6</td>
<td>Mr. Khurram Shams Khan</td>
<td>Social Development Specialist</td>
</tr>
<tr>
<td>7</td>
<td>Ms. Zulekha Soorma</td>
<td>Health &amp; Safety Specialist</td>
</tr>
<tr>
<td>8</td>
<td>Ijaz Hussain Khilji</td>
<td>Expert on Coal Transportation</td>
</tr>
<tr>
<td>9</td>
<td>Mr. S.M. Zaman</td>
<td>Geologist</td>
</tr>
</tbody>
</table>
# Table of Contents

2.0 Policy, Legal & Regulatory Framework................................................................. 1
2.1 The 18th Amendment In Constitution Of Pakistan.................................................. 2
2.2 Sindh Environmental Protection Act, 2014.............................................................. 2
2.3 Relevant Organization............................................................................................. 4
2.4 Sindh EPA Review Of IEE And EIA Regulations 2014............................................. 5
2.5 Guidelines For Public Consultation ....................................................................... 8
2.6 Sindh Environmental Quality Standards................................................................. 9
2.7 Self-Monitoring And Reporting By Industry Rules 2014........................................ 11
2.8 The Hazardous Substances Rules 2014................................................................. 12
2.9 Sindh Wildlife Protection Ordinance 1972............................................................. 12
2.10 Sindh Fisheries Ordinance 1980........................................................................... 13
2.11 Sindh Forest Act 1927.......................................................................................... 13
2.12 The Factories Act 1934......................................................................................... 13
2.13 Land Acquisition Act (LAA) 1984......................................................................... 14
2.14 Port Qasim Authority Act 1973 (Amendments 2002)............................................. 15
2.15 Pakistan Penal Code............................................................................................... 15
2.16 Sindh Antiquities Act 1974.................................................................................... 15
2.17 Sindh Cultural Heritage (Preservation) Act 1994.................................................... 16
2.18 The Boilers Act 1923............................................................................................ 16
2.19 Guidelines For Coal Fired Thermal Power Plants – NIAP (2014)........................... 16
2.20 IFC Guidelines For Thermal Power Plants............................................................ 16
2.21 IFC General EHS Guidelines.............................................................................. 17
2.22 Requirement Of The Equator Principles............................................................... 18
2.23 IFC Performance Standards 2012......................................................................... 18
2.24 IMO Conventions Marpol 73/78 & OPRC 90......................................................... 20
2.25 London Convention 1972..................................................................................... 21
2.26 United Nations Convention On Law Of The Sea .................................................. 21
2.27 Convention On Conservation Of Migratory Species, 1979..................................... 22
2.28 Convention Of International Trade In Endangered Species (CITES) 1973......... 22
2.29 Convention On Wetlands Of International Importance; Ramsar Convention 1971 22
2.30 IUCN Red List...................................................................................................... 23
2.31 International Convention On Biodiversity 1992.................................................... 23
2.32 Kyoto Protocol (1992) And United Nation’s Climate Change Convention............ 24
2.0 Policy, Legal & Regulatory Framework

This section describes the current legal responsibilities of the Project proponent (DPKPG) in the context of the environment and sustainable development, and the institutions that exist in the country that may influence the environmental management of the proposed Project.

Article 9 of the Constitution defines the right to life as a “fundamental right” in these words “No person shall be deprived of life or liberty save in accordance with law”. The Supreme Court of Pakistan in its judgment in the case Shehla Zia and others vs WAPDA (1994) declared that the right to a clean environment is part of the fundamental constitutional right to life.

Pakistan is also signatory to a number of International environmental conventions which have been ratified by the government (Table 2.1). In carrying out this Environmental Assessment, relevant international guidelines have duly been followed.

<table>
<thead>
<tr>
<th>Convention</th>
<th>Date of Treaty</th>
<th>Entry into force in Pakistan</th>
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<tbody>
<tr>
<td>Climate Change and the ozone layer</td>
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</tr>
<tr>
<td>Kyoto Protocol to the UNFCCC</td>
<td>1997</td>
<td>2005</td>
</tr>
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<td>Vienna Convention for the Protection of the Ozone Layer</td>
<td>1985</td>
<td>1993</td>
</tr>
<tr>
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<td>1987</td>
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<td>Waste and pollution</td>
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<td>International Convention on Oil Pollution Preparedness, Response and Co-operation</td>
<td>1990</td>
<td>1995</td>
</tr>
<tr>
<td>Desertification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>International Convention to Combat Desertification</td>
<td>1994</td>
<td>1997</td>
</tr>
<tr>
<td>Biodiversity and the protection of plants and animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convention on Biological Diversity</td>
<td>1992</td>
<td>1994</td>
</tr>
<tr>
<td>Cartagena Protocol on Biosafety to the Convention on Biological Diversity</td>
<td>2000</td>
<td>2009</td>
</tr>
<tr>
<td>Memorandum of Understanding concerning Conservation Measures for the Siberian Crane</td>
<td>1998</td>
<td>1999</td>
</tr>
<tr>
<td>International Plant Protection Convention</td>
<td>1951/52</td>
<td>1954</td>
</tr>
<tr>
<td>Agreement for the Establishment of the Near East Plant Protection Organization</td>
<td>1993</td>
<td>2009</td>
</tr>
<tr>
<td>Cultural heritage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convention concerning the Protection of the World Cultural and Natural Heritage</td>
<td>1972</td>
<td>1976</td>
</tr>
</tbody>
</table>
2.1 The 18th Amendment In Constitution Of Pakistan

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.

As a result, the Ministry of Environment at the federal level has been abolished. Its functions related to the national environmental management have been transferred to the provinces. The international obligations in the context of environment will be managed by the Ministry of Climate Change.

2.2 Sindh Environmental Protection Act, 2014

The SEPA 2014 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes.

This act is applicable to a broad range of issues that extends to air, water, industrial liquid effluent, marine, and noise pollution as well as to the handling of hazardous wastes. The applicable sections of the act to this project are:

- **Section 11(1):** Subject to the provisions of this Act and the rules and regulations, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely to cause pollution or adverse environmental effects, as defined in section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards; or, where applicable, the standards established under Section 6(1)(g)(i); or direction issued under Section 17, 19, 20 and 21 of this Act; or any other direction issued, in general or particular, by the Agency.

The proposed project shall comply with all applicable standards. Comprehensive and appropriate control measures will be incorporated in the design of the project such as Wet Type Limestone Gypsum Flu Gas Desulphurization (FGD), waste water treatment plant and low NOx burners. Environmentally safe disposal and recycling of Ash will also be undertaken.

- **Section 11(2):** All persons, in industrial or commercial or other operations, shall ensure compliance with the Environmental Quality Standards for ambient air, drinking water, noise or any other Standards established under section 6(1)(g)(i); shall maintain monitoring records for such compliances; shall make available these records to the authorized person for inspection; and shall report or communicate the record to the Agency as required under any directions issued, notified or required under any rules and regulations.

SEQS which have been established for gaseous emission, liquid effluent, ambient air quality, noise, and drinking water shall be adequately followed. Besides, a Continuous Emissions Monitoring System (CEMS) is also proposed to continuously monitor all critical gaseous emissions.
Section 11(3): Monitoring and analysis under sub-section (1) and (2), shall be acceptable only when carried out by the Environmental Laboratory certified by the Agency as prescribed in the rules.

All stipulated tests will be regularly performed from designated laboratories approved by Sindh EPA.

Section 12: No person shall import hazardous waste into Sindh province or its coastal, internal, territorial or historical waters, except acquiring prior approval of the Agency.

The coal which shall be imported will be free of any radioactivity. No hazardous material will be imported.

Section 13: Subject to the provisions of this Act, no person shall import, generate, collect, consign, transport, treat, dispose of, store, handle or otherwise use or deal with any hazardous substance except- Handling of hazardous substances. (a) under a license issued by the Agency; or (b) in accordance with the provisions of any other law, rule, regulation or notification for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Government is a party.

Any hazardous waste generated during construction and operational phase of the project will be handled only after obtaining a license from Sindh EPA and proper SOPs will duly be developed.

Section 17(1): No proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment, and has obtained from the Agency approval in respect thereof.

The EIA of the proposed Project will be submitted to the Sindh Environmental Protection Agency (EPA) for approval and only after the issuance of approval will the construction activity be commenced. The Sindh EPA will organize public hearing for the proposed project.

Section 17(3): Every review of an environment impact assessment shall be carried out with public participation and, subject to the provisions of this Act, after full disclosure of the particulars of the project.

Section 31(1): The Agency shall cause relevant details of any proposed project regarding which an Environmental Impact Assessment has been received to be published, along with an invitation to the public to furnish their comments thereon within a specified period. (2) In accordance with such procedure as may be prescribed, the Agency shall hold public hearings to receive additional comments and hear oral submissions. (3) All comments received under sub-sections (1) and (2) shall be duly considered by the Agency while reviewing the environmental impact assessment or strategic impact assessment, and decision or action taken thereon shall be communicated to the persons who have furnished the said comments.

A number of rules and regulations have been promulgated under the SEPA 2014. These are:

- Environmental Samples Rules, 2014
- Pollution Charge for Industry (Calculation and Collection) Rules, 2014
- Provincial Sustainable Development Fund Board (Procedure) Rules, 2001
- The Sindh Environmental Quality Standard (Self-Monitoring and Reporting by Industry) Rule, 2014
- Sindh Environmental Protection Agency (Review of IEE and EIA), Regulations 2014
- Sindh Environmental Quality Standards.
There is a long list of legislation that falls in the category of or is relevant to environmental law. Some of the more important ones are:

- Sindh Wildlife Protection Ordinance, 1972
- The Antiquities Act, 1975
- Sindh Cultural Heritage (Preservation) Act, 1994
- Land Acquisition Act, 1894
- Factories Act, 1934
- Electricity Act, 1910
- Boilers Act, 1923

### 2.3 Relevant Organization

Administration on environment has been divided into federal and provincial government. International issues such as the environmental policy and regulation has been managed by Ministry of Climate Change. On the other hand, national environmental matter has been managed by provincial government. In Sindh province, Sind EPA has been responsible for the provincial matters. All of the environmental technical issues such as EIA, monitoring, enforcement of law/environmental quality standards are headed by Director General of Sindh EPA. The structures of Sindh province and Sindh EPA are shown in Figure 2.1.

**Figure 2.1 – Structure of Sindh Province and Sindh EPA**
2.4 Sindh EPA Review Of IEE And EIA Regulations 2014

The Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2000 define Schedules (I & II) of projects falling under the requirement of IEE or EIA. This EIA Study has, for environmental classification of the Project into Category A or B, taken account of the requirements of the Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 which define Schedules (I & II) as follows:

**Schedule I:** A project falls in Schedule I if it is likely to have adverse environmental impacts, but of lesser degree or significance than those for category ‘A’ and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE report including EMP.

**Schedule II:** Projects are categorized in Schedule II if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through: a) Areas declared by the Government of Pakistan as environmentally sensitive (National Parks/Sanctuaries/Game Reserve), b) Areas of international significance (e.g. protected wetland as designated by the RAMSAR Convention), or c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.

According to Sindh Environmental Protection Agency Regulation, 2014, a proponent of a project falling in any category listed in Schedule II shall file an EIA with the Sindh Environmental Protection Agency, since the listed projects are generally major projects and have the potential to affect a large number of people. Coal Power Projects above 50 MW are placed in Schedule II thus requiring an EIA.

### SCHEDULE II

(See Regulation 4)

**List of projects requiring an EIA**

A. **Energy**
   1. Hydroelectric power generation over 50 MW
   2. Thermal power generation over 100MW
   3. Coal power projects above 50 MW
   4. Transmission lines (11 KV and above) and distribution projects.
   5. Nuclear power plants
   6. Wind energy projects if falls under any sensitive, protected area.

B. **Oil and Gas projects**
   1. Petroleum refineries.
   2. LPG and LNG Projects(including LNG Terminals, re-gasification units) except LPG filling stations
   3. Oil and gas transmission systems
   4. Oil and gas gathering system, separation and storage.

C. **Manufacturing and processing**
   1. Cement plants
   2. Chemical manufacturing industries
   3. Fertilizer plants
   4. Steel Mills
   5. Sugar Mills and Distilleries
   6. Food processing industries including beverages, dairy milk and products, slaughter houses and related activities with total cost more than Rs. 200 Million
   7. Industrial estates (including export processing zones)
   8. Man-made fibers and resin projects with total cost of Rs 200M and above
   9. Pesticides (manufacture or formulation)
10. Petrochemicals complex
11. Synthetic resins, plastics and man-made fibers, paper and paperboard, paper pulping, plastic products, textiles (except apparel), printing and publishing, paints and dyes, oils and fats and vegetable ghee projects, with total cost more than Rs. 10 million
12. Tanning and leather finishing projects
13. Battery manufacturing plant

D. Mining and mineral processing
1. Mining and processing of coal, gold, copper, sulphur and precious stones
2. Mining and processing of major non-ferrous metals, iron and steel rolling
3. Smelting plants with total cost of Rs. 100 million and above.

E. Transport
1. Airports
2. Federal or Provincial highways or major roads (including rehabilitation or rebuilding or reconstruction of existing roads)

F. Ports and harbor development
1. Railway works
2. Flyovers, underpasses and bridges having total length of more than 500m

G. Water management, dams, irrigation and flood protection
1. Dams and reservoirs with storage volume of 25 million cubic meters and above having surface area of 4 square kilometers and above
2. Irrigation and drainage projects serving 15,000 hectares and above
3. Flood Protection

H. Water supply and filtration
Large Water supply schemes and filtration plants.

I. Waste Disposal and treatment
1. Handling, storage or disposal of hazardous or toxic wastes or radioactive waste (including landfill sites, incineration of hospital toxic waste)
2. Waste disposal facilities for municipal or industrial wastes, with total annual capacity of 10,000 tons and above.
3. Waste water treatment facility for industrial or municipal effluents.

J. Urban development and tourism
1. Housing schemes above 10 acres
2. Residential/commercial high rise buildings/apartments from 15 stories and above.
3. Land use studies and urban plans (large cities)
4. Large scale public facilities.
5. Large-scale tourism development projects

K. Environmentally Sensitive Areas
All projects situated in environmentally sensitive areas

L. Other projects
1. Any other project for which filing of an EIA is required by the Agency under sub-regulation (2) of Regulation 5.
2. Any other project likely to cause an adverse environmental effect

The overall flow of obtaining the approval of EIA is shown in figure 2.2.
Figure 2.2 – EIA Review and Approval Procedure

Environmental Impact Assessment for 2 x 350 MW Coal Power Project

EMC Pakistan Pvt. Ltd
Page 7 of 24
2.5 Guidelines For Public Consultation

Public consultation is mandated under Sindh’s environmental law. Regulation 11 of the IEE-EIA Regulations 2014 provides the general requirements whereas the sectoral guidelines indicating specific assessment requirements are provided in the Guidelines for Public Consultation 2014 (the ‘Guidelines’). These are summarized below.

- **Objectives of Public Involvement:** ‘To inform stakeholders about the proposed project, to provide an opportunity for those otherwise unrepresented to present their views and values, providing better transparency and accountability in decision making, creating a sense of ownership with the stakeholders’;

- **Stakeholders:** ‘People who may be directly or indirectly affected by a proposal will clearly be the focus of public involvement. Those who are directly affected may be project beneficiaries, those likely to be adversely affected, or other stakeholders. The identification of those indirectly affected is more difficult, and to some extent it will be a subjective judgment. For this reason it is good practice to have a very wide definition of who should be involved and to include any person or group who thinks that they have an interest. Sometimes it may be necessary to consult with a representative from a particular interest group. In such cases the choice of representative should be left to the group itself. Consultation should include not only those likely to be affected, positively or negatively, by the outcome of a proposal, but should also include those who can affect the outcome of a proposal’;

- **Mechanism of consultations:** ‘Provide sufficient relevant information in a form that is easily understood by non-experts (without being simplistic or insulting), allow sufficient time for stakeholders to read, discuss, consider the information and its implications and to present their views, responses should be provided to issues and problems raised or comments made by stakeholders, selection of venues and timings of events should encourage maximum attendance’;

- **Timing and Frequency:** Planning for the public consultation program needs to begin at a very early stage; ideally it should commence at the screening stage of the proposal and continue throughout the EIA process;

- **Consultation Tools:** Some specific consultation tools that can be used for conducting consultations include; focus group meetings, needs assessment, semi-structured interviews; village meetings and workshops;

- **Other Important Considerations:** ‘The development of a public involvement program would typically involve consideration of the following issues; objectives of the proposal and the study; identification of stakeholders; identification of appropriate techniques to consult with the stakeholders; identification of approaches to ensure feedback to involved stakeholders; and mechanisms to ensure stakeholders’ consideration are taken into account’.

As above, the Guidelines for Public Consultation introduces effective ways to inform the contents of the project to the general public during the planning stage and that eventually consensus building toward the implementation of project is reached.

Incorporating public involvement into the stages of environmental assessment is explained in the guidelines that public consultation meeting has to be carried out after the works on "developing options, and assessing and mitigating impacts" for comments and assessment.

For the proposed DPKPG-CPP Project, the consultation program is based on the following principles:
- Development and maintenance of an open and transparent dialogue with all parties which have an interest or influence on the project and its proposed area;
- Demonstration of how, when and why input from stakeholders was or was not utilized to make project iterative and flexible (so that decisions can be continually fed into design, construction and operation);
- Learning from stakeholder experience so as to modify and adapt future consultation activities and project design;
- Maintaining continuous dialogue with stakeholders throughout the project planning, designing, actual construction and operation;
- Development of the consultation process in recognition of the existence of understanding at different levels amongst the stakeholders, and
- Providing complete/updated information about the project, with regard to such issues as design, construction methodology, engineering and operation, besides necessary mitigation measures.

2.6 Sindh Environmental Quality Standards

With the SEPA, 2014 the Sindh EPA revised the Environmental Quality Standards (EQS) with full consultation of the private sector, industrialist, trade and business associations and NGOs. DPKPG is committed to comply with the applicable Sindh-EQS in letter and spirit. Table 2.2 shows Sindh environmental quality standard for ambient air.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Time-weighted average</th>
<th>Concentration in Ambient Air</th>
<th>Method of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td>Annual Average*</td>
<td>80μg/m³</td>
<td>Ultraviolet Fluorescence Method</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>120μg/m³</td>
<td></td>
</tr>
<tr>
<td>Oxides of Nitrogen as (NO)</td>
<td>Annual Average*</td>
<td>40μg/m³</td>
<td>Gas Phase Chemiluminescence</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>40μg/m³</td>
<td></td>
</tr>
<tr>
<td>Oxides of Nitrogen as (NO₂)</td>
<td>Annual Average*</td>
<td>40μg/m³</td>
<td>Gas Phase Chemiluminescence</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>80μg/m³</td>
<td></td>
</tr>
<tr>
<td>O₃</td>
<td>1 hour</td>
<td>130μg/m³</td>
<td>Non dispersive UV absorption method</td>
</tr>
<tr>
<td>Suspended Particulate Matter (SPM)</td>
<td>Annual Average*</td>
<td>360μg/m³</td>
<td>High volume Sampling, (Average flow rate not less than 1.1m³/minute)</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>500μg/m³</td>
<td></td>
</tr>
<tr>
<td>Respirable Particulate Matter (PM10)</td>
<td>Annual Average*</td>
<td>120μg/m³</td>
<td>B Ray absorption method</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>150μg/m³</td>
<td></td>
</tr>
<tr>
<td>Respirable Particulate Matter (PM2.5)</td>
<td>Annual Average*</td>
<td>40μg/m³</td>
<td>B Ray absorption method</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>75μg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour</td>
<td>15μg/m³</td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>Annual Average*</td>
<td>1μg/m³</td>
<td>ASS Method after sampling using EPM 2000 or equivalent Filter paper</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>1.5μg/m³</td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>8 hours**</td>
<td>5mg/m³</td>
<td>Non Dispersive Infra Red (NDIR) method</td>
</tr>
<tr>
<td></td>
<td>1 hours</td>
<td>10mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.
**24 hourly / 8 hourly values should be met 98% of the time, it may exceed but not on two consecutive
days.

Table 2.3 shows the standards for motor vehicle noise.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Standards (maximum permissible limit)</th>
<th>Measuring method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td>85dB(A)</td>
<td>Sound-meter at 7.5 meter from the source</td>
</tr>
</tbody>
</table>

Table 2.4 shows the proposed national environmental quality standard for noise.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Category of Area / Zone</th>
<th>Day Time Limit in dB(A) Leq*</th>
<th>Night Time Limit in dB(A) Leq*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Residential area (A)</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Commercial area (B)</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>Industrial area (C)</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>Silence Zone (D)</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>

Note: 1 Day time hours: 6.00 a.m to 10.00 p.m
2 Night time hours: 10.00 p.m to 6.00p. m
3 Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4 Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

*dB(A)Leq Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

The SEQS for effluents are shown in Table 2.5.

<table>
<thead>
<tr>
<th>S. #</th>
<th>Parameter</th>
<th>Into Inland Waters</th>
<th>Into Sewage Treatment</th>
<th>Into Sea</th>
<th>unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature or Temp. increase</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>°C</td>
</tr>
<tr>
<td>2</td>
<td>pH value (H+)</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Biological Oxygen Demand (BOD) at 20°C</td>
<td>80</td>
<td>250</td>
<td>80</td>
<td>mg/l</td>
</tr>
<tr>
<td>4</td>
<td>Chemical Oxygen Demand (COD)</td>
<td>150</td>
<td>400</td>
<td>400</td>
<td>mg/l</td>
</tr>
<tr>
<td>5</td>
<td>Total Suspended Solids (TSS)</td>
<td>200</td>
<td>400</td>
<td>200</td>
<td>mg/l</td>
</tr>
<tr>
<td>6</td>
<td>Total Dissolved Solids (TDS)</td>
<td>3500</td>
<td>3500</td>
<td>3500</td>
<td>mg/l</td>
</tr>
<tr>
<td>7</td>
<td>Oil and Grease</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>mg/l</td>
</tr>
<tr>
<td>8</td>
<td>Phenolic Compounds (as Phenol)</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>mg/l</td>
</tr>
<tr>
<td>9</td>
<td>Chloride (as Cl)</td>
<td>1000</td>
<td>1000</td>
<td>SC</td>
<td>mg/l</td>
</tr>
<tr>
<td>10</td>
<td>Fluoride (as F⁻)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>mg/l</td>
</tr>
<tr>
<td>11</td>
<td>Cyanide (as CN⁻) total</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>12</td>
<td>An-ionic detergents (as MBAS)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>mg/l</td>
</tr>
<tr>
<td>13</td>
<td>Sulphate(SO₄²⁻)</td>
<td>600</td>
<td>1000</td>
<td>SC</td>
<td>mg/l</td>
</tr>
<tr>
<td>14</td>
<td>Sulphide(S²⁻)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>15</td>
<td>Ammonia (NH₃)</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>mg/l</td>
</tr>
<tr>
<td>16</td>
<td>Pesticides</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>mg/l</td>
</tr>
<tr>
<td>17</td>
<td>Cadmium</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>mg/l</td>
</tr>
<tr>
<td>18</td>
<td>Chromium (trivalent and hexavalent)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>19</td>
<td>Copper</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>20</td>
<td>Lead</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>mg/l</td>
</tr>
<tr>
<td>21</td>
<td>Mercury</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>mg/l</td>
</tr>
<tr>
<td>22</td>
<td>Selenium</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>mg/l</td>
</tr>
<tr>
<td>23</td>
<td>Nickel</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>24</td>
<td>Silver</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>25</td>
<td>Total toxic metals</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>26</td>
<td>Zinc</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>27</td>
<td>Arsenic</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mg/l</td>
</tr>
<tr>
<td>28</td>
<td>Barium</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>mg/l</td>
</tr>
</tbody>
</table>
The SEQS for drinking water are shown in Table 2.6.

<table>
<thead>
<tr>
<th>S.#</th>
<th>Properties / Parameters</th>
<th>Standard Values for Pakistan</th>
<th>S.#</th>
<th>Properties / Parameters</th>
<th>Standard Values for Pakistan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Essential Inorganics (mg/liter)</td>
<td></td>
<td></td>
<td>Essential Inorganics (mg/liter)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All water intended for drinking (E.Coli or Thermo tolerant Coliform bacteria)</td>
<td>Must not be detectable in any 100 ml sample</td>
<td>3</td>
<td>Aluminum (Al)</td>
<td>≤ 0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>Antimony (Sb)</td>
<td>≤ 0.005</td>
</tr>
<tr>
<td>2</td>
<td>Treated water entering the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)</td>
<td>Must not be detectable in any 100 ml sample</td>
<td>5</td>
<td>Arsenic (As)</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>Barium (Ba)</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>Boron (B)</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>Treated water in the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)</td>
<td>Must not be Detectable in any 100 ml sample. In case of large supplies, where sufficient samples are examined, must not be resent in 95% of the samples taken throughout any 12 month period.</td>
<td>8</td>
<td>Cadmium (Cd)</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>Chloride (Cl-)</td>
<td>&lt; 250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Chromium (Cr)</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Copper (Cu)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Organic (mg/L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>Phenolic compounds</td>
<td>&lt; 0.0002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Toxic Inorganics (mg/liter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>Cyanide (CN-)</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>Fluoride (F)</td>
<td>≤ 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>Lead (Pb)</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>Manganese (Mn)</td>
<td>≤ 0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>Mercury (Hg)</td>
<td>≤ 0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>Nickel (Ni)</td>
<td>≤ 0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Physical</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>Color</td>
<td>&lt; 15 TCU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>Taste</td>
<td>Non-objectionable/ Acceptable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>Odor</td>
<td>Non-objectionable/ Acceptable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>Turbidity</td>
<td>&lt; 5 NTU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>Total Hardness as CaCO₃</td>
<td>&lt; 500 mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>TDS</td>
<td>&lt; 1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>pH</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radioactive</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Alpha Emitters bq/L</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>Beta emitters</td>
<td>1</td>
</tr>
</tbody>
</table>

### 2.7 Self-Monitoring And Reporting By Industry Rules 2014

The self-monitoring and reporting system (SMRS) defines the priority parameters for each industry that falls in either of the schedules of liquid and gaseous emissions. It takes into account the resources and interests of both the EPA and industry.

Schedule I is for industries and establishments producing effluents and places them into categories (A), (B), and (C), each corresponding to a specified reporting frequency; category (A) being the most
polluting. The category (A) industries are bound to report their effluents and emission levels every month while category (B) industry quarterly and category (C) industry biannually.

Schedule II categorizes the gaseous emission producing industries. It has two categories (A) and (B) wherein category (A) again represents industries that are prone to produce more pollutants as compared to category (B).

The industries must have their effluents tested by an EPA certified/ accredited laboratory and enter the results in the electronic forms (as well as a hard copy) included in the software package. The data must be sent to the respective provincial EPA via email or on a floppy disk. Sampling and analysis requirements and procedures and the charges have evolved through the process of coordination among representatives of industry, government, environmental NGOs and academic researchers. Appreciable progress has been made towards operationalizing the process.

Thermal Power Plants have been placed in Category (B) of schedule I for reporting of their liquid effluents. While in schedule II of gaseous emissions, they are placed in Category (A). They are also required to report their gaseous emissions, besides their boilers, ovens, furnaces and kilns on monthly basis.

DPKPG shall stick to these requirements in accordance with the law.

2.8 The Hazardous Substances Rules 2014

The Hazardous Substances Rules 2014 define the hazardous substances in schedule I and make it compulsory for any proponent who is filing an EIA to apply for a license for transporting any hazardous substance that it has in its plans. The rules also stipulate a waste management plan to be in place in such a facility holding hazardous materials. Further SEP Act 2014 also requires the proponent to obtain a license to store any such hazardous substance.

DPKPG is obligated to follow in accordance with the provisions of the act and rules and obtain license for hazardous substances before implementation of the project.

2.9 Sindh Wildlife Protection Ordinance 1972

The Sindh Wildlife Protection Ordinance 1972 empowers the government to declare areas of ecological significance as protected. The law provides three different types of such areas, the national park, the wildlife sanctuary and the game reserve. Responsible authority for each classification is Sindh Forest & Wildlife Department. According to guidelines for sensitive and critical areas 1997, thirty (30) wildlife sanctuaries (532,582ha), one (1) national park (308,733ha) and eleven (11) game reserves (127,020ha) are designated.

The proposed area for the installation of DPKPG Coal Power Plant lies within a designated industrial area of Port Qasim Authority. The project site is located outside of any wildlife protected area therefore the project will not contravene with any provisions of this Act.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Responsible Authority</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife sanctuary</td>
<td>Sindh Forest &amp; Wildlife Department</td>
<td>▪ undisturbed breeding ground</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ prohibited or regulated public areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ non-exploitation of forest</td>
</tr>
<tr>
<td>National park</td>
<td></td>
<td>▪ protection and preservation of scenery, flora</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and fauna in its natural state</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ an area of outstanding scenic merit and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>natural interest</td>
</tr>
</tbody>
</table>
Game reserves

| Hunting and shooting of wild animals is not be allowed, except under a specific permit, which may specify the maximum number of animals or birds that may be killed or captured and the area and duration for which such permits shall be valid. |

Source: Guidelines for sensitive and critical areas, 1997

2.10 Sindh Fisheries Ordinance 1980

This ordinance mainly regulates fishing in any public waters for any purpose. The regulated waters include the coastal areas and rivers. The section 8 of this ordinance specifically prohibits the dumping of untreated industrial or domestic sewage waste into a water body in Sindh, unless treated and made harmless for fish and other aquatic life.

The proposed project will not release any harmful and untreated effluent in any water body, hence fulfilling the stipulated requirement.

2.11 Sindh 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. Some 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.

The Sindh Forestry Department manages official forestry reserves and has expressed concern about the level of woodcutting, camel breeding which has taken place in the area. IUCN, Engro Polymer Chemical Pakistan Ltd, EVTL as well as FOTCO have undertaken plantation of mangrove trees in a systematic manner and their experience will ensure that the mangroves are conserved/replanted.

Adoption of Conservation practices has been demonstrated at several sites, for e.g. Jhari Creek, where the *Rhizophora* species has been introduced at the water line. Similar practices will be adopted at the proposed project site at the pre-construction and construction stages.

2.12 The Factories Act 1934

This act relates to the health and safety of the workers of a factory or an industrial establishment, employing ten or more than ten workers. The following are the applicable sections which relate to this project during the construction phase:

- **Section 13:** Workplace should be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- **Section 14(2):** Where gas, dust or other impurity is generated in the course of work, adequate measures shall be taken to prevent injury to the health of workers.
- Measures will be in place to control any dust emission both during and after construction. An engineered stack will be built to keep harmful gases away from everyone.
- **Section 19(I):** In every factory a sufficient supply of water fit for drinking shall be provided for the workers at suitable places.
- Safe drinking water will be available to everyone as an RO plant is also in plan.
- **Section 19(3):** In every factory, a sufficient supply of water suitable for washing shall be provided for the use of workers, at suitable places and with facilities for its use, according to such standards as may be prescribed.

- **Section 20:** Sufficient latrines and urinals, according to the prescribed standards, shall be provided, for male workers and for female workers separately, of suitable patterns and at convenient places as prescribed, and shall be kept in a clean and sanitary condition during all working hours.

- All basic sanitation facilities shall be provided to all workers.

- **Section 26(1):** Safety of buildings and machinery. If it appears to the Inspector that any building or part of a building or any part of the ways, machinery or plant in a factory is in such a condition that it is dangerous to human life or safety, he may serve on the manager of the factory an order in writing specifying the measures which in his opinion should be adopted, and requiring them to be carried out before a specified date.

Section 26(2): If it appears to the Inspector that the use of any building or part of a building or of any part of the ways, machinery or plant in a factory involves imminent danger to human life or safety, he may serve on the manager of the factory an order in writing prohibiting its use until it has been properly repaired or altered.

The proponent is obliged to abide by all of the injunctions presented in this act that apply to this project. The applicable sections have been mentioned above.

### 2.13 Land Acquisition Act (LAA) 1984

The 1894 Land Acquisition Act (LAA) with its successive amendments is the main law regulating land acquisition for public purpose in Pakistan. The LAA has been variously interpreted by local governments, and some province has augmented the LAA by issuing provincial legislations. The LAA and its Implementation Rules require that following an impacts assessment/valuation effort, land and crops are compensated in cash at market rate to titled landowners and registered land tenants/users, respectively.

The LAA mandates that land valuation is to be based on the latest 3 years average registered land sale rates, though, in several recent cases the median rate over the past year, or even the current rates, have been applied. Due to widespread land under-valuation by the Revenue Department, current market rates are now frequently used with an added 15 per cent Compulsory Acquisition Surcharge as provided in the LAA.

1) Based on the LAA, only legal owners and tenants registered with the Land Revenue Department or possessing formal lease agreements are eligible for compensation or livelihood support.

2) It is also noted that the LAA does not automatically mandate for specific rehabilitation/assistance provisions benefiting the poor, vulnerable groups, or severely affected PAPs, nor it automatically provides for rehabilitation of income/ livelihood losses or resettlement costs. This however it is often done in many projects in form of ad hoc arrangements based on negotiations between a specific EA and the PAPs.

3) Exceptions to the rule are intrinsic to the fact that the law is elastic and are broadly interpreted at provincial level depending on operational requirements, local needs, and socio-economic circumstances. Recourse is often taken to ad hoc arrangements, agreements and understandings for resettlement in difficult situations. The above is also influenced by the fact that an amendment of the LAA has been considered necessary by the Ministry of Environment. Accordingly, a National Resettlement Policy
(NRP) and a Resettlement Ordinance have been drafted to broaden LAA provisions and current practices so as to widen the scope of eligibility and tightening up loopholes (i.e. regarding definitions of malpractices, cut-off dates, political influence on routing, etc.). But both these documents are still awaiting government's approval for implementation.

The Act would apply for all the situations during the project when land area for the purpose of the project is needed to be acquired.

2.14 **Port Qasim Authority Act 1973 (Amendments 2002)**

This Act provides for the establishment of the Port Qasim Authority, defines its functions, powers and internal organization and lays down rules relative to management of and navigation in marine ports and inland waterways ports. The particular sections applicable to the Project are:

- Section 71(B)(2) No Owner, Agent or Master of a vessel, or any industry, manufacturing establishment, mill, factory or any kind, cargo handling company, terminal operator, etc., shall discharge any solid or liquid, waste, oily, noxious radioactive and hazardous substances, bilge discharges, residues and mixtures containing noxious solid and liquid wastes, de-blasting of unwashed cargo tanks and line washing, garbage, emission of any effluent or waste or air pollution or noise in any amount concentration or level in excess of the National Environmental Quality Standards, or standards, which may be specified, from time to time, by the Authority for Port limits.

- No wastes that are generated at any stage of the project will ever be discharged into any water body untreated. A CEMS will continuously monitor all gaseous emissions and SEQS shall be followed accordingly. Coal which will be imported will be free of any radioactivity.

- Section 71 (C)(1) No proponent of a project shall commence construction or operation unless he has filed with this Authority as Initial Environmental Examination (IEE) or, where the project is likely to cause an adverse environmental effect, an Environment Impact Assessment (EIA), and has obtained from the authority approval in respect thereof.

Without the prior approval of this EIA, construction activity within PQA cannot be commenced.

2.15 **Pakistan Penal Code**

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use.

- Section 277: Fouling water of public spring or reservoir: Whoever voluntarilry corrupts or fouls the water of any public spring or reservoir, so as to render it less fit for the purpose for which it is ordinarily used.

DPKPG shall strictly monitor their contractor(s) activities & the contractor shall restrain from disposing off any kind of waste/effluent in the sea.

2.16 **Sindh Antiquities Act 1974**

The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area which may contain articles of archaeological significance. Under the Act, the project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity
If an archaeological discovery is made during the course of the project, it should be reported to the Department of Archaeology, Government of Pakistan.

The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GOP to prohibit excavation in any area that may contain articles of archaeological significance.

DPKPG is obligated to ensure that no activity is undertaken within 61 m (200 Ft) of a protected antiquity and to report to the GOP's Department of Archaeology of any archaeological discovery made during the course of the project.

2.17 Sindh Cultural Heritage (Preservation) Act 1994

The Sindh Cultural Heritage (Preservation) Act, 1994 is the provincial law for the protection of cultural heritage. Its objectives are similar to those of the Antiquity Act, 1975.

None of the sites protected under these laws has been identified in the vicinity of the project site.

2.18 The Boilers Act 1923

The boilers act extends to whole of Pakistan and is applicable to all steam boilers having a volume of greater than 20 gallons. Every boiler is required to have a registration and certification prior to its use. The boiler must not exceed the pressure which is mentioned on its certificate.

DPKPG shall comply all regulations and statutes that relate with boilers.

2.19 Guidelines For Coal Fired Thermal Power Plants – NIAP (2014)

With the establishment of Government of Pakistan's 2013 Energy Policy, one of the goals is to promote coal fired power plants in the country to meet the growing demand of electricity. These Guidelines have been prepared in collaboration with IUCN. They cover the key environmental issues that need to be addressed, mitigation measures and alternatives that need to be considered in the actual EIA.

The guidelines also gives a detailed comparison of the existing technology for both the power generation and emission control technologies with comparative values of effectiveness of different measures in order to give a benchmark for comparison and wise decision making.

2.20 IFC Guidelines For Thermal Power Plants

The IFC industry sector EHS guidelines are designed to be used together with the General EHS Guidelines, which provide guidance to users on common EHS issues potentially applicable to all industry sectors. Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).

The Guidelines for Thermal Power Plants has three sections and two annexures. Section 1 deal with industry specific impacts and their management; section 2 helps establish performance indicators and monitoring after installation of plants.

The guidelines give the details of following major areas as they particularly relate to thermal power plants.

- Air emissions
- Energy efficiency and Greenhouse Gas emissions
- Water consumption and aquatic habitat alteration
- Effluents
- Solid wastes
- Hazardous materials and oil
- Noise

The aim is to achieve maximum possible efficiency while minimizing the environmental impacts. Different control measures are described in the section of air emissions which are currently being used in the industry. Annexure A gives a general description of industrial activities while annexure B describes the environmental assessment guidance for thermal power projects. IFC Guidelines also contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of these Guidelines to K-Electric’s new power plant facilities will involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

The guidelines also help establish performance indicators for Effluents and Emissions and Occupational Health and Safety. For emissions, the guideline describes particular levels for different type of fuels and combustion technology. For discharge of treated effluent to surface waters for general use, site-specific discharge levels may be established based on the availability and conditions in the use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water using classification as described in the General EHS Guidelines. Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in standards of countries with recognized regulatory frameworks.

2.21 IFC General EHS Guidelines

These Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors.

The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally.

For IFC, such assessment is carried out consistent with Performance Standard 1, and for the World Bank, with Operational Policy 4.01 based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.
For complex projects, use of multiple industry-sector guidelines may be necessary. And therefore in the case of proposed Power Plant, the industry specific guidelines are being followed along with the general EHS guidelines.

2.22 Requirement Of The Equator Principles

Leading financial institutions around the world involved in project finance have adopted the “Equator Principles” as a common framework to assess and manage the environmental and social risks in project financing. In essence, the financing institutions adhering to the Equator Principles have agreed to use the same environmental standards as that of the World Bank Group’s International Finance Corporation (IFC).

IFC applies a set of performance standards to manage social and environmental impacts of the project that it finances. Together, the eight performance standards (PS) are:

- PS 1: Social and Environmental Assessment and Management System
- PS 2: Labour and Working Conditions
- PS 3: Pollution Prevention and Abatement
- PS 4: Community Health, Safety and Security
- PS 5: Land Acquisition and Involuntary Resettlement
- PS 6: Biodiversity Conservation and Sustainable Natural Resource Management
- PS 7: Indigenous Peoples, and
- PS 8: Cultural Heritage.

Performance Standard 1 establishes the importance of: (i) integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client’s management of social and environmental performance throughout the life of the project. Performance Standards 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate. While all relevant social and environmental risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential social and environmental impacts that require particular attention in emerging markets. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

This environmental assessment has been conducted in compliance with the provisions of the Equator Principles.

2.23 IFC Performance Standards 2012

The IFC’s Policy on Social and Environmental Sustainability requires that all projects financed by the IFC should be socially and environmentally sustainable. The requirement is met by applying a set of rigorous performance standards.

These Performance Standards are essential documents to help IFC and its clients manage and improve their social and environment performance through an outcomes-based approach. The desired outcomes are described in the objectives of each Performance Standard, followed by specific requirements to help clients achieve these outcomes through means that are appropriate to the nature and scale of the project.
and commensurate with the level of social and environmental risks (i.e., likelihood of harm) and impacts. Central to these requirements is a consistent approach to avoid adverse impacts on workers, communities, and the environment or, if avoidance is not possible, to reduce, mitigate, or compensate for the impacts, as appropriate.

The key performance standards that are likely to have significance for the proposed Project are the following:

**Social & Environmental Assessment and Management System** – Performance Standard 1 underscores the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management). It requires the development of an effective social and environmental management system that promotes a continuous process initiated by management and involving communication between the client, its workers, and the local communities directly affected by the project. It is expected that the system will entail the thorough assessment of potential social and environmental impacts and risks from the early stages of project development, and provide order and consistency for mitigating and managing these on an ongoing basis.

The standard also requires that project proponents will conduct a process of Social and Environmental Assessment that will consider, in an integrated manner, the potential social and environmental (including labor, health, and safety) risks and impacts of the project.

Lastly, specific management programs, action plans, monitoring plans, and training programs to enhance the capacity of the responsible persons to implement the environmental and social plans is required. Community involvement, public disclosure and setting up of a grievance redressal mechanism are the other key requirements of this standard.

**Labor and Working Conditions** – This performance standard recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection of the basic rights of workers. It requires that businesses should recognize that the workforce is a valuable asset, and a sound worker-management relationship is key to the sustainability of the enterprise. To achieve this, it is expected that a human resource labor policy shall be developed. Under the policy, the project proponent shall provide employees with information regarding their rights under national labor and employment law, including their rights related to wages and benefits. This policy will be clear and understandable to employees and will be explained or made accessible to each employee upon taking employment. The policy will cover working conditions, right to organize, non-discrimination, grievance mechanisms, child labor, and forced labor.

**Pollution Prevention and Abatement** – This performance standard recognizes that increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level. It outlines a project approach to pollution prevention and abatement in line with these internationally disseminated technologies and practices. The performance standard promotes the private sector’s ability to integrate such technologies and practices as far as their use is technically and financially feasible and cost-effective in the context of a project that relies on commercially available skills and resources.

**Community Health, Safety and Security** – This performance standard recognizes that although private sector projects often bring benefits to communities they can also increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failures, and releases of hazardous materials. Communities may also be affected by impacts on their natural resources, exposure to diseases, and the use of security personnel. This performance standard addresses the
responsibilities of project proponents in avoiding or minimizing the risks and impacts to community health, safety and security that may arise from project activities.

**Land Acquisition and Involuntary Resettlement** – This performance standard is designed to minimize the potentially adverse impacts arising out of land acquisition and involuntary resettlement. IFC desires that to the extent possible, involuntary resettlement should be avoided and, if that is not possible, than it should be minimized. It also requires that where involuntary resettlement is unavoidable, appropriate measures should be taken to mitigate adverse impacts on displaced persons and also on the communities in which the displaced persons are relocated. The direct involvement of the community and the client in resettlement activities is encouraged to make the process cost-effective and efficient, as well as to find innovative approaches to improving the livelihoods of those affected by resettlement. Lastly, project proponents are encouraged to acquire land rights through negotiated settlements wherever possible, even if they have the legal means to gain access to the land without the seller’s consent. This approach is preferred since experience suggests that negotiated settlements help avoid expropriation and eliminate the need to use governmental authority to remove people forcibly.

**Biodiversity Conservation and Sustainable Natural Resource Management** – This performance standard is based on the recognition that protecting and conserving biodiversity and its ability to change and evolve, is fundamental to sustainable development. It encourages conservation of biological diversity and the promotion of use of renewable natural resources in a sustainable manner. It addresses how project proponents can avoid or mitigate threats to biodiversity arising from their operations, as well as sustainably manage renewable natural resources.

**Indigenous Peoples** – This performance standard is based on the recognition that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. Because of their economic, social and legal status, often they have limited capacity to defend their interests and rights and are thus exposed to different types of risks and severity of impacts, including loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and disease. The IFC expects the project proponents to create opportunities for Indigenous Peoples to participate in, and benefit from project related activities that may help them fulfil their aspiration for economic and social development. In addition, this performance standard recognizes that Indigenous Peoples may play a role in sustainable development by promoting and managing activities and enterprises as partners in development.

**Cultural Heritage** – This Performance Standard aims to protect irreplaceable cultural heritage and to guide project proponents in protecting cultural heritage in the course of their business operations.

### 2.24 IMO Conventions Marpol 73/78 & OPRC 90

Ship-generated waste is regulated globally as part of the implementation of the International Convention for the prevention of pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78). It covers two main subjects: i) The special construction and equipment rules for the prevention of accidental pollution; and ii) The circumstances in which discharges in the sea are authorised. The requirement of MARPOL 73/78 is established in 20 Articles, two Protocols and five annexes; these include contamination by oil, noxious liquid substances carried in bulk, harmful substances, sewage and garbage. Pakistan is signatory to all five annexes. Nevertheless, pollution prevention practices consistent with MARPOL requirements will be adhered to during all the phases of project. The Project proponent will be mandated to ensure safe shipping of the Coal Carriers and besides adopting measures for

2.25 **London Convention 1972**

In 1972, the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter defines a Black List of toxic substances, and a Grey List of less hazardous substances.

Under Article-IV, Annex-I the following substances are included in the “Black List”.

1. **Black List**
   - Organohalogen Compounds;
   - Mercury and Mercury Compounds;
   - Cadmium and Cadmium Compounds;
   - Persistent Plastics and other persistent synthetic materials;
   - Crude oil and petroleum products;
   - High level radioactive wastes; and
   - Materials produced for biological and chemical warfare.

*Note (1): Item-viii gives exemption to the above listed substances which are “rapidly rendered harmless” provided they do not make edible organisms unpalatable or endanger human health or that of domestic animals.*

*Note (2): Item-xi gives exemption to dredged material containing the above substances as trace contaminants but subject such materials to Grey List status.*

Under Article 4, Annex-2 the following less harmful substances are included in the “Grey List” or special care substances. These substances can only be dumped into the sea after a special permit has been issued:

2. **Grey List**
   - Wastes containing significant amounts of arsenic, lead, copper, zinc, organosilicon compounds, cyanides, fluorides, pesticides and their by-products;
   - Additional list in the case of disposal of large quantities of acids and alkalis: beryllium, chromium, nickel, vanadium;
   - Generally bulky wastes, which may cause a hazard to fishing or shipping;
   - Radioactive wastes (other than high level);
   - Incineration of waste at sea is also controlled; and
   - Substances which, though non-toxic, may become harmful due to the quantities in which they are dumped.

In 1990 this Convention was amended to require signatory countries to consider whether an adequate scientific basis exists for assessing the environmental impact of a substance (i.e. dredged material) before issuing a permit for dumping. Pakistan is signatory to the London Convention and a Notification came into force on 8th April 1995.

The Project Proponent will follow the procedures adopted by the other units based in Port Qasim area for dumping the wastes including dredged material and on guidelines of PQA.

2.26 **United Nations Convention On Law Of The Sea**

The UN Convention on the Law of the Sea was adopted and opened for signature in 1982. On 16th November 1994, it entered into force for 68 countries. Pakistan is a signatory to the Convention.
The Convention establishes a comprehensive framework for use of the ocean and its resources. Its 320 articles, supplemented by nine detailed annexes, specify the rights all nations may exercise in the world oceans and their responsibility to do so with due regards for the rights and interests of other nations. The preservation and protection of the marine Environment & the conservation of marine living resources are fundamental obligations.

The Law of the Sea Convention represents the first comprehensive statement of international law on protection and preservation of the marine environment and provides a legal and institutional framework for marine environmental protection and related dispute Settlement.

It establishes a basic structure of obligations, objectives and principles covering all sources of marine pollution that include Pollution by vessels (operational and accidental discharges from ships); dumping (the deliberate disposal of wastes at sea by ships, aircraft, platforms, or other man-made structures).

The Convention establishes the General Principles for the preservation and protection of the marine environment and identifies the Source Categories for the prevention, reduction and control of marine pollution. It discusses in great detail issues such as Response to Marine Pollution Emergencies.

2.27 Convention On Conservation Of Migratory Species, 1979

This convention was adopted in Bonn, Germany in 1979 and Pakistan ratified it in 1987. This is the sole international treaty that seeks to specifically address the conservation of international migratory animals. The species covered by this convention include Avian, Mammalia and Pisces. Pakistan has its 12% of its area designated as protected as wildlife sanctuaries, national parks, game reserves and as community conservation area. These measures along with many laws preventing human intervention and exploitation of wild make sure the compliance of this convention.

Pakistan lies at the Indus-flyway route 4 (also called the green route), a corridor for migratory birds who come for wintering from Siberia and finally reach India Bharatpura.

The proposed site does not fall in the migratory bird’s flyway zone.

2.28 Convention Of International Trade In Endangered Species (CITES) 1973

The early 1960s saw an international discussion which started focusing on the rate at which the world’s wild flora and fauna were being threatened by illegal international trade. Later as a result of a resolution adopted in 1963, the CITES was drafted at a meeting of the International Union for the Conservation of Nature (IUCN) in Nairobi, Kenya. At a meeting of representatives of 80 countries in Washington D.C., the text of the Convention was agreed upon on March 3rd, 1973. Just about 2 years later, on July 1st 1975, CITES entered into force.

Pakistan’s accession to CITES occurred in 1976 and it was ratified later in the same year.

2.29 Convention On Wetlands Of International Importance; Ramsar Convention 1971

Pakistan is a signatory to the RAMSAR Convention. The principal obligations of contracting parties to the Convention are:

- To designate wetlands for the List of Wetlands of International Importance
- To formulate and implement planning so as to promote wise use of wetlands
- To carry out Environmental Assessment before transformations of wetlands, and to make national wetland inventories
- To establish nature reserves on wetlands and provide adequately for their wardening and through management to increase waterfowl populations on appropriate wetlands
- To train personnel competent in wetland research, management and wardening
- To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system
- To promote wetland conservation concerns with development aid agencies
- To encourage research and exchange of data

So far 18 sites in Pakistan have been declared as wetlands of International Importance or RAMSAR Sites. Of these, there are about 45 game sanctuaries and reserves spread over an area of 0.90 million hectares in Sindh. None of these wetlands have been included within or close to the project area. Haleji Lake and Kinjhar (Kalri) Lake are the two lakes designated as Wildlife Sanctuary. These freshwater lakes are internationally important areas for breeding, staging and wintering water birds. They are however at 70 km and 150 km distance from project site.

### 2.30 IUCN Red List

It has been about 50 years now when IUCN first established the Red List. It is the world’s most comprehensive source of information for conservation status of animals, fungi and plant species. The list categorizes the species as:

![IUCN Categorization of Threatened Species](source www.iucnredlist.org)

No faunal species that fall under the IUCN Red List category were observed during the surveys at the site for the EIA study.

### 2.31 International Convention On Biodiversity 1992

The International Convention on Biodiversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programs and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.
2.32 Kyoto Protocol (1992) And United Nation’s Climate Change Convention

The United Nations Framework Convention on Climate Change (UNFCCC) and the subsequent Kyoto Protocol is an attempt to initiate a process to develop a more specific and binding agreement on the reduction of greenhouse gas emissions in an attempt to address the cause of global warming. Pakistan ratified the Convention and the Kyoto Protocol was adopted at a Conference of the Parties to the UNFCCC in Kyoto, Japan in December 1997.

The conference resulted in a consensus decision to adopt a protocol under which industrialized countries (Annex 1 parties) will reduce their combined greenhouse gas emissions by at least 5% compared to 1990 levels in the period 2008 to 2012. Pakistan, being a developing country (non-Annex 1 party) does not have to make any comparable greenhouse gas emission reductions.

In developing the Kyoto Protocol, the need to promote sustainable development was recognised. This means implementing policies and measures to, among others, enhance energy efficiency, protect and enhance sinks and reservoirs of greenhouse gases, promote sustainable forms of agriculture, increase the usage of new and renewable forms of energy and of advanced, innovative and environmentally sound technologies. Pakistan Climate Change Policy is in place and puts emphasis on cleaner technology and production, and a shift towards sustainable development.
3.0 Description Of Project

The proposed 2x350 MW Coal Fired Project will be established by DPKPG over an area of 216 acres in the Eastern Industrial Zone of Port Qasim, southeast of Karachi, on the northern bank of the Arabian Sea. The land around the Project is a designated industrial area. Number of coal power plants are coming-up in the same zone including Siddiqsons Energy 350 MW CPP, PQEPC (Sinohydro) 2x660 MW CPP, Lucky Power Project 650 MW and FFBL 165 MW. Some of the existing major industrial establishments in the study area include Pakistan Steel Mills (PSM), K-Electric Power Station, Engro Zarkhez complex, Engro Polymer & Chemicals Limited, Lotte Pakistan, Linde Pakistan, & ASG Metals.

The proposed project will include the installation of a thermal power plant with 2x350 MW super-critical coal fired boilers. Coal for the power plant will be made available through Indonesia, South Africa or Australia and a coal jetty will be constructed as part of the main project. The project will incorporate state-of-the-art waste treatment technologies to minimize the associated wastes and mitigate their adverse impacts on the physical and socioeconomic environment of the region to the maximum possible levels. The cooling water requirement for the power plant will be met by extracting water from the Arabian Sea and treating it in Seawater Desalination System (SDS). Water for services and domestic purposes will also be met through the treated water from the SDS.

3.1 Main Principles Of Design

- The construction scale of this project will be 2×350MW supercritical condensing coal-fired generator sets. The annual utility hours is 7446 hours.
- Coal will be transported by sea. It is considered to be transferred by (Dimensions 22m by 265) dedicated coal jetty.
- The circulating water system will adopt Sea Water Cooling Tower of unit system. The source of the circulating cooling water will be the seawater. The temperature rise at the boundary of the drainage mixing area shall not exceed 3°C.
- The plant will have an intake used for make-up water for Cooling Towers and Water Treatment Plant. The intake shall be located at east of the coal unloading jetty. The plant drains will be drained by buried drainage pipes located at South of Main Power Building.
- Seawater desalination will be considered as the source of fresh water supply. Industrial water of power plant will adopt seawater one level reverse osmosis water. Boiler make-up water and domestic water of power plant will adopt two-level reverse osmosis water.
- The generator sets will adopt the generator-transformer unit wiring connected to the system at 220kV voltage class. The generators will be connected with main transformers via enclosed isolated phase bus. The 220kV switchgears will adopt new indoor GIS. The double bus scheme will be adopted for wiring. 2 main transformer bays, 3 outgoing bays, 1 HV standby transformer bay & 1 bus coupler bay will be provided, and 1 expandable bay space will be reserved. The dividing point with power grid will be located at the first pole of 220kV GIS outgoing lines.
- The general layout of the plant area has been considered according to the new 2×350MW supercritical coal-fired generator sets and related auxiliary facilities, with space reserved for expansion of 2 sets in the future.
- The maximum coal chimneying capacity of coal yards will meet the consumption by the boilers within the whole plant for operation of 60 days. The scheme in which 2 strip coal yards are provided will be
adopted, with 2 bucket-wheel chimneys and 3 bulldozers provided to implement the supporting work at coal yards.

- The ash storage yard of this project will be designed according to the requirement that the slag calculated by the design coal can be stored for five years. The land from coal storage yard to coastline has been considered to be selected as the planned ash yard.

- Wet Limestone/Gypsum desulfurization system has been considered for this project. The SO$_2$ emission concentration at the chimney outlet shall strictly comply with the SEQS and IFC limits.

- The in-furnace low-nitrogen combustion technology is mainly considered to be adopted for the denitrification in this project, so as to reduce the NOx discharge from the boiler outlet. After the low nitrogen combustion technology is adopted, the NOx concentration at the boiler outlet will be controlled no more than SEQS and IFC limits.

- Each boiler will be provided with 2 dual-chamber five field electrostatic precipitators for the dust emission of not more than SEQS limits at the outlet of stack.

- The boiler will be the coal fired once-through boiler with supercritical pressure and variable pressure operation, which adopts single furnace, Π (π) -shaped arrangement, balanced ventilation, dual air pre-heaters, the mode of corner tangential burning and opposed burning of front and back walls, solid slag discharge and suspension structure of full steel frame as well as medium speed mill direct-firing pulverizing system with cold primary air fan of positive pressure.

- The steam turbine is considered to be the supercritical, single-shaft, double-cylinder, double-exhaust and primary intermediate reheat condensing steam turbine, with the steam pressure and temperature before the main stop valve being at 24.2MPa and 566°C respectively and the steam temperature before the reheat stop valve being at 566°C.

- The generator will be with a rated power of 350MW, adopting the water-hydrogen-hydrogen cooling method.

- 2x50%-capacity steam-driven feedwater pumps and 1x50%- capacity motor-driven feedwater pump will be provided for the water supply system; 3 full-capacity HP heaters are provided for the HP water supply system, adopting the large bypass system as well. When any HP heater fails, the feedwater will be directly supplied to the boiler economizer by bypassing the three HP heaters through three-way bypass valve.

- The whole process polishing has been considered for condensate water. The polishing device will be “2×50% prefilter+3×50% high flow rate mixed bed and bypass ”system.

Plant components are shown in Figure 3.1.
3.2 Fuel Supply

3.2.1 Coal Quality And Consumption

Coal for the plant will be imported from Indonesia, South Africa or Australia, with expected calorific value of 20.14 MJ/kg. The ash content is expected to be 8-14%. The expected sulphur content is < 1%. The planned facility will thus have the provision to use Thar lignite once it is available in suitable quantities after
blending with higher grade coal. Main parameters of the design coal and check coal determined based on the coal quality data are as shown in Table 3.1.

<table>
<thead>
<tr>
<th>Table 3.1 - Main Parameters of Coal Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
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<td>6</td>
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<td>7</td>
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<tr>
<td>8</td>
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<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

Coal consumption of boilers in the whole plant is as follows:

<table>
<thead>
<tr>
<th>Table 3.2 - Coal Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRL</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>Hourly coal consumption (t/h)</td>
</tr>
<tr>
<td>Daily coal consumption (t/d)</td>
</tr>
<tr>
<td>Annual coal consumption (×10⁴t/a)</td>
</tr>
</tbody>
</table>

Note: 1. BRL working condition corresponds to the steam turbine’s TMCR working condition; BMCR working condition corresponds to the steam turbine’s VWO working condition. 2. The annual utility hours is counted by 7446 hours. The equivalent hours for one day is 20.4 hours.

3.2.2 Coal Transportation

Coal will be transported through sea. 50,000 DWT capacity Ship will be unloaded at project site with single berthing, Double Unloader and 12.5 m Draft Jetty. For this 1.5 km strip of Channel with average draft of 8 m will be dredged to 12.5 meters corresponding to a dredged material quantity of 1.5 million meter³. The dredged material will be dumped to reclaim the land to the east of Plant site and submerged portion of Project site (Figure 3.2).

General layout design is based on the general layout plan of power plant and shoreline water area conditions, natural conditions, berth scale, handling technology etc., which is described as below.

Build one coal unloading jetty of 50,000DWT at seaside of the plant, with the berth length of 265m Front line (apron) of jetty is located near the -6.0m contour. Front line of jetty is basically parallel to the contours. Front line of jetty is 1.094km away from the rear slope crest for. Berthing area at apron of jetty is 64.6m wide, with design water depth of -13.2m. The turning basin is in the shape of ellipse, with long axis of 522.5m, short axis of 313.5m. Design water depth of turning basin is the same as that of approach channel, which is -12.5m for navigation of 50,000DWT bulk carrier. Based on process layout and use requirement, the total width of jetty is 22m, where ship unloader adopts the rail gauge of 16m, seaside rail is 3m away from the apron of jetty, and rear side rail is 3m away from the back edge of jetty. One approach bridge is located at North side of jetty to connect with the land area of power plant, and the approach bridge is 9m wide and 1094m length. A complex building is located at rear of the jetty, for arrangement of substation and worker waiting room.

The description of the Channel from where the ship will navigate and the Jetty is located has the following layout.

Width of channel: For a new 50,000DWT coal unloading jetty, the width of channel will be 148m.

Channel Depth: The natural mud surface elevation of the area from the Port Qasim to the plant is -6.0 to -8.5m. In order to reduce the dredging quantities, the vessels can navigate to the port by taking the tide, the
tide-bound water level takes 2.0m (MSL), the design bottom elevation of channel for navigation of 50,000DWT bulk carrier takes -12.5m.

**Approach channel:** For the option of building a new 50,000DWT jetty at the seaside of power plant, the vessels can navigate to the turning basin of berth in Port Qasim by the approach channel of it, through the new channel to the apron of the proposed jetty. The maintenance depth of Port Qasim approach channel is 12.5m, the width is 150m, the width and depth can both meet the navigation requirements of design vessels. At present, the natural depth of the area from the Port Qasim to the proposed jetty is relatively small, and it is needed to build a new channel to connect to the approach channel of the Port Qasim. The Length of the new channel is about 1.5km, the width of the new channel takes 148m, and the design bottom elevation of the new channel takes -12.50m.

The total dredging quantity is expected to be around 1.5 million cubic meter.

**Dredging Requirements:** The design bottom elevation of turning basin and the new channel is -12.5m, the design bottom elevation of the berth area is -13.2m. The natural water depth of the area from Port Qasim to the propose jetty is -6.0m to -9.0m, the depth can't meet the design requirements, these areas need to be dredged. The proposal excavation slope takes 1:3. After calculation, dredged quantities is 1.5 million cubic meter. The dredging material will be utilised for reclamation of South side of the plant which includes Coal yard, Ash Yard and phase 2 of the project.

Coal requirement for the boiler will depend on the heating values of the coal and expected to reach 2.5million tons per annum. Each boiler will require continuous fuelling at a rate of 293–363tons of coal per hour which translates to an annual demand of 2.2 to 5.70million tons at 85% load factor.

**Figure 3.2 - Layout of Coal Jetty**

**Construction Characteristics**

- The quay deck and trestle all is high-pile beam-slab structure.
- According to the nature characteristic of the site, the quay deck can be constructed from water area and the trestle can be constructed from land area.
- The key control point of the project and difficulty of construction, the controlling factor of quality and duration of the project is the construction of pile foundation. Therefore, the construction company
should be equipped with precast production, lifting and installation equipment, and other construction equipment.

- As the large number of offshore works, the construction should be carefully planned, closely preparation, and good construction organization. The construction company should make practical processes, and give full utilization of construction machinery to strengthen management processes. Especially, the company should strengthen the important and the difficult engineering management, to ensure construction quality, safety and schedule.

**Construction Technology**

- *Marine Structure Construction sequence:* The quay deck construction sequence diagram is shown in 3.3, and the trestle construction sequence diagram is shown in 3.4.

- *Machine installation sequence:* Machine order → Machine installation → Test → Completion and check for acceptance

- *Building Construction sequence:* Foundation Construction → Major structure construction → Exterior wall construction → Roofing construction → Water and electricity supply installation → Decoration of indoor and outdoor → Completion and check for acceptance

---

**Fig 3.3: Quay Deck Construction Sequence**

```
| Preparation for construction                |
| Kick off                                    |
| Fabricating steel casing                    |
| Bored pile construction                     |
| Cast in site down transverse beam           |
| Precast longitudinal beam                   |
| Installation longitudinal beam              |
| Cast in site up transverse                  |
| Precast slab                                |
| Installation slab and coating               |
| Installation auxiliary facilities           |
| Installation the pipe and equipment         |
| Completion and check for acceptance         |
```
Fig 3.4: Trestle Construction Sequence

The detailed feasibility of the Jetty is attached at Annexure

3.3 Technical Specifications Of Main Equipment

3.3.1 Boiler

The boiler is a coal fired once-through boiler with supercritical pressure and variable pressure operation, which adopts single furnace, \(\prod\)-shaped arrangement, balanced ventilation, dual air pre-heaters, the mode of corner tangential burning or opposed burning of front and back walls, solid slag discharge and suspension structure of full steel frame as well as medium speed mill direct-firing pulverizing system with cold primary air fan of positive pressure.

Each boiler is provided with five layers of low NOx coal burner, and there are 20 burners in total.

The minimum DC load of the boiler shall not be more than 30\%BMCR, and the minimum load for steady combustion of the boiler without oil shall be 30\%BMCR.
Table 3.3 - Main Technical Data of the Boiler (design coal, provisional)

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>Unit</th>
<th>BRL (Match to turbine TMCR)</th>
<th>BMCR (Match to turbine VWO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Superheated steam flow</td>
<td>t/h</td>
<td>1018.4</td>
<td>1095.9</td>
</tr>
<tr>
<td>2</td>
<td>Superheated steam pressure</td>
<td>MPa(g)</td>
<td>25.36</td>
<td>25.40</td>
</tr>
<tr>
<td>3</td>
<td>Superheated steam temperature</td>
<td>ºC</td>
<td>571</td>
<td>571</td>
</tr>
<tr>
<td>4</td>
<td>Reheat steam flow</td>
<td>t/h</td>
<td>860.5</td>
<td>924.0</td>
</tr>
<tr>
<td>5</td>
<td>Inlet pressure of reheater</td>
<td>MPa(g)</td>
<td>4.25</td>
<td>4.56</td>
</tr>
<tr>
<td>6</td>
<td>Outlet pressure of reheater</td>
<td>MPa(g)</td>
<td>4.08</td>
<td>4.37</td>
</tr>
<tr>
<td>7</td>
<td>Inlet temperature of reheater</td>
<td>ºC</td>
<td>317</td>
<td>324</td>
</tr>
<tr>
<td>8</td>
<td>Outlet temperature of reheater</td>
<td>ºC</td>
<td>569</td>
<td>569</td>
</tr>
<tr>
<td>9</td>
<td>Inlet temperature of economizer</td>
<td>ºC</td>
<td>279</td>
<td>283</td>
</tr>
<tr>
<td>10</td>
<td>Temperature of primary air at inlet of the preheater</td>
<td>ºC</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>11</td>
<td>Temperature of secondary air at inlet of the preheater</td>
<td>ºC</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>12</td>
<td>Temperature of primary air at outlet of the preheater</td>
<td>ºC</td>
<td>323</td>
<td>327</td>
</tr>
<tr>
<td>13</td>
<td>Temperature of secondary air at outlet of the preheater</td>
<td>ºC</td>
<td>329</td>
<td>334</td>
</tr>
<tr>
<td>14</td>
<td>Exhaust gas temperature of the boiler (after correction)</td>
<td>ºC</td>
<td>130</td>
<td>132</td>
</tr>
<tr>
<td>15</td>
<td>Guaranteed efficiency of the boiler (LHV)</td>
<td>%</td>
<td>93.5</td>
<td>93.5</td>
</tr>
<tr>
<td>16</td>
<td>Minimum steady load of the boiler</td>
<td>%</td>
<td>No more than 30%</td>
<td>No more than 30%</td>
</tr>
<tr>
<td>17</td>
<td>Guaranteed air leakage rate of the air preheater</td>
<td>%</td>
<td>BMCR</td>
<td>≤6</td>
</tr>
</tbody>
</table>

3.3.2 Steam Turbine

Type: supercritical, single-shaft, double-cylinder, double-exhaust and primary intermediate reheat condensing steam turbine.

Model: N350-24.2/566/566

The main thermodynamic parameters of the steam turbine are listed as follows:

Table 3.4 - Thermodynamic parameters of the steam turbine

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Unit</th>
<th>TMCR</th>
<th>VWO</th>
<th>TRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rated power</td>
<td>MW</td>
<td>350</td>
<td>372.795</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>Pressure of main steam</td>
<td>MPa(a)</td>
<td>24.2</td>
<td>24.2</td>
<td>24.2</td>
</tr>
<tr>
<td>3</td>
<td>Temperature of main steam</td>
<td>ºC</td>
<td>566</td>
<td>566</td>
<td>566</td>
</tr>
<tr>
<td>4</td>
<td>Flow of main steam</td>
<td>t/h</td>
<td>1018.4</td>
<td>1095.9</td>
<td>1043.7</td>
</tr>
<tr>
<td>5</td>
<td>Temperature of reheat steam</td>
<td>ºC</td>
<td>566</td>
<td>566</td>
<td>566</td>
</tr>
<tr>
<td>6</td>
<td>Flow of reheat steam</td>
<td>t/h</td>
<td>860.5</td>
<td>924.0</td>
<td>879.0</td>
</tr>
<tr>
<td>7</td>
<td>Exhaust pressure of HP cylinder</td>
<td>MPa</td>
<td>4.442</td>
<td>4.759</td>
<td>4.530</td>
</tr>
<tr>
<td>8</td>
<td>Exhaust temperature of HP cylinder</td>
<td>ºC</td>
<td>318.0</td>
<td>324.8</td>
<td>319.8</td>
</tr>
<tr>
<td>9</td>
<td>Rated back pressure</td>
<td>kPa(a)</td>
<td>6.70</td>
<td>6.70</td>
<td>9.20</td>
</tr>
<tr>
<td>10</td>
<td>LP exhaust flow</td>
<td>t/h</td>
<td>594.4</td>
<td>630.0</td>
<td>604.5</td>
</tr>
<tr>
<td>11</td>
<td>Water supply temperature</td>
<td>ºC</td>
<td>279.0</td>
<td>283.8</td>
<td>280.4</td>
</tr>
<tr>
<td>12</td>
<td>Extraction stage</td>
<td>Stage</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>13</td>
<td>Makeup water rate</td>
<td>%</td>
<td>0</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>14</td>
<td>Heat consumption rate</td>
<td>kJ/kW.h</td>
<td>7783.2</td>
<td>7761.5</td>
<td>7887.6</td>
</tr>
</tbody>
</table>

3.3.3 Generator

The parameters of the generator are listed as follows:

Rated capacity: 412MVA

Rated power: 350MW

Rated voltage: 20kV (provisional) Rated power factor: 0.85 (lag) Frequency: 50Hz
Rated rotation speed: 3000r/min

Efficiency: 98.9%

Excitation system: self-excited static excitation system

Cooling method: water-hydrogen-hydrogen

3.3.4 Thermo-Economic Indexes

Theoretical thermo-economic indexes for the rated conditions of this project are shown as follows:

<table>
<thead>
<tr>
<th>S.#</th>
<th>Item</th>
<th>Unit</th>
<th>Design Coal TMCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Unit gross power output at generator terminals</td>
<td>MW</td>
<td>2×350</td>
</tr>
<tr>
<td>2.</td>
<td>Coal consumption</td>
<td>t/h</td>
<td>2×146.86</td>
</tr>
<tr>
<td>3.</td>
<td>Gross standard coal consumption rate</td>
<td>g/kWh</td>
<td>288.7</td>
</tr>
<tr>
<td>4.</td>
<td>Gross efficiency</td>
<td>%</td>
<td>42.6</td>
</tr>
<tr>
<td>5.</td>
<td>Auxiliary electrical consumption rate</td>
<td>%</td>
<td>7.6</td>
</tr>
<tr>
<td>6.</td>
<td>Net standard coal consumption rate</td>
<td>g/kWh</td>
<td>312.5</td>
</tr>
<tr>
<td>7.</td>
<td>Net efficiency</td>
<td>%</td>
<td>39.3</td>
</tr>
</tbody>
</table>

3.4 Thermodynamic System

3.4.1 Thermodynamic System Configuration

All thermodynamic systems of this Project, except the auxiliary steam system which is designed as a header system, are unit systems.

Main steam, reheat steam and steam turbine bypass systems: The main steam and hot reheat steam systems are both unit systems. They are configured in the way of 2-1-2. Main steam pipe and hot reheat steam pipe are led out from both sides of the header of superheater and reheater respectively, and incorporated into one before being led to the steam turbine, where the incorporated pipe is divided into two branches connected to the main steam shutoff valve and reheat steam shutoff valve at the left and right sides of the HP cylinder and MP cylinder respectively. In this way, the steam temperature and pressure deviation resulted from the thermal deviation at both sides of the boiler and from the difference in pipeline layout can be reduced; besides, it will facilitate the safe operation of the generating set and the selection of proper pipeline specifications, so as to save the pipeline investment.

Cold reheat steam pipe, being a single pipe, is led out from the steam outlet of steam turbine’s HP cylinder and divided into two branches at boiler which are respectively connected to the two connections of boiler reheater’s inlet header.

The throttle valve of steam turbine has a good tightness, and the isolating valve is not mounted in front of the main throttle valve, so as to reduce the pressure drop of the main steam system and improve the economic efficiency. The warming, running and acceleration of the steam turbine are all controlled by the main steam regulating valve. The main steam pipeline is not mounted with the flow measuring device, and the main steam flow is calculated by measuring the pressure behind the regulating stage of the high-pressure steam turbine.

In addition to supplying steam to No. 2 HP heater for heating, the cold reheat steam system also provides steam source for gland seal system, auxiliary steam system and feedwater pump turbine. The exhaust main pipe of HP cylinder is provided with power controlled check valve, so as to cut off the steam in case of an accident and consequently avoid the turbine over speed caused by the return of steam into the turbine.
Proper drain points and corresponding pneumatic drain valves are considered in main steam pipe, and hot and cold reheat steam pipes (cold reheat steam pipe is additionally provided with drain pot) to ensure that condensate can be promptly and completely drained out from the pipes under the conditions of start-up warming, low load or fault of the unit, and prevent water intrusion into steam turbine.

The material of main steam and high-temperature reheated steam pipes shall be temporarily the ASTM A335P91, and the material of low-temperature reheated steam pipe shall be temporarily the ASTM A672B70CL32.

In order to meet the requirements for peak regulation operation of the unit and improve the start-up performance of the unit, the two-stage series steam turbine bypass system is connected the main steam and reheat steam pipes. The capacity of the bypass system is determined at 40% of boiler maximum continuous rating.

HP bypass is connected from main steam pipe, and depressurized and attemperated prior to being connected to the cold reheat steam pipe. Attemperating water is supplied by the water supply system at the outlet of feedwater pump. LP bypass is connected from hot reheat steam pipe, and depressurized and attemperated prior to being connected to the condenser. Attemperating water is supplied by the condensate system at the outlet of condensate polisher.

The high and low-pressure in-series dual-stage bypass system is set to speed up the start-up and shutdown of the generating set, coordinate the steam balance between the turbine and the boiler, recover the condensed water, reduce the circulating steam-water loss of the generating set, and facilitate the flexible operation of the system.

One loop of cold reheat steam is connected to be used as the standby HP steam source of feedwater pump turbine, supplying steam to feedwater pump turbine during start-up and low-load operation. The cold reheated steam is taken as the standby steam source of feedwater pump turbine to facilitate the fast start-up and smooth running of the feed-water pump turbine.

The spring safety valves are mounted respectively on the main steam pipeline for outlet of the boiler superheater, so as to provide the overpressure protection for the superheater. The main steam pipeline for the outlet of the superheater is also mounted with the electromagnetic relief valve as an additional measure for overpressure protection of the superheater, with the purpose of avoiding frequent operation of the spring safety valve and consequently reducing the maintenance workload of the spring safety valve. Thus, the setting value of the electromagnetic relief valve shall be lower than the operating pressure of the spring safety valve, and the operator can carry out the operation in the control room.

Spring safety valves are mounted respectively on the steam pipelines for the inlet and outlet of the reheater for the overpressure protection of low-temperature reheat steam pipeline, reheater, and high-temperature reheat steam pipeline.

**Steam extraction system:** The unit has 8 non-regulated extraction stages. The first, second and third extraction stages supply steam to three HP heaters respectively. The fourth extraction stage supplies steam to feedwater pump turbine, deaerator and auxiliary steam system. The fifth, sixth, seventh and eighth extraction stages supply steam to four LP heaters.

The first, third and fourth-stage steam extraction pipelines are close to the extraction opening, and the second-stage steam extraction pipeline is close to the low-temperature reheat steam pipeline; each pipeline is mounted with an emergency shut-off motorized isolating valve and a pneumatic non-return valve; the pneumatic non-return valve is mounted in front of the motorized isolating valve. The motorized isolating valve is taken as the primary protection of preventing water from entering the steam turbine, and the
pneumatic non-return valve is taken as the over speed protection of steam turbine and is concurrently taken as the secondary protection of preventing water from entering the steam turbine.

Mount two in-series pneumatic non-return valves and one motorized isolating valve on the fourth-stage steam extraction manifold close to the extraction opening of the steam turbine. The two non-return valves are mounted because the fourth-stage steam extraction is connected with many devices, and each of these devices has the high-pressure steam source (for example, the feed-water pump turbine is connected with the second-stage extraction steam source, etc.). During start-up, low-load operation, load shedding or shutdown of the generating set, the steam of any other steam source may enter the fourth-stage steam extraction pipeline and consequently cause the danger of turbine over speed. The two in-series pneumatic non-return valves mounted can play a role of dual protection.

The pipeline from the fourth-stage steam extraction to the deaerator is mounted with a motorized isolating valve and a non-return valve, to prevent the water from entering the steam turbine through the steam extraction pipeline when the deaerator is filled with water.

The start-up heating steam from auxiliary steam system is also available in the heating steam pipe to deaerator.

The fourth extraction header is connected to the L.P steam pipe of feedwater pump turbine, from which the steam will be delivered through flow measuring nozzle to feedwater pump turbine. The pipeline is mounted with a motorized isolating valve and a non-return valve. The non-return valve is mounted to prevent the high-pressure steam from entering the steam extraction system when switching the high-pressure steam source and also to prevent the auxiliary steam from entering the steam extraction system. The cold reheat steam is used as standby steam source of feedwater pump turbine.

The steam drain of the feed-water pump turbine is vertically downward, and a horizontal pressure balanced expansion joint is set on the steam discharge pipe. A film-type pressure relief valve is set on the steam discharge pipe to protect the feed-water pump turbine and the steam discharge pipe. An electric butterfly valve is also mounted on the steam discharge pipe close to the connector of the condenser, so as to facilitate the maintenance of the feed-water pump turbine.

The fifth-stage and sixth-stage extraction openings of turbine are in the condenser. Thus, the fifth and sixth extraction pipes pass through the condenser. The motorized isolating valve and the non-return valve on the steam extraction pipeline are mounted close to the condenser.

The seventh-stage and eighth-stage LP heaters are mounted at the throat of condenser. The two seventh-stage and four eighth-stage extraction pipes are arranged inside the condenser. The seventh and eighth steam extraction pipelines are to be designed and supplied by the condenser manufacturer.

**Water supply system:** The water supply system is provided with 2 x 50%-capacity steam-driven feedwater pumps, 1 x 50%-capacity motor-driven feedwater pump (common for two units). During normal operation, LP feedwater will be supplied from deaerator feedwater tank to the inlet of boiler economizer through the booster pump of steam-driven feedwater pump, steam-driven feedwater pump, No. 3 HP heater, No. 2 HP heater and No. 1 HP heater.

An electric gate valve and a primary strainer are set on the water inlet pipeline of the booster pump according to the water flow direction. The non-return valve and electric gate valve are mounted in sequence on the outlet pipeline of the feed-water pump, and the minimum flow recirculating water pipes are led out in front of the non-return valve and are separately connected to the deaerator feed-water tank.

During the initial operation or the preliminary-stage operation after overhaul of the generating set, the primary strainer is to protect the water pump and prevent the foreign matters, which may accumulate in
the feed-water tank of deaerator and the water inlet pipeline during installation or overhaul, from entering the water pump. After operation for a certain period of time, the strainer shall be cleaned or can be removed to reduce the resistance of the water inlet pipeline.

The steam feed pump within the system is driven by the feed-water pump turbine; the inlet pipeline is mounted with a fine strainer with a function same as that of the primary strainer of the booster pump; however, when the pressure difference is large due to blockage of fine strainer after operation for a certain period of time, the pump shall be shut down for cleaning.

The outlet pipe of steam-driven feedwater pump is connected to HP heater. HP bypass attemperating water pipe of turbine is led out of the feedwater pipe before No. 3 HP heater.

Attemperating water pipe of boiler reheater is led out from the centre tap of steam-driven feedwater pump.

HP water supply system is provided with three full-capacity HP heaters and adopts large bypass system. In this way, the number of high-pressure valves can be reduced, the system and layout can be simplified, and the investment can be saved. As the accident rate of high-pressure heater directly affects the economic efficiency of the power plant operation, it is required for this project to adopt the high-pressure heater produced by a manufacturer with mature experience, so as to maximize its operational reliability. When any of the HP heaters fails, feedwater will be directly supplied to boiler economizer by bypassing the three HP heaters through three-way bypass valve.

The electric emergency cut-off valve (being turned off after the feed-water three-way bypass valve is turned on), feed-water flow measuring device, electric gate valve, and non-return valve are mounted in sequence on the pipeline from the outlet of No.1 high-pressure heater to the inlet of the economizer. As the steam feed pump driven turbine has a reliable regulating performance, the inlet pipeline of economizer is not mounted with the large-flow feed-water regulating valve.

Condensate system: Condensate is led out through a header from condenser heat sink, and then delivered to two full-capacity condensate pumps (one for operation and one as standby) in two branches. Then, the two branches are incorporated into one and supplied to deaerator through MP condensate polisher, gland seal cooler and four LP heaters.

The inlet pipeline of condensate water pump is mounted with the electric gate valve, strainer and wave-form expansion joint, and the outlet pipeline of the pump is mounted with a non-return valve and an electric gate valve. A pressure relief valve is mounted behind the suction pipe valve of each pump, so as to avoid the overpressure of the pump suction pipe due to the pressure water flowing into the standby pump during operation.

Condensate, after flowing through condensate polisher, is delivered to gland seal cooler. Gland seal cooler is a surface heat exchanger used to condense the steam that leaks from gland seal and LP valve lever. The gland steam condenser maintains its micro-vacuum status through the axial-sealing blower fan, to prevent the steam from leaking into the atmosphere and the steam turbine lubricating oil system. To maintain above-mentioned vacuum, sufficient condensed water is also required to flow through the gland heater to condense the above-mentioned leaked steam.

Condensate system is provided with the minimum flow recirculating pipeline. Condensate from gland seal cooler outlet passes through the minimum flow recirculation valve and flows back to condenser, so as to ensure the minimum flow of the condensate water pump during start-up and low-load period, avoid cavitation of condensate water pump, and guarantee sufficient condensed water to cool the gland steam condenser during start-up and low-load period.
Condensate heating and deaerating system consists of four full-capacity surface type LP heaters and one deaerator. No. 5 and No. 6

LP heaters are of horizontal structure, and the condensate adopts gear-driven isolating valve type small bypass system. No. 7 and No. 8

LP heaters are of integrated horizontal structure. The #7 and #8 low-pressure heater bypass system is adopted. When any one of the heaters has the high-high water level, the electric bypass valve is turned on automatically, and the electric gate valves for the inlet and outlet are turned off automatically. The condensed water inlet pipeline of the deaerator is mounted with a non-return valve to prevent the steam in the deaerator from flowing into the condensed water system.

The condensate water pipeline for the outlet of gland heater is mounted with a regulating valve to control the water level in the water tank of deaerator. An condensate water outlet pipeline is connected from the #5 low-pressure heater to the circulating water discharge pipeline so as to discharge the unqualified condensate water during cold-state cleaning.

**Drain system of heater:** The three HP heaters will normally be drained in cascades to deaerator ultimately. During the start-up and shutdown or under any emergency condition, they will be drained through emergency drain valve to HP drain flash tank and condenser. Overflow from deaerator will be drained to condenser. The four LP heaters will normally be drained in cascades to condenser, and in abnormal condition or emergency condition, they will be drained through emergency drain valve to condenser.

The above-mentioned normal drainage and emergency drainage pipelines as well as deflation and nitrogenization of equipment are all included in the system design scope.

In normal operation, HP heater will be drained from No.1 HP heater to No.2 HP heater, from No.2 HP heater to No.3 HP heater, and then from No.3 HP heater to deaerator. Each drain pipe is provided with a drain regulating valve for the purpose of controlling normal water level at the steam side of HP heater. An isolating valve is mounted in front of and behind each regulating valve. When the normal drainage regulating valve needs to be isolated for maintenance due to any fault, the drained water is discharged through the high-pressure heater emergency drainage regulating valve to the high-pressure emergency drainage flash tank and into the condenser.

When a high-pressure heater pipe is broken or the pipe-plate weld joint has leakage during operation and the feed-water enters the steam side, or when the high-pressure drainage regulating valve is emrgently turned off due to the high water level in the water tank of the next-stage high-pressure heater or deaerator, which results in rising of water level at the high-pressure heater steam side, it is required to turn on the high-pressure heater emergency drainage valve and discharge the water into the condenser after pressure relief of the high-pressure heater emergency drainage flash tank. Considering the low drainage pressure due to the random start-up adopted for most high-pressure heaters of the large generating set, the drainage water can be discharged into the condenser through the emergency drainage valve during start-up.

In normal operation, LP heater will be drained from No.5 LP heater to No.6 LP heater, from No.6 LP heater to No.7 LP heater, and then from No.7 LP heater to No.8 LP heater and finally to condenser. Each drain pipeline is provided with drain regulating valve and isolating valve. The operating mode of emergency drainage is the same as that of high-pressure heater; however, it can be discharged directly into the condenser.

**Auxiliary steam system:** The plant-area auxiliary steam system is to provide steam that meets the parameter requirements in the conditions of start-up, shutdown, normal operation, load shedding, etc. of the generating set. The flow and parameters of the steam to be provided by the system are related to capacity of generating set, structural characteristics of equipment, fuel type, start-up and operation modes, etc.
An auxiliary steam header is provided for this Project. The header is mounted with the safety valve, of which the operating parameters are 0.588 ~ 0.98 MPa, 316 ~ 330℃. The header is mainly used to supply steam to the auxiliary steam consumers of this unit. When the unit is started, steam obtained by start-up boiler will be used as the auxiliary steam source. When the load of the unit increases to around ~ 15%, steam will be supplied to auxiliary steam header from the cold leg reheat steam instead of steam obtained by start-up boiler. When the load of the unit increases to around ~ 80%, the steam source will be changed to the fourth extraction stage of this unit. During the normal operation of the unit, the fourth extraction stage of the unit will supply steam to steam consumers through auxiliary steam header.

The drainage water of the auxiliary steam system is completely discharged into the drainage flash tank of the auxiliary steam system; the 1.5m³ drainage flash tank is arranged on the 6.3m layer, and the drainage flash tank has two water outlet routes; qualified water is discharged into condenser for recovering the working medium, and the unqualified water is discharged into the periodic sewage flash tank.

Closed cycle cooling water system: Closed cycle cooling water system will supply cooling water to auxiliary equipment in boiler house and turbine house, and will cool, pressurize, transport and regulate return water. Closed cycle cooling water system consists of two 100%-capacity closed cycle cooling water pumps, two 100%-capacity closed cycle cooling water-water heat exchange equipments, and one highly positioned expansion tank. The main and branch water supply and return pipes, cut-off valve, regulating valve, etc. of each auxiliary equipment consist of the closed circulating loop. One cooling water pump shall be used for operation, and one cooling water pump shall be used as standby. For most of the time, the operation of a closed circulating water – water heat exchanger can meet the requirements on cooling water for the whole system, and just for a little time, two closed circulating water – water heat exchangers are needed for simultaneous operation.

The make-up water of the closed cycle cooling water system is connected from the condensate water fine treatment device; prior to start-up, the make-up water comes from the chemical make-up water.

With the volume of is 20m³, the expansion tank is mounted at deaeration layer. As a closed cycle cooling water buffer tank, the expansion tank is used to regulate any flow fluctuation and absorb thermal expansion of water in the system. The normal water level of expansion tank is just maintained at one second of the capacity of the water tank, so as to allow certain expansion space. Its water level is controlled by the water level controller and the flow regulating valve on the make-up water pipeline. Besides, when the auxiliary power is cut off, the cooling water in the expansion tank can be used as the cooling water necessary for boiler water sampling cooler, the instrument air compressor and other equipment, so as to ensure the safe shutdown of the generating set.

The cooling water inlet and outlet pipelines for each auxiliary equipment are mounted with cut-off valves. The cut-off valve on the outlet pipeline can be used for coarse adjustment of the cooling water flow and for one-off adjustment of each auxiliary equipment's cooling water flow during the initial operation, so as to adjust the flow distribution of each water consumer in the closed cycle cooling water system. Besides, the water outlet pipelines of some important auxiliary equipment are also mounted with the flow regulating valve to control the temperature of cooled media such as oil, water and air of each equipment.

Plant cooling water systems: One nature draft counter flow cooling tower will be adopted for one unit in the project and the preliminary design parameter of cooling tower is as follows:

- Drenching area: around 7500m²
- Height: 120m
- Diameter at EL0.0m: 104.5m
3.4.2 Coal Pulverizing System

Medium-speed coal pulverizer with positive-pressure direct-firing pulverizing system is proposed for this project. Each unit adopts 5 raw coal hopper equipped with 5 coal feeders and 5 medium-speed coal pulverizers. The lower cones of the steel coal hoppers are lined with stainless steel plates. The coal storage capacity of four coal hoppers (excluding one standby coal hopper) is sufficient for 8-hour at BMCR load of the boiler with design coal. Each coal hopper is provided with one electronic weighing type coal feeder and one medium-speed coal pulverizer.

5 medium-speed coal pulverizers and 5 coal feeders, according to the total output obtained by 4 coal pulverizers milling the design coal, can meet the demand for boiler maximum continuous output and 10% allowance is reserved; according to the total output obtained by 5 coal pulverizers milling the check coal, can meet the demand for boiler maximum continuous output. The output of coal feeders is selected as 110% of coal pulverizer's maximum design output.

2 adjustable moving-blade axial-flow cold primary air fans with 50% capacity are used to inhale cold air from atmosphere directly. Electronic weighing type belt coal feeder shall be used. Its output shall be sufficient for continuous coal feeding to maintain boiler load or mill output. In addition, it shall have bearing capacity over pressure and good tightness.

3.4.3 Flue Gas And Air System

Flue gas and air system of boiler is of balanced ventilation. It satisfies the air input and flue gas emission requirement of boiler firing design coal from start-up to reaching BMCR. In addition, it is also can be used for check coal firing. 2 adjustable moving-blade axial-flow forced draft fans with 50% capacity are used. Prior to be induced into air preheater, cold secondary air will be heated through hot air recirculation to prevent the cold section of air preheater from being corroded. Each boiler shall be provided with 2 trisector regenerative air preheaters with 50% capacity.

2 adjustable moving-blade axial-flow induced draft fans with 50% capacity and 2 five-field electrostatic precipitators with dust collection efficiency of 99.62% shall be used. In addition, each unit is also provided with fire detection cooling air system & sealing air system respectively.

3.4.4 Coal Handling System

The coal handling system covers the design, construction, installation and commissioning of coal handling system in dock and bridge approach and coal handling system within the power plant. The relevant works include civil, electrical, HVAC and fire protection systems. The coal unloading system within the plant has been is designed based on the information about coal unloading system in the dock (TBD). The design of coal unloading system within the plant matches that of the coal unloading system in the dock.

In accordance with the general arrangement plan, two strip-shape coal yards will be built for the project. The design pile height of the coal yards is 13-14m. One set of bucket wheel stacker reclaimer with an arm length of 38m is installed in each coal yard. Its rated stacking capacity and reclaiming capacity are 2000t/h and 600t/h, respectively. The maximum storage capacity of the coal yard is about 520 thousand tons, which meets coal demand of 2 x 350MW units running for 2 months.

Dust-retaining walls and routes for coal yard machineries such as coal pushers are provided around the coal yards. Three sets of crawler type coal pushers are provided as stacking, compacting and shaping machineries in the coal yard. Double circuits of belt conveyors for feeding coal is designed based on parameters B=1000mm, V=2.5m/s and Q=600t/h. The calculation shows that the output of the belt conveyors meet the operation requirements of 2x350MW units.
Electric drive ploughs are used in the coal bunker for coal blending. The rated capacity of roller screen and coal crushers provided is 600t/h and 400t/h, respectively. In order to protect equipment and coal mills in the system, three sets of iron removers are arranged in the transfer stations before the coal yards and upstream and downstream of the coal crushers. The iron removers are controlled by programs. When coals pass through the iron removers, metallic parts are separated from coal. Belt weighers are arranged in the middle of belt conveyors before coal yards and coal bunkers to meter the quantity of coal fed to the plant and boiler. The belt weighers adopt dynamic cyclic checking. In order to ensure safe boiler operation, the system is equipped with intermediate coal samplers to take and prepare samples for coal fed to the plant and boiler. To facilitate equipment maintenance, single-beam electric cranes, electric blocks and chain blocks are provided in all transfer stations, coal crusher rooms and coal bunkers. Other maintenance facilities are considered for the entire plant. Auxiliary buildings such as coal pusher garages and slurry ponds have been provided for the project. PLC program control is used for the project.

Dust collection and water spray facilities are provided in the coal unloading station and coal transfer stations and water spray facilities are provided on the stacker reclaimers in the coal yards. All transfer stations, coal crusher room, coal bunkers and galleries are cleaned with water. To avoid secondary pollution caused by water flushing, sewage is collected into the settling pond in the coal yard. After treated by sewage treating equipment, coal slurries are recycled. Treated water is also recycled.

In order to protect operator safety, guard rails are provided on both sides of belt conveyors, all rotating parts are equipped with guards and moving equipment are equipped with audible and visual alarms.

### 3.4.5 Ash & Slag Handling System

The amount of ash and slag is shown in the following table:

<table>
<thead>
<tr>
<th>Table 3.6 - The amount of ash and slag production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Coal consumption</td>
</tr>
<tr>
<td>Design coal type</td>
</tr>
<tr>
<td>Check coal type</td>
</tr>
<tr>
<td>Ash, slag quantity</td>
</tr>
<tr>
<td>Design coal type</td>
</tr>
<tr>
<td>Check coal type</td>
</tr>
<tr>
<td>Fly ash</td>
</tr>
<tr>
<td>Design coal type</td>
</tr>
<tr>
<td>Check coal type</td>
</tr>
<tr>
<td>Slag</td>
</tr>
<tr>
<td>Design coal type</td>
</tr>
<tr>
<td>Check coal type</td>
</tr>
</tbody>
</table>

An ash storage yard will be set up just adjacent to the plant site and is able to store the amount of ash and slag produced by two boilers running for 3 years under B-MCR conditions.

The **ash handling system** is designed in such way that ash is handled separately from slag.

The ash handling system consists of three parts, ash handling, storage and discharge parts. Ash is handled by a positive pressure pneumatic conveying system. The system collect ash from economizers and electrostatic precipitators, conveys ash to dry ash silo in the plant. Then, dry ash discharger discharges dry ash into ash tank cars for comprehensive utilization, alternatively, ash is wet with water by a wetting mixer, loaded and transported to ash storage yards.

Flying ash from economizers and electrostatic precipitators is conveyed by a positive pressure dense-phase pneumatic transport system. One transport system is provided for each boiler. The design system capacity has an allowance of at least 50 percent of ash discharge under boiler B-MCR condition when the design coal is fired, and has an allowance of 20 percent of ash discharge when the check coal is fired. The capacity of the ash handling system for each boiler is preliminarily determined as 35t/h. The ash handling system runs continuously and conveys ash from ash hoppers of electrostatic precipitators and economizers to the
dry ash silo. The tsm automatically run under the program control. Two ash pipes are provided for each boiler.

Two dry ash silos of steel structure are provided within the power plant. Each ash silo has an effective volume of 1000m$^3$ and two silos are able to store ash produced by 2 boilers which fire design coal for about 73 hr and fire the check coal for about 30hr. One set of dry ash discharge device and one set of double-shaft mixer are provided under each ash silo so as to load dry or wet ash. The capacity of each dry ash discharge device and each double-shaft mixer is 100t/h.

A hot air system is provided at the bottom of electrostatic precipitator ash hopper and dry ash silo. The electrostatic precipitator ash hopper of each boiler is equipped with one gasification fan and one electric heater. One additional gasification fan is provided for two boiler as common standby one. Three gasification fans and two electric heaters are provided for two ash silos.

**The boiler slag system** for 1x350MW generating set forms one unit. The slag is continuously conveyed from the boiler bottom to the slag silo through air-cooled slag dryer, and then discharged into dump trucks by dry discharge devices for comprehensive utilization.

One set of air-cooled dry slag discharge device is provided for each boiler. The preliminary normal capacity and maximum capacity of the dry slag discharge device are 2-4t/h and 15t/h, respectively as determined according to the coal quality provided by the owner. The slag discharge device is driven by a VFD. A slag discharge device at boiler bottom is provided upstream of the dry slag discharge device to break large slag. One set of 20t/h slag crusher is provided at the outlet of the dry slag discharge device. After being crushed, cooled slag is discharged to the slag silo.

One dry slag silo made of steel is provided for each boiler, has an effective volume of 100m$^3$ and is able to store slag produced by 1 boiler which fire design coal for about 77 hr and fire the check coal for about 32hr. One set of dry discharge device and one set of double-shaft mixer are provided at the bottom of the slag silo and used for directly loading dry slag or wetting and then transporting slag to the slag yard. The capacity of the dry slag discharge device and double-shaft mixer is 100t/h.

**Pebble coal** is periodically handled by a pebble coal collection car and transferred to a temporary storage yard in ash storage yards by a battery fork lift truck. Five coal pulverizers, including 4 operating ones and 1 standby one, are provided for each boiler. The pebble coal hopper of each coal pulverizer has a volume of 0.5m$^3$ and is able to store the amount of pebble coals produced for 5h. Atomization nozzles are mounted at the top of pebble coal hoppers. Before pebble coal is discharged, operators manually open water spray devices to minimize dust generation during pebble coal discharge and transportation. The duty of the pebble coal handling system is determined according to actual situations.

A **central air compressor station system** is used for the project to supply compressed air to instrument air systems, plant air system, maintenance and pneumatic conveying systems. Six sets of screw air compressors (volume flow: 32Nm$^3$/min, discharge pressure: 0.85MPa) including 4 operating ones and 2 standby ones are provided for the whole plant. The discharge ports of air compressors adopts main system connections. The number and parameters of air compressors for the project will be finalized according to the final air consumption by the ash handling system. Three sets of combination dryers (including 2 operating ones and 1 standby one) and three sets of refrigerant air driers (including 2 operating ones and 1 standby one) are provided as compressed air post handlers for instrument air and pneumatic ash handling systems.

**Slag & dry ash** are transported by truck for comprehensive utilization or wet with water and transported to the ash storage yard. Only ash and slag transport trucks are considered for the project. Transport trucks for comprehensive utilization is settled by the users compressively utilizing ash and slag.
3.4.6 Flue Gas Desulfurization And Denitrification

Flue gas desulfurization: According to the local environmental protection requirements and the actual situation of the project, the desulfurization device will be considered necessary for this project.

The design coal for the project contains 0.5% sulfur content. According to the requirement for SO₂ emission limit of 350mg/Nm³ (6%O₂) at chimney outlet and based on the calculation, it is required to ensure that the desulfurization efficiency is above 82%, and the desulfurization efficiency obtained by the seawater desulfurization method and limestone-gypsum wet desulfurization method can be up to above 82%, meeting the design requirements for the project.

Flue gas denitrification: According to the local environmental protection requirements, the in-furnace low-nitrogen combustion technology is mainly considered for denitrification in this project, so as to reduce the NOx discharge from the boiler outlet. The low-nitrogen combustion technology is to control, by various technological means, the amount of NOx generated during combustion, which is often called "low-NOx combustion technology". From the perspective of technology and economy, the low-NOx combustion technology is currently the widely used method to control the NOx discharge from coal-fired boiler.

The NOx control during combustion is to control the NOx generation and discharge during combustion based on the NOx generation mechanism during combustion and by improving the combustion technology, of which the major methods include: 1) reduce the oxygen concentration around the fuel, including reducing the excess air number in the small furnace, so as to reduce the total air amount in the furnace; reduce the mixing of primary air flow and fuel of unburned volatiles with the secondary air flow, so as to reduce the oxygen concentration at the burning section; 2) maintain sufficient standing time under the condition of low oxygen concentration to restrain NOx generation due to nitrogen in the fuel; meanwhile, the generated NOx is restored and decomposed; 3) reduce the burning temperature under the condition of excess air, so as to reduce the generation of thermal NOx. After adopting the low-nitrogen combustion technology, the NOx concentration at the boiler outlet shall meet SEQS limits.

3.4.7 Chemical Water Treatment System

Industrial water required for the project is obtained through sea water desalination. Industrial water for the power plant is supplied from Class 1 RO system and boiler makeup water and domestic water is supplied from Class 2 RO system. The capacity of Class 1 RO system is 3x140t/h and the one of Class 2 RO system is 2x80t/h (TBD).

The process flow of the SWRO pre-desalinization system is as follows: Raw sea water pond → Sea water booster pump → Seawater pre-treatment → Clean seawater pond → Booster pump → Sea water desalination part → Industrial clean water pond.

The circulating cooling water of the power plant may be used as water source for seawater desalination. The sea water desalination part for the project adopts the following process flow: Pre-treated sea water → Self-flushed cartridge filter → Ultra filter → Ultrafilited water tank → Ultrafilited water pump → 5µ cartridge filter → Class 1 seawater film HP pump group → Class 1 seawater RO unit → Class 1 fresh water tank → Class 2 fresh water HP pump → Class 2 fresh water RO unit → Pre-desalinated water tank.

The boiler make-up water for the project is pre-desalinated water (upstream of Class 2 RO). The boiler make-up water treatment system adopts Class 1 desalination plus mixed bed process. The system process flow is as follows: Pre-desalinated water pump → Cation exchanger → Anion exchanger → Mixed bed exchanger → Demineralized water tank → Demineralized water pump → to condensate tank in the main building.
Two water treating plants (including one operating plant and one standby plant) are provided and each water treating plant has a capacity of 60 t/h. This can meet makeup water quality requirements of the boiler.

The **chemical water treatment system** is designed as oxygenation treatment. Full-flow condensate polishing is considered. Considering the factors such as result of iron removal and silicon cleaning and desalination, differential pressure and operation load of the condensate polishing system, the polishing device designed for the project is "2x50% pre-filter + 3x50% high-speed mixed bed and bypass" systems. One set of external regenerative device is common to two generating sets.

The principal process flow is as follows: Condensate from the main condensate pump → Pre-filter → High-speed mixed bed for external regeneration device → thermodynamic system.

Two mixed beds operate and one mixed bed is as standby one. High tower separation process is used for external regeneration.

**Polished condensate & feedwater** are subject to ammonification treatment and oxidization treatment. The ammonification and oxidization points are located in polishing water outlet mains and downcomer.

In order to inhibit corrosion and fouling of closed circulating cooling water systems, ammonia is dosed into cooling water. The chemical dosing system is designed as a system which has common solution tank, separate dosing pumps and common standby pumps.

This Project shall adopt the system of production of sodium hypochlorite by electrolysis of concentrated seawater generated by reverse osmosis seawater desalination to control the breeding of microorganisms in the condenser and prevent the occurrence of pollution, clogging and corrosion to the cooling equipment.

The system of production of sodium hypochlorite by electrolysis of concentrated seawater consists of the concentrated seawater lift pump, sodium hypochlorite generator, sodium hypochlorite storage tank, hydrogen diffuser, pickling unit, rectifier transformer and rectifier cabinet, etc. The system is planned to be provided with 2×60kg/h sodium hypochlorite generators and 2×50m³ storage tanks.

Three x sets of 1000m³ waste water basin is provided for the project. The main treatment methods used are flocculation, settlement, clarification, final neutralization and the design system capacity is 60t/h.

The remaining water for flushing conveyor gallery, ash silos and rainwater from coal yards are settled in the settling pond and lifted to high-efficiency water cleaner by a self-priming pump. The water is subject to settlement, flocculation, centrifugal separation and filtration and then discharged to the Clear water pond from the top of water cleaner. Finally, the water is pumped to the recycled water pond. The slurry is discharged by gravity flow from the bottom of high-efficiency water cleaner to the front end of slurry pond. The system capacity is 2x20m³/h.

Oily water may be produced during maintenance in condenser floor. One set of Q = 1 m³/h mobile oil separator is provided.

### 3.4.8 Water Supply And Drainage System And Cooling Facilities

1. **Circulating cooling water system**

For Main Condenser cooling of the steam turbine closed loop sea water based Hyperbolic Cooling Tower shall be installed which will also fulfill Auxiliary cooling requirements of the plant. The source of the cooling water is seawater that enters the plant via intake arrangement as shown in Figure 3.2 i.e. water intake will be from the east of the coal unloading jetty and discharged via pipes South of Main Power Building. The circulating water intake structure is tentatively considered to set in the sea area at the east of the coal unloading jetty outside the plant and nearby the isobath of -9.3m elevation; the discharge structure is proposed to set on the offshore mud flat of the bay at the south of the plant main power building. The
2×350MW units are provided with two water intake structures, which are located at the east of the plant jetty and about 400m away from the plant ash storage yard embankment; the drainage pipe is located at the south of the main power building and about 850 m away from the main power building. The source of makeup water for the Cooling Tower is the seawater. The project will adopt two natural draft cooling towers and 5 circulating water pumps (4 operating and 1 for standby).

The circulating cooling water system is proposed as following:

Cooling tower →intake culvert box →hydraulic steel gate→ trash cleaning device → circulating cooling water pump → outlet valve → circulating water supply pipe→ condenser → circulating water return pipe → cooling tower.

2. Circulating cooling water volume

It is preliminarily calculated, analyzed and determined that the TRL cooling rate of circulating water for this project is 92; the condenser cooling area is 21000 m² (full titanium); backpressure of TMCR steam turbine is 6.70kPa, and that of TRL steam turbine is 9.20kPa.

<table>
<thead>
<tr>
<th>Design Capacity (MW)</th>
<th>Cooling Water makeup for Cooling tower(m³/h)</th>
<th>Cooling Water flow for ST Condenser (m³/h)</th>
<th>Cooling Water for Auxiliaries (m³/h)</th>
<th>Total Cooling Water (m³/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x350</td>
<td>1,821.5</td>
<td>40896</td>
<td>3700</td>
<td>445946</td>
</tr>
<tr>
<td>2x350</td>
<td>3,643.0</td>
<td>81792</td>
<td>7400</td>
<td>11,043.0</td>
</tr>
</tbody>
</table>

[Notes] 1. The cooling water volume for condenser in this Table is determined based on the calculation as per TRL equivalent condensing rate of 681.74t/h and m=92.
2. Temperature rise of circulating water drainage: 6.37 ℃ for TMCR, 6.81 ℃ for TRL, 6.93 ℃ for VWO.

3. Layout scheme of circulating cooling water system

Water intake and diversion tunnel shall be completed once according to construction scale of 2×350MW at this phase. According to recommended scheme, two water intake pipes are set up. The pipes can be filament winding GRP sand pipe or steel pipe (with enhanced anti-corrosion and anode loss protection at both inside and outside). The water intakes are set up on seabed with a distance of about -9.30m from southern side of coal jetty outside the breakwater of the plant area; its top elevation and inner bottom elevation are respectively designed as -1.0m and -14.40m. Water will be charged from the periphery; intake window will be provided with coarse trash rack, and its upper edge elevation, lower edge elevation.

Two pipes shall be used for drainage from Cooling Tower and other discharges from main power house; length of single pipe shall be about 800 m; the pipe shall use filament winding GRP sand pipe with rigid ring, enhanced anticorrosion and cathodic protection.

Cooling Tower and other plant drains will enter the aeration tank. From Areation tank it will enter into siphon well from where it will be discharged via two drain pipes into the sea south of the main power building.

4. Cooling Tower

One nature draft counter flow cooling tower will be adopted for one unit in the project and the preliminary design parameter of cooling tower is as following:

- Drenching area: around 7500m²
- Height: 120m
- Diameter at EL0.0m: 104.5m

The makeup seawater consumption includes the makeup water for cooling tower and the raw sea water for the sea water desalination system. According to the preliminary water balance calculation, the consumption of cooling tower makeup water is about 3643m³/h, the consumption of the raw water for the seawater
desalination system is about \(735 \text{m}^3/\text{h}\) and the loss of the pretreatment system is about \(3 \text{m}^3/\text{h}\). The total raw seawater consumption is about \(4381 \text{m}^3/\text{h}\) (such a figure will be finalized at PD stage).

The makeup seawater will be intaken from the sea water area in front of the site of the power plant. The makeup seawater is intaken from the sea via the open channel or intake head, then will be fed to the pretreatment system by makeup pumps and two pipes. The seawater makeup pump station will be located near the dyke, with pumps and motors, hydraulic steel gate and electric single-beam portal crane.

### Table 3.8 - Main Equipment in Circulating Water Pump Station

<table>
<thead>
<tr>
<th>S/N</th>
<th>Description</th>
<th>Specifications</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Circulating water pump</td>
<td>Vertical mixed-flow pump</td>
<td>Sets</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Trash cleaning devices</td>
<td></td>
<td>sets</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Trash rack</td>
<td></td>
<td>pcs.</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Hydraulic steel gate</td>
<td></td>
<td>pcs.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(equipped with 4 groups of guide slots)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hydraulic butterfly valve</td>
<td></td>
<td>pcs.</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Power-driven double-girder gantry crane</td>
<td></td>
<td>set</td>
<td>1</td>
</tr>
</tbody>
</table>

Circulating water pump station: the circulating water pump station is preliminarily determined to be reinforced concrete structure and without shelter or rain proof for the devices in forebay.

According to the preliminary geological exploration the upper part of the place where the pump station is located is the mucky silty clay layer, and the substratum is the sandy soil.

Circulating water supply and return pipe: the circulating water supply and return pipes will be steel pipes or GRP pipes and heavy-excavation construction will be adopted.

### 1 x 350 MW 2 x 350 MW

<table>
<thead>
<tr>
<th>Hyperboloid</th>
<th>Natural Draft</th>
<th>Counterflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Height:</td>
<td>Overall Diameter:</td>
</tr>
<tr>
<td></td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>1,821.50</td>
<td>44,596.00</td>
<td>120.00</td>
</tr>
<tr>
<td>1,192.00</td>
<td>2,384.00</td>
<td>104.50</td>
</tr>
<tr>
<td>7,519.56</td>
<td>15,039.12</td>
<td>120.00</td>
</tr>
<tr>
<td>2.55</td>
<td>5.10</td>
<td>10% NaClO</td>
</tr>
<tr>
<td>100.00</td>
<td>200.00</td>
<td>Scale Inhibitor</td>
</tr>
<tr>
<td>18,000.00</td>
<td></td>
<td>Sump / Basin Capacity:</td>
</tr>
</tbody>
</table>

### 3.4.9 Fresh Water Makeup System

1. Fresh water makeup volume for the whole plant

The fresh water is mainly used as production and domestic water in this power plant. According to the preliminary water balance, the fresh water makeup volume for the 2 × 350MW unit in this project is \(180 \text{m}^3/\text{h}\); the fresh makeup water in the power plant is mainly supplied to: chemical water treatment system, domestic water system, industrial non-drinking water system, high-pressure wash water system, industrial service water system, ash storage yard for washing the ash transport trucks, coal storage yard and ash yard for dust control, etc. By optimizing the water supply structure of the plant-area fresh water supply system, with the principle of recycling-treatment-reuse principle for various wastewater, and under the conditions...
of taking water-saving measures such as strict control of water consumption indexes and wastewater discharge, the total fresh water consumption after the preliminary integrated balance of fresh water volume is 180 m³/h. Water consumption index of the 2×350MW units is: 0.0714m³/S·GW, which will be further optimized in the next step of work.

Table 3.9 - Fresh Makeup Water Consumption Within Plant Area

<table>
<thead>
<tr>
<th>S/N</th>
<th>Item</th>
<th>Unit</th>
<th>Water Consumption</th>
<th>Water Recycling</th>
<th>Water Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chemical water</td>
<td>m³/h</td>
<td>62</td>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Domestic water</td>
<td>m³/h</td>
<td>15</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Truck wash water in front of the plant</td>
<td>m³/h</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Miscellaneous water for engine and boiler</td>
<td>m³/h</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Hydraulic cleaning water for coal system</td>
<td>m³/h</td>
<td>12</td>
<td>9.5</td>
<td>2.5</td>
</tr>
<tr>
<td>6</td>
<td>Hydraulic cleaning water for coal wharf</td>
<td>m³/h</td>
<td>5</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>7</td>
<td>Wash water for dry ash can area</td>
<td>m³/h</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Makeup water for air conditioner</td>
<td>m³/h</td>
<td>9</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>Cooling water for circulating water pump</td>
<td>m³/h</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>10</td>
<td>Water for ash silo management area</td>
<td>m³/h</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>Water for flue gas desulfurization (in future if required)</td>
<td>m³/h</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Water for dust suppression of coal handling system</td>
<td>m³/h</td>
<td>20</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>Spraying water for coal yard</td>
<td>m³/h</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Spraying water for coal yard stacker-reclaimer</td>
<td>m³/h</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>Water for dry ash humidification of ash disposal system</td>
<td>m³/h</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Water for plant-area road greening</td>
<td>m³/h</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>17</td>
<td>Other industrial water</td>
<td>m³/h</td>
<td>30</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>18</td>
<td>Total</td>
<td>m³/h</td>
<td>216</td>
<td>36</td>
<td>180</td>
</tr>
</tbody>
</table>

Note: Total fresh water consumption within plant area: 180 m³/h, Water consumption index: 3/S·GW

2. Fresh water makeup scheme

According to the local fresh water resource and water supply conditions, the source of fresh water for this project is supplied through sea water desalination. The total fresh water makeup volume for the whole plant is about 180 m³/h, where the primary RO water consumption is about 101 m³/h and the secondary RO water consumption is about 79 m³/h. The raw water for sea water desalination is collected from the outlet pressure pipe of the circulating water pump and is supplied to the sea water desalination system after coagulating sedimentation and filtration. The clean sea water after sedimentation and filtration is about 735 m³/h.

3.4.10 Raw Seawater Pretreatment

The volume of sea water to be desalinated for this project is considered to be 180 m³/h. According to the volume of desalinated seawater, the raw seawater required is calculated to be about 735 m³/h, and the maximum volume of raw seawater during the high turbidity is about 735.5 m³/h. As the project is located in the tropical coastal area where the mean annual seawater temperature is 28°C and the highest seawater temperature in summer is 34°C, the temperature of raw seawater for desalination can basically meet the requirement on seawater temperature for permeable membrane reverse osmosis process. Therefore, it is considered that the raw seawater for desalination will be collected directly from the circulating water intake pressure pipe and supplied after coagulating sedimentation, filtration, sterilization and algae killing.

According to the quality of the seawater for this project, the process flow for seawater desalination is: Circulating water intake pipe → seawater makeup pipe → mixed reaction sedimentation basin → V-shaped filter basin → clean seawater basin → clean seawater booster pump → seawater desalination system. The blow-off water of the draw seawater pre-treatment system is precipitated by the sludge sedimentation basin,
and the supernate is recycled; the sludge water is transported to the ash yard after being treated by the sludge dewatering equipment.

Clean seawater required for seawater desalination is about 735 m³/h; it is preliminarily considered to set 2 sets of 600 m³/h mixed reaction sedimentation basins, 2 sets of 450 m³/h V-shaped filter basins, 1 set of 2000 m³ clean seawater basin, 3 sets (2 sets in operation and 1 set for backup) of clean seawater pumps with such parameters as Q=400 m³/h, H=36mH₂O and N=75kW, and relevant dosing and sterilizing facilities in the seawater purifying station.

1. Production & Domestic Water Supply and Drainage System

The water supplied for production in this project mainly includes the makeup water for the chemical water treatment system, miscellaneous water for steam turbine and boiler house, water for lubricating and cooling the circulating water pumps, water for washing and dust control of coal handling system, water for ash and slag disposal system, etc. According to the demands of different process systems, the production water is supplied by subsystems and is subject to the principle of water supply, recycling for treatment and reuse, so as to achieve the purposes of saving water and minimizing the discharge.

The source of domestic water is the desalinated secondary RO seawater supplied after mineralization and sterilization; the constant-pressure variable frequency water supply system is adopted.

The separate system is adopted for domestic sewage and rainwater in this project. It is proposed to set up the independent domestic sewage pipe network to collect the domestic sewage from all buildings in this construction phase, send it to the domestic sewage treatment device for treatment; the treated domestic sewage will be then filtrated & sterilized and finally used for plant-area road spraying and greening.

2. Plant-Area Drainage System

The rainwater-sewage separation and drainage scheme is adopted within the plant area; the plant-area sewage (wastewater) is recycled and treated for comprehensive utilization. The plant-area rainwater is collected by the pipe network and then pressurized in the rainwater pump house or automatically flows (during low tide level) to the sea; the rainwater system will be determined based on the recurrence bay of 3 ~5 years and the rainstorm intensity at the place where the plant site is located.

3. Fire Water System

The independent stabilized high-pressure fire water supply system is set for this project, and the number of fire disasters at the same time is determined to be 1 time; it is also proposed to set up 1 fire pool, 2 fire pumps (1 electric-drive fire pump and 1 diesel powered fire pump (for backup)), 2 stabilized pressure pumps (1 set in operation and 1 set for backup), and 1 set of pressure tank. According to relevant code requirements, it is proposed to set up the indoor and outdoor fire hydrant systems, water spray fire-fighting system, automatic fire-sprinkling system, gas fire-extinguishing system etc. and equip appropriate mobile fire extinguishers and firefighting trucks.

3.4.11 Structural Design Of Hydraulic Buildings And Structures

The project is located at southern plot of the Textile City, with a distance of about 9.5km to the east of Port Qasim in Karachi, Pakistan; the main plant area is near the sea; it is of coastal alluvial geomorphology with ground elevation of about 6m. At site, the upper strata mainly consist of sandy soil, gravel sand, clayey sand and silty soil and sand, and the lower bedrock strata mainly sandstone, shale, mudstone, siltstone, conglomerate and other soft rocks.

The peak horizontal seismic acceleration at plant area is 0.2g, equivalent to 8 and above degrees of seismic intensity as specified in the national norms. Based on standard penetration test results from
10 boreholes at early stage, it is judged that it is liquefied sandy soil within range of 0 ~ 7.5m for hole S07, for which liquefaction grade is severe and which is located at ash field area to the south of the main plant area; and it is liquefied sandy soil within range of 7.0 ~ 9.0m for hole S-02, for which liquefaction grade is medium and which is located at main plant area.

1. Structural design of circulating water system buildings and structures

For this project, Cooling Tower system shall be applied with the scheme of intake water to the east of coal jetty of the power plant and open drainage via Drainage Pipe to the south of main power house; related buildings and structures mainly include: water intake and intake tunnel, circulating water pump station, circulating water inlet pipe, siphon well, circulating water drainage Pipe, drainage connection well, and drainage exit.

Two water intakes shall be connected directly to pumping stations through diversion tunnel; the diversion tunnel shall be of filament winding GRP sand pipe or steel pipe (with enhanced anti-corrosion and anode loss protection at both inside and outside). If conditions construction permit, single-point water intake can also be used.

**Intake head:** For this project, two-point type water intake head shall be considered tentatively. The water intake shall be applied with two-cylindrical reinforced concrete prefabricated structures; it shall be installed with the assistance of floats, tug boats and floating crane after overall prefabrication on temporary dock nearby, or installed with the assistance of pontoons after prefabrication on semi-submersible barge.

**Intake tunnel:** The diversion tunnel shall be of two filament winding GRP sand pipes or steel pipes (with enhanced anti-corrosion and anode loss protection at both inside and outside). Each pipe consists of two parts, namely land part and sea part; the pipe of land part shall be laid via large excavation and subject to foundation treatment via bored pile; the pipe of sea part shall be sunk into the water by the diver with the assistance of floats, tug boats and floating crane after transferring to designated location, thus to connect with the pipe of land part, and subject to foundation treatment via bored pile; the part above the pipe shall be backfilled with riprap.

**Circulating water pump station:** the circulating water pump station is preliminarily determined to be reinforced concrete structure and without shelter or rain proof for the devices in forebay.

**Circulating water intake pipe:** the circulating water supply and return pipes will be steel pipes or GRP pipes and heavy-excavation construction will be adopted.

**Siphon well:** The function of the siphon well is to reduce the geometric water supply elevation of the circulating water system, lower the power of the circulating water pump and save the auxiliary power. The siphon well in this project is of underground reinforced concrete structure. It is preliminarily considered to adopt the open caisson method for construction and the bored cast-in-situ piles for foundation treatment.

**Drainage connection well:** The drainage connection well is used to connect the drainage pipe and tunnel, and is concurrently used as the working well for drainage tunnel construction. The drainage connection well in this project is of underground reinforced concrete structure; it is preliminarily considered to adopt the open caisson construction method.

**Plant Water Drainage:** The Cooling Tower Water drainage pipe will be buried at a depth of approx. with top at a height of 2.5m. It is proposed to adopt the heavy-excavation construction; bored cast-in-situ piles are to be utilized for foundation treatment.

**Drainage structure:** The drainage structure is located in the south side of the main building and about 850 m from the main building. It is determined to use buried Pipes for drainage purposes.

2. Structural design of seawater makeup water system buildings and structures
Seawater makeup system buildings and structures mainly include makeup water pipe connected from the circulating water intake pipe directly; the 2 pieces of steel mesh skeleton plastic composite pipes are adopted, and the single-line length is about 800m; center distance of the two pipes is 1.0m, and the burial depth of pipe top is 1.2m; it is preliminarily considered to adopt the excavation construction, and the pipe bottom is laid with the medium-coarse sand cushion and rock ballast cushion.

3. Design of purifying station and industrial water system buildings and structures

Main power buildings and structures for purifying station and industrial water system include: comprehensive water pump house and fire pump house, chlorine dosing room and dewatering house, 2000m³ industrial water basin and 2000m³ clean seawater basin, mixed reaction basins of 600m³/h, V-shaped filter basins of 450m³/h, etc.

**Comprehensive pump house and fire pump house:** The comprehensive pump house and fire pump house are in a single-storey building with basement. The plane dimension of the upper structure is 64m×8m and the height is 8m; it is of steel structure, and the periphery is protected with single-layer coloured steel plates; the roofing is of the cast-in-situ reinforced concrete slabs applied with the modified asphalt roof waterproofing material; ground surface is constructed with cement, and aluminium alloy doors and windows are mounted; internal and external wall surfaces are painted; the plane dimension of underground structure is 64m×8m, and the depth is 2.5m; it is of cast-in-situ reinforced concrete structure, the heavy-excavation construction is adopted, and the bored cast-in-situ piles are utilized for foundation stabilization.

**Chlorine dosing room and dewatering house:** Chlorine dosing room and dewatering house are of overground steel structure building, and its dimension is 55m×8m×13m (height); its periphery is protected with single-layer coloured steel plates, and the roofing is of the cast-in-situ reinforced concrete slabs applied with the modified asphalt roof waterproofing material, and aluminium alloy doors and windows are mounted; internal and external wall surfaces are painted; the bored cast-in-situ piles are utilized for foundation stabilization.

**Industrial water basin and clean seawater basin of 2000 m³:** The boundary dimension of the basin is 24m×24m×5m (depth), and it is of semi-underground reinforced concrete structure; the heavy-excavation construction is adopted, & the bored cast-in-situ piles are utilized for foundation stabilization.

**Mixed reaction basin and V-shaped filter basin:** Mixed reaction basin and V-shaped filter basin are of semi-underground reinforced concrete structure and adopt heavy-excavation construction, and the bored cast-in-situ piles are utilized for foundation stabilization.

4. Structural design of firefighting system buildings and structures

Main buildings and structures of firefighting system include: fire pool, foam liquid room, and deluge valve room.

**Fire pool:** Fire pool is of semi-underground reinforced concrete structure with size of 24m×12m×5m (H); it is subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.

**Foam liquid room & deluge valve room:** Both foam liquid room & deluge valve room are of overground steel structure; it is applied with strip foundation; foundation is strengthened via bored piles.

5. Design of Building sand Structures of Wastewater Treatment System

Main buildings and structures of wastewater treatment system include: wastewater pool, water clarification pool and final neutralization pool, and clean water pool.

**Wastewater pool:** Wastewater pool is of underground reinforced concrete structure; it is subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.
Water clarification pool and final neutralization pool: Water clarification pool and final neutralization pool are of underground reinforced concrete structure; they are subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.

Clean water pool: Clean water pool is of underground reinforced concrete structure; it is subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.

6. Structural design of drainage system buildings and structures

Main buildings and structures of drainage system include: emergency oil pool, sewage treatment station, and rainwater pumping station.

Emergency oil pool: Emergency oil pool is of underground reinforced concrete structure; it is subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.

Sewage treatment station: Sewage treatment station is of semi-underground reinforced concrete structure; it is subject to construction in manner of heavy excavation; foundation is strengthened via bored piles.

Rainwater pumping station: Rainwater pumping station is of semi-underground reinforced concrete structure; it is subject to construction in manner of drop shaft sinking.

7. Design of Building sand Structures of Coal Yard

Main buildings and structures of coal yard mainly include 2 slime sedimentation tanks with size of 45m×6m×5m (deep) for each, which are semi-underground reinforced concrete structure and subject to construction in manner of heavy excavation, and for which foundation is strengthened via bored piles.

3.4.12 Layout Of Ash And Slag Storage Yard

It has been considered to construct the dykes at the seaward, east and west sides of the ash and slag storage yard, of which the total length is about 1400m; the average original elevation of the slag yard is 4.15m, and the designed elevation of the ash storage surface is 10.0m; the average elevation of the dyke top is temporarily determined to be 10.5m, and the inclined rubble structure is proposed; the ground of the ash yard is laid with impermeable membrane. Rock rip-rap is adopted for slope protection of dykes, and internal slope is applied with impermeable membrane and clay cushion; the top is constructed with the plain concrete pavement. According to preliminary geological exploration data, the surface of area where ash yard is located is of liquefied sandy soil, for which thickness is 7.5m and liquefaction grade is severe. However, there is only one geological borehole at the area where ash yard is located; therefore, it is unable to clearly determine scope of liquefaction, and it is recommended to survey additional borehole. For the area where liquefaction grade is severe, it is proposed to use anti-vibration and shock gravel pile for anti-liquefaction foundation treatment.

3.4.13 HVAC & Dust Removal

1. Main design principles

- According to provisions of the “Technical Standard on Heating, Ventilation and Air Conditioning Design for Thermal Power Plant” (DL/T5035 — 2004), the plant area is the heating area; therefore, the heating of all buildings within the plant area shall be designed as per provisions on heating area. Except for those rooms where hot air is required in winter, all other buildings are not provided with heating facilities.

- The steam turbine room is provided with the ventilation system that utilizes the electric rainproof shutter for natural air inlet and the roof ventilator for air exhausting.
- The central control room and electronics room will be provided with the air conditioning system for full-year use; control rooms of all auxiliary systems within the plant area, production offices, duty room and other rooms requiring air conditioning are provided with air conditioning facilities.

- The concentrated refrigerating and heating station is set for the plant area.

- Coal-handling comprehensive building and other buildings far away from the cold source are provided with the independent direct-expansion air conditioning system.

- The coal handling system and bunker bay are provided with the level-1 electrostatic dust collection system, so as to keep the opening of the guide chute at each transfer point in a negative pressure state and to make the system discharge meet the national discharge standard. The dust removal scheme is: to set the electrostatic dust collector for each raw coal hopper in the bunker bay and provide the electrostatic dust collection system for each belt at coal transfer point and in the coal breaker room.

- As for this project, one set of fixed vacuum cleaning pipe network system will be set for each boiler in the boiler room, and one vehicular vacuum cleaning device will be set for each two boilers.

3.4.14 Instrumentation And Control Automation

1. Scope of design

In the Project, thermal control design consists of instrumentation and control systems of boiler, steam turbine, generator and other auxiliary machines in main power building; instrumentation and control systems of auxiliary systems such as seawater desalination system, boiler makeup water treatment system, condensate polishing and regeneration system, chemical dosing system, steam-water sampling system, hydrogen production system, waste water centralized treatment system, circulating cooling water system, raw seawater pre-treatment system, ash and slag system, compressor air system, air conditioning system, flue gas desulfurization and denitration system, etc. as well as CCTV system in the plant area.

2. Control mode

Unit centralized control mode of boiler, turbine and generator is adopted in main power building for the Project. Both units are controlled integrally with one Central control building. Temporary monitoring points are used for coal handing system, ash and slag handing system, water treatment system and flue gas desulfurization system in auxiliary buildings. Local operation station and engineer station are provided for monitoring points, which are for maintenance, debugging and local emergency operating. If necessary all of the auxiliary systems and network monitoring system can be centrally monitored in Central control building.

3. Central control building, electrical control building and central control room

Central control building: A central control building is established in the Project, between boilers No. 1 and No.2, which accommodates central room, engineer room(s), patrol inspector lounge and other auxiliary rooms (e.g. shift turnover room, locker room), etc.

Central control room: Central control room is set in central control building, connected with operating layer of steam turbine hall via an access and in same elevation as the layer. Operator station of one-to-one system unit, comprehensive duty operator station of BOP, network control operator station, shift foreman console, fire alarm panel, industrial TV to detect level in steam drum, TV to detect furnace flame of boiler and CCTV supervision system of whole plant, etc. are set in the room.

Electrical equipment rooms: Each unit is equipped with electrical equipment of steam turbine and that of boiler respectively. In accordance with principle of arrangement of physical distribution, electrical equipment room of turbine is arranged on middle layer of the main power building, while that of boiler is arranged between the two boilers on operating layer in the main power building.
Control level: The two 350MW Supercritical coal fired generator units in the Project are designed on basic load. The units shall be equipped with desirable peaking capability to adapt to low-load operation during night, shall be table to start up and load up in cold state, warm-up state, hot state and extreme hot state respectively, and have such Runback ability that it can operate under constant pressure and sliding pressure.

In design of instrumentation, control and automation system in the Project, the automation level shall be increased, for the purpose of guaranteeing safe and cost-efficient operation of the units, on the basis of engineering situation and characteristics of the units, on the premise of that technical policies are not violated. In the system, DCS is used as the center of supervision and control of the units and realizes functions of Data Acquisition System (DAS), Modulating Control System (MCS), Sequence Control System (SCS), Furnace Safeguard Supervisory System (FSSS), generator-transformer unit and station-service power control. DCS, equipped with ST Digital Electro-Hydraulic system (DEH), ST Emergency Trip System (ETS), Turbine Safety Instrumentation (TSI), Automatic Voltage Regulator (AVR) and Automatic Synchronized System (ASS) and other automation equipments, as well as with auxiliary panels, to comprise a complete set of automatic control system, controls and supervises the boiler, steam turbine, generator-transformer and station-service power system. The automation level is expected to be such that:

- Start and stop control of the units can be realized in central control room through local coordination of only a few of attendants.
- Operating personnel of the units supervise and control the units via the operator station in Central Control Room to ensure safe and cost-efficient operation of the units.
- Design of sound Modulating Control System and Sequence Control System fulfils coordinated control of steam turbine, boiler and generator, as well as fulfils automatic control of the units from boiler minimum stable load without auxiliary fuel support to full load, thus to reduce labor intensity of the operating personnel.
- When abnormality or accident happens in the units, interlock protection system can put appropriate system or equipment into or out of operation to ensure that the units can operate under safe condition or be shut down.

3.5 Implementation Outline Schedule

- Construction start – January 2017
- Commissioning – June
4.0 Environmental & Social Baseline

4.1 Introduction

This section of the EIA study presents the baseline data pertaining to the environmental quality and the social conditions in the microenvironment of proposed Project. For this study, the environmental characteristics of the project area were established through extensive literature search, field sampling / measurements, laboratory analysis, stakeholder consultation and data interpretation. Appropriate standard scientific methods have been used for each component of the study, and are described in the sections covering the respective components. For all spatial information, Global Positioning System (GPS) was used to mark the sampling sites. In addition to the field visits specifically conducted for this Project, vegetation and wildlife data for the area were compiled using previously published literature and from assessments appearing in past studies conducted by EMC and other consultants.

4.2 Physical Environment

DPKPG has acquired around 216 acres of land in the eastern industrial zone for setting-up the proposed coal fired power plant. The site is situated in the same zone where Siddiqsons Energy Limited and PQEPC (Sinohydro) are constructing power plants based on imported coal. The general topography of the microenvironment is flat and is partially submerged in the creek system. Here, land will be reclaimed using dredged sand to prepare the site for construction. The general elevation of the area is less than 4 m above Mean Sea Level (MSL).

Figure 4.1 shows the location of DGKPG power plant site.

The present project is yet another milestone in the development and expansion of the Port Muhammad Bin Qasim which originally was built to cater the needs of Pakistan Steel Mills.

This port is situated on the eastern coast of the country which has a mesh of numerous creeks interconnecting coastal area and high sea waters. One of these navigable creeks named “Phitti” was chosen to serve as approaching navigational channel to connect the open sea (Arabian Sea) with berthing site of Port Qasim. The channel runs along one of the many natural waterways that make up the historic Indus Delta. The channel was initially dredged in 1978 and is a total of 43.7 km long from Buoys Number 1 and Number 2 to the marginal wharf turning basin. The channel can be considered in three sections, namely:

A. The exposed Outer (Ahsan) Channel between the open sea and Bundal Island;
B. The more sheltered Inner Channel from Bundal Island to the Iron Ore and Coal Berth (IOCB);
C. The ‘Reach’ from the IOCB to the marginal wharfs.

PQ-A Creeks: The Indus delta covers an area of about 600,000 hectares and is characterized by 16 major creeks and innumerable minor creeks, dominated by mud flats, and fringing mangroves. The coastal morphology is characterized by a network of tidal creeks and a number of small islands with sparse mangrove vegetation, mud banks, swamps, and lagoons formed because of changes in river courses. The Gharo Phitti Creek System close to the Project area consists of three creeks: Gharo Creek, Kadiro Creek and Phitti Creek.

All three are connected in a series starting from Gharo Creek at the north-eastern end to the Phitti Creek at the south-western end and located at 22.3 km from Karachi. This creek system is about 28 km long and its width ranges from 250 to 2,500 m. The Korangi Creek, and Kadiro Creeks are connected with it at the north-eastern end while it acts as main waterway connected with the open sea at the south-western end. The main channel of Port Bin Qasim lies in this creek system, which has been dredged to maintain a navigable depth of -11.3 m from the surface of the creek. The creek system around PQ and the proposed power plant are shown in Figure 4.2.

![Creek system around Port Qasim and the Proposed Power Plant](image)

**Figure 4.2 - Creek system around Port Qasim and the Proposed Power Plant**

**4.2.1 Climate**

The climate of the Port Qasim coastal area can be characterized by dry, hot and humid conditions and in general it is moderate, sunny and humid. There is minor seasonal intervention of a mild winter from mid-December to mid-February into a long hot and humid summer extending from April to September. Observatory record of the Pakistan Meteorological Department (PMD) at Port Qasim and at Karachi International Airport has been used as a data source for temperature, wind and precipitation. These have been supplemented by the meteorological data obtained during the ambient air quality monitoring study carried out by the Space and Upper Atmospheric Research Organization (SUPARCO).
4.2.1.1 Temperature

The air temperature of entire coastal zone of Karachi is invariably moderate. The mean maximum summer temperature is 36°C, while the mean minimum temperature is 13°C. There are occasions when the coastal belt is in the grip of heat wave and the maximum temperatures exceed 40°C but this happens only two to three times in a year and lasts for a maximum of three days. Average maximum and minimum temperatures recorded near Pakistan Meteorological (MET) Station at Jinnah Terminal, which has been used for the Bin Qasim area as reference are shown in Table 4.1, Table 4.2 & Figure 4.3 respectively. Only Air Port is the nearest MET station from Bin Qasim.

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Source: Pakistan Meteorological Department

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<td>18.1</td>
<td>13.0</td>
<td>21.9</td>
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</table>
4.2.1.2 Precipitation

The rainfall in the Karachi coastal zone is extremely low and erratic; therefore this region falls in the semi-arid climatic zone. Table 4.3 shows the last few years’ precipitation data recorded at Karachi Airport station and Figure 4.4 below shows the fraction of days in which various types of precipitation are observed.

Table 4.3: Monthly Amount of Precipitation (mm) at Karachi Airport

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
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<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
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<tr>
<td>2001</td>
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<td>N/A</td>
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<td>16.3</td>
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<td>2006</td>
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<td>0.0</td>
<td>66.2</td>
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<tr>
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<td>N/A</td>
<td>N/A</td>
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<td>54.0</td>
<td>37.5</td>
<td>Trace</td>
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<td>2009</td>
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<td>Trace</td>
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<td>0.0</td>
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<td>0.0</td>
<td>0.0</td>
<td>Trace</td>
<td>Trace</td>
<td>8.1</td>
<td>121.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
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<td>20.0</td>
<td>2.8</td>
<td>30.0</td>
<td>0.0</td>
<td>Trace</td>
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<td>1.2</td>
<td>0.0</td>
<td>0.0</td>
<td>168.9</td>
</tr>
</tbody>
</table>

Source: Pakistan Meteorological Department

The above record for rainfall provide by PMD for Karachi Airport (2001-2013) suggests that July & August are the wettest months and that the maximum rainfall recorded in Karachi during last few years is 270.4 mm in July 2003.

On the other hand, during the year of 2006, heavy monsoon and winter rainfall was recorded during the months of July/August and November respectively. Average rainfall recorded for the month of December 2006 was around 61.3 mm.

Highest rainfall events have occurred in July 1994: 256.3mm, July 2003: 270.4mm and August 2006: 77mm in 3 hours. According to observations recorded for the year 2007, August 10 and 11 was witness to unusually high rainfall of 107 mm in 24 hours compared with the normal of about 60 mm for August. The wettest August ever experienced by the city was in 1979, when over 262mm of rainfall was recorded. The record for the maximum rainfall within 24 hours in the eighth month was 166mm of rain on August 7, 1979. The heavy rainfall was not unusual since it was caused by the general monsoon system that
travels from across Rajasthan and lays over Sindh. The monsoon weather system did not move towards Baluchistan but the penetration of moist currents from Sindh brought scattered to heavy rain in southern Baluchistan, particularly along its coastal regions.

The probability that precipitation will be observed at this location varies throughout the year. Precipitation is most likely around August 4, occurring in 35% of days. Precipitation is least likely around April 27, occurring in 2% of days.

If more than one type of precipitation is reported in a given day, the more severe precipitation is counted. For example, if light rain is observed in the same day as a thunderstorm, that day counts towards the thunderstorm totals. The order of severity is from the top down in this graph, with the most severe at the bottom.

Over the entire year, the most common forms of precipitation are thunderstorms, drizzle, and moderate rain; Thunderstorms are the most severe precipitation observed during 38% of those days with precipitation. They are most likely around August 12, when it is observed during 12% of all days. Drizzle is the most severe precipitation observed during 34% of those days with precipitation. It is most likely around July 30, when it is observed during 14% of all days. Moderate rain is the most severe precipitation observed during 22% of those days with precipitation. It is most likely around July 28, when it is observed during 8% of all days.

Inundation due to Heavy Rainfall Events - Major inundation and land submergence was noticed on Shahrae Faisal in July 2003 and August 2006 and on both occasions, precipitation pattern and intensity was almost similar. For estimating the impact of inundation on the six corridors, the maximum intensity of Rainfall of 18th August 2006 at 77mm in about 3 hours i.e. 25.7mm/hour will be considered critical and adopted for making estimates on land submergence.

4.2.1.3 Humidity

The relative humidity typically ranges from 25% (dry) to 91% (very humid) over the course of the year, rarely dropping below 10% (very dry) and reaching as high as 100% (very humid). The air is driest around February 9, at which time the relative humidity drops below 33% (comfortable) three days out of four; it is most humid around August 2, exceeding 83% (humid) three days out of four. Figure 4.5 shows average daily high and low relative humidity with percentile bands.
The average daily high (blue) and low (brown) relative humidity with percentile bands (inner bands from 25th to 75th percentile, outer bands from 10th to 90th percentile)

The mean relative humidity is 60 - 65% while the mean winter relative humidity is 25 - 30%. The rainfall in the coastal belt of Karachi zone is extremely low and erratic; therefore this region falls in the semi-arid climatic zone. Table 4.4 shows the last five years precipitation data recorded at Karachi Airport. The 5 years record for rainfall of PMD at Karachi Airport (2001-2005) suggests that July and August are the wettest months and highest rainfall recorded in Karachi during last five years is 240.4 mm, which was recorded during July 2003. It states that Karachi has been facing drought conditions as the average range of rainfall seen during five years (2001-2005) is 8-24 mm. On the other hand during July, August and November of 2006, heavy monsoon and winter rainfall was recorded. Average rainfall recorded in the month of December 2006 was 61.3 mm.

Table 4.4: Monthly Amount of Precipitation (mm) at Karachi Air Port

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<td>3.0</td>
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<td>Trace</td>
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<td>68.9</td>
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</table>

Source: Pakistan Meteorological Department

4.2.1.4 Wind Direction And Speed

During the summer or south-west monsoon (from June to August), winds reverse their direction and blow from the west-south-west, with wind speed vary from 0 kn to 16 kn (calm to fresh breeze), rarely exceeding 25 kn (strong breeze). Inter-monsoon transitions occur during October to November and March to May is between 4-6 knots in the NNE direction. The wind direction is unsettled and speed is low during the period intervening the two seasons viz. summer and winter. Wind direction and distribution are given in Figure 4.6 and Figure 4.7.
Figure 4.6: The average daily minimum (red), maximum (green), and average (black) wind speed with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile).

To create a Wind Rose, the data was prepared in such a way that rows contain the wind directions, columns contain the ranges and values of the speed of winds in percentages.

The Wind Roses have been made for following wind speeds and corresponding wind directions:
1. Mean monthly wind speed (knots) and corresponding wind directions (degrees) at 00:00 UTC.
2. Maximum monthly wind speed (knots) and corresponding wind directions (degrees) at 00:00 UTC.
3. Mean monthly wind speed (knots) and corresponding wind directions (degrees) at 00:12 UTC.
4. Maximum monthly wind speed (knots) and corresponding wind directions (degrees) at 00:12 UTC.

In all the above scenarios, the wind speeds and wind directions of the past 30 years' data (1984-2013) were used. The 30 years' wind speed data was arranged in descending order and ranges of wind speeds were made covering the whole data. The wind direction given in whole circle bearings (degrees) were converted to the corresponding 16 quadrantal bearings and the percentage of each range of wind speed was calculated for different wind directions, and then the Wind Rose was plotted. Same procedure was applied for all four Wind Roses.

For the project site, four Wind Roses have been developed using the wind speed and wind direction data of Karachi Airport meteorological station, Karachi. One Wind Rose is for mean monthly wind speeds and the second for the maximum wind speeds at 00:00 UTC. Third Wind Rose is for mean monthly wind speeds and the fourth for the maximum wind speeds at 00:12 UTC.

Figure 4.7 shows the Wind Rose for Mean monthly wind speeds (knots) and corresponding wind directions at 00:00 UTC. The Figure depicts that 0.1 to 2 Knots winds have the highest frequency of occurrence in the ENE direction, whereas, highest wind speeds have the WSW direction.

Figure 4.8 shows the Wind Rose for maximum wind speeds (knots) and corresponding wind directions at 00:00 UTC. The Figure depicts that 7 to 11 Knots winds has the highest frequency of occurrence in the N direction, whereas, highest wind speeds have the N and W directions.

Figure 4.9 shows the Wind Rose for Mean monthly wind speeds (knots) and corresponding wind directions at 00:12 UTC. The Figure depicts that 7.1 to 9 Knots winds have the highest frequency of occurrence in the WSW direction, whereas, highest wind speeds have also the WSW direction.
Figure 4.10 shows the Wind Rose for maximum wind speeds (knots) and corresponding wind directions at 00:12 UTC. The Figure depicts that 13 to 16 Knots winds have the highest frequency of occurrence in the W direction, whereas, highest wind speeds have the N and W directions.

Figure 4.7: Wind Rose for mean monthly wind speeds at 00:00 UTC

Figure 4.8: Wind Rose for maximum wind speeds at 00:00 UTC
Figure 4.9: Wind Rose for mean monthly wind speeds at 00:12 UTC

Figure 4.10: Wind Rose for maximum wind speeds at 00:12 UTC
4.2.1.5 Dew Point

Dew point is often a better measure of how comfortable a person will find the weather than relative humidity because it more directly relates to whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Figure 4.11 shows the dew point variation with percentile bands.

Over the course of a year, the dew point typically varies from 2°C (dry) to 26°C (oppressive) and is rarely below -8°C (dry) or above 27°C (very oppressive). There are two periods in the year that are most comfortable: The first is between January 1 and March 17 and the second is between November 10 and December 31. The air feels neither too dry nor too muggy during these periods.

4.2.1.6 Cloud Cover

The median cloud cover ranges from 4% (clear) to 85% (mostly cloudy). The sky is cloudiest on July 24 and clearest on November 14. The clearer part of the year begins around September 19. The cloudier part of the year begins around May 30. Figure 4.12 shows the median daily cloud cover with percentile bands.

![Figure 4.11 - Dew point variation with percentile bands](image)

![Figure 4.12 - The median daily cloud cover (black line) with percentile bands (inner band from 40th to 60th percentile, outer band from 25th to 75th percentile)](image)
4.2.1.7 Sunshine

The length of the day varies significantly over the course of the year. The shortest day is December 21 with 10:36 hours of daylight; the longest day is June 20 with 13:41 hours of daylight.

![Figure 4.13 - The number of hours during which the Sun is visible (black line), with various degrees of daylight, twilight, and night, indicated by the colour bands.](image)

From bottom (most yellow) to top (most grey): full daylight, solar twilight (Sun is visible but less than 6° from the horizon), civil twilight (Sun is not visible but is less than 6° below the horizon), nautical twilight (Sun is between 6° and 12° below the horizon), astronomical twilight (Sun is between 12° and 18° below the horizon), and full night.

4.2.2 Ambient Air & Noise Quality

EMC Pakistan commissioned EPA Certified Laboratory ‘SUPARCO’ to undertake a primary baseline air quality monitoring survey at the proposed power plant site. The air quality of the area was also studied from other EIAs conducted by EMC Pakistan and Hagler Bailly Pakistan for:

- Bin Qasim Coal Conversion Project (Final Report prepared by EMC Pakistan)
- Siddiqssons Energy 350 MW Coal Power Plant (Final Report prepared by EMC Pakistan)
- Sino hydro’s 2×660 MW Coal Power Plant (Final Report prepared by Hagler Bailly Pakistan)
- Coal Jetty, Shipping Lane and Ash Disposal Site for PQEPC 2×660 MW Coal Power Plant (Final Report prepared by Hagler Bailly Pakistan)

SUPARCO’s mobile air-monitoring vehicle collected air-quality data of criteria pollutants such as NOx (as sum of NO and NO2), SO2, TSP, PM10 and PM2.5 at all the sampling locations. The air quality parameters were measured using state of the art instruments based upon the USEPA and ASTM methods. Meteorological parameters such as wind speed, wind direction, temperature and relative humidity were also measured onsite. Data for both the air quality and meteorological parameters were collected for 24 hours at each site. The survey helped characterize the existing air quality in the air shed of the proposed power plant site.

Atmospheric concentrations of NO2 were measured indirectly by photometrically measuring the light intensity, at wavelengths greater than 600 nanometers, resulting from the chemi-luminescent reaction of nitric oxide (NO) with ozone (O3).

SO2 was measured using the SO2 analyser which is based on the principle of fluorescence technique in which a molecule of sulphur dioxide is radiated with particular wavelengths of ultraviolet light.

Concentrations of PM10 and PM2.5 were measured using the β-ray absorption technique. The instrument used in this technique senses the air mass flow rate.
Table 4.4: Description of Ambient Air Monitoring Stations

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<tr>
<th>Site ID</th>
<th>Lat</th>
<th>Long</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
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<td>67°21'54.88&quot;</td>
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</tr>
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</tr>
<tr>
<td>A3</td>
<td>24°47'53.60&quot;</td>
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<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
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<td>24°49'17.71&quot;</td>
<td>67°23'30.71&quot;</td>
<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
<tr>
<td>A5</td>
<td>24°47'18.75&quot;</td>
<td>67°23'38.66&quot;</td>
<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
<tr>
<td>A6</td>
<td>24°47'42.76&quot;</td>
<td>67°26'07.22&quot;</td>
<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
<tr>
<td>A7</td>
<td>24°47'06.64&quot;</td>
<td>67°22'44.99&quot;</td>
<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
<tr>
<td>A8</td>
<td>24°48'23.05&quot;</td>
<td>67°23'20.95&quot;</td>
<td>SO₂, PM₂.₅, PM₁₀, TSP, NOₓ (NO and NO₂)</td>
</tr>
</tbody>
</table>

Figure 4.14 - Air Quality Monitoring Stations

The summary and comparison air monitoring results with provincial standards are provided in Table 4.5. The level of all air pollutants were well within the prescribed limits of SEPA for Ambient Air Quality.

Table 4.5: Ambient Air Quality of the Project Area

<table>
<thead>
<tr>
<th>Site ID</th>
<th>Sulfur Dioxide (SO₂) (µg/Nm³)</th>
<th>Nitrogen Dioxide (NO₂) (µg/Nm³)</th>
<th>Nitrogen Oxide (NO) (µg/Nm³)</th>
<th>Suspended Particulate Matter (SPM) (µg/Nm³)</th>
<th>Less than 10 Microns (PM₁₀) (µg/Nm³)</th>
<th>Less than 2.5 Microns (PM₂.₅) (µg/Nm³)</th>
<th>Carbon Monoxide (CO) (mg/Nm³)</th>
<th>Ozone (O₃) (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>16.0</td>
<td>12.9</td>
<td>8.9</td>
<td>183</td>
<td>80.4</td>
<td>18.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-2</td>
<td>11.8</td>
<td>10.1</td>
<td>6.1</td>
<td>216.2</td>
<td>88.9</td>
<td>20.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-3</td>
<td>13.4</td>
<td>9.3</td>
<td>6.4</td>
<td>199.6</td>
<td>81.1</td>
<td>18.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-4</td>
<td>11.8</td>
<td>10.1</td>
<td>6.1</td>
<td>216.9</td>
<td>88.9</td>
<td>20.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>A-5</td>
<td>13.6</td>
<td>13.3</td>
<td>9.1</td>
<td>-</td>
<td>87.6</td>
<td>23.5</td>
<td>0.9</td>
<td>14.8</td>
</tr>
<tr>
<td>A-6</td>
<td>9.5</td>
<td>11.1</td>
<td>5.8</td>
<td>-</td>
<td>79.8</td>
<td>18.7</td>
<td>0.6</td>
<td>8.7</td>
</tr>
<tr>
<td>A-7</td>
<td>26</td>
<td>9.7</td>
<td>9.6</td>
<td>-</td>
<td>83.7</td>
<td>32.2</td>
<td>2.8</td>
<td>-</td>
</tr>
<tr>
<td>A-8</td>
<td>17.4</td>
<td>10.0</td>
<td>13.5</td>
<td>386</td>
<td>51</td>
<td>26.4</td>
<td>2.16</td>
<td>12.0</td>
</tr>
<tr>
<td>A-9</td>
<td>12.5</td>
<td>8.7</td>
<td>14.5</td>
<td>419</td>
<td>131</td>
<td>22.2</td>
<td>0.8</td>
<td>12.2</td>
</tr>
<tr>
<td>Avg.</td>
<td>14.7</td>
<td>10.6</td>
<td>8.9</td>
<td>270.1</td>
<td>85.8</td>
<td>22.4</td>
<td>1.5</td>
<td>11.9</td>
</tr>
<tr>
<td>SEQS</td>
<td>120</td>
<td>80</td>
<td>40</td>
<td>500</td>
<td>150</td>
<td>75</td>
<td>10</td>
<td>130</td>
</tr>
</tbody>
</table>
Environmental Impact Assessment for 2 x 350 MW Coal Power Project

**Sulfur Dioxide (SO₂)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>16</td>
</tr>
<tr>
<td>A-2</td>
<td>11.8</td>
</tr>
<tr>
<td>A-3</td>
<td>13.4</td>
</tr>
<tr>
<td>A-4</td>
<td>11.8</td>
</tr>
<tr>
<td>A-5</td>
<td>13.6</td>
</tr>
<tr>
<td>A-6</td>
<td>9.5</td>
</tr>
<tr>
<td>A-7</td>
<td>26</td>
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<tr>
<td>A-8</td>
<td>17.4</td>
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<tr>
<td>A-9</td>
<td>12.5</td>
</tr>
<tr>
<td>SEQS</td>
<td>120</td>
</tr>
</tbody>
</table>

**Nitrogen Dioxide (NO₂)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>12.9</td>
</tr>
<tr>
<td>A-2</td>
<td>10.1</td>
</tr>
<tr>
<td>A-3</td>
<td>9.3</td>
</tr>
<tr>
<td>A-4</td>
<td>10.1</td>
</tr>
<tr>
<td>A-5</td>
<td>13.3</td>
</tr>
<tr>
<td>A-6</td>
<td>11.1</td>
</tr>
<tr>
<td>A-7</td>
<td>9.7</td>
</tr>
<tr>
<td>A-8</td>
<td>10.0</td>
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<tr>
<td>A-9</td>
<td>8.7</td>
</tr>
<tr>
<td>SEQS</td>
<td>80</td>
</tr>
</tbody>
</table>

**Nitrogen Oxide (NO)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>8.9</td>
</tr>
<tr>
<td>A-2</td>
<td>6.1</td>
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<tr>
<td>A-3</td>
<td>6.4</td>
</tr>
<tr>
<td>A-4</td>
<td>6.1</td>
</tr>
<tr>
<td>A-5</td>
<td>9.1</td>
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<tr>
<td>A-6</td>
<td>5.8</td>
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<td>A-7</td>
<td>9.6</td>
</tr>
<tr>
<td>A-8</td>
<td>13.5</td>
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<tr>
<td>A-9</td>
<td>14.5</td>
</tr>
<tr>
<td>SEQS</td>
<td>40</td>
</tr>
</tbody>
</table>
### Suspended Particulate Matter (SPM)

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>183</td>
</tr>
<tr>
<td>A-2</td>
<td>216.2</td>
</tr>
<tr>
<td>A-3</td>
<td>199.6</td>
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<tr>
<td>A-4</td>
<td>216.9</td>
</tr>
<tr>
<td>A-7</td>
<td>0</td>
</tr>
<tr>
<td>A-8</td>
<td>0</td>
</tr>
<tr>
<td>A-9</td>
<td>0</td>
</tr>
<tr>
<td>SEQS</td>
<td>500</td>
</tr>
</tbody>
</table>

### Less than 10 Microns (PM₁₀)

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>80</td>
</tr>
<tr>
<td>A-2</td>
<td>90</td>
</tr>
<tr>
<td>A-3</td>
<td>80</td>
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<tr>
<td>A-4</td>
<td>70</td>
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<td>A-5</td>
<td>70</td>
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<td>A-6</td>
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<tr>
<td>A-7</td>
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<td>A-8</td>
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</tr>
<tr>
<td>A-9</td>
<td>500</td>
</tr>
<tr>
<td>SEQS</td>
<td>160</td>
</tr>
</tbody>
</table>

### Less than 2.5 Microns (PM₂.₅)

<table>
<thead>
<tr>
<th>Location</th>
<th>Concentration in µg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>10</td>
</tr>
<tr>
<td>A-2</td>
<td>10</td>
</tr>
<tr>
<td>A-3</td>
<td>10</td>
</tr>
<tr>
<td>A-4</td>
<td>10</td>
</tr>
<tr>
<td>A-5</td>
<td>10</td>
</tr>
<tr>
<td>A-6</td>
<td>10</td>
</tr>
<tr>
<td>A-7</td>
<td>100</td>
</tr>
<tr>
<td>A-8</td>
<td>50</td>
</tr>
<tr>
<td>A-9</td>
<td>50</td>
</tr>
<tr>
<td>SEQS</td>
<td>80</td>
</tr>
</tbody>
</table>
Environmental Impact Assessment for 2 x 350 MW Coal Power Project

The project lies in an industrial area where no human settlements exist anywhere within a 5 km radius.

The SEQS for noise were issued by SEPA in 2010 is given in Table 4.6.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Category of Area / Zone</th>
<th>Effective from 1st July, 2010</th>
<th>Effective from 1st July, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Limit it in dB(A) Leq*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day Time</td>
<td>Night Time</td>
</tr>
<tr>
<td>1</td>
<td>Residential area (A)</td>
<td>65</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Commercial area (B)</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Industrial area (C)</td>
<td>80</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>Silence Zone (D)</td>
<td>55</td>
<td>45</td>
</tr>
</tbody>
</table>

Notes
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 a competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4: Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

* dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

The measured minimum, maximum and mean concentrations of Noise were 61.4 dB (A), 74.2 dB (A) and 67.8 dB (A) respectively. These levels of Noise were well within prescribed limits of Sindh EQS. When comparing the above levels with different Zones as mentioned in the Sindh EQS for Ambient Noise we find that the values are below 75 dB(A) i.e. allowable for Day time value for Industrial Zone.

![Figure 4.15 - Ambient noise monitoring at project site](image)

### 4.2.3 Site Geotechnical Characteristics

Geotechnical Investigation for the proposed site was carried out in order to determine geotechnical parameters of subsurface deposits. Scope of work included drilling of seventeen (17) on-shore boreholes at proposed Plant area and nine (09) off-shore boreholes at Jetty area as shown in figure 4.16.

The maximum depth of boreholes are 40 meters for on-shore boreholes and 50 meters for off-shore boreholes. The maximum explored depth of these boreholes is 40 meters below the existing ground level. Soil, rock, and groundwater samples were collected during field investigation. Laboratory testing of these samples has been carried out in the “Soil Testing Services” laboratory, Karachi.

The subsurface deposits up to the explored depth consist of the following units:

- Sand
- Conglomerate
- Sandstone
- Mudstone
- Clay stone
- Gravel
- Siltstone
Following sub-sections describe the strength characteristics of the geological units and the groundwater conditions.

**Sand:** Deposits of sand were encountered in all boreholes drilled at site. State of compactness according to SPT ‘N’ counts has been determined as ‘medium dense to very dense’. According to Unified Classification System (UCS), these deposits lie in categories; ‘SM’, ‘SP’, ‘SP-SM’ and ‘SW-SM’. Table 4.7 summarizes the details of these deposits.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-01</td>
<td>0 to 21.0</td>
</tr>
<tr>
<td>BH-K-02</td>
<td>0 to 21.5</td>
</tr>
<tr>
<td>BH-K-03</td>
<td>0 to 22.5</td>
</tr>
<tr>
<td>BH-K-04</td>
<td>0 to 13.5</td>
</tr>
<tr>
<td>BH-K-05</td>
<td>0 to 21.2</td>
</tr>
<tr>
<td>BH-K-06</td>
<td>0 to 22.5</td>
</tr>
<tr>
<td>BH-K-07</td>
<td>0 to 19.5</td>
</tr>
<tr>
<td>BH-K-08</td>
<td>0 to 10.5</td>
</tr>
<tr>
<td>BH-K-09</td>
<td>0 to 21.0</td>
</tr>
<tr>
<td>BH-K-10</td>
<td>0 to 13.5</td>
</tr>
<tr>
<td>BH-K-11</td>
<td>0 to 16.5</td>
</tr>
<tr>
<td>BH-K-12</td>
<td>0 to 3.0, 4.5 to 20.0</td>
</tr>
<tr>
<td>BH-K-13</td>
<td>0 to 4.5, 12.0 to 22.5</td>
</tr>
<tr>
<td>BH-K-14</td>
<td>0.5 to 9.0, 12.0 to 16.5</td>
</tr>
<tr>
<td>BH-K-15</td>
<td>0.5 to 12.0</td>
</tr>
<tr>
<td>BH-K-16</td>
<td>0.0 to 3.0</td>
</tr>
<tr>
<td>BH-K-17</td>
<td>0 to 1.5, 4.0 to 10.5</td>
</tr>
</tbody>
</table>

**Silt:** Deposits of sandy/clayey silt were encountered in few boreholes drilled at site. State of compactness according to SPT ‘N’ counts has been determined as ‘soft to hard’. According to Unified Classification System (UCS), these deposits lie in categories; ‘ML’ and ‘CL-ML’. Table 4.8 summarizes the details of these deposits.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-12</td>
<td>3.0 to 4.5</td>
</tr>
<tr>
<td>BH-K-13</td>
<td>6.0 to 12.0</td>
</tr>
<tr>
<td>BH-K-14</td>
<td>9.0 to 12.0</td>
</tr>
<tr>
<td>BH-K-16</td>
<td>3.0 to 6.0</td>
</tr>
<tr>
<td>BH-K-17</td>
<td>1.5 to 4.0</td>
</tr>
</tbody>
</table>

**Clay:** Deposits of silty clay were encountered in few boreholes drilled at site. State of compactness according to SPT ‘N’ counts has been determined as ‘stiff’. According to Unified Classification System (UCS), these deposits lie in category; ‘CL’. Table 4.9 summarizes the details of these deposits.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-13</td>
<td>4.5 to 6.0</td>
</tr>
<tr>
<td>BH-K-14</td>
<td>0.0 to 0.5</td>
</tr>
<tr>
<td>BH-K-15</td>
<td>0.0 to 0.5</td>
</tr>
</tbody>
</table>
**Conglomerate:** Deposits of highly weathered and fractured conglomerate were encountered in four of the boreholes drilled at site. According to BS 5930 (based on unconfined compressive strength of rock), these deposits are classified as ‘extremely weak to very weak’ rock. The details regarding these deposits have been summarized in table 4.10.

<table>
<thead>
<tr>
<th>Table 4.10: Deposits of Conglomerate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Borehole No.</strong></td>
</tr>
<tr>
<td>BH-K-01</td>
</tr>
<tr>
<td>BH-K-04</td>
</tr>
<tr>
<td>BH-K-09</td>
</tr>
<tr>
<td>BH-K-11</td>
</tr>
<tr>
<td>BH-K-12</td>
</tr>
<tr>
<td>BH-K-14</td>
</tr>
<tr>
<td>BH-K-15</td>
</tr>
<tr>
<td>BH-K-17</td>
</tr>
</tbody>
</table>

**Sandstone:** Deposits of highly weathered and fractured sandstone were encountered in all boreholes. According to BS 5930, these deposits are classified as ‘very weak to weak’ rock. The details regarding these deposits have been summarized in Table 4.11.

<table>
<thead>
<tr>
<th>Table 4.11: Deposits of Sandstone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Borehole No.</strong></td>
</tr>
<tr>
<td>BH-K-01</td>
</tr>
<tr>
<td>BH-K-02</td>
</tr>
<tr>
<td>BH-K-03</td>
</tr>
<tr>
<td>BH-K-04</td>
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<td>BH-K-05</td>
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<tr>
<td>BH-K-06</td>
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<td>BH-K-07</td>
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<td>BH-K-08</td>
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<td>BH-K-09</td>
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<tr>
<td></td>
</tr>
<tr>
<td>BH-K-10</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>BH-K-11</td>
</tr>
<tr>
<td>BH-K-12</td>
</tr>
<tr>
<td>BH-K-13</td>
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<td>BH-K-14</td>
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<td>BH-K-15</td>
</tr>
<tr>
<td>BH-K-16</td>
</tr>
<tr>
<td>BH-K-17</td>
</tr>
</tbody>
</table>

**Mudstone:** Deposits of highly weathered & fractured mudstone were encountered in three of boreholes drilled at site. According to BS 5930, these deposits are classified as ‘very weak to weak’ rock. The details regarding these deposits have been summarized in Table 4.12.

<table>
<thead>
<tr>
<th>Table 4.12: Deposits of Mudstone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Borehole No.</strong></td>
</tr>
<tr>
<td>BH-K-02</td>
</tr>
<tr>
<td>BH-K-07</td>
</tr>
<tr>
<td>BH-K-11</td>
</tr>
<tr>
<td>BH-K-12</td>
</tr>
<tr>
<td>BH-K-13</td>
</tr>
<tr>
<td>BH-K-15</td>
</tr>
<tr>
<td>BH-K-17</td>
</tr>
</tbody>
</table>
**Clay stone:** Deposits of highly weathered and fractured clay stone were encountered in three boreholes. According to BS 5930, these deposits are classified as ‘extremely weak’ rock.

The details regarding these deposits have been summarized in Table 4.13.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-05</td>
<td>21.2 to 24.0</td>
</tr>
<tr>
<td>BH-K-09</td>
<td>30.0 to 31.5</td>
</tr>
<tr>
<td></td>
<td>34.5 to 36.0</td>
</tr>
<tr>
<td>BH-K-11</td>
<td>25.5 to 27.0</td>
</tr>
<tr>
<td>BH-K-12</td>
<td>34.5 to 36.0</td>
</tr>
<tr>
<td>BH-K-15</td>
<td>24.0 to 36.0</td>
</tr>
</tbody>
</table>

**Gravel:** Deposits of gravel were encountered in two boreholes. State of compactness according to SPT ‘N’ counts has been determined as ‘very dense’. According to Unified Classification System (UCS), these deposits are classified as ‘GM’. Table 4.14 summarizes the details of these deposits.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-08</td>
<td>10.5 to 21.0</td>
</tr>
<tr>
<td>BH-K-10</td>
<td>25.5 to 27.5</td>
</tr>
</tbody>
</table>

**Siltstone:** Deposits of highly weathered and fractured siltstone were encountered in two boreholes. According to BS 5930, these deposits are classified as ‘extremely weak to weak’ rock. The details regarding these deposits have been summarized in Table 4.15.

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-09</td>
<td>28.5 to 30.0</td>
</tr>
<tr>
<td></td>
<td>31.0 to 34.0</td>
</tr>
<tr>
<td></td>
<td>37.0 to 40.0</td>
</tr>
<tr>
<td>BH-K-10</td>
<td>22.0 to 27.5</td>
</tr>
<tr>
<td></td>
<td>28.0 to 30.0</td>
</tr>
<tr>
<td>BH-K-14</td>
<td>21.0 to 25.5</td>
</tr>
</tbody>
</table>

**Groundwater Conditions:** Groundwater was encountered at a depth ranging from surface to 4.8 meters below existing ground level in the boreholes, drilled onshore, at the time of investigation. However, this may fluctuate due to tidal, seasonal and other environmental variations.
Figure 4.16 – Location of boreholes
4.2.4 Soil Quality

Three (03) soil samples were collected from plant site surrounding areas for analysis: sample 1 was collected from power plant site, sample 2 was collected from ash pond site while sample 3 was collected from coal jetty construction site. The samples were analyzed for pH, metals organic carbon and matter. There are no regulatory criteria for soils. To provide the context to discuss the soil analysis results for metals and understand if there are any environmental or health risk, the target limit for metals in the soil is set as three times the average abundance of metals in the earth’s crust. A parameter is considered ‘elevated’ if its concentration in the soil sample is more than three times its average crustal abundance.

![Figure 4.17 – Location of Soil Samples](image)

The average pH of soil collected from two sampling points is 7.3. The average organic matter is 0.27%, while average organic carbon is 0.18% for the soil collected from three sampling points of plant site. The concentration of all the parameters have been found within three times crustal abundance. Soil analysis results are provided in Table 4.16.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>LOR</th>
<th>Three Times Crustal Abundance</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td>7.3</td>
<td>7.3</td>
<td>7.4</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>%</td>
<td></td>
<td></td>
<td>0.28</td>
<td>0.23</td>
<td>0.32</td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>%</td>
<td></td>
<td></td>
<td>0.18</td>
<td>0.17</td>
<td>0.21</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/kg</td>
<td>1</td>
<td>6.3</td>
<td>2.24</td>
<td>2.38</td>
<td>2.43</td>
</tr>
<tr>
<td>Boron</td>
<td>mg/kg</td>
<td>5</td>
<td>26.1</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/kg</td>
<td>0.05</td>
<td>0.5</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/kg</td>
<td>0.05</td>
<td>420</td>
<td>31</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/kg</td>
<td>0.5</td>
<td>204</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
### Table 4.16: Soil Analysis Results

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>LOR</th>
<th>Three Times Crustal Abundance</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>mg/kg</td>
<td>0.5</td>
<td>189,000</td>
<td>Sample 1</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/kg</td>
<td>1</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/kg</td>
<td>1</td>
<td>3,300</td>
<td>208</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/kg</td>
<td>0.5</td>
<td>270</td>
<td>22</td>
</tr>
<tr>
<td>Selenium</td>
<td>mg/kg</td>
<td>5*</td>
<td>0.225</td>
<td>0.13</td>
</tr>
</tbody>
</table>

### 4.2.5 Bathymetry Of The Channel

The PQA channel shall be used for the transportation of coal and for this reason a Bathymetric Survey was undertaken to map the sea floor. The area between PIBT – QICT – PTCL was surveyed employing Hypack 2009.

![Figure 4.18 - The Study Area](image)

**Survey Instrument:** A single screw wooden survey boat with trained operator for manning the console has been used. The HYPACK program allowed advance planning of the survey lines and precise navigation of these lines with the help of resolved GPS position in real time. The screen became a real time Helm for tracking the vessel. The following survey instruments have been used for the bathymetric survey & coast lining / topographic survey.
### Instruments used for Bathymetric Survey with Calibration dates

<table>
<thead>
<tr>
<th>Make &amp; Model with Sr. No</th>
<th>Purchased/Calibration Date</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimble 5800 L1,L2 (LRK/RTK) GPS Sr. # : 4437137804</td>
<td>12 June 2012</td>
<td><a href="http://www.trimble.com/">Trimble</a></td>
</tr>
<tr>
<td>Trimble 5700 L1,L2 (LRK/RTK) GPS Sr. # : 0220308776</td>
<td>07 February 2013</td>
<td><a href="http://www.trimble.com/">Trimble</a></td>
</tr>
<tr>
<td>Pacific Crest Radio Modem (PDL HPB 19,200bps) Sr. # : 011835753 &amp; 06458009</td>
<td>11 January 2010</td>
<td><a href="http://www.pacificcrest.com/">Pacific Crest</a></td>
</tr>
<tr>
<td>SYQwest Bathy-500 Multi Frequency Echo-Sounder Sr. # : B5MF-0422</td>
<td>11 January 2010</td>
<td><a href="http://www.syqwestinc.com/">Syqwest</a></td>
</tr>
</tbody>
</table>

**Survey Parameters:** Following survey parameters were used for the bathy survey which was provided by the PQA.

- **Spheroid:** WGS-84
- **Semi-major Axis:** 6378137.0m
- **Flattening:** 298.2572235630
- **Projection:** UTM
- **Zone:** North-42
- **Origin of Latitude:** 00 N
- **Origin of Longitude:** 69 E
- **False Easting:** 500,000
- **False Northing:** 0
- **Scale Factor:** 0.9996

**Bathymetric Survey:** Bathymetric survey was carried out with a line spacing 10m and 25m apart inside the creeks. SYQWest Bathy 500MF Echo Sounder integrated with Hydrographic Survey System. Echo sounder has been used & calibrated by using disk bar method.

Precise position was achieved by using the Trimble Navigation’s RTK GPS 5700dual frequency receivers combined with a real time telemetric differential data link with shore stations. The system was a real time kinematic system (RTK) with 35 watts power radio modems linked to Trimble 5700 placed on base station onshore. The receiving rover station (Trimble 5700) was installed on the boat for logging data to an onboard computer running hydrographic survey package HYPACK (Figure 4.20).
HYPACK was running on a laptop computer with high resolution color display onboard the survey vessel with trained operators manning the console. The HYPACK program allowed advance planning of the survey lines and precise navigation of these lines with the help of resolved GPS position in real time. The screen was a real time Helm for tracking the vessel. Accuracy of survey is adopted as per IHO standard and specification.

Real Time RTK tide has been measured by using HYPACK software and Trimble 5700 RTK system & has been subtracted from the sounding. RTK tide was also be cross checked with offshore tide.
Quantity Calculation: Hypack® software utility “Cross Section & Volumes” has been used for the calculating the dredging volume for the proposed channel. The cross section interval is 50m for the studied options.

**Option I:** Channel length is 2.1km, width 148m with 1:3 side slopes at 12.5m below Chart Datum. Total Dredging quantities are 1,848,367.06m³.

**Option II:** Channel length is 2.875km, width 148m with 1:3 side slopes at 12.5m below Chart Datum. Total Dredging quantities are 2,745,745.99m³.

![Figure 4.22 - SYQWest Bathy 500MF Echo Sounder](image)
Figure 4.23 – Bathymetry of Sea Floor and Options for Jetty

Option 1

Option 2
4.2.6 Seismicity

The Geological Survey of Pakistan has defined the area of Port Qasim, where the site under study is located, to fall in a Seismic Zone 2B region. This suggests the possibility of moderate to major seismic hazards i.e. probability of earthquakes of intensity VI to VIII MM scale and 5.6 to 6.6 on Richter scale. From the charts published, the peak ground level acceleration (PGA) for this zone is 28%. The seismic risk factor of 0.2 is advisable and will need to be incorporated in the design for constructions and installations in the coastal zone, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-VI to VIII). The design of the project must take these values into consideration.

Fig. 4.24. Seismic Hazard Zones of Pakistan (after Geological Survey of Pakistan, 2005)
4.2.7 Tsunamis

Tsunamis in Indo-Pak region are relatively rare. Destructive tsunamis that may have occurred in the Arabian Sea have not been documented. The oldest known tsunamis in North Indian Ocean are in 326 BC, 1008 AD, 1884 AD, 26th June 1941 and 27th /28th November 1945 (origin Makran).

Major damages done by Tsunamis, the impulsively generated seawater waves that are a result of underwater earthquakes, have not been recorded for the coastal area south of Karachi. There are, however, evidences of a 1.2 m tsunami generated by an offshore earthquake of intensity 8 M in 1945, which caused only minor damages in Port Qasim area. This event was followed by another Tidal wave that was recorded in 1953. The Tsunami of December 26, 2004 had no impact on the macro environment of the Port Qasim area.

4.2.8 Cyclones & Storms

Tropical Cyclones contain heavy bands of clouds and cause heavy rains during landfall or sometimes cross along the coast far away. Heavy rainfall occurs as the end result. The Arabian Sea is known to be frequented by general cyclonic storms and some of these had been among the worst cyclonic storms of the world from their severity point of view, resulting in huge losses to life and property in the coastal areas. A significant number of the cyclonic storms produced in the Arabian Sea move towards north and northeast and some of them land in Pakistan. However most of these cyclones which tend to move towards southern part of the Pakistan coast very often reciprocate towards eastern coast of India.

High heat content of the Arabian Sea that is adjacent to the extensive heat zone of Pakistan usually upsets the heat balance and hence the water-balance of the region, particularly because it is the destination of windstorms. Tropical cyclones generally develop over Arabian Sea in low latitude i.e. 5-20 degrees north and dissipate after they move over land. The maximum frequency of tropical cyclone formation occurs in April, May and June and in the October-November period. The month of June receives least tropical cyclones in the region. About 76% of tropical cyclones in Karachi approach from the south through the east. The one that came near the coastal area on May 12, 1999 changed its direction and hit the coastal area of Badin, however Karachi was safe from this cyclone as it is located in the peripheral area and only rain showers of moderate intensity were recorded. The cyclone in September 2006 proceeded towards coastal belt of Badin; but it did not hit the area and changed its direction. Although some cyclones have passed near the coastal belt of Badin but still it is classified outside the zone of cyclone activity for the Arabian Sea. Soon after the beginning of June 07 the tropical cyclone Gonu visited the Coastal area of Oman for the first time in history and set the beginning of destruction over the coastal area of western Baluchistan. At this time it seemed that cyclone Yemyin was trekking westward south of Sindh and Baluchistan while also weakening, but numerical forecasts were indicating that a huge, strong system was developing high up in the sky diagonally on the path i.e. Arabia and Iran and thereby cutting off the impact and almost restraining the cyclonic system to proceed further from the Indus Delta and proceeding towards Karachi. On the night of July 3, 2007 Sindh especially lower Sindh received widespread rains, but luckily Karachi escaped from a high impact of this system. Scattered rains in Sindh with isolated heavy falls in eastern Sindh occurred. The June 6, 2010 cyclone 03A, nicknamed Phet had landed on the coast of Oman and had lost its intensity. Moving in clockwise direction it poured heavy rains on Gwadar and Pasni. The rain bearing winds moved along the coastline towards Karachi. It touched Karachi only tangentially and brought 100 mm rainfall two days before it landed south of Thatta District.

The low cloud covers and increased sunshine results in rise in temperature of landmass in the hinterland. Moenjo Daro recorded the world record of 55°C on May 25. Such high temperatures on vast territory has (i) turned large territory of Pakistan into an extensive heat zone, and (ii) raised the temperature of the North Arabian Sea by 1°C to 1.5°C. The heat zone serves as the main heat engine and the significant rise
in temperature of the Arabian Sea leading to higher salinity can trigger cyclones in the Arabian Sea just south of Project area besides heavy monsoon rains all over the Indo-Pakistan region. Such rise in temperature indicates onset of low-pressure zone on land and salinity steep gradient on the sea. The former parameter can attract rain bearing winds in case they are around, while the latter can nucleate cyclones/storms.

The Table 4.17 shows the movement of cyclones and storms in the Arabian Sea. The movement is generally in the west-north-westerly direction. Thunderstorm frequency is also low and is reported to occur at an average rate of 10 thunderstorms/year.

<table>
<thead>
<tr>
<th>Sr. #</th>
<th>Year</th>
<th>Type/ Location of Cyclone</th>
<th>Wind Speed Range (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>May 2001</td>
<td>Very Severe Cyclonic Storm/East Central Arabian Sea</td>
<td>&gt; 118</td>
</tr>
<tr>
<td>10.</td>
<td>May 2004</td>
<td>Very Severe Cyclonic Storm/Southeast Arabian Sea</td>
<td>&gt; 118</td>
</tr>
<tr>
<td>13.</td>
<td>02 June 2007</td>
<td>Tropical Cyclone/East Central Arabian Sea</td>
<td>62 – 88</td>
</tr>
</tbody>
</table>
| 14.   | 07 June 2007 | Very Severe Cyclonic Storm/North-westerly of East Central Arabian Sea | > 118 |)
| 15.   | 21 June 2007 | Tropical Cyclone (Deep Depression)/Northeast Arabian Sea | > 50                 |
| 16.   | 07 June 2010 | Tropical Cyclone/Northeast Arabian Sea       | > 50                    |

Coastal Sindh is more vulnerable than the west coast of Pakistan to storm surges, associated with the severe cyclonic storm generated in the adjoining Arabian Sea. The available data on cyclones and storm reveals that Pakistan is vulnerable mostly during the period from April through June while no storm has ever been observed during January to March (Table 4.18). The main cyclonic activity in the Project Area takes place in the month of June. All the cyclonic storms that emerge in the Arabian Sea either curve sharply into the Gulf of Kutch or cross the Arabian Sea from East to West and end up at the coast of the Arabian Peninsula creating some storm surges at the coast (UNESCAP, 1996). When the cyclones cross the coast they are accompanied by storm surges, generally known as storm tides. The cyclones that cross the coast in the month of June generate winds of approximately 15-18 m/s.

<table>
<thead>
<tr>
<th>Months</th>
<th>Intensity of Storms on an arbitrary scale 0-4</th>
<th>Primary Area of activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>0-no storm</td>
<td>S. Arabian Sea</td>
</tr>
<tr>
<td>Feb</td>
<td>0-no storm</td>
<td>S. Arabian Sea</td>
</tr>
<tr>
<td>Mar</td>
<td>0-no storm</td>
<td>N Arabian Sea</td>
</tr>
<tr>
<td>Apr</td>
<td>2</td>
<td>N Arabian Sea</td>
</tr>
<tr>
<td>May</td>
<td>3</td>
<td>N Arabian Sea</td>
</tr>
<tr>
<td>Jun</td>
<td>3</td>
<td>N Arabian Sea</td>
</tr>
<tr>
<td>Jul</td>
<td>1</td>
<td>N Arabian Sea</td>
</tr>
<tr>
<td>Aug</td>
<td>1</td>
<td>North and Central Arabian Sea</td>
</tr>
<tr>
<td>Sep</td>
<td>2</td>
<td>South eastern Arabian Sea</td>
</tr>
<tr>
<td>Oct</td>
<td>4-severe</td>
<td>South eastern Arabian Sea</td>
</tr>
<tr>
<td>Nov</td>
<td>4-severe</td>
<td>South eastern Arabian Sea</td>
</tr>
<tr>
<td>Dec</td>
<td>1</td>
<td>South eastern Arabian Sea</td>
</tr>
</tbody>
</table>
Tropical cyclones squander between Gulf of Cambay and Karachi. The size of the tropical cyclones is generally 270-720 Km with an average speed of 7 to 18 Km/hr. Majority of the cyclones land in the vicinity of Indus deltaic creek system creating storm surges of few feet height. In the creek system the tidal range is quite high which is favorable for the amplification of surges. If the peak surge does not occur close to the time of high tide, no major water level oscillations occur in this region. Beside these, the SW monsoon wind also blows in June and adds about 0.3 m of surge to the current tides. Thus very high tidal level over 4.0 m prevailing in the Port Qasim region inundate the creek banks and erode the coastal areas.

Sometime the cyclones cross the deltaic coast itself. Cyclones generally constitute the strong winds having the speed of over 60 Knots and the central pressure as low as 980 mb. The wind and low pressure creates the storm surges which when combined with high tides, becomes a destructive force in the coastal area. Coastal erosion and inundation are commonly associated with storm surges. Beside the cyclones, several depression with less severe intensity frequently occur in the northern Arabian sea, which are also related with surges. These surges which are about 0.5 m in height, when combined with HHW becomes the potential source of the erosion thus creating high waves in the open sandy coast thereby increasing tide water level favoring tidal inundation.

Tidal data recorded at Port Qasim as well Karachi Port was obtained and analyzed for the separation of surges on the basis of the recorded values. 1982 was selected for analysis due to the fact that the data for both the parts was available for that particular year. It was observed that maximum surge was never more than 2.0 feet. When surge occurs at the rising tide, it builds up whereas during falling tide the interactive effect reduces its intensity. Although most of the storms resulted in the rise of sea level but the surge height was never critical. Nevertheless, the coastal topography being gentle and flat, even a surge of 2.0 feet during spring tide can create flooding.

Analysis of the tidal data on surges for Karachi for the period of fourteen years has been extracted and is recorded in Table 4.19.

Table 4.19: High tides and surges in past

<table>
<thead>
<tr>
<th>Month</th>
<th>Height of tide (ft)</th>
<th>Height of surges (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun 58</td>
<td>9.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Jul 58</td>
<td>8.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Oct 58</td>
<td>9.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Nov 58</td>
<td>8.1</td>
<td>0.8</td>
</tr>
<tr>
<td>May 59</td>
<td>9.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Jun 59</td>
<td>6.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Jun 59</td>
<td>9.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Jun 64</td>
<td>8.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Jun 70</td>
<td>8.4</td>
<td>2.0</td>
</tr>
</tbody>
</table>


4.2.9 Waves

The waves and their height at Karachi Coast vary with the season. During NE winter monsoon the wind speed is around 10 knots and the coastal waters are almost calm and the wave height is less than 1 meter. During SW summer monsoon the winds pick up speed of about 25 knots; the wave height on the Karachi Coast is then in the range of 3 to 4 meters. In the interim months i.e. inter-monsoon period the wave height is around 1.5 to 2.5 meters.

Pakistan lies to the northern end of the Arabian Sea that extends southwards into the Indian Ocean for thousands of kilometers. The coast is exposed to waves from the south, southwest and west. The distances involved mean that the wave generation times, and consequently the wave periods may be very long. During the severe weather in the summer due to the monsoons, the majority of the wind, and hence
the waves come from the southwest. During the winter months, however, the weather conditions are very different, with the wind no longer coming predominantly from one direction. Therefore, in the winter both swell waves and locally wind generated waves influence the coast.

For the swell waves, voluntary observations of weather data by ships of passage are considered to give the most realistic offshore wave data. However, for the locally generated waves, wind data from nearby coastal stations are considered to be more accurate.

Deep sea wave data, for the SW monsoon months (May to September) applicable to Pakistan coast is given in Table 4.20.

<table>
<thead>
<tr>
<th>Resultant Wave Height (m)</th>
<th>Wave Period (Seconds) for Higher of Sea/Swell Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-3</td>
</tr>
<tr>
<td>0 to 0.5</td>
<td>2.6%</td>
</tr>
<tr>
<td>0.6 to 1.0</td>
<td>1.1%</td>
</tr>
<tr>
<td>1.1 to 1.5</td>
<td>1.2%</td>
</tr>
<tr>
<td>1.6 to 2.0</td>
<td>0.1%</td>
</tr>
<tr>
<td>2.1 to 2.5</td>
<td>0.0%</td>
</tr>
<tr>
<td>2.6 to 3.0</td>
<td>1.3%</td>
</tr>
<tr>
<td>3.1 to 4.0</td>
<td>1.1%</td>
</tr>
<tr>
<td>4.1 to 5.0</td>
<td>0.2%</td>
</tr>
<tr>
<td>5.1 to 6.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>6.1 to 7.0</td>
<td>0.2%</td>
</tr>
<tr>
<td>7.1 to 8.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>8.1 to 9.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>9.1 to 10.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>10.1 to 12.0</td>
<td>0.0%</td>
</tr>
<tr>
<td>12.1 or more</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5.1%</td>
</tr>
</tbody>
</table>

Notes:
1. Sea Area Coverage: 15-25 N, 60-70 E
2. Seasonal Coverage: May to September
3. Period of data: January 1949-October 1995
4. Blank indicates zero frequency whilst 0.0% indicates less than 0.05%
5. Total number of observations were 38143

Source: EIA report of EVTL Terminal by Hagler Bailly Pakistan

### 4.2.10 Tides

Tides along Karachi Coast are semidiurnal but diurnal inequality is also present. The effect of this inequality shows up in daily tidal cycle as there are two High Waters and two Low Waters which also vary considerably from each other in tidal heights. These are classified as HHW, LHW, LLW and HLW. The tides move from west to east i.e. the tide at the Hub River estuary arrives about 20 minutes earlier than at Karachi. Similarly the tides at Karachi Harbor arrive at about 10 minutes earlier than at entrance of Port Qasim. When tides progress up the Phitti Creek its magnitude increases and there is a time lag. At Port Bin Qasim which is about 32 km from Karachi and is located about 25 km ups the creek from the sea the tides reach after 22 minutes. At Gharo Creek tides fall rapidly due to frictional effects and the gradual weakening of the tidal forces. At Gharo 60 km from the Phitti Creek entrance the tides are almost half of the mean sea tides at the entrance.

The tides at Port Qasim are predominantly semi-diurnal with a substantial diurnal component. The Mean Higher High Water (MHHW) to Mean Lower Low Water (MLLW) range is about 2.4 m at the port complex while the peak tide over diurnal range is about 3.5 m. The tide levels at Port Qasim are presented in Table 4.21. The flow pattern within this large, relatively deep and generally stable creek system around Port Qasim is strongly influenced by tides and the presence of extensive inter-tidal flats.
### Table 4.21: Tidal Levels at Port Qasim

<table>
<thead>
<tr>
<th>Location</th>
<th>MLLW</th>
<th>MLHL</th>
<th>MLHW</th>
<th>MHH</th>
<th>HAT</th>
<th>LAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundal Island</td>
<td>+0.6</td>
<td>+1.2</td>
<td>+2.3</td>
<td>+2.9</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Hasan Point</td>
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<td>+1.3</td>
<td>+2.8</td>
<td>+2.9</td>
<td>+3.4</td>
<td>+0.6</td>
</tr>
<tr>
<td>Phitti Creek</td>
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<td>+1.4</td>
<td>+2.1</td>
<td>+3.4</td>
<td>+4.00</td>
<td>-0.6</td>
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</tbody>
</table>

### 4.2.11 Seawater Currents

The speed of sea currents is generally low: ~0.5 knots. The speed increases up to 1 knot during SW monsoon. The direction of the sea current is directly related with the prevailing wind system. The set is generally easterly in the SW monsoon and westerly in the NE monsoon. The slight difference in direction in the Western and Eastern part of Karachi Coast is due to circulatory pattern of the current around gyral which are usually formed at the center of the sea. There is a clockwise gyre during SW monsoon and anti-clockwise gyre during NE monsoon (Quraishee, 1988). Quraishee (1984, 1988) has also observed the existence of warm core eddies in the offshore areas of Pakistan.

### 4.2.12 Air & Seawater Temperature

According to UNESCAP Report (1996) the average annual sea-surface temperature in near shore waters along Karachi Coast Ranges between 20.7°C and 29.3°C as shown in Table 4.22. During winter months the temperature range is 20.7°C to 23.8°C whereas during summer months the range is between 27.9°C to 29.3°C. In the creeks along Indus Delta the sea-surface temperature generally ranges between 23.4°C to 29.5°C as shown in Table 4.23. Water temperature in tidal channels in the Indus Delta creeks have been reported from 19°C in January to 30°C in June (Harrison et al. 1994, Zaqoot, 2000). The temperatures at a depth of 100 m are lower and generally have an annual range between 19.5°C to 24.5°C.

#### Table 4.22: Monthly distribution of temperature along the Pakistan Coast (UNESCAP, 1996)

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<tr>
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<th></th>
<th></th>
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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Air</td>
<td>Indus delta</td>
<td>19.2 %</td>
<td>23.6 %</td>
<td>20.2 %</td>
<td>23.8 %</td>
<td>24.3 %</td>
<td>24.9 %</td>
<td>29.0 %</td>
<td>27.0 %</td>
<td>29.5 %</td>
<td>27.9 %</td>
<td>30.0 %</td>
</tr>
<tr>
<td>Karachi Coast</td>
<td>19.2 %</td>
<td>23.5 %</td>
<td>20.5 %</td>
<td>23.8 %</td>
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<td>24.8 %</td>
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<td>27.9 %</td>
<td>30.0 %</td>
<td>29.3 %</td>
</tr>
<tr>
<td>Gwadar</td>
<td>18.3 %</td>
<td>20.2 %</td>
<td>19.5 %</td>
<td>20.2 %</td>
<td>22.3 %</td>
<td>22.0 %</td>
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<td>30.1 %</td>
<td>26.5 %</td>
<td>31.2 %</td>
<td>28.3 %</td>
</tr>
<tr>
<td>Air</td>
<td>Indus delta</td>
<td>29.5 %</td>
<td>28.7 %</td>
<td>28.0 %</td>
<td>28.5 %</td>
<td>26.5 %</td>
<td>27.0 %</td>
<td>27.0 %</td>
<td>27.8 %</td>
<td>23.5 %</td>
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<td>28.0 %</td>
<td>28.0 %</td>
<td>28.5 %</td>
<td>27.3 %</td>
<td>27.2 %</td>
<td>27.0 %</td>
<td>27.5 %</td>
<td>24.4 %</td>
<td>27.0 %</td>
<td>20.7 %</td>
</tr>
<tr>
<td>Gwadar</td>
<td>29.2 %</td>
<td>27.3 %</td>
<td>28.5 %</td>
<td>28.0 %</td>
<td>29.4 %</td>
<td>28.3 %</td>
<td>27.0 %</td>
<td>28.0 %</td>
<td>23.1 %</td>
<td>25.3 %</td>
<td>20.1 %</td>
<td>23.2 %</td>
</tr>
</tbody>
</table>

#### Table 4.23: Sea-water Temperature of Creeks

<table>
<thead>
<tr>
<th>Locations</th>
<th>Sea water Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizri Ck (top end)</td>
<td>21°C</td>
</tr>
<tr>
<td>Gizri Ck (DHA club)</td>
<td>20°C</td>
</tr>
<tr>
<td>Korangi Ck (Rehri)</td>
<td>22°C</td>
</tr>
<tr>
<td>Korangi Ck (Lath Basti)</td>
<td>23°C</td>
</tr>
<tr>
<td>PSO Oil Jetty</td>
<td>25°C</td>
</tr>
<tr>
<td>Phitti Creek</td>
<td>22.7°C</td>
</tr>
<tr>
<td>Jhari Creek</td>
<td>23°C</td>
</tr>
<tr>
<td>Chara Creek</td>
<td>23°C</td>
</tr>
<tr>
<td>Gharo Creek</td>
<td>24°C</td>
</tr>
</tbody>
</table>

### 4.2.13 Water Resources

**Surface Water:** There is no significant natural freshwater source in the project area. The Arabian Sea is the only surface water body in the region. It is bordered on the north by Pakistan and Iran, on the west by the Arabian Peninsula, and on the east by the western coast of India. Arabian Sea has a surface area of
about 3,862,000 km$^2$ and a maximum depth of over 4.5 km. The proposed site for DPKPG is located along the section of Arabian Sea coastline that is made up largely of saltwater creeks, mudflats, and mangrove forests. The site lies along the Gharo creek, which is accessible from open water via the Korangi or Phitti creeks.

The existing bulk water supply system conveys water to Karachi from two main sources, namely, Indus River and Hub Dam. Water from the Indus River is distributed over Sindh Province through three barrage systems, namely, Guddu, Sukkur and Kotri. Urban and industrial water for Karachi is taken from the Kotri Barrage and discharged through the Kalri Baghar Feeder Upper (KB Feeder Upper) to Keenjhar Lake. Kotri Barrage is the lowest barrage on the River Indus. It was completed in 1955 to command a gross area of 1.34 Mha (13,400 km$^2$) mainly on the left (east) bank of the Indus and southeast of Hyderabad. The right (west) bank command of 310,000 ha (3,100 km$^2$) gross is supplied by a single canal, the KB Feeder which also supplies Karachi 150 km west-southwest of the off-take. The KB Feeder Upper has a design capacity at its head of 9,075 cusecs (22,300,000 m$^3$/d) and terminates at the head of Kinjhar Lake. This is also the off take for the Right Bank Link Canal which, since it was opened in 1982, has enabled water from the KB Feeder Upper to be supplied directly to the KB Feeder Lower without passing through the lake. This allows unsettled silty water to be supplied to downstream irrigators and also serves to reduce sedimentation of the lake.

Indus River, the main source of water for Karachi, is severely constrained by dry season demand, but has abundant wet season discharges. Except during the summer flood season, very little water escapes to the sea. The quota for urban supplies in Karachi from the River Indus was first sanctioned on May 11, 1957, which allowed Karachi to take 450 cusecs (242 mgd or 1,100,000 m$^3$/d) from 16 October to 15 April (rabi) and 520 cusecs (280 mgd or 1,270,000 m$^3$/d) from 16 April to 15 October (kharif) from the Kotri Barrage system through the Kalri Baghar Feeder and the Keenjhar Lake. Later, a presidential decree in 1988 increased this quota to 1,200 cusecs (645 mgd or 2,940,000 m$^3$/d).

Hub Dam is a multi-purpose dam (municipal, industrial and irrigation purposes) constructed on the Hub River approximately 50 km to the north-west of Karachi City. Construction of Hub dam started in September 1963 and completed after 18 years in September 1981. Construction of the Lasbela Canal and Hub Main Canal was completed in September 1981 and September 1982 respectively. The catchment area of the dam extends across two provinces namely Sindh and Balochistan covering a total area of 3,410 sq. miles (8,730 km$^2$). The existing bulk water supply system for Karachi City (Figure 4.25) has a capacity of 600 mgd as summarized in Table 4.24.

<table>
<thead>
<tr>
<th>Bulk Water System</th>
<th>Rated Capacity</th>
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</thead>
<tbody>
<tr>
<td>GK System*</td>
<td>280 mgd</td>
</tr>
<tr>
<td>Haleji System</td>
<td>20 mgd</td>
</tr>
<tr>
<td>K-II System</td>
<td>100 mgd</td>
</tr>
<tr>
<td>K-III system</td>
<td>100 mgd</td>
</tr>
<tr>
<td>Dumlottee Wells</td>
<td>20 mgd</td>
</tr>
<tr>
<td>Hub system</td>
<td>80 mgd</td>
</tr>
<tr>
<td>Total</td>
<td>600 mgd</td>
</tr>
</tbody>
</table>

*: downstream of Fore Bay
Source: Karachi Water Supply Improvement Project, KW&SB
Figure 4.25: Existing Bulk Water Supply Network

The water distribution network in Karachi covers 18 towns, 6 Cantonments and a Defense Housing Authority (DHA) Area. These 18 towns are included in 5 administrative water supply zones classified by KW&SB, which is shown in Figure 4.54.

Figure 4.26: Present Water Supply Zones

Water is supplied through water trunk mains from water filtration plants, reservoirs, pumping stations or Dumlottee Wells (depending on recharge of aquifer) in the city of Karachi. Port Qasim Authority (PQA)
also gets its bulk water supply from Karachi Water & Sewerage Board to distribute water to other businesses.

Surface water resources in the macroenvironment of the ecosystem are limited to the catchment area of Ghaggar, Pipri and Badal Nalas, which run from the north and passing through the Bin Qasim Town fall in the Gharo Creek. On the west of the shoreline the Nalas are not prominent; while the Lyari which brings freshwater only during the monsoon season is grossly polluted with industrial as well as sewage effluent.

The Pipri and Badal Nala remain dry during the dry season. During wet season there is flooding along the banks due to heavy rain. Pipri Nala and Badal Nala have an extensive catchment area starting from the far northern edge of Port Qasim industrial zone to the shoreline in the south at Arabian Sea. Both Nalas merge near the Engro Asahi plant.

The Ghaggar Nala is a component of Ghaggar-Dhabeji-Gharo eco-subsystem which is governed by the catchment area of Ghaggar, a natural non-perennial stream that flows North-South along the Eastern boundary of Eastern Industrial Zone of Port Qasim. It finally drains into the Choudhry Creek. The stream discharge depends on the rainfall in its catchment shown in Figure 4.27. The rainfall record for the years 2001 to 2007 at Karachi Airport and Meteorological Department shows wide range monthly and annual variation. Monthly precipitation varies from almost nil in the month of March, April and May and November to maximum in July and August. Similarly year 2002 and 2004 had very little rains (55.5mm and 65.9mm), while year 2003 and 2006 were wet years with 324.9mm and 301.1mm rainfall respectively. The quality of Ghaggar water is sweet, however, the physical examination indicates that municipal as well as industrial wastewater is being discharged into the stream and is polluting it.

The groundwater samples in Ghaggar ecosystem had SAR ranging from 2.17 to 8.03 and 16.52. Samples of the well water had TDS ranging between 478 mg/liter and 4040 mg/liter, and dissolved oxygen ranging from 0.82 to 4.84. The samples were collected after November. The SAR values being higher than the range for fresh water, the analysis in all cases except one corresponds to that of leachates of soil of mineral origin, while their biological analysis shows that they are all contaminated with sewage organisms. The analysis of well water sample with SAR 16.52, TDS 4040 mg/L, DO 1.27 and high concentration of sodium and chloride ions corresponds to that of water of marine origin implying the possibility of seawater intrusion due to extensive extraction of groundwater from deep down strata. Analysis of surface water sampled from Ghaggar area after the rains showed that the water accumulations in the nalas had SAR ranging from 1.25 to 1.77 and the domestic effluent SAR was 3.33. The surface water samples had TDS ranging between 113 mg/liter to 229 mg/liter, and dissolved oxygen ranging from 1.76 to 4.58. The DO of the sewage effluent was 3.49 mg/L. As expected the SAR values were within the range for fresh water, but the low DO indicated biological contamination, which is confirmed by the presence of faecal organisms in all samples.
Ground Water: Groundwater level is generally high in the project area due to the presence of sea in the vicinity; however, the quality of ground water is not potable and is unfit for drinking purposes. In the high tide season, sea water intrudes the ground water level and affects the ground water depth.

Coastal Water Quality: About 60-70% of the water supplied to Karachi City is said to return as sewage. A total quantity of 315 mgd (1,432,000 m³/d) of domestic and toxic industrial wastewater is generated in
the city. There are three sewage treatment plants in Karachi. The total design capacity of these treatment plants is 151 mgd (686,000 m$^3$/d). The untreated sewage is disposed of into the sea through nallah and rivers including the Lyari and Malir Rivers. The total length of sewers is approximately 3,290 km and ranges from 8 inches (200 mm) to 84 inches (2,130 mm) diameter of trunk sewers, secondary sewers and laterals.

Domestic sewage is a major source of pollution. National Conservation Strategy (NCS) states that almost 40% of deaths are related to water borne diseases. The situation is further aggravated by the addition of untreated wastewater from small-scale industries.

The large and small industrial units in the Landhi and Korangi Industrial Areas discharge their waste water into Korangi Nallah which terminates into the Malir River at the Gizri Creek. But for the disposal into the storm water drains, which are poorly maintained, the waste water handling in these industrial areas is not that unsystematic as in the SITE whose effluent is discharged into the Lyari. Here the major polluting units pertain to textile and leather goods production but other diversified industries producing pharmaceuticals, food products, glass, refractories, ultramarine blue, and refineries processing petroleum are also carrying out their activities equally effectively.

The Steel Mills and the Port Qasim thermal power stations use sea water for cooling purposes and they discharge the hot water into Phitti Creek. The Korangi Thermal power station and the one on the premises of Sind Alkalis discharge their hot water into the Korangi Creek. The hot water discharged by the power stations has a temperature 4 to 10°C higher than sea water and does not seem to have disturbed the ecological balance in any way because the organisms have perhaps adapted themselves to the warm environment of the tropics already.

The Korangi Creek also has some well-established salt works which have been producing some good quality sea salt since times before Partition. These units, unlike the ones in the Manora Channel, receive uncontaminated input from the intake channel constructed for the purpose. These open into the creek whose water has the higher salinity required for salt production. The salt works, however, do not utilize bittern, the waste product which is higher in ionic concentration than sea water and discharge it into the sea. This output is low and hence they may not be considered as polluting industries. Their input may also not be considered as polluted by industrial effluents because it is sufficiently diluted to have any adverse effect on the process of crystallization, which is all that this industry deals with.

The Korangi Creek receives strong sewage from the cattle colony in Quaidabad which holds more than 50,000 heads of buffaloes, and also from the slaughter house in the vicinity. The discharge of waste water is approximately 0.8 MGD containing biodegradable organic matter having a BOD value of 15,000 tons per annum. The cattle owners also make extensive use of agrochemicals to protect their animals and the products. These ultimately find their pathway into the Creek.

The amount of domestic sewage flowing into the Gizri-Korangi Creek system appears to have been underestimated by the rapid assessment survey in 1987 (26) because the concerned population is nearly 50% of the megapolis and not just 0.9 million. Similarly the total flow has also been underestimated at 35 MGD because the localities discharging the waste water are equally large. Accordingly the volume should be half of the total i.e. approximately 100 MGD.
The Korangi Creek receives strong sewage from the cattle colony in Quaidabad which holds more than 50,000 heads of buffaloes, and also from the slaughter house in the vicinity. The discharge of wastewater is approximately 0.8 MGD containing biodegradable organic matter having a BOD value of 15,000 tons per annum. The cattle owners also make extensive use of agrochemicals to protect their animals and the products. These ultimately find their pathway into the Creek.

The constant inflow of untreated effluent into the Karachi coastal waters has led to marine pollution which, by various accounts, has reduced the quality of water and led to loss of habitat for flora and fauna, reduced species diversity, smothering by high suspended solids and oils, accumulation of toxins in marine organisms especially in the larval stages of commercial species, tar balls on beaches, and reduction in amenities, and the eventual loss of marine living resources in the polluted areas. Very little study on chemical accumulation of and its harmful effects has been done in Pakistan but a survey show that plankton in the Arabian Sea has Dichlorodiphenyltrichloroethane (DDT) concentration of 0.005 to 3.21 ppm which shows an alarming trend of pollution. The 3,500 km² area covered by the creeks off the coast of Karachi were once a spawning ground for a large number of commercial species of marine organisms. Pollution from the land has reduced the fishing potential of Gharo, Gizri and Korangi Creeks. Consequently, due to excessive pollution in the creeks there has also been a significant decrease in fish catch.

The seawater quality within the Gharo Creek is comparatively good, except in certain localized places where effluents are discharged directly from areas such as the Bhains Colony (Cattle Colony), Pakistan Steel Mills, and KESC Power Plants, and the other parts of Port Qasim Area. The Korangi Creek is polluted due to the effluent discharged directly from the fishing villages and industries located further northwards. The Kadiro Creek appears to be relatively pollution free except for small quantities of oil that flows in from the adjacent Phitti Creek. The Phitti Creek is the main channel leading to Port Qasim, and has seen an increase in sea traffic over the last two decades, since the Port became operational. Thus, the biggest contributors to the pollution load in this creek are the ships going to and fro from Port Qasim. The ships and boats contribute to the pollution by releasing oils, ship refuse, cargo refuse, and garbage.

- Physico-chemical characteristics of water from different sources including seawater, groundwater, industrial wastewater, spring overflow in the macroenvironment of PQA are summarized in Table 4.25 & 4.26.

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<td>40000</td>
<td>43280</td>
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<td>1549</td>
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<td>67700</td>
<td>4040</td>
<td>3110</td>
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<td>23230</td>
<td>770</td>
<td>630</td>
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<td>mg/L</td>
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<td>mg/L</td>
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<td>Sulphate (SO₄²⁻)</td>
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<td>18.8</td>
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</table>

1 P. Driver (1987) Rapid Assessment Survey of the Industrial Pollution in Korangi/Phitti Creek, Karachi, pp.36
Environmental Impact Assessment for 2 x 350 MW Coal Power Project

### Table 4.25 - Summary of Water Analysis (Korangi-Ibrahim Hyderi-Rehri-Port Qasim Section)

<table>
<thead>
<tr>
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<th>Parameters / Analytes</th>
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<th>5</th>
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<tbody>
<tr>
<td>12</td>
<td>Carbonate (CO₃)</td>
<td>mg/L</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>13</td>
<td>Calcium (Ca)</td>
<td>mg/L</td>
<td>830</td>
<td>1203</td>
<td>1170</td>
<td>1302</td>
<td>225</td>
<td>135</td>
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<tr>
<td>14</td>
<td>Magnesium (Mg)</td>
<td>mg/L</td>
<td>520</td>
<td>876</td>
<td>850</td>
<td>990</td>
<td>170</td>
<td>105</td>
</tr>
<tr>
<td>15</td>
<td>Sodium (Na)</td>
<td>mg/L</td>
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<td>13190</td>
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<td>mg/L</td>
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<td>259</td>
<td>312</td>
<td>270</td>
<td>113</td>
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<tr>
<td>17</td>
<td>5-Days BOD</td>
<td>mg/L</td>
<td>BDL</td>
<td>BDL</td>
<td>237</td>
<td>468</td>
<td>BDL</td>
<td>BDL</td>
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<tr>
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<td>BDL</td>
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<td>559</td>
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<tr>
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<td>Mercury (Hg)</td>
<td>mg/L</td>
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<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>20</td>
<td>Lead (Pb)</td>
<td>mg/L</td>
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<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>21</td>
<td>Cadmium (Cd)</td>
<td>mg/L</td>
<td>0.876</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
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<tr>
<td>22</td>
<td>Arsenic (As)</td>
<td>mg/L</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>0.0418</td>
<td>BDL</td>
<td>BDL</td>
</tr>
<tr>
<td>23</td>
<td>Nickel (Ni)</td>
<td>mg/L</td>
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<td>0.0621</td>
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<td>Zinc (Zn)</td>
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<td>8.984</td>
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<tr>
<td>25</td>
<td>Total Plate Count @37°C</td>
<td>Cfu</td>
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<td>TNTC</td>
<td>TNTC</td>
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<tr>
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<td>TNTC</td>
<td>TNTC</td>
<td>TNTC</td>
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</tr>
<tr>
<td>27</td>
<td>Escherichia Coli @37°C</td>
<td>Cfu</td>
<td>+ ve</td>
<td>TNTC</td>
<td>TNTC</td>
<td>TNTC</td>
<td>TNTC</td>
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<td>:</td>
<td>66.09</td>
<td>76.84</td>
<td>71.31</td>
<td>72.53</td>
<td>5.94</td>
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- Sea water samples collected from Steel Mills intake and outfall channels, and from Ziarat Hasan Shah had lower SAR ~66 to 76 but TDS varying from 30,000 to 43,280 at 26 and 27°C, pH 7.44 and 8.4, and DO~4.0 showing dilution with wastewater discharges and concentration due to evaporation on the outside of the creek. Seawater at the Ziarat Hasan Shah beach had SAR 71.3, TDS 40,000, DO 3.39 and pH 7.47 at 23.5°C.

- The samples from spring and the Nala receiving the overflow from the spring show characteristics of groundwater having higher proportions of sodium and chloride ions.

### Table 4.26 - Summary of Water Analysis (Korangi- Ibrahim Hyderi-Rehri-Port Qasim Section)

<table>
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<td>26.6</td>
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<td>pH Value</td>
<td>SU</td>
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<td>App.</td>
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<td>susp</td>
<td>clear</td>
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<td>Bicarbonate (HCO₃⁻)</td>
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<td>1920</td>
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<td>34</td>
<td>930</td>
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<td>Nitrate (NO₃)</td>
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<tr>
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<td>Calcium (Ca)</td>
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<td>1220</td>
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<td>12.0</td>
<td>970</td>
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<td>12770</td>
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<tr>
<td>17</td>
<td>5-Days BOD</td>
<td>mg/L</td>
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<td>BDL</td>
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<tr>
<td>18</td>
<td>Chemical Oxygen Demand (COD)</td>
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<tr>
<td>19</td>
<td>Mercury (Hg)</td>
<td>mg/L</td>
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<td>BDL</td>
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Table 4.26 - Summary of Water Analysis (Korangi- Ibrahim Hyderi-Rehri-Port Qasim Section)

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<tr>
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<td>BDL</td>
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<tr>
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<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
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</tr>
<tr>
<td>23</td>
<td>Nickel (Ni)</td>
<td>mg/L</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
<td>BDL</td>
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<tr>
<td>24</td>
<td>Zinc (Zn)</td>
<td>mg/L</td>
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<td>BDL</td>
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<td>Total Coliforms @42°C</td>
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<td>27</td>
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<td>+ ve</td>
<td>+ ve</td>
<td>+ ve</td>
<td>+ ve</td>
<td>+ ve</td>
<td>+ ve</td>
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<tr>
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<td>Sodium Absorption Ratio (SAR)</td>
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<td>1.53</td>
<td>1.48</td>
<td>65.93</td>
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<td>3.04</td>
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</table>

1-Sea water Lath Basti. 2-KDA Water Lath Basti #1. 3-KDA Line Water Lath Basti. 4-Sea Water Lath Basti. 5-Boring Water Cattle Farm. 6-Boring Water Cattle Farm 200ft.

- Sea water samples collected from Lath Basti had lower SAR~65 but TDS ~38700 at 26 and 28°C, pH 7.44 and 7.58, and DO~4.0 showing dilution with wastewater discharges from the surrounding. The samples from boreholes show characteristics of groundwater having higher proportions of sodium and chloride ions. The water supply samples with SAR above 1.2 show characteristics of fresh water contamination with groundwater.

- Wastewater samples collected from Korangi Industrial Area which is the outfall region of Malir River, had SAR values ranging from 2.79 to 5.56; TDS ranging from 1228 to 4310; low DO 0.39 to 0.62 and the high BOD and COD values in the samples; they are characterized as industrial wastewater mixed with sewage. The sewage is in higher proportion upstream while industrial effluent is dominant as the river enters its delta area. Seawater intrusion was noted at Malir River/Korangi Industrial Area during high tide. It was noted that the sample collected from here had SAR 57.68, TDS 22300, DO 0.82 and quite high BOD and COD, and is characterized as seawater contaminated with sewage and industrial effluent.

### 4.3 Biological Environment

#### 4.3.1 Coastal Ecology

The natural setting of creek coastal ecosystem of the project area has been characterized as (Saifullah et al.):

- **Dwarf common plants:** Prosopis juliflora, Salvadora persica, Cressa cretica.
- **Grasses:** Suaeda nudiflora, Cenchrus biflora, Sporobolus tremulus and Juncellus laerigatis.
- **Mangrove plants:** Avicennia marina and Rhizophora sp. are dominant species. Rhizophora is being planted in the coastal areas by various organizations under different mangrove rehabilitation programs.
- **Mangrove associated microorganisms:** Phaeocystis (phytoplankton) algae occur exclusively in areas rich in organic matters along the detritus of mangroves and sewage pollutants from residential settlements, discharged into the sea.

According to Flora of Pakistan (1972) eight species of mangroves have been reported from Pakistan. Though of these species, only four continue to thrive. These are *Avicennia marina*, *Aegiceras corniculatum*, *Ceriops tagal* and *Rhizophora mucronata*.

Bacterial and fungus populations observed along with the mangrove community in creek area belong to species *Entrophops sp.*, *Acaulospora gadanskensis*, *A. mellea* and *A. gadanskis*. 
Data on the Phytoplankton along the shelf and coastal waters of Pakistan is scarce. According to IUCN, more than 200 species of diatoms, more than 59 species of coccolithophorids, and more than 120 species of dinoflagellates are known to occur in the Arabian Sea.

Indus Delta mangrove ecosystem provide protection to the coastline from wind, waves and water currents, reduce sedimentation of navigational channels, reduce impacts of storm surges and cyclones and promote eco-tourism. The direct economic importance of the mangroves is attached to its capacity as a fisheries production area, sustenance and support for coastal and offshore fisheries, and nursery areas for young fish species and shrimps. The second most significant indirect economic activity supported by the study area is providing nutrient regeneration to support fishery production.

Mangrove forest has vast environmental value for their capacity to clean air, assimilate water pollution except oil, and regulate carbon cycle in the atmosphere. Their well-developed root system holds the shore sands tight and prevents soil erosion and desertification. The evergreen forests of mangrove trees provide a habitat for many waterfowl and a variety of marine organisms including edible species of fish, crustaceans and mollusks. In winter, a large number of migrating waterfowl use the area for feeding and breeding. The mangroves are also home to a variety of reptiles including snakes, fiddler crabs, shrimps, prawns and mudskippers. Mangroves also provide a variety of marketable products. Mangrove forest provides fodder for domestic cattle, camels, fire wood; Jhugis, timber, low cost housing; fishing poles; pulp, honey and has some medicinal uses as well.

4.3.2 Coastal Belt and Intertidal Zone

The distinguishing characteristics of the mangrove community are the great variety of land and water organisms that live together there because the habitats of land and sea overlap. Probably no other habitat in the marine environment is associated with such a variety of fauna as the mangrove swamps. They provide food and shelter to fish and waterfowl. The mangrove swamps act as nurseries and nutrients suppliers for economically important fish species on which many coastal communities in developing countries depend. Many marine animals live on the trunks and roots of the mangrove attached in the same way as they are on rocks elsewhere.

51 species of fish have so far been recorded from the mangroves and crest area of the Karachi (Jaleel and Khaliluddin 1981). Among the fish fauna of the swamps, mudskippers (Periophthalmidae) are the best adapted for this peculiar type of habitat. Two species of dolphin have been observed locally known as Tabi and Malar (Sousa plumbea) are relatively abundant. These are bottle nosed dolphins and are very often observed towards the eastern side of Port Qasim. They are seen in schools of four or five. It is often seen following sardine shoals when it enters the creek, however its favorite food is shrimp. The population of this species is declining considerably although it is noted to occur throughout the year but not very often sighted. Pollution in the creeks area might be a reason for the decline in this species (pollution is so heavy in this region that it is difficult for animals such as dolphins to survive).

Indian Ocean green turtle and pacific turtle are the two turtle species that are reported from the coastal area of Karachi (Hafiz ur Rehman and Fehmida 1997).

The crustaceans form a major component of the fauna with highest density and biomass. The fauna includes shrimps 6 species, crabs 10 species and lobsters 3 species (Jaleel and Khaliluddin 1981).

Among the sea snakes, the following have been known to occurred in the swamps area: Hydrophis cyanocinctus (Daudin) (annolated sea snake); H caerulescens (George Shaw) (many toothed sea make); H mamillaris; (Daudin) (Beaked sea snake); Microphalosops gracilis gracilis (Shaw) (common small headed sea snake); Pelamis platurns (Himaens) (pelagic sea snake); and Ephydrina schistose (beaked sea snake). Ten species of lizard have been reported.
The coastal area attracts a number of migratory birds, particularly waterfowl. In all, 285 species of birds belonging to 23 orders and 60 families are known to exist in the Sindh coastal waters. Among these 147 birds are residents, 5 summer visitor, 85-winter visitor, and others are migratory in nature (HBP). The Green Turtle & Olive Ridley Turtles frequent the shores of the Karachi coast, where they come to nest.

Far towards the sea in the mangrove forest the jackal (Canis aureus aureus) population is known to live in the mangrove forest. The presence of vast intertidal area provides a microhabitat for species that might not otherwise be present. Other invertebrates that appear to be fairly common are the barnacle Balanus amphitrite, the ocypodid (Uca annulipes, U. lactea, Macrophthalmus and grapsid crabs (Metapograpsus), the gastropods and the bivalves. Most mangroves stands in the region support very large numbers of grapsoid and ocypodid crabs. The main species found are Metapograpsus messor, Prasesarma plicatum, Uca annulipes, Uca lacteal, Uca sindensis, Macrophthalmus and Eurypranes orientalis. These live in burrows in the sediment and scavenge organic matter on the surface during periods of low tide. During the site visit, the whole intertidal mud flat appeared to be completely worked with burrow, and burrow structures likely burrows of mudskippers and crab holes were observed in the substrate. The only crabs seen were young blue swimming crabs Portunus pelagicus and the fiddler crab, Uca annulipes on the Russian beach. Active holes can be found in the subtidal but they also come well up into the intertidal zone. The second kind of burrow hole is quite small and is situated in the centre of a circular mound which on average is about 2 to 3 cm in diameter and 3 to 5 cm high. These are likely the holes of crabs, members of ocypodid and grapsid crabs. The constructions of earthen structures have been shown to function for sexual attraction: pillars, hoods, mud balls and chimneys. It is a well-known phenomenon that adult males of some species of fiddler crabs of the genus Uca construct an earthen structure at the entrance of the burrow. The density of the burrows was very high over a large area, ranging from about 1 to 3 per square meter of mud skippers burrows to 20 to 45 square meters of crabs burrows.

The intertidal flats around and within the mangroves, on the seaward and landward side of the mangroves, are very important as a feeding area for birds, where large numbers of waders and other species rely on this and other similar sites in the Indus Delta mangroves, as vital feeding areas on their long migrations between breeding sites in Asia. The mangroves increase the diversity of food available for birds, and provide shade and shelter from the elements.

![Figure 4.29: Mud Skippers and Shore crabs observed during the site survey](image)

### 4.3.3 Mangroves

The mangroves play an important role in the swampy ecosystems of the macro-environment. They accumulate silt, stabilize shoreline, and prevent erosion of the coastline, and beaches. Their most important function is to provide food, shelter and to serve as nursery grounds for a variety of larvae and
juveniles of marine organisms. They increase primary productivity of the coastal waters. The mangroves support a rich invertebrate fauna dominated by crustaceans and provide nutrient-rich habitat to a large number of juveniles of fish and shrimps. The Korangi and adjoining creeks also support a well-established fishing industry. The Avicenna marina is the dominant species of the mangroves in the Indus Delta.

The Mangrove (Avicenna marina) population is very thin near project site. The density of mangrove trees is estimated at between 15-20/100 m². The height of the individual tree within the established Avicenna marina habitat is greater than ~1.5 m. The mangrove trees growing 200-300 m away from the creek (seawater) in the landward direction show an overall decline in the height of the mangrove plantations.

![Figure 4.30: Mangroves observed at the Project Site](image)

### 4.3.4 Phytoplankton

The major marine flora consists of phytoplankton of different type as given in Table 4.27 below:

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<td>Asteramphaias sp.</td>
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Table 4.2: Various kinds of phytoplankton species found in marine water of creeks

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<tr>
<td>23</td>
<td>Climocodium sp.</td>
<td></td>
<td>70</td>
<td>Rhizosolenia crassipina</td>
</tr>
<tr>
<td>24</td>
<td>Cvelotella sp.</td>
<td></td>
<td>71</td>
<td>Rhizosolenia cylindms</td>
</tr>
<tr>
<td>25</td>
<td>Cymbella sp.</td>
<td></td>
<td>72</td>
<td>Rhizosolenia habitatata</td>
</tr>
<tr>
<td>26</td>
<td>Diploneis sp.</td>
<td></td>
<td>73</td>
<td>Rhizosolenia imbricate</td>
</tr>
<tr>
<td>27</td>
<td>Ditvium sp.</td>
<td></td>
<td>74</td>
<td>Rhizosolenia punqens</td>
</tr>
<tr>
<td>28</td>
<td>Dimophvysis sp</td>
<td></td>
<td>75</td>
<td>Rhizosolenia robusta</td>
</tr>
<tr>
<td>29</td>
<td>Epithemia sp.</td>
<td></td>
<td>76</td>
<td>Rhizosolenia schrubsolei</td>
</tr>
<tr>
<td>30</td>
<td>Eircampia Zodiacus</td>
<td></td>
<td>77</td>
<td>Rhizosolenia stolterfolthii</td>
</tr>
<tr>
<td>31</td>
<td>Grammatophora marina</td>
<td></td>
<td>78</td>
<td>Rhizosolenia setoera</td>
</tr>
<tr>
<td>32</td>
<td>Grammatophora anqulosa</td>
<td></td>
<td>79</td>
<td>Rhizosolenia stvlfvformis</td>
</tr>
<tr>
<td>33</td>
<td>Grammatophora sp.</td>
<td></td>
<td>80</td>
<td>Skeletonema costatum</td>
</tr>
<tr>
<td>34</td>
<td>Convodoma sp.</td>
<td></td>
<td>81</td>
<td>Spirodinium sp.</td>
</tr>
<tr>
<td>35</td>
<td>Guinardia flaccida</td>
<td></td>
<td>82</td>
<td>Stephanopyxis sp.</td>
</tr>
<tr>
<td>36</td>
<td>Gyrosiama sp</td>
<td></td>
<td>83</td>
<td>Stephanophixis turis</td>
</tr>
<tr>
<td>37</td>
<td>Hemidiscus sp.</td>
<td></td>
<td>84</td>
<td>Steriatella sp.</td>
</tr>
<tr>
<td>38</td>
<td>Histoneis sp.</td>
<td></td>
<td>85</td>
<td>Surirella sp.</td>
</tr>
<tr>
<td>39</td>
<td>Leptcvlindricus danicus</td>
<td></td>
<td>86</td>
<td>Schroederella sp.</td>
</tr>
<tr>
<td>40</td>
<td>Licmophora flabellate</td>
<td></td>
<td>87</td>
<td>Synedra acus</td>
</tr>
<tr>
<td>41</td>
<td>Licmophora sp.</td>
<td></td>
<td>88</td>
<td>Synedra robusta</td>
</tr>
<tr>
<td>42</td>
<td>Lithodesmium sp.</td>
<td></td>
<td>89</td>
<td>Thallasionema sp.</td>
</tr>
<tr>
<td>43</td>
<td>Melosira moliniformis</td>
<td></td>
<td>90</td>
<td>Thallasiosira sp</td>
</tr>
<tr>
<td>44</td>
<td>Melosira granulate</td>
<td></td>
<td>91</td>
<td>Thallasiothrix sp</td>
</tr>
<tr>
<td>45</td>
<td>Mastogloia sp.</td>
<td></td>
<td>92</td>
<td>Triceratuim sp.</td>
</tr>
<tr>
<td>46</td>
<td>Navicula cancellata</td>
<td></td>
<td>93</td>
<td>Trichodesmium sp.</td>
</tr>
<tr>
<td>47</td>
<td>Navicula cruciformis</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3.5 Vegetation

The micro-environment of project area consists of only four different species of vegetation (Table 4.28)

Table 4.28: List of Vegetation Recorded

<table>
<thead>
<tr>
<th>S #</th>
<th>Family name</th>
<th>Scientific name</th>
<th>Common name</th>
<th>Lift form</th>
<th>Lift span</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asclepiadaceae</td>
<td>Calotropis procera</td>
<td>Ak</td>
<td>Shrub</td>
<td>Perennial</td>
</tr>
<tr>
<td>2</td>
<td>Tamaricaceae</td>
<td>Tamarix indae</td>
<td>Lawi</td>
<td>Shrub</td>
<td>Perennial</td>
</tr>
<tr>
<td>3</td>
<td>Mimosaceae</td>
<td>Prosopis juliflora</td>
<td>Devi</td>
<td>Shrub</td>
<td>Perennial</td>
</tr>
<tr>
<td>4</td>
<td>Chaeopodiaceae</td>
<td>Smeda fruticosa</td>
<td>-</td>
<td>Shrub</td>
<td>Perennial</td>
</tr>
</tbody>
</table>
No threatened species of flora was recorded from the Project Area.
4.3.6 Pelagic Fish Community

This community includes powerful swimmers, which are exclusively carnivore in nature like predaceous fishes, mullets, croakers, snappers, carangids breams, perchés, & sea snakes. In the mangrove ecosystem the predaceous forms are often small in size and easily wander among the mangroves at high tide (Bianchi, 1985). The local fisher folk use small gill set nets across small tidal creeks to trap between 2-10 kg of fish in a day mostly mullets (Mugil cephalus) during ebb & flow tides.

4.3.7 Marine Benthic Flora And Fauna

This community includes the microbes, detritus feeders, small and large herbivores, and small and large carnivores. In the mangrove ecosystem, the benthic community of the adjacent shallow water is a subject of interest. Here, the microbes decompose the plant litter into organic detritus - a fundamental commodity of system energy. This detrital matter is picked up by the detritus feeders over the bottom, such as fishes, shrimps and shellfish, and then carried to the littoral zone by wave action, shared by the intertidal fauna such as crabs, shrimps, mudskippers, invertebrates and waders. At low tide, when a large part of muddy bottom is exposed, crabs, mudskippers and waders are seen in large numbers picking up their food which includes worms and different animals left behind by the receding tide.

An on shore and offshore benthic survey was undertaken on 18th December 2015 near proposed DGKPG Coal Fired Power Plant construction site (Fig 4.35). The objective of the survey was to identify the species of organisms living in the benthic communities near the proposed project site. Three sampling sites were chosen to evaluate the distribution of benthic faunal densities, macro-faunal diversities, and similarities of faunal organisms within the stations sampled. The sampling was undertaken at low tidal position so that maximum coastline was exposed at receding tide.

![Figure 4.35 - Location of sampling stations for marine benthic faunal analysis](image-url)
1. Methodology

Sampling was done using a shallow draft boat. A hand held GPS (Garmin) was used for identifying the station positions. A plastic spade was used to excavate approx. 20x20 cm³ of sediments from a depth of 15 cm of exposed coastal area at low tide from each station. The silty cum muddy substrate sediments along with the benthic in faunal organisms were preserved in 10% formalin in large mouth plastic jars for further analysis of the collected samples in the laboratory. The organisms in the sediment samples were sieved, identified and enumerated. Statistical software was used for calculating distribution, diversity, faunal affinities etc.

2. Survey Results

The descriptive statistics of benthic organisms observed in the three sampling stations are given in Table 4.29. The mean number of organisms ranged from 50 to 185 per 10 cm². The total species encountered at the three sampling stations ranged from 5-8.

Table 4.29: Descriptive Statistics - Benthic Fauna of DGKPG Project Site

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mean Individuals</th>
<th>Variance</th>
<th>Standard Deviation</th>
<th>Std. Error</th>
<th>Total Individuals</th>
<th>Total Species</th>
<th>Max</th>
<th>Mean Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>50.6</td>
<td>22892.71</td>
<td>151.303</td>
<td>47.846</td>
<td>506</td>
<td>7</td>
<td>481</td>
<td>14189.04</td>
</tr>
<tr>
<td>Sample 2</td>
<td>95.4</td>
<td>75569.39</td>
<td>274.899</td>
<td>86.931</td>
<td>954</td>
<td>8</td>
<td>877</td>
<td>46838.39</td>
</tr>
<tr>
<td>Sample 3</td>
<td>185.8</td>
<td>331346</td>
<td>575.627</td>
<td>182.029</td>
<td>1858</td>
<td>5</td>
<td>1824</td>
<td>205370.39</td>
</tr>
</tbody>
</table>

Figure 4.36 - Sampling and preservation of benthic sediments

3. Species Distribution Of Benthic Fauna

The distribution of benthic organisms (Table 4.30) observed collectively from the project site shows Nematode worms to be by far the dominant species followed by Harpactoid Copepods in the sediment samples. Nematodes, Harpactoid Copepodes, Polychaete worms and larva and organisms show an aggregate behavior, presumably due to their mode of reproduction. While other benthic organisms show a random distribution, the random distribution may be due to strong tidal flows in the creek. The Benthic organisms encountered are not listed as threatened or endangered by the IUCN.

Table 4.30: Species distribution of Benthic Fauna at DGKPG Project Site

<table>
<thead>
<tr>
<th>Species</th>
<th>Variance</th>
<th>Mean</th>
<th>Chi-sq</th>
<th>d.f.</th>
<th>Aggregation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nematode worm</td>
<td>476212</td>
<td>1060.667</td>
<td>897.9492</td>
<td>2</td>
<td>Aggregated</td>
</tr>
<tr>
<td>Harpacticoid copepod</td>
<td>252</td>
<td>22</td>
<td>22.9091</td>
<td>2</td>
<td>Aggregated</td>
</tr>
<tr>
<td>Nauplii</td>
<td>0.3333</td>
<td>0.3333</td>
<td>2</td>
<td>2</td>
<td>Random</td>
</tr>
<tr>
<td>Cyclopoid copepodite</td>
<td>14.3333</td>
<td>5.3333</td>
<td>5.375</td>
<td>2</td>
<td>Random</td>
</tr>
<tr>
<td>Calanoid copepod</td>
<td>0.3333</td>
<td>0.3333</td>
<td>2</td>
<td>2</td>
<td>Random</td>
</tr>
</tbody>
</table>
Table 4.31: Diversity Index values at the three sampled stations

<table>
<thead>
<tr>
<th>Index</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shannon H' Log Base 10.</td>
<td>0.111</td>
<td>0.17</td>
<td>0.05</td>
</tr>
<tr>
<td>Shannon Hmax Log Base 10.</td>
<td>0.845</td>
<td>0.903</td>
<td>0.699</td>
</tr>
<tr>
<td>Shannon J'</td>
<td>0.131</td>
<td>0.188</td>
<td>0.071</td>
</tr>
</tbody>
</table>

4. Shannon Weiner Diversity Index

The Shannon Weiner Biodiversity Index was undertaken; the results are given in Table 4.31. Both the species diversity and the species richness are relatively poor. The species diversity ranges from 0.69 to 0.90 (the normal range is 3.0) whereas the species richness i.e. number of species in each of the community measured between 0.07 at sample 3 to 0.188 at station 1 {species richness ranges from 0.01 (low) to (1.0) high}. It is not unusual, since the PQA creeks are generally a disturbed area.

5. Bray And Curtis Cluster Analysis

The Bray and Curtis similarity dendrogram (Figure 4.49) shows sampling station with high similarity clubbed together. Sampling Station B and C have been clubbed while station A is dissimilar to station B and C. Both sampling stations B and C are sheltered while station A is exposed to strong sediment erosional forces, possibly due to ebb and flow of tides and waves action in the creek.
4.3.8 Mammals

The five species of mammals recorded from the Project Area include: Indian Jackal (*Canis aureus*), Desert Hedgehog (*Hemiechinus collaris*), Small Indian Mongoose (*Herpestes javanicus*), Five striped Palm Squirrel (*Funambulus pennant*) and Indian Gerbil (*Tatera indica*).

<table>
<thead>
<tr>
<th>S.#</th>
<th>Order</th>
<th>Family</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insectivore</td>
<td>Erinaceidae</td>
<td><em>Hemiechinus collaris</em></td>
<td>Long eared or Desert Hedgehog</td>
</tr>
<tr>
<td>2</td>
<td>Carnivora</td>
<td>Canidae</td>
<td><em>Canis aureus</em></td>
<td>Jackal</td>
</tr>
<tr>
<td>3</td>
<td>Carnivora</td>
<td>Herpestidae</td>
<td><em>Herpestes javanicus</em></td>
<td>Small Indian Mongoose</td>
</tr>
<tr>
<td>4</td>
<td>Rodentia</td>
<td>Sciuridae</td>
<td><em>Funambulus pennant</em></td>
<td>Five striped Palm Squirrel</td>
</tr>
<tr>
<td>5</td>
<td>Rodentia</td>
<td>Muridae</td>
<td><em>Tatera indica</em></td>
<td>Indian Gerbil</td>
</tr>
</tbody>
</table>

Figure 4.40 - Bray-Curtis Cluster Analysis (Single Link) sampling station at offshore DPKPG PQA - similar species have been clubbed together

Figure 4.41 - Gerbil hole
4.3.9 Avi Fauna (Birds)

The intertidal areas of the Indus Deltaic Creeks provide food and shelter to a number of endemic species of birds. Some of these birds are also migratory. Generally, the endemic species of birds found in the Indus delta among others include Oystercatcher, Lesser Sand Plover, Greater Sand Plover, Grey Plover, Golden Plover, Little Ringed Plover, Kentish Plover, Sanderling, Dunlin, Curlew, Whimbrel, Marsh Sandpiper and Common Sandpiper. Breeding activities of a number of endemic birds have been reported in the coastal wetlands of the Indus Delta particularly of the Little Tern, Common Tern, Gull billed Tern, Yellow legged Herring, Lesser Black backed Gull & Great Black headed Gull. The diversity of bird fauna is indicative of food availability, different bird have a range of benthic animals to feed on. The birds feed on a range of organisms from plankton to polychaete worms, crabs & mud skipper.

A fresh survey was conducted of the project site to establish the baseline of the birds in the project’s micro-environment. Only 13 species were recorded (Table 4.33) which include mostly the resident species such as Black Kite, Red Wattled Lapwing, Blue Rock Pigeon, Little Brown Dove, Crested Lark, Black Drongo, Indian Myna, House Crow and House Sparrow. The migratory birds recorded include: Common Sandpiper, Collared Sand Martin, Variable Wheatear and Desert Wheatear.

<table>
<thead>
<tr>
<th>S. #</th>
<th>Order</th>
<th>Family</th>
<th>Scientific name</th>
<th>Common Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Milvus migrans</td>
<td>Black Kite</td>
<td>R</td>
</tr>
<tr>
<td>2</td>
<td>Charadriiformes</td>
<td>Charadriidae</td>
<td>Vanellus indicus</td>
<td>Red Wattled Lapwing</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>Charadriiformes</td>
<td>Scolopacidae</td>
<td>Tringa hypoleucos</td>
<td>Common Sandpiper</td>
<td>WV</td>
</tr>
<tr>
<td>4</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Columba livia</td>
<td>Blue Rock Pigeon</td>
<td>R</td>
</tr>
<tr>
<td>5</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Streptopelia senegalensis</td>
<td>Little Brown Dove</td>
<td>R</td>
</tr>
<tr>
<td>6</td>
<td>Passeriformes</td>
<td>Alaudidae</td>
<td>Galerida cristata</td>
<td>Crested Lark</td>
<td>R</td>
</tr>
<tr>
<td>7</td>
<td>Passeriformes</td>
<td>Hirundinidae</td>
<td>Riparia riparia</td>
<td>Collared Sand Martin</td>
<td>WV</td>
</tr>
<tr>
<td>8</td>
<td>Passeriformes</td>
<td>Dicruridae</td>
<td>Dicrurus adsimilis</td>
<td>Black Drongo or King Crow</td>
<td>R</td>
</tr>
<tr>
<td>9</td>
<td>Passeriformes</td>
<td>Sturnidae</td>
<td>Acridotheres tristis</td>
<td>Indian Myna</td>
<td>R</td>
</tr>
<tr>
<td>10</td>
<td>Passeriformes</td>
<td>Corvidae</td>
<td>Corvus splendens</td>
<td>Sind House Crow</td>
<td>R</td>
</tr>
<tr>
<td>11</td>
<td>Passeriformes</td>
<td>Turdidae</td>
<td>Oenanthe deserti</td>
<td>Desert Wheatear</td>
<td>WV</td>
</tr>
<tr>
<td>12</td>
<td>Passeriformes</td>
<td>Turdidae</td>
<td>Oenanthe picata</td>
<td>Variable Wheatear</td>
<td>WV</td>
</tr>
<tr>
<td>13</td>
<td>Passeriformes</td>
<td>Passeridae</td>
<td>Passer domesticus</td>
<td>House Sparrow</td>
<td>R</td>
</tr>
</tbody>
</table>

Legend: R = Resident, WV = Winter Visitors, M = Migratory, PM = Passage Migrant,
Figure 4.42 – EMC expert identifying birds during ecological survey

Figure 4.43 - Red wattled lapwing

Figure 4.44 - Reef Heron
Figure 4.45 - Rroad billed sandpiper and Red wattled lapwing

Figure 4.46 - Black headed gull and Black tailed godwit

Figure 4.47 - Blue rock pigeon
4.3.10 Reptiles

Reptiles are rare in the area. Indian Cobra & Saw-scaled Viper have been reported from the surrounding areas.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Family</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elapidae</td>
<td>Naja naja</td>
<td>Black Cobra</td>
</tr>
<tr>
<td>2</td>
<td>Viperidae</td>
<td>Echis carinatus</td>
<td>Saw Scale Viper</td>
</tr>
</tbody>
</table>

No threatened species of fauna was recorded from the Project Area.

4.4 Socioeconomic Environment

The proposed project site is located in the immediate east of proposed site for Siddiqsons Energy Coal Power Plant and north of the famous shrine of Hassan Shah. Presently the proposed site is bordered by empty land in the east, north and west and Gharo Creek in the south. Pipri Badal Nala (stream) flows northwest of the proposed site. This Nala ultimately fall into the Gharo creek located to the south of the
proposed site. There are no villages or residential colonies in the project area. The nearest human settlement from the proposed site is village Let Basti which is 10 km west to the site. The dargah (shrine) of Noor Hasan Shah is located approximately at 1000 m southeast to the site. Other settlements which lie in the north and northwest of the project area at more than 10 km are Goth Lal Mohammad, Goth Mohammad Keserani & Pipri Colony. The port Qasim residential colony is located approximately 11 km northwest from the existing boundary.

4.4.1 Coastal Communities

During the 18\textsuperscript{th} and 19\textsuperscript{th} centuries the Indus Delta was flourishing well with plenty of freshwater and sediment discharge from the Indus River all the year round. There were two river-sea ports: Keti Bandar and Shah Bandar that used to handle all imports and exports from Sindh and Bombay, Gwadar, and Middle East. Similarly the coastal agriculture areas of Keti Bandar, Kharo-chan and Shah Bandar were producing Rice as the main crop for export. The sea-borne goods in transit to upper Sindh area used to be transported to river boats. The socio-economy of these areas was very good and people were prosperous (Sindh Gazette, 1876). River Ports Shah Bandar – a river port established in 1759 by Kalhoro Regime was a viable port till the earthquake of 1819 that altered the flow of river to the port and reduced it to the level of a fishing village.

Rehri (a coastal fishing village in the east of the project location is about 4,060 years old), after the Kotri Barrage in 1958, the freshwater disappeared from many parts of Indus Delta and many people from the affected parts settled in and around Rehri Village. These coastal communities have long been dependent on the coastal resources to meet their demands of food, fodder, fuel wood, sea-salt, timber for their temporary hutments (Jhuggi) and generation of income and for economic activities. Almost all of the populations of the coastal areas are engaged in fishing, fishing trade and as laborers in fishing industries, forest products, fishing boats, boat engine mechanics and camel raising, etc. Within these coastal communities, the drinking water supply is inadequate or absent. Public health care is minimum and sanitation is poor.

There are a number of coastal communities including permanent fishing villages along the coast, especially the fishing villages of Ibrahim Hyderi, Rehri and Lat Basti. The Coastal zone of Sindh is inhabited by communities such as Moros, Khaskhels, Jats and Machees engaged in fishing. The main communities in the coastal areas along mangrove ecosystem are:

- Southeastern coast, Karachi: Jamote, Dhori, Mir Baher, Rabwai, Phullai, Khaskelli, Syeds, Jats, Bangali & Burmees, Baloch, Brohi, Larak. Musani, Panjwani, Waryani, Qasimani, Malkai & Shah;
- Port Qasim area: Mirbaher, Jat, Khaskheli, Syed, Baloch, Shaikh, Bangali, Burmees;
- East Karachi: Mirbahar, Baloch, Syed, Khaskheli;

Housing facilities are inadequate, mostly kutch, semi-pucca and hutments (\textit{Jhugis}). Basic public utilities are not available to most of the households except in the coastal zone adjacent to Karachi. The poor socio-economic situation is clearly reflected in the low illiteracy, high un-employment, and low income. Poverty and lack of essential civic necessities have increased the dependence of coastal communities on the available natural resources that ensure their livelihood security under the prevailing socioeconomic situation. Most of the population lives in hutments (\textit{Jhugis}) made up of local indigenous materials i.e., local vegetation, wood from mangrove trees, straw, etc. Most of the coastal communities live within or close to mangrove forests. Almost all the population in the coastal villages are fishermen or involved in fisheries related activities. A small percentage is involved in raising camels, buffaloes and goats, woodcutting or dry wood collecting from mangrove forests. The rate literacy is very low. Very few primary schools, dispensaries and mosques exist in the coastal areas. Skin diseases are common and Goiter cases are absent due to fish consumption. They have increased stamina, particularly in women, due to regular fish diets. The coastal villages lack all basic civic facilities including supply of drinking water roads and sewerage.
The mangrove ecosystem is of economic and ecological significance to the entire coastal area and for the dependent human settlements. Coastal communities of the area are heavily dependent on the coastal fisheries resources for their daily income generation and daily food. The rate of consumption of fish in the daily food (0.2 to 0.5 kg/head/day) of fishermen in the coastal communities has not changed much. Communities prefer to eat fish over mutton or beef and use vegetable or pulses only once a week.

The traditional fishing communities used to engage in sustainable harvesting. They knew how to fish, without depleting the fish stocks or harming the mangroves. The new entrants (Burmees, Bangladeshis, Afghans) in fishing business activities in Indus Delta are blamed for their main interest in making good profits and do not follow the age-old fishing practices and traditions of local communities for sustainable use of coastal resources. The reduction of wild stocks of fish and shrimp in the Indus delta area, appears to be mainly due to:

- Reduction in the availability of freshwater and sediment supply to Indus Delta and,
- Unsustainable fishing by local and foreign fishing boats. The following factors also contributed to the depletion of fish stocks:
  - The use of non-judicious fishing techniques (use of Jari, Boola and Katra nets (small mesh size bag set net);
  - The local Jat community changing to fishing business from camel breeding;
  - Influx of foreign fishing communities (i.e. Bangladesh, Burma) increasing pressure on local and coastal fisheries;
  - Increase in fishing effort by mechanized fish trawlers along the coast that are based in Karachi;
  - Increased fishing effort by foreign and Pakistani fishing vessels under Joint fishing Ventures within the territorial waters;
  - Increased levels of marine pollution from industrial and domestic sources.

Most of the local population of the coastal communities is directly or indirectly involved in fishing business. The livelihood main stay of the village folk is coastal fishing using small sized nets to catch mullets, small size fishes, juvenile shrimp and crabs etc. The coastal fishermen catch about 3,000 metric tons of fish, 2,000 metric tons shrimp and about 2,500 metric tons of crabs to earn their livelihood. Most of the small size fish is also used for making fish meals and manure. The fish constitute the main diet of all coastal communities in the area. The increase in the number of fishermen population and the fishing labour force in the area have been mainly due to a large number of local communities that have migrated from Keti Bundar and adjacent parts of Indus Delta and have permanently moved to Korangi-Gharo Creek system due to loss of the agriculture activity and for better economic opportunities. Most of them opted for fishing and fisheries related professions. These migrations have increased the existing pressures of coastal resources.

The coastal areas at the end of Gharo Creek are being used to produce sea-salt for the last 50 years. An estimated 480,000 kg sea-salt/year is being produced from the two main sea-salt producing factories in the area.

The mangrove forest has been providing good potential sites for honey production. Both the villagers and the fishermen collect it from the mangrove forest. It is estimated that about 1,000 kg of honey per year can be produced from the Korangi-Gharo Creek system. The quantity produced per year is negligible because it is based on beehives in the wild. On the average about less than 2% of the mangrove wood collectors from the coastal villages are engaged in honey collection (1-2 kg per head) as part time business mostly during March to April period, the flowering period of mangroves.

4.4.2 Historical Background

Before the construction of Port Qasim, the area of Bin Qasim was seasonally occupied by nomads. The nomads constructed temporary dwellings in the area and cultivate food crops using rain water. In the
early 1970s the Port Authority acquired the entire area for industrial development. Agriculture was stopped and all temporary and permanent villages in the vicinity of project site were shifted to the interior of Sindh province.

4.4.3 Demography of Bin Qasim Town

The town had a population of about 315,000 at the 1998 census, of which 97% are Muslim and include several ethnic groups. Urdu speakers, Punjabis, Sindhis, Pakhtuns, and Balochs are main ethnic groups. The Bin Qasim town is consisted of 7 union councils names cattle colony, Gaghr, gulshan-e-Hadeed, Ibrahim Hyderi, Landhi Colony, Qaidabad, and Rehri.

The cattle colony is the center of cattle and meat trade in Karachi. The Cattle Colony is the dairy products shopping and supply center of Karachi.

4.4.4 Livelihood

A large proportion of the residents of Pipri Colony and coastal area are employed as unskilled industrial labor at Port Qasim Industrial Area, and Pakistan Steel Mills. According to a survey conducted in the coastal area, the unskilled labor with irregular jobs earn between Rs 4,000 and 5,000 per month, depending on the industry and the level of activity involved. These figures are estimated to be increased by 20% during last three years. A small number of people work in various government departments such as the education and police departments, where they earn a similar amount.

4.4.5 Gender

Most women form a part of the informal labor market, working to supplement inadequate household incomes. Female ‘invisibility’ and segregation are therefore comparatively rare and largely confined to the more conservative migrants from Sindh, Balochistan and the NWFP.

4.4.6 Community Life

In the ethnic mix of the colonies, each community strives to maintain its identity regional languages are still commonly spoken, endogamous marriages are a continuing tradition, and specific ethnic groups dominate many occupations. The majority of labor and transport sector workers, for instance, tend to be Pakhtuns while Bengalis form a large part of the fishing industry and Christians are generally employed as sanitation workers. Despite such ethnic groupings, a degree of cohesion exists when it comes to a collective external threat from public sector officials. The residents of the colony are perpetually harassed by officials; in particular, the police. The colony’s vision for a better future focuses on good governance, access to health care, and better educational facilities.

4.4.7 Cultural and Archeological Resources

There are two dargahs (shrines) in the surroundings of the project area. Dargah Noor Hasan Shah is located at south of the project area approximately at 1km from the boundary of K.E and another shrine in the west at 9 kms close to village Let Basti.

At Rehri, along the coast east of Karachi, Karachi University archaeological team discovered a few Mesolithic and Late Palaeolithic sites. Most of these sites have vanished during the last twenty years. Nevertheless their discovery shed new light on the prehistory of the coastal area of Lower Sindh. Scatters of flint were found in different spots, some of which were associated with Terebralia palustris mangrove shells.
5.0 Screening Of Alternatives, Potential Impacts & Proposed Mitigation Measures

Identification and assessment of feasible alternatives to project design and implementation is among the main components of Environmental & Social Impact Assessment procedures. Alternatives illustrate and contrast the environmental implications and consequences of different options available to achieve the proposed objective. In this way, both the proponent and the authorities who must consider granting the authorization, are put in a position where all involved are able to make informed choices or decisions.

Selection of preferred alternative is based on scores of factors including cost, schedule of delivery, environmental and social impact and the cost for their redressal. The drivers that affect potential alternative options and scenarios include: availability of project sites, current technologies; design changes that need to be introduced, operational situation, capital & recurrent costs, environmental & social issues, their potential impacts, and costs of mitigation. The “No Project” alternative situation is taken into account to demonstrate the need of the Project. In consideration of the different drivers, potential alternatives within the Project are restricted to the following aspects:

- No Project Option
- Project Alternatives
- Technology selection
- Availability of site and infrastructure
- Availability of appropriate energy source

5.1 No Project Alternative

The no-development option simply means that the Government of Pakistan does nothing to address the purpose and need for the power generation and transmission. The most significant outcomes of this approach would be a negative impact on current electricity supplies, and the possibility of complete blackouts at times of high demand. The power generation capacity of Pakistan meets only 40 percent of the current demand and if the “No Project” is to have its way, the Country will have to slow down the growth rate of its economy and all its development projects will come to a standstill. At present additional pressure is being put on already deficient electricity generation capacity by the urban and industrial demand. The present shortfall is estimated at 3,000 MW and the power outage has gone up from 6 to 8 hours in urban areas and 10 to 12 hours in rural areas.

Government of Pakistan is desperately looking for all options to bridge this gap. The National Energy Policy 2013 requires development of strategy to i) ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coal (Thar coal) and hydel power, ii) address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan, and iii) shift Pakistan’s energy mix towards cheaper fuel and conservation of gas for power.

It is the professional opinion of the EIA Team that the no-development option is unrealistic, and, indeed, following this approach would result in the stagnation or cessation of many Government strategies that have been planned and implemented. Due to the negative consequences of the no-development option, it has been discarded from further consideration in this EIA.
5.2 Site Alternatives

The selection process for locating a suitable site for power plant and Jetty is the basic and key instrument for factoring in environmental impact issues at an early stage of Project development.

Selection of site for installation of a 700 MW Coal fired power plant is based on following criteria:

- Availability of land
- Close proximity to Load center
- Availability of coal logistics
- Availability of water for cooling and process;
- Access to electric grid station and transmission system;
- Availability of infrastructure;
- Availability of managerial and skilled personnel.

After reviewing various options, the DPKPG has opted for the location of the land adjacent to Abbas Steel at Port Qasim (Option 1, Figure 5.1) due to the following advantages.

- Sufficient land available for the construction of 2 x 350 MW coal fired generating station and future space available for development of additional 700 MW power plant.
- The site requires lower dredging volume for construction of coal jetty for handling handymax vessel which makes this site feasible for this project.
- Easy access to port for transportation of equipment to the site during construction phase.
- The infrastructure for power evacuation is already available and a new Grid station specifically designed for this project is already in progress.

The client had two alternate sites available for the installation of 2 x 350 MW coal fired power plant which are defined as follows:

Alternate Option # 2 (Figure 5.2)

- No infrastructure available for power evacuation into K-Electric network.
- As the site is located in open sea, operation of vessel will be limited during monsoon season.
- Jetty construction would be very expensive due to break water requirement.

Alternate Option # 3 (Figure 5.3)

- Insufficient Land (126 Acres)
- Power Evacuation far away which will increase project cost.
- Far Away from main sea channel making it infeasible to bring 50,000 DWT Capacity ship, also high cost of dredging as dredged material quantity would have reached 18 ~20 million cubic meter. Adverse environmental impact and higher cost.
- Land title is ambiguous.
Figure 5.1: DPKPG opted location of the land adjacent to Abbas Steel (Option – 1)

Figure 5.2: Land Site near Hub Power Plant (Option-2)

Figure 5.3: Land Site at Textile City (Option-3)
5.3 Technology Alternatives

There are several coal combustion techniques:

**Coal**

- Pulverized Coal
  - Subcritical Technology
  - Supercritical Technology
  - Ultra-supercritical Technology
- Fluidized Bed Combustion
- Integrated Gasification Combined Cycle (IGCC)
- Gas Fired Units
  - Condensing Steam Turbine Power Station.
  - Simple Cycle Gas Turbine Power Station.
  - Combined Cycle Power Plant (CCPP).
- Solar to Power Generating Units
- Wind to Power Generating Units

**Coal combustion technologies/alternatives**

1. **Pulverized coal combustion**

Suspension firing is the primary combustion mechanism in pulverized-coal-fired and cyclone-fired units. Grate firing is the primary mechanism in underfeed and overfeed stoker-fired units. Both mechanisms are employed in spreader stokers. In a fluidized bed combustor (FBC), the coal is introduced to a bed of either sorbent or inert material (usually sand), which is fluidized by an upward flow of air.

The Pulverized-coal is generally entrained in primary air before being fed through the burners to the chamber, where it is fired in suspension. Pulverized-coal furnaces are classified as either dry or wet bottom, depending on the ash removal technique. Dry-bottom furnaces fire coals with high ash fusion temperatures, and dry ash removal techniques are used. In wet-bottom furnaces, coal with low ash fusion temperature is used, and molten ash is drained from the bottom of the furnace. Pulverized coal furnaces are further classified by the firing position of the burners, that is, single (front and rear) wall, horizontally opposed, vertical, tangential (corner fired), turbo, or arch fired.

In pulverized coal boilers, coal is ground to the consistency of flour and air blown into a furnace for rapid combustion. Pulverized coal technology is the most prevalent type for coal-based generation and is used in steam boilers around the world operating with subcritical, supercritical and ultra-supercritical steam conditions. (OECD/IEA 2013).

New pulverized coal combustion systems - utilizing supercritical and ultra-supercritical technology - operate at increasingly higher temperatures and pressures and therefore achieve higher efficiencies than conventional pulverized coal combustion units and significant CO₂ reductions.

Subcritical technology is most commonly used in coal-fired plants, for conventional pulverized coal combustion. Powdered coal is injected into the boiler and burned to raise steam for subsequent expansion in a steam-turbine generator. Subcritical steam cycles have a main steam pressure that is below the critical point of water. The steam conditions used in current subcritical units are up to ≈ 179bar/541°C (2600 psia/1100°F).
Although subcritical steam cycles are not considered “advanced” technology for Rankine cycles plants, many “advanced” technology coal plants (e.g., IGCC and oxy-combustion) may incorporate subcritical steam cycles (OECD/IEA 2013).

Supercritical technology involves the increasing steam temperature and pressure; the efficiency of the steam turbine (and hence, of electricity generation) can be increased. As the steam pressure and temperature increases to a critical point, the characteristics of steam are altered such that water and steam are no longer distinguishable. This is known as supercritical steam and is a more efficient technology (IL&FS, 2010). Supercritical steam cycle technologies became fully commercial in coal plants in the early 1960s (OECD/IEA 2013), and have been used for decades and are becoming the system of choice for new commercial coal-fired plants in many countries. Research and development is under way for ultra-supercritical units operating at even higher efficiencies, potentially up to around 50% (see Figure 3-6). The introduction of ultra-supercritical technology has been driven, over recent years, in countries such as Denmark, Germany and Japan, in order to achieve improved plant efficiencies and reduce fuel costs. Research is focusing on the development of new steels for boiler tubes and on high alloy steels that minimize corrosion (WCI, 2013).

Current supercritical steam cycles typically have main steam pressures of about 240 bar (3500psi) or higher and main steam and reheat temperatures of around 565°C (1050°F). Supercritical plants are more economical at larger boiler and turbine sizes; typically units are superior to 500MW (OECD/IEA 2013).

Ultra-supercritical technology is similar to supercritical generation, but operates at even higher temperatures and pressures. Steam conditions are defined as the main steam temperature of around 600°C (1110°F) and main steam pressure greater than 300 bar (4365 psig). While not common, these plants represent the highest efficiency in pulverized coal plants available today (up to 40%) (OECD/IEA 2013).

2. **Fluidized Bed Combustion**

Another type of combustion-based coal power plant is Fluidized Bed Combustion (which can operate at atmospheric or pressurized furnace conditions). Coal is burned in a more coarse form in a bed of hot sorbent particles suspended in motion (fluidized) by combustion air (OECD/IEA 2013).

Fluidized Bed Combustion (FBC) systems improve the environmental impact of coal-based electricity, reducing SOx and NOx emissions by 90%. The coal is burned in a reactor comprised of a bed through which gas is fed to keep the fuel in a turbulent state. This improves combustion, heat transfer and recovery of waste products. The higher heat exchanger efficiencies and better mixing of Fluidized Bed Combustion systems allows them to operate at lower temperatures than conventional pulverized coal combustion. By elevating pressures within a bed, a high-pressure gas stream can be used to drive a gas turbine, generating electricity.

FBC fits into two groups, non-pressurized systems (FCB) and pressurized systems (PFBC), and two subgroups, circulating or bubbling fluidized bed.

3. **IGCC**

This technology converts the available coal fuel into combustion gas called synthesis gas, which is suitable for combustion in high efficiency units for power generation. The costs associated with converting coal to combustible gas is high (heat energy lost by fuel and equipment CAPEX and operating costs). This is feasible where coal quality is not suitable for transportation or transportation costs are high.

Over here this technology may not be viable in present case.

**EIA Guidance for Coal-Fired Power Plants in Pakistan**

High-efficiency coal power plants substantially reduce CO₂ emissions (OECD/IEA, 2013).
1. Non-pressurized FBC systems operate at atmospheric pressure and are the most widely applied type of FBC (also known as Atmospheric FBC). They have efficiencies similar to PCC – 30 to 40%.

2. Pressurized FBC systems operate at elevated pressures and produce a high-pressure gas stream that can drive a gas turbine, creating a more efficient combined cycle system – over 40%.

3. Bubbling uses low fluidizing velocity, so the particles are mainly held in a bed. This is generally used with small plants offering a non-pressurized efficiency of around 30%.

4. Circulating uses a higher fluidizing velocity, so the particles are constantly held in the flue gases, and is used for much larger plants offering an efficiency of over 40%.

The flexibility of FBC systems allows them to utilize abandoned coal waste that previously would not be used due to its poor quality (WCI, 2013).

4. Natural Gas Generating Units

Available option for the power plant are:

- Condensing Steam Turbine Power Station.
- Simple Cycle Gas Turbine Power Station.
- Combined Cycle Power Plant (CCPP).

Following major factors can be considered for selecting the most suitable design option for power plants based on natural gas:

- Capital Cost
- Thermal Efficiency.
- Completion Time

The following data summarizes the electrical generating efficiency for various types of power generation systems:

**Prime Power Efficiency**

- Pass Out Steam Turbine  10 – 20%
- Combined Cycle Gas Turbines  35 – 55%
- Open Cycle Gas Turbine  25 – 42 %
- Compressed Ignition Engine  35 – 45%

[Source: The European Association for Promotion of Co-Generation]

Above data provides for the fact that Combined Cycle Power Plant is the most feasible and economical option for natural gas based power plant.

The factor is against this technology being the unavailability of local gas and high prices of imported gas when compared with imported or local coal.

5. Solar To Power Generating Units

Solar energy—power from the sun—is a vast and inexhaustible resource. Once a system is in place to convert it into useful energy, the fuel is free and will never be subject to the ups and downs of energy markets. Furthermore, it represents a clean alternative to the fossil fuels that currently pollute our air and water, threaten our public health, and contribute to global warming. Given the abundance and the appeal of solar energy, this resource is poised to play a prominent role in our energy future.

Solar technology alternatives that were considered and which are suitable for the Project site area in general include the Photovoltaic, Concentrated Solar Power (CSP) and the Concentrated Photovoltaic (CPV). CSP technology uses mirrors to concentrate (focus) the sun’s light energy and convert it into heat to create steam to drive turbine that generates electrical power. On the other hand, CPV technology uses optics such as lenses or curved mirrors to concentrate a large amount of sunlight onto a small area of solar photovoltaic
(PV) cells to generate electricity. The alternatives were compared on three (3) main criteria and which include:

- technical performance,
- commercial-technical maturity, and
- production cost.

First, the PV technology was compared with the CSP and based on a qualitative analysis the PV technology was preferred. The below table summarizes the technical attributes which were investigated and compared between both technologies.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>PV</th>
<th>CSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Density (land area)</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Water Requirements</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Field Experience</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Operation and Maintenance (O&amp;M) Cost</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Suitability to Jordan’s Solar Resources</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Ease of Siting and Permitting</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Modularity and Scalability</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Peak Load Following Capability</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Suitability for Storage</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Dispatchability</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Simplicity of Design and Operation</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Capacity Factor</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Balance of Plant Requirements</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

Similarly, a comparative assessment was undertaken for the PV technology & the CPV. Based on qualitative analysis, the PV technology was preferable. The below Table summarizes the technical attributes which were investigated and compared between both technologies.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>PV</th>
<th>CPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Coverage Ratio</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Water Requirements</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Field Experience</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Operation and Maintenance (O&amp;M) Cost</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Suitability of Jordan Solar Resource</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Ease of Siting and Permitting</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Modularity and Scalability</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Suitability for Storage</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Potential for Future Cost Reductions</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Simplicity of Design and Operation</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Balance of Plant Requirements</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>9.5</td>
<td>7.75</td>
</tr>
</tbody>
</table>

The comparative assessment then investigated several alternatives with regards to solar PV technologies. Generally there are two (2) known PV technologies which exist in the market today;

- crystalline modules, and
- thin film modules.

Crystalline modules are made from silicon as a semi-conductor material whereas thin film is made from thin layers of photovoltaic material such as Cadmium Telluride (CdTe) or Copper Indium Gallium Selenide (CIGS). In general, silicon modules do not utilize hazardous semiconductor materials (silicon as semiconductor material), whereas thin film could utilize hazardous materials (such as CdTe).
The comparison took into account the advantages of utilizing either of the above technologies and the challenges of using each, in addition to site specific factors (such as climatic conditions). Such comparisons are summarized in the table below. Similarly, based on such comparisons the thin film technology was the more favourable option.

<table>
<thead>
<tr>
<th>Crystalline Technology</th>
<th>Thin-Film Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantages</td>
<td></td>
</tr>
<tr>
<td>Rapid price decrease</td>
<td>Better performance in warm or hot conditions</td>
</tr>
<tr>
<td></td>
<td>(specially after taking into account climatic conditions in Ma’an)</td>
</tr>
<tr>
<td>High efficiency</td>
<td>Less complicated form factor (no soldering, no bypass diodes)</td>
</tr>
<tr>
<td>Demonstrated operational life</td>
<td>Better response to partial shading/partial soiling</td>
</tr>
<tr>
<td></td>
<td>One product form factor focus</td>
</tr>
<tr>
<td>Challenges</td>
<td></td>
</tr>
<tr>
<td>Manufacturer consolidation</td>
<td>Fewer significant or established players in that domain</td>
</tr>
<tr>
<td>Squeeze on margins, manufacturing cost higher</td>
<td>Limited historical lifetime data</td>
</tr>
<tr>
<td>72 cell module innovation not field tested &lt;5 years – possible solder failures</td>
<td>Yearly output degradation 0.7% vs. 0.5%</td>
</tr>
<tr>
<td>New innovations, such as selective emitter, do not have a 30 year demonstrated operational life</td>
<td>Could entail the use of hazardous material as a semiconductor material</td>
</tr>
</tbody>
</table>

Even though solar intrigues all, the biggest weakness being availability of fuel 24 hours a day. When considering developing a power generating unit to cope with ever increasing power needs of commercial hub of Pakistan thinking of solar or wind is not at all conducive. We require power 24 hours a day rather than when fuel is available. Added to this weakness is the associated technology cost which renders wind and solar more expensive even when fuel costs are included for coal generating units (plant life of 15 years).

6. Proposed Technology for Boiler Combustion

The selected coal combustion technology for the proposed project is the super-critical pulverized boiler. The main reason for selecting pulverized boiler is fuel flexibility, low SO₂ and NOₓ emissions, combustion efficiency and economic feasibility.

5.4 Coal Transportation Alternatives

The Project is designed to utilize imported lignite coal preferably from Indonesia or South Africa. Coal imports in Pakistan in 2010 were 4.3 million tons, mainly for use in cement plants. Coal can be received at Karachi at either the Karachi port operated by the Karachi Port Trust or the Port Qasim (PQ), operated by the Port Qasim Authority. Both the ports have facilities to handle coal, and are connected to the road and rail network for transportation of goods to the northern markets in the country. The imported lignite coal will be transported to the plant site using any of the three options listed below:

Alternate Option # 1

The vessel carrying imported coal will be unloaded at PIBT, an under construction dedicated terminal for coal and bulk material imports. Coal will be offloaded from the vessels to the PIBT storage area (a coal handling capacity of 8 million tons/year) with the help of self-unloading arms installed on the vessel. In addition to it, grab cranes installed at PIBT terminal can also be employed to offload coal into the storage area.

Transportation of coal from PIBT to power plant shall be via: (i) Trucks, (ii) Conveyor or (iii) Railways

(i) Trucks will be loaded & sent to plant site. This will cause massive congestion on existing infrastructure. Also the process reliability will remain an issue during plant operation. So this option was rejected.
(ii) This is a much more feasible option. This would imply hassle free (massively reduced emissions) transportation of coal to plant site. This makes the process more fool proof. The only difficulty we foresee is getting right of way for conveyors and the land availability to build a conveyor. The maintenance will also be a factor which makes it unfeasible.

(iii) Railway construction will be very expensive and difficult. Another major issue will be getting right of ways. So this option is also not feasible.

In summary PIBT is not the preferred option due to difficulty in coal transportation from PIBT to Project site.

Alternate Option # 2

Coal from self-unloaded vessels can be offloaded to the Karachi Port and transported to Plant site by
- Trucks
- Rail Way

The distance to be covered is estimated at 150 km which makes this option not feasible. There are no railway lines existing or planned in near future.

Alternate Option # 3:

50,000 DWT vessel carrying imported coal for the project will dock at the jetty that will be constructed at the plant site with 2.9 million tonnes / annum unloading capacity. The ship will be guided by tugs and then pilot into the jetty. Coal will be then be transported to the coal storage area via conveyer belt.

Option 1 is not feasible due to above mentioned reasons
Option 2 is not feasible as transportation coal to such a long distance is not viable
Option 3 Is the best available option.

5.5 Cooling Water Alternatives

There are two options under consideration

Alternate Option # 1

Sea water intake would be via intake channel / Pipes. The flow required for cooling will be 100,000 cubic meter per hour. The discharge water will be discharged as shown in Figure 5.4. For this option modelling was carried out by reputed Chinese hydrological consultant (Tianjin Research Institute of Water Transport Engineering [TIWTE]) and report is attached as Annexure. The report shows that for a significant period during neap time the sea water temperature increase outside the mixing zone significantly exceeds the environmental limits. So this option has been rejected.
Alternate Option # 2

Cooling Tower shall be utilized for cooling of Steam Turbine Condenser and other Auxiliary heat loads. The Cooling tower will operate on sea water. The sea water makeup rate shall be 3463 m³/hr and discharge 2384 m³/hr for both the Cooling Towers. Waste heat will be discharged into the atmosphere in the form of vapours. This option is in complete compliance with environmental standards and guidelines. Hence this is the option selected for 2 x 350 MW Power Plant.
5.6 Screening Of Potential Environmental Impacts

Presented in this section are the screening of potential environmental impacts and assessment of their severity based on stakeholder perceptions about the project which was obtained at the outset of the EIA activity together with the data detailed in chapter 4. Screening process has been adopted to identify significant environmental and social aspects during the construction and operation stages of proposed coal fired power plant project. Based on the environmental issues identified during the stakeholders meetings and by the screening process mitigation measures have been proposed. These measures will have to be adopted in order to reduce, minimize or compensate for the negative impact as far as possible. Screening of potential impacts due to construction and operation stages of proposed DPKPG-CPP at Port Qasim are related to:

- Evaluation of Structural Stability
- Geology, Geomorphology & Hydrogeology
- Dredging
- Disposal of Dredged Spoil
- Oceanography and Navigation
- Air Quality & Noise
- Marine Ecology
- Water Resources and Water Quality
- Ash management
- Wastewater Discharge
- Solid Waste Management
- Land Use
- Safety & Health
- Socioeconomic aspects

5.6.1 Evaluation of Structural Stability

Engineering Design Considerations: Keeping in view the subsoil conditions prevailing at the site and the loads expected to be transferred to the foundations, deep foundations including pile foundations are recommended as the foundation system.

Shallow Foundations - Allowable Bearing Pressures: The gross allowable bearing pressure has been calculated following shear strength determination, through in-situ field tests. Table 5.1 gives the net allowable bearing pressures for isolated and raft foundations at the depth of 2.0 meters below existing ground level (EGL).

<table>
<thead>
<tr>
<th>Marking</th>
<th>Minimum Embedment below EGL (m)</th>
<th>Isolated Foundation (kPa)</th>
<th>Raft Foundation (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-K-01</td>
<td>2.0</td>
<td>250</td>
<td>380</td>
</tr>
<tr>
<td>BH-K-02</td>
<td>2.0</td>
<td>260</td>
<td>400</td>
</tr>
<tr>
<td>BH-K-03</td>
<td>2.0</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>BH-K-04</td>
<td>2.0</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>BH-K-05</td>
<td>2.0</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>BH-K-06</td>
<td>2.0</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>BH-K-07</td>
<td>2.0</td>
<td>170</td>
<td>380</td>
</tr>
<tr>
<td>BH-K-08</td>
<td>2.0</td>
<td>250</td>
<td>380</td>
</tr>
<tr>
<td>BH-K-09</td>
<td>2.0</td>
<td>250</td>
<td>380</td>
</tr>
</tbody>
</table>
The settlement of shallow foundations due to net allowable bearing capacity has been estimated within allowable limit of 25mm and 50mm for isolated and raft foundation, respectively.

Calculations for liquefaction analysis shows that the soils at borehole no. BH-K-12, BH-K13, BH-K-14 and BH-K-17 are highly susceptible to liquefaction for the peak ground acceleration of 0.20g, up to the maximum depth of 7m. Hence, shallow foundations are not recommended for any structure near this borehole locations. Therefore, it is recommended to perform soil improvement before placement of shallow foundations or provide piles foundation for structures near these boreholes.

A significant portion of the proposed onshore locations gets inundated during the high tides and some of the area is permanently under water. These locations are under the onshore development plan and areas covered between K12, 13, 14 & 15 will be reclaimed as per the design requirements of the development. Appropriate compacting technique will be used for improvement of the reclaimed soils. Because many of the near-shore habitats around project site will be undergoing modification due to island expansion and construction of shoreline protection, and because new habitats may still not have established themselves along the shoreline, the impact of compacting process on existing and new habitats will be minimal. The compacting activity would need to be completed prior to the reestablishment of new near shore habitats around project area. When proposed works are complete, no anticipated adverse long-term operational impacts from site filling and soils compacting are expected.

Four boreholes BH-K-12, BH-K-13, BH-K-14 and BH-K-17 are found to be susceptible to liquefaction as factor of safety for these boreholes are less than one (1.0) from 3.0 to 7.0 meters. To increase the safety factor against liquefaction either ground improvement techniques will be employed or pile foundations will be provided for structures near these borehole locations.

Deposits of loose fine sand with amount of silt are found to be susceptible to liquefaction for the combination of 0.20g PGA and Mw 6.6 earthquake. The most effective method for soil improvement in this type of soil is vibro flotation and/or installation of Stone Columns. The following sections describe the process of vibro flotation and installation of stone columns in detail.

Soil Profile Type (According To UBC-97): Chapter 16, Division V, Section 1636 of UBC-97 deals with the determination of Soil Profile Types. Design practice involves using seismic parameters of zone 2B for the area under consideration.

Seismic Zone Factor: Table 16-I of UBC-97 defines the seismic zone factor to be used in choosing seismic coefficients for a location. The seismic zone factor “Z” will be taken as 0.20.

Seismic Coefficients: Seismic coefficients are as under: For SC: Ca = 0.24 & CV = 0.32

Type of Cement: Tests on soil and groundwater samples obtained from the boreholes indicate ‘moderate’ for ground water, for sulphate and chloride exposure. Under these conditions it is recommended to use Ordinary Portland Cement (OPC) with slag for all underground concrete works.

5.6.2 Dredging & Disposal Of Dredged Spoil

It is estimated that up to 1.5 million cubic meters of material will be dredged to create berthing basin for ship and the same dredged material will be utilised for reclamation as discussed above.
According to the geotechnical investigation report of the site under examination the overburden soils exist in the form of soft to firm silty Clay/ clayey Silt, non-plastic Silt, dense gravelly Sand and hard silty Clay/Shale deposits, which are easily dredge-able. Dredging along the terminal piled bridge structure will be accomplished utilizing a bucket dredge that allows transfer of excavated material to the spoil storage area in large “clumps”, minimizing soil dispersion and siltation.

The disturbance of bed sediments through activities such as dredging can lead to a number of impacts on marine water quality including: 1) Turbidity Plumes, 2) Release of Contaminants, & 3) Oxygen Depletion. The re-suspension of sediment during dredging can cause dense turbidity plumes. Turbidity plumes are usually harmful to aquatic ecosystems because, inter alia, of the effect of reduced light penetration through water column. The impact on biological environment is discussed in separate section. Re-suspended sediments can be transported and re-deposited causing the smothering of benthic fauna and fishery resources.

Direct impacts on water quality tend to arise when the sediments are contaminated. The release of any heavy metals, hydrocarbons, organo-halogen compounds, etc. from the sediment into the water column can cause toxic effects on aquatic biota. The release of organic wastes can cause localized oxygen depletion of the water, again creating stressful conditions for aquatic biota.

The sediment to be dredged and disposed does not appear to be contaminated. It is therefore expected that water quality would not be adversely affected by the dredging and disposal of spoil. In addition, potential toxic impacts on aquatic biota due to the bio-availability of any contaminants are not expected.

The dredged material would be dumped into the disposal areas (as shown in Figure 5.6). The slurry will be properly contained in settling ponds to allow suspended solids to settle down and a relatively clean effluent will be released to the creek.

The overall effect of the disposal operation is therefore not thought likely to cause significantly adverse turbid conditions.

Figure 5.6: Dredge Material Disposal / Land Reclamation
The dredging of a berthing pocket adjacent to the existing navigation channel, compared to even the maintenance dredging of navigation channel being carried out regularly by port Qasim, will be insignificant. The hydraulic model studies for Port Qasim have extensively studied the impacts of dredging of navigation channel and the spoil areas for over a decade. No significant impact on geology, geomorphology and hydrogeology was identified. The comparatively very small dredging for the berthing pocket and disposal of spoil in the areas designated by Port Qasim may cause some negative impact on the channel geomorphology but this will be small.

**Mitigation Measures**

- Inspection and monitoring of dredging activities will be conducted through an Independent Monitoring Consultant (IMC) to evaluate the effectiveness of impact prevention strategies, and re-adjusted where necessary.
- Turbidity will be monitored during dredging event to ensure compliance with relevant international standards. If the turbidity standard is exceeded, dredging will be shut down temporarily until modifications can be made to the dredging technique to bring the operation back into compliance.
- Prior to initiation of dredging activities, materials will be evaluated for their chemical, biological, and engineering properties to inform the evaluation of dredge materials reuse or disposal options (e.g. land reclamation, open water discharge, or contained disposal). If found contaminated, the dredged material will be disposed of into a special Coffer Dam near ash yard area with proper measures as environmental standards. Treatment of dewatering liquids (e.g. metals and persistent organic pollutants) will also be required prior to discharge. Site-specific discharge quality standards will be established in consultation with EPA depending on the type and toxicity of the effluents and the discharge location.
- Excavation and dredging methods will be selected to minimize suspension of sediments, minimize destruction of benthic habitat, increase the accuracy of the operation, and maintain the density of the dredge material, especially if the dredge material includes contaminated areas.
- Use techniques (e.g. silt curtains), to minimize adverse impacts on aquatic life from the re-suspension of sediments.
- The delivery of fill material to dumping site as shown in Figure 5.5 will be equalized with spreading and compaction of fill layers to avoid spillage into the water.
- During operation of the proposed Terminal, periodic bathymetric surveys will be conducted by PQA and DPKPG within the berthing and turning basin to measure changes in bottom elevation and locate areas of sediment accumulation.

**5.6.3 Impact On Ambient Air Quality And Noise**

**Air Quality:** Following activities may affect the local air quality in the microenvironment of proposed DPKPG-CPP during the construction phase:

- Operation of Construction Equipments
- Operation of Diesel Generators
- Movement of Vehicles

A marginal increase in the levels of oxides of nitrogen, carbon monoxide and hydrocarbons is envisaged due to the movement of vehicles for transportation of construction material and diesel generators required during construction phase. However, this increase in concentration would be temporary in nature and localized. The access to the site is over an existing paved road. The movement of trucks bringing in construction materials is therefore not expected to create significant dust nuisance.
The predominant wind direction in the area is from the south west that is from the sea to the land. The airborne dust and emissions from the construction site would be blown towards the Port Qasim Industrial Area. However, these would be limited to construction period. As the site is located away from urban areas and human settlement and the surrounding industrial area is not fully developed yet, these will not create any negative impacts.

Site preparation activities would include clearing, excavation, earth & fill movement, and transportation of machinery and associated equipment to the site. Since heavy machinery will be involved during the entire construction period the said activities may lead to extensive soil erosion, or alteration of soil quality or removal of topsoil at the site. Impact due to wind erosion of exposed surfaces and uncovered stock piles, dust emission from movement of dump trucks, construction equipment and other vehicles on unpaved roads, and mixing and batching of aggregate for concrete preparation (if done on site) will be of moderate order. Most of the material excavated from the project site will be used as fill within the project area; this will not require additional borrow material.

Suspended particulate matter (SPM) is likely to be a major problem because of the arid and dusty environment all around. Particulate matter (PM$_{10}$), according to Sindh’s Ambient Air Quality Standards should not to exceed 150µg/m$^3$ for a weighted average time of 24 hours. Mitigation measures needed under the circumstances would aim at protection of the personnel.

Combustion of fuel for running the generators and construction equipment will have negative impact on the ambient air quality of the microenvironment of construction site if the operation of the equipment is not environment friendly in the sense that their engines are not appropriately tuned and their exhaust fumes are not suitably discharged.

Control of air emission during construction will be the responsibility of DPKPG and their contractors who will be mandated to follow the Environmental Management Plan in letter and spirit. The following mitigation measures will be adopted:

- Regular and periodic sprinkling of water on all exposed surfaces to suppress emission of dust. Frequency of sprinkling may be increased to keep dust emissions under control, particularly during the stormy season of mid-April to mid-June when wind is blowing at high speed and varying direction.
- Keeping the construction material in moist condition (if possible) at site.
- Locating stockpiles away from the wind direction and covering it with tarpaulin or thick plastic sheets, to prevent dust emissions.
- All routes within the project construction site facility will be paved providing hardened surface as early as possible upon the commencement of construction work. Other temporary tracks within the site boundary will be compacted and sprinkled with water during the construction works.
- Construction traffic will maintain a maximum speed limit of 20km/hr on all unpaved roads within the proposed site.
- Construction materials that are vulnerable to dust formation or those that comprise loose materials will be transported only in securely covered trucks to prevent dust emission during transportation.
- The exposure of construction workers to dust will be minimized by providing dust masks.
- All vehicles, generators and other equipments used during the construction will be appropriately tuned and maintained in good working condition in order to minimize exhaust emissions.
The stacks of the generators while in operation will be vented through vertical stacks to safe heights in order to minimize dispersions at ground level.

Diesel and other petroleum products used for the operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.

**Emissions from Power Plant:** Raw coal contains carbon (C), nitrogen (N), sulfur (S), ash, trace amounts of mercury (Hg) and other elements. Once these elements go through a combustion process with air, pollutants such as NOx, SO2 and SO3 and are formed. The pollutants of concern from coal power plant are sulfur dioxide [SO2], nitrogen oxides [NOx], carbon monoxide, and particulate matter [PM]. They are also called “criteria” pollutants because the EPA sets the criteria for permissible levels. Metals are constituents of coal and are emitted as part of fly ash during combustion. Trace metals emissions include antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead.

NOx refers to the cumulative emissions of nitric oxide (NO), nitrogen dioxide (NO2) and trace quantities of other nitrogen species generated during combustion. Combustion of any fossil fuel generates some level of NOx due to high temperatures and the availability of oxygen and nitrogen from both the air and fuel. N2 and O2 present in the air combine to form NO and NO2 at high temperatures. The quantity of NOx formed during combustion depends on the quantity of nitrogen and oxygen available, the temperature, the intensity of mixing and the time for reaction. Exposure to NO2 is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics and decreased pulmonary function.

When a sulfur-containing fuel is fired in a combustor, the sulfur in the fuel combines with oxygen and forms gaseous SO2. Some of the SO2 produced is oxidized to SO3. The effects for SO2 observed include reductions in respiratory volume capacity, increases in specific airway resistance, and symptoms such as wheezing or shortness of breath. Such effects are enhanced by exercise, which increases the volume of air inspired thereby allowing sulphur dioxide to penetrate further into the respiratory tract (WHO 2000).

Particulates are very small diameter solids or liquids that remain suspended in the flue gas and which, without a collection device, are discharged to the atmosphere. The solids are typically made up of non-combustible ash or partially combusted soot. Fine particulate can also be formed by chemical reactions in the air. The aerodynamic properties of particles are related to their size, shape and density. The deposition of particles in different regions of the respiratory system depends on their size: PM10 and PM2.5 are of concern due to their health impact potentials. Such fine particles are able to be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung. Smaller particles (PM10) pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Particles are removed by impacting with the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA/FPAC Working Group, 1998; Dockery and Pope, 1994).

Impact Assessment: Sindh Environmental Protection Agency (SEPA) has prescribed permissible limits for criteria pollutants, known as Sindh Environmental Quality Standards, 2014. At the same time, there is an increasing recognition that coal use must meet increasingly tighter environmental standards for emissions of criteria pollutants (particulates, SO2 and NOx), while also addressing growing environmental concerns over the carbon intensity of energy consumption by limiting emissions of CO2.

Modeling or simulation is a process whereby a system is created to simulate a real-life situation. Computer modeling is generally the most inexpensive and versatile method for analyzing a real-life situation and has
become prevalent for solving problems related to physical processes, especially in research and development. Simulation generally involves modeling a physical process and analyzing it through the use of a personal computer. Computer modeling of dust dispersion from a source can allow for the identification of potential hazard areas surrounding the source from a health and safety standpoint. It can also allow for the evaluation of dust control techniques to determine modifications necessary to improve dust control.

The results from modeling the emissions of a facility are used to ensure that the regional air quality does not exceed the SEQS or deteriorate the air quality further. If the modeling results show the facility will not cause the regional air quality to exceed the SEQS or deteriorate the air quality then the air quality permit will be granted, otherwise the quality permit application will be denied. Therefore, it is important that the modeling method accurately estimate both the amount of pollutant a facility will emit and the pollutants dispersion.

Air quality modeling is used for determining and visualizing the significance and impact of emissions to the atmosphere. Air quality models estimate the air pollutant concentration at many locations which are referred to as receptors. These models provide a cost effective way to analyze impacts over a wide spatial area where factors such as meteorology, topography and emissions from nearby sources are considered. The source data is evaluated in conjunction with meteorological information such as wind speed, wind direction, temperature etc. in the air quality model. The model examines all of these components together to characterize the state of the atmosphere and predict how pollutants are transported from the sources and estimates the concentration of these pollutants in the atmosphere.

USEPA regulatory model was used to simulate criteria pollutants from major sources in the project area & predict air quality for SO₂, NO₂, PM₁₀ & PM₂.₅. Specific objectives of the air quality impact assessment were to:

- Predict the impact of the proposed Project on the ambient air quality of the surrounding area
- Assess the predicted air quality against the applicable standards and guidelines
- Identify the mitigations measures, if any, that are required to ensure compliance with the applicable standards and guidelines
- Identify the optimum height of the emission stacks

**Applicable Standards:** Sindh Environmental Quality Standards (SEQS): The primary pollutants of concern are particulate matter, oxides of nitrogen (NOₓ), and sulfur dioxide (SO₂). The SEQS for ambient air quality applicable to the project are shown in Table 5.2.

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Time-weighted Average</th>
<th>Concentration in Ambient Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average*</td>
<td>80 μg/m³</td>
<td></td>
</tr>
<tr>
<td>24 hours**</td>
<td>120 μg/m³</td>
<td></td>
</tr>
<tr>
<td>Oxide of Nitrogen as (NO)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average*</td>
<td>40 μg/m³</td>
<td></td>
</tr>
<tr>
<td>24 hours**</td>
<td>40 μg/m³</td>
<td></td>
</tr>
<tr>
<td>Oxide of Nitrogen as (NO₂)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average*</td>
<td>40 μg/m³</td>
<td></td>
</tr>
<tr>
<td>24 hours**</td>
<td>80 μg/m³</td>
<td></td>
</tr>
<tr>
<td>Respirable Particulate Matter (PM₁₀)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average*</td>
<td>120 μg/m³</td>
<td></td>
</tr>
<tr>
<td>24 hours**</td>
<td>150 μg/m³</td>
<td></td>
</tr>
<tr>
<td>Respirable Particulate Matter (PM₂.₅)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average***</td>
<td>40 μg/m³</td>
<td></td>
</tr>
<tr>
<td>24 hours**</td>
<td>75 μg/m³</td>
<td></td>
</tr>
</tbody>
</table>

* Annual arithmetic mean of minimum 104 instruments in a year taken twice a week. 24 hourly at uniform interval
** 24 hourly /8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.
*** Annual Average limit of 40 μg/m³ or background annual average concentration plus allowable allowance of 9 μg/m³, whichever is low.
IFC Emission Guidelines: IFC emission guidelines are different for degraded and non-degraded air sheds. The degraded air shed is defined by IFC as: 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. As Pakistan has established national ambient air quality standards which, although not identical to those of the WHO, are comparable and even more stringent in certain cases, the decision of degraded or non-degraded airshed shall be based solely on the national criteria.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-degraded airshed</td>
</tr>
<tr>
<td>Particulate Matter (PM)</td>
<td>50 mg/m$^3$</td>
</tr>
<tr>
<td>Sulphur dioxide (SO$_2$)</td>
<td>400 mg/m$^3$</td>
</tr>
<tr>
<td>Nitrogen dioxide (NO$_2$)</td>
<td>200 mg/m$^3$</td>
</tr>
</tbody>
</table>

IFC recommends that facilities in degraded airsheds should minimize incremental impacts by meeting IFC guidelines. Further, it suggest that “facilities or projects located within poor quality airsheds should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards …”

Model Input Parameters:

Meteorological Data: The five years, hourly micro-meteorological parameters like wind direction, wind speed and ambient temperature were utilized for the modeling purpose. The analysis of meteorological data reveals that the winds were flowing predominantly from the WSW direction and the calm conditions (wind speed less than 1m/s) were 3.6%. The wind-rose diagram is presented in Figure.

Receptor Locations: A study area of 10km radius around the proposed power plant was considered and receptors were placed on Cartesian grid system, origin at 220 m high stack.

Emission Source Data: Emission inventory has been prepared based on the engineering details available with DPKPG. Release rate of pollutants has been calculated after considering the pollution control measures. Emission inventory of PM10, PM2.5 SO$_2$ and NOx has been prepared for modeling because they are considered criteria pollutants covered under the local regulations (ambient air and emission standards). The model input parameters are presented below:

<table>
<thead>
<tr>
<th>Table 5.4: Emission Source Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling Parameters</td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>No. of Stacks</td>
</tr>
<tr>
<td>Stack Height, m</td>
</tr>
<tr>
<td>Inner Dia, m</td>
</tr>
<tr>
<td>Flue Gas Temperature, K</td>
</tr>
<tr>
<td>Exit velocity, m/s</td>
</tr>
<tr>
<td>Pollutant Flow Rate</td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>SO$_2$</td>
</tr>
</tbody>
</table>
**Modeling Results:** The model was set up for calculation of 24-hour & annual average values. The Ground Level Concentration (GLC) were plotted as Isopleths.

**Discussion:** The worst incremental 24 hourly average GLC value of SO$_2$, NOx, PM10 and PM2.5 from the project at full operating load with 220 m high stack will be 17.6μg/m$^3$, 32.6μg/m$^3$, 2.0μg/m$^3$ and 1.3μg/m$^3$ respectively in the downwind ENE direction at a distance of 2 km from the plant site. The worst incremental annual average GLC vale of SO$_2$, NOx, PM10 and PM2.5 from the project at full operating load will be 3.9 μg/m$^3$, 7.3μg/m$^3$, 0.6μg/m$^3$ and 0.3μg/m$^3$ respectively in the downwind ENE direction at a distance of 2 km from the plant site. The 24-Hr. maximum incremental GLC is superimposed over the maximum baseline ambient air level and the resultant values are shown in Table 5.2.

Apparently all the emissions are getting dispersed at the designed height of 220 m. Based on this height, the concentration indexes of pollutants NOx, SO$_2$ and smoke calculated according to the lading concentration limit calculation are 576mg/Nm$^3$, 350mg/Nm$^3$ and 44.8mg/Nm$^3$ respectively. Such indexes completely meet the requirements of the environmental protection department of Sindh province on pollutant concentration of thermal power plant.

The 220 m tall stack heights with high momentum and buoyancy takes the plume above the highest mixing height. 99.98%. PM emissions are controlled using ESP, SO$_2$ by FGD and NOx by Low NOx burners. This results in lowest ground level concentration of air pollutants in the study area.

The values of the emissions at the fallout distance are within the Sindh Environmental Quality Standards (SEQS). The value of PM$_{10}$& PM$_{2.5}$ which is the parameter of concern in coal fired power plants is much within the limits suggested by SEQS. As such introduction of mitigation measures will entail emissions that will be within all standards and guidelines. The emission levels meet SEQS limits / requirements which says: 24 hourly values should be met 98% of a year, 2% of the time it may exceed but not on two consecutive days.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Incremental GLC (24-Hr. Max.) for DPKPG</th>
<th>Incremental GLC (24-Hr. Max.) for Sinohydro</th>
<th>Background Level</th>
<th>Superimposed Value (DPKPG)</th>
<th>Superimposed Value (DPKPG + Sinohydro CPP) [Cumulative Effect]</th>
<th>Sindh EQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO$_2$</td>
<td>17.6μg/m$^3$</td>
<td>36.1</td>
<td>14.7μg/m$^3$</td>
<td>32.3μg/m$^3$</td>
<td>68.4</td>
<td>120 μg/m$^3$</td>
</tr>
<tr>
<td>NOx</td>
<td>32.6μg/m$^3$</td>
<td>47.4</td>
<td>19.5μg/m$^3$</td>
<td>52.1μg/m$^3$</td>
<td>99.5</td>
<td>120μg/m$^3$</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>2.0μg/m$^3$</td>
<td>4.9</td>
<td>85.8μg/m$^3$</td>
<td>87.8μg/m$^3$</td>
<td>92.7</td>
<td>150μg/m$^3$</td>
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<td>PM$_{2.5}$</td>
<td>1.3μg/m$^3$</td>
<td>2.45</td>
<td>22.4μg/m$^3$</td>
<td>23.7μg/m$^3$</td>
<td>26.15</td>
<td>75μg/m$^3$</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Standards</th>
<th>Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter</td>
<td>mg/Nm$^3$</td>
<td>500</td>
<td>44.8</td>
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<tr>
<td>Sulphur Oxides</td>
<td>Tons per day</td>
<td>500</td>
<td>10.4</td>
</tr>
<tr>
<td>Oxides of Nitrogen</td>
<td>nanogram per Joule of heat input</td>
<td>300</td>
<td>101.8</td>
</tr>
</tbody>
</table>

**Mitigations Measure:**

- For all criteria pollutants (particulates, SO$_2$ & NOx), the inclusion of appropriate flue gas cleaning systems will meet all current requirements reliably and economically. These systems use well-proven technology such as ESPs for fine particulates removal, FGD for SO$_2$ control, together with combustion modifications (low-NOx burners) for control of NOx.
- LO-NOx burner plus air classification technology will be used for denitrification, so as to limit the NOx emission at the boiler outlet to fulfill the emission standard without using other DeNOx devices.

- Each boiler is equipped with electrostatic precipitators with a dust removal efficiency of at least 99.7%, so as to achieve a dust concentration of less than 50mg/Nm$^3$ at chimney outlet.

- Flue Gas Desulphurization (FGD) units (efficiency > 96%) using lime slurry will be installed to limit SO$_2$ emissions on the existing as well as the proposed plant.

- Each boiler and belt layer is set up with a set of negative pressure cleaning piping system. Two boilers are set up with a set of mobile vehicular vacuum suction device.

- A complete extractive-type continuous emission monitoring system (CEMS) will be provided with flue gas analyzers for SO$_2$, NO$_x$, CO$_2$, and opacity meters for the unit. The CEMS will be furnished with sampling systems, sample conditioning, sample lines, analyzers, a programmable logic controller (PLC), and a shelter to house the CEMS equipment. The PLC will have a redundant link to the plant DCS.

- Coal and coal waste products, including fly ash, bottom ash, and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into the environment. Major portion of these heavy metals may remain with ash. The efficient ash management system adopted for the proposed power plant shall control release of ash as well as heavy metal into the environment.

- Continuous online monitoring system for SPM, CO, SO$_2$ and NOx with computer display and recording facility will be installed to facilitate regular checkup of air emissions and ensure compliance with the prescribed standards.

- Windbreak will be installed around the coal piles. Wind breaks are made of Aluminum-zinc coated steel plate, galvanized steel plate, cold-rolled steel plate, stainless steel sheet, polymer resin-based composite materials, carbon fiber reinforced polymer composite materials. Using the principle of aerodynamic, wind, which is the source of the dust, is effectively controlled. So that, it can achieve the maximum attenuation of the wind kinetic energy, reduce the dust arousing and carrying capacity of wind and achieve the effect of dust suppression. Dust suppression rate can be much more than 80%. At present, it has been one major dust pollution control technology being applied. The height of the walls is typically kept at least 30% more than the height of the coal pile. Typical wind break and the profile of each element in the windshield are shown in following Figure.

---

1. Working Principle of Wind Break
Wind break and dust suppression wall is a porous barrier. At the back of the wall, a low-velocity zone is formed. It effectively reduces the average wind speed, thereby prevents dust from moving, and achieves the purpose of dust suppression.
Dense belt of trees that would be planted as afforestation measures at the dumping sites, will serve as dust arresters for the fugitive dust emitted from the dust raising activity area. It may be noted that one hectare of dense trees with large canopy can catch (arrest) about 40 tonnes of dust. The afforestation component of the Project covers a much larger area to catch the fugitive dust. The project also has provision for spraying water over the dusty areas. The trees in the designated belt will accordingly be sprayed off and on so that the landscape does not lose the green cover.

Dust suppression and extraction system will be provided at each critical location to minimize the impact of coal dust that is known to cause irritation to the eyes and mucous membrane.
Compliance status of SO$_2$ (24 Hourly)

<table>
<thead>
<tr>
<th></th>
<th>Background SO$_2$ level without FGD</th>
<th>SO$_2$ level with FGD</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc. µg/m$^3$</td>
<td>14.7</td>
<td>272.91</td>
<td>17.6</td>
<td>32.3</td>
<td>120</td>
</tr>
</tbody>
</table>
Compliance status of SO\(_2\) (Annual)

<table>
<thead>
<tr>
<th>Conc. µg/m(^3)</th>
<th>Background without FGD</th>
<th>SO(_2) level with FGD</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.7</td>
<td>61.76</td>
<td>3.9</td>
<td>18.6</td>
<td>80</td>
<td>50</td>
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</table>

Compliance status of NO\(_x\) (24 hourly)

<table>
<thead>
<tr>
<th>Conc. µg/m(^3)</th>
<th>Background without LNB</th>
<th>NO(_x) level with LNB</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.5</td>
<td>828.94</td>
<td>32.6</td>
<td>52.1</td>
<td>120</td>
<td>150</td>
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</table>
Compliance status of NOx (Annual)

<table>
<thead>
<tr>
<th></th>
<th>NOx level without LNB</th>
<th>NOx level with LNB</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc. µg/m³</td>
<td>19.5</td>
<td>171.66</td>
<td>7.3</td>
<td>26.8</td>
<td>80</td>
</tr>
</tbody>
</table>

Compliance status of PM10 (24 Hourly)

<table>
<thead>
<tr>
<th></th>
<th>PM10 level without ESP</th>
<th>PM10 level with ESP</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc. µg/m³</td>
<td>85.8</td>
<td>279.43</td>
<td>2</td>
<td>87.8</td>
<td>150</td>
</tr>
</tbody>
</table>
Compliance status of PM10 (Annual)

<table>
<thead>
<tr>
<th></th>
<th>Background</th>
<th>PM10 level without ESP</th>
<th>PM10 level with ESP</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>World Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc. µg/m³</td>
<td>85.8</td>
<td>79.78</td>
<td>0.6</td>
<td>86.4</td>
<td>120</td>
<td>50</td>
</tr>
</tbody>
</table>

Compliance status of PM2.5 (24 hourly)

<table>
<thead>
<tr>
<th></th>
<th>Background</th>
<th>PM2.5 level without FGD</th>
<th>PM2.5 level with FGD</th>
<th>Super Imposed V value</th>
<th>Sindh EQS</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc. µg/m³</td>
<td>22.4</td>
<td>175.92</td>
<td>1.3</td>
<td>23.7</td>
<td>75</td>
<td>20</td>
</tr>
</tbody>
</table>
### Compliance status of PM2.5 (Annual)

<table>
<thead>
<tr>
<th>Conc. µg/m³</th>
<th>Background</th>
<th>PM2.5 level without FGD</th>
<th>PM2.5 level with FGD</th>
<th>Super Imposed Value</th>
<th>Sindh EQS</th>
<th>WHO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22.4</td>
<td>39.89</td>
<td>0.3</td>
<td>22.7</td>
<td>40</td>
<td>10</td>
</tr>
</tbody>
</table>

The chart shows the concentration levels of PM2.5 over different scenarios, with the WHO standards set as a benchmark for compliance.
Noise: During the construction phase works such as pile driving, dredging, drilling, earthworks, etc. as well as site plant such as compressors, would all contribute noise. These activities at the site are likely to increase the background noise levels by 2-3 dBA at a distance of 0.5 km.

Factors that would affect the degree of the potential noise impact during terminal construction include:

- Background noise levels;
- Prevailing wind conditions;
- The acoustic effect of the creeks;
- Features that may provide shielding or damping effects;
- Tolerance by the workers in the nearby industrial area.

Prevailing wind conditions are discussed in Chapter 4. The prevailing wind direction is from the SW. Wind speed data indicate that winds are inclined to blow from the southwest. Offshore winds are also generated by convection changes as the land warms during the day. It is considered likely that there would be regular occasions when the prevailing wind is such that noise is directed towards the land.

The acoustic effect of the creeks especially during low water would be to echo the noise, possibly causing a weak echo effect for sharp bursts of noise such as those associated with pile driving. However, the open land would help the dissipation of construction noise. There are no notable buildings or topographical features that would provide shielding or damping effects.

The major human settlements are more than 7.5 km away from the site. There are no developed residential areas or sensitive buildings (schools or hospitals) close to proposed DPKPG -CPP site. Hence there will not be any excessive noise impact on the community.

Dredging operations typically proceed for 24 hours a day. It is not necessary to restrict dredging times because there is no residential area or any school, hospital or library in the area.

During construction the other sources of noise and vibration will be the movement and operation of heavy construction equipment, excavation and fill operation for grading, pipeline cutting, welding and installation etc. These noises will be confined to the site (local) and of temporary nature.

Based on the review of data for similar activities performed for other projects of similar nature the expected noise levels would be well below both the daytime limit and the nighttime limit of 70 dB(A) required by World Bank Guidelines. If the noise emitted from construction operations reaches levels which exceed the World Bank Guidelines then modest noise control measures can be employed that will reduce the noise by 5 to 10 dB. The construction workers who may be exposed to high noise would be provided ear plugs to be worn as protective measures.

During piling activity, working times typically cover daylight hours and are based around two shifts. As the main working activity in the area is industrial, with typical times to a working day, it is therefore believed that by not restricting pile driving to daylight hours, there would be no problem of sleep disturbance in the area.

The potential changes in sound quality on other local roads resulting from increased vehicle traffic during construction are not expected to be significant. The potential changes in ambient sound pressure levels are expected to be low.

Noise emission during dredging operations can impact the marine fauna. The significance of this impact depends on the ambient noise levels, the acoustic nature of the area to be dredged, the sensitivity of the species affected and the type of dredger used. However, very little work has been carried out relating the
sensitivity of marine fauna to noise levels for the Port Qasim area. The ambient noise levels within the Project area are relatively low, in comparison with the noise emitted from a dredger. The area of dredging is relatively very small which limits the significance of the impact. The species thought to be most vulnerable to noise are fish. It is likely that fish will be able to avoid noisy areas and it is therefore considered that this particular aspect will be of minor, temporary and local significance.

The operation of cargo unloading, and storage is low impact activities. Noise emissions during project operation is expected to be much lower and generally derived from facility operations such as pumps, engines, other on-site machinery, and from cargo carriers unloading at the jetties.

Noise level immediately outside these facilities is generally reduced to acceptable level of 75dB(A). There are no continuously noisy systems around the facility, while the noisy standby power generator would be housed in its own building, and its occasional use inside an adequately sealed structure would reduce the emission level from almost 90 dB(A) to less than 75 dB(A) at the boundary wall of the facility.

Noise emissions from the marine vessels would mainly be generated by the operation of the vessel’s engines. The noise emissions from vessel engines are substantially attenuated by their placement deep within the confines of the vessel. Only one vessel will be using the berth at any point of time. The increase in noise emissions from marine vessels using the berth is not expected to result in significant increase in level (<3dBA). Additionally, sound emissions from marine vessels will occur on an intermittent and infrequent basis.

The design noise level for the various equipments for proposed CPP are given in Table 5.7.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Installation Position</th>
<th>Level of Single Noise Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator</td>
<td>Main power building</td>
<td>90 ～ 95</td>
</tr>
<tr>
<td>Steam Turbine</td>
<td>Coal crusher room</td>
<td>90 ～ 93</td>
</tr>
<tr>
<td>Exiter</td>
<td>Coal-bunker bay</td>
<td>88 ～ 92</td>
</tr>
<tr>
<td>Coal crusher</td>
<td>Air compressor</td>
<td>90</td>
</tr>
<tr>
<td>Coal pulverizer</td>
<td>Compressor plant</td>
<td>75</td>
</tr>
<tr>
<td>Air compressor</td>
<td>Outdoor</td>
<td>86</td>
</tr>
<tr>
<td>Main transformer</td>
<td></td>
<td>85 ～ 93</td>
</tr>
<tr>
<td>Circulating pump</td>
<td></td>
<td>86</td>
</tr>
<tr>
<td>Induced-draft fan</td>
<td></td>
<td>87 ～ 90</td>
</tr>
<tr>
<td>Primary air fan</td>
<td></td>
<td>87 ～ 90</td>
</tr>
<tr>
<td>Forced draft fan (3m in front of air inlet)</td>
<td></td>
<td>87 ～ 90</td>
</tr>
<tr>
<td>Steam exhaust of boiler</td>
<td>Upper position of boiler</td>
<td>130</td>
</tr>
</tbody>
</table>

The cumulative noise levels due to the combined operation of power generating units, ships loading/unloading, movement of machinery are predicted to be 62 dBA at a distance of 250 m and 59dBA at a distance of 500 m from the boundary. Thus there will be an incremental noise level of 1-2 dB(A) over the baseline at distance of 500 m from the proposed onshore terminal. As no major settlement is located within 7.5 km from the area, no noise impact on the community is envisaged. Plantation of large canopy trees will further help to capture the fugitive dust and attenuate the noise apart from improving the aesthetics. Hence SEQS levels will be achieved at the boundary of the plant.

Equivalent sound pressure level (Leq) averaged over 8 hours is used to describe noise exposure in workplace environment. The damage risk criteria for hearing as enforced by OSHA (Occupational Safety and Health Administration) stipulate that the noise levels up to 80 dB (A) are acceptable for 8 hour exposure per day.
Mitigation Measures

- All emissions from construction and operation must be in compliance with air quality standards in vogue. With adherence to the applicable legal requirements, impacts to regional air quality during operation of the Project would be insignificant but would continue for the life of the Project. Regular monitoring and evaluation is recommended.

- Construction impacts on air quality will be mitigated through construction management practices.

- During periods when the prevailing wind direction is north-easterly and strong enough to generate airborne dust naturally, consideration would be given to either wetting or avoiding works that would worsen such conditions. It is not likely that dusty conditions would occur often enough to significantly disrupt the construction works.

- Emissions from vehicles and other engine-driven construction equipment will be temporary and cease once the project is completed. Nevertheless, mitigation measures including proper maintenance of construction equipment and controlling unnecessary idling of equipment will be implemented.

- Contractors and operators will be mandated to use new generators and to regularly maintain them so that the emission levels are within acceptable range. Mitigation measures including proper maintenance of construction equipment & controlling unnecessary idling of equipment will be implemented.

- Over 5000 trees will be planted in and around the project area. The plantation width will vary from 25–100 m, depending upon the space available. After the site is prepared for starting the construction activity and boundary wall is completed, the land portion earmarked for green will be fenced. The main objective of greenbelt is to provide a barrier between the sources of pollution and the surrounding habitation. The greenbelt will help to capture the fugitive dust and attenuate the noise apart from improving the aesthetics. Greenbelt and greenery development also prevent soil erosion and washing away of top soil besides helping in stabilizing the functional ecosystem, make the climate more conducive and restore water balance.

- Health and safety of workers will be given due importance and wherever necessary workers will be provided with earplugs as per specifications to meet the World Bank guidelines.

- Periodic maintenance of construction machinery and transportation vehicles should be undertaken to reduce the noise impact.

- Overall, the impact of generated noise on the environment is likely to be insignificant, reversible and localized in nature and mainly restricted to the day hours and sufficient noise control measures would be undertaken.

Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) provides additional protection to workers exposed to workplace hazards in conjunction with other facility controls and safety systems. PPE is considered to be a last resort that is above and beyond the other facility controls and provides the worker with an extra level of personal protection. Table 5.8 presents general examples of occupational hazards and types of PPE available for different purposes.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Workplace Hazards</th>
<th>Suggested PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye and face protection</td>
<td>Flying particles, molten metal, liquid chemicals, gases or vapors, light radiation</td>
<td>Safety glasses with side-shields, protective shades, etc.</td>
</tr>
<tr>
<td>Head</td>
<td>Falling objects, inadequate height</td>
<td>Plastic helmets with top and side impact</td>
</tr>
</tbody>
</table>
Table 5.8: Occupational hazards and types of PPEs available

<table>
<thead>
<tr>
<th>Protection</th>
<th>Clearance, and overhead power cords</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing protection</td>
<td>Noise, ultra-sound</td>
<td>Hearing protectors (ear plugs or ear muffs)</td>
</tr>
<tr>
<td>Foot protection</td>
<td>Failing or rolling objects, points objects. Corrosive or hot liquids</td>
<td>Safety shoes and boots for protection against moving and failing objects, liquids and chemicals</td>
</tr>
<tr>
<td>Hand protection</td>
<td>Hazardous materials, cuts or lacerations, vibrations, extreme temperatures</td>
<td>Gloves made of rubber or synthetic material (Neoprene), leather, steel, insulation materials, etc.</td>
</tr>
<tr>
<td>Respiratory protection</td>
<td>Dust, fogs, fumes, mists, gases, smokes, vapors</td>
<td>Facemasks with appropriate filters for dust removal and air purification (chemical, mists, vapors and gases). Single or multi-gas personal monitors, if available</td>
</tr>
<tr>
<td></td>
<td>Oxygen deficiency</td>
<td>Portable or supplied air (fixed lines). Onsite rescue equipment</td>
</tr>
<tr>
<td>Body / leg protection</td>
<td>Extreme temperatures, hazardous materials, biological agents, cutting and laceration</td>
<td>Insulating clothing, body suits, aprons etc. of appropriate materials</td>
</tr>
</tbody>
</table>

Recommended measures for use of PPE in the workplace include:

- Active use of PPE if alternative technologies, work plans or procedures cannot eliminate, or sufficiently reduce, a hazard or exposure
- Identification and provision of appropriate PPE that offers adequate protection to the worker, coworkers, and occasional visitors, without incurring unnecessary inconvenience to the individual
- Proper maintenance of PPE, including cleaning when dirty and replacement when damaged or worn out. Proper use of PPE should be part of the recurrent training programs for Employees
- Selection of PPE should be based on the hazard and risk ranking described earlier in this section, and selected according to criteria on performance and testing established

Measures for Occupational Health Hazards

- Detect the possible onset of an occupational disease
- Check the effectiveness of preventive and control measures on regular basis.
- Where there is potential for exposure to substances poisonous by ingestion, suitable arrangements are to be made for provision of clean eating areas where workers are not exposed to the hazardous or noxious substances
- Adequate supplies of potable drinking water should be provided to workers
- Water supplied to areas of food preparation or for the purpose of personal hygiene (washing or bathing) should meet drinking water quality standards
- Periodic medical hearing checks should be performed on workers exposed to high noise levels
- Preventing spread of communicable diseases
- Provisions should be made to provide OHS orientation training to all new employees to ensure they are apprised of the basic site rules of work at / on the site and of personal protection and preventing injury to fellow employees
- Contractors that have the technical capability to manage the occupational health and safety issues of their employees should be hired, extending the application of the hazard management activities through formal procurement agreements
- Two ambulances and full fledge First aid treatment facilities should be available onsite.
5.7 Impact On Soil & Water Quality

During the construction phase site preparation (levelling, excavations etc.) and erection of structures will have temporary effect on the water quality of receiving water body, i.e. Gharo Creek. Flow of loose materials (soil and construction material) into the drain, especially during monsoons will result in higher turbidity and suspended solids content. However, such impacts will be short term and limited to construction areas only. Adequate arrangement would be made to ensure proper drainage and disposal of the wastewater; so that water does not stagnate in the form of cess pools promoting breeding of mosquitoes and creating in-sanitary conditions. The wash off will be directed to a septic tank before discharge. Hence no significant increase in the suspended solid content of the water regime is expected.

During the construction of proposed Jetty it is possible that construction materials could either be lost accidentally or dumped intentionally into the aquatic environment.

It is further anticipated that the piling operations associated with the jetty construction will produce small spoil material. Samples of the spoil material produced from mud flats would be tested for contamination and, if heavily contaminated, would be disposed off in a specially designed Coffer Dam.

Possible sources of soil and water impact include:

- Spills during refueling, discharges during vehicle and equipment maintenance, traffic accidents, handling of chemicals and leakages from equipment and vehicles often result in contamination of soil during construction;
- Runoff after a storm from the plant site or the construction site may contain oil that may pollute the surrounding lands. Earthwork may also alter the drainage pattern and affect the storm water flow and result in possible flooding of sections of surrounding land;
- Improper disposal of domestic effluent from the camp may result in contamination of soil and water and become a health hazard;
- Various types of wastes such as packing waste; metal scrap, and excess materials, uprooted vegetation, and excess soil will be generated during the construction phase. Besides being an eyesore, the waste can be a health hazard and pollute waterways, if disposed improperly;
- The untreated discharge of sanitary wastewater effluent from the power plant can potentially affect the sea water;
- The direct discharge of liquid waste effluent from the power plant can potentially affect the water resources;
- Sea contamination during the coal handling and transfer;
- The direct discharge of heated water from the power plant to the water resources.

The operations phase will require use of process chemicals some of which can be hazardous. These chemicals require proper handling in order to avoid any potential damage.

Soil Contamination

A significant impact on soil will be interpreted if visible amounts of hydrocarbons are observed in the soil. A significant impact will be interpreted if:

- Visible quantity of liquid waste (oil & grease etc.) and coal dust is present in the runoff from the site
- A significant impact on the environment will be interpreted if wastewater discharged to the environment is not in compliance with the SEQS.
As no regulations for waste handling and disposal exists, an adverse impact on the environment will be interpreted if,

- Any person is exposed to potentially hazardous waste generated by the Project
- The Project generates waste that can be avoided through practicable means (waste minimization)
- Reusable waste generated by the Project is discarded
- Recyclable waste instead of separation at the source is dumped at the trash bins
- Any waste generated by the Project is scattered at any place outside the designated bins, or
- Non-recyclable and non-reusable waste ends up at any place other than the designated disposal site.
- A significant impact will be interpreted if hazardous material is handled in manner other than that prescribed in the Material Safety Data Sheets (MSDS), without a valid justification.
- Ash generated from the project is stored at any place other than designated disposal site

**Drainage and Storm Water Run-off**

The storm water runoff from construction sites can carry oil and grease if the soil is contaminated or the potentially contaminated areas (oil and grease storage areas, maintenance areas and workshops) are in contact with the run-off from the surrounding areas and will release in the sea water. Any risk may be eliminated by taking measures to avoid spills and taking immediate remedial measures in case of accidental spillage of oil.

**Camp Effluent**

The staff and labor camps for the construction and operation of the power plant will be a source of wastewater generated from the toilets, washrooms, and the kitchen. The untreated wastewater will not meet the national environmental standards and will therefore need treatment prior to disposal.

**Plant Effluent**

The effluents from the plant include the boiler blow down, cooling water and waste water from the plant. A water treatment plant will be constructed at the plant site which will ensure the effluents meet the SEQS limits. Brine will be discharged into sea as per the requirements of SEQS.

While developing the water system for the project, utmost care has been taken to maximise the recycle/reuse of effluents and minimize effluent quantity. All major water systems of the plant (cooling water system, service water system, coal handling water system and bottom ash handling system) have recirculatory systems. However, discharge of effluents from a power plant cannot be totally eliminated.

Hyperbolic type cooling tower will suffice cooling water requirements of Steam Turbine condenser and other auxiliaries. The source of the cooling water is seawater that enters the plant via intake arrangement i.e. water intake will be from the east of the coal unloading jetty and discharged via pipes South of Main Power Building. The circulating water intake structure is tentatively considered to set in the sea area at the east of the coal unloading jetty outside the plant and nearby the isobath of -9.3m elevation; the discharge structure is proposed to set on the offshore mud flat of the bay at the south of the plant main power building. The 2×350MW units are provided with two water intake structures, which are located at the east of the plant jetty and about 400m away from the plant ash storage yard embankment; the drainage pipe is located at the south of the main power building and about 850 m away from the main power building. The source of makeup water for the Cooling Tower is the seawater. The project will adopt two natural draft cooling towers and 5 circulating water pumps (4 operating and 1 for standby).
The circulating cooling water system is proposed as following:

Cooling tower →intake culvert box →hydraulic steel gate→ trash cleaning device → circulating cooling water pump → outlet valve → circulating water supply pipe → condenser → circulating water return pipe → cooling tower.

The Equipment’s are as follows

<table>
<thead>
<tr>
<th>S.#</th>
<th>Description</th>
<th>Specifications</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Circulating water pump</td>
<td>Vertical mixed-flow pump</td>
<td>Sets</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Trash cleaning devices</td>
<td></td>
<td>sets</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Trash rack</td>
<td></td>
<td>pcs.</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Hydraulic steel gate</td>
<td></td>
<td>pcs.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(equipped with 4 groups of guide slots)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hydraulic butterfly valve</td>
<td></td>
<td>pcs.</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Power-driven double-girder gantry crane</td>
<td></td>
<td>set</td>
<td>1</td>
</tr>
</tbody>
</table>

**Sanitary Wastewater Treatment System:** Several lift stations will be provided for transporting raw sewage from the main power block and outlying areas to the sanitary treatment system. The concrete basin extended-aeration type sewage treatment plant equipment contains an integral submerged bar screen at the inlet to the surge tank compartment. Dual sewage pumps provide a flow to the aeration tank chamber based on the depth of water in the surge tank. Flow from the aeration chamber to the dual hopper clarifier is by gravity. Aeration blowers are mounted above the aeration tank and supply air to the biological treatment process. The resulting solids are settled into downstream clarifier hoppers while floating solids are skimmed from the clarifier surface and returned to the aeration chamber. The clarified effluent flows into an integral chlorine contact tank where sodium hypochlorite is added before discharge. There is an integral airlift system for the return of settled solids from the clarifier hoppers to the aeration basin.

The treated sanitary effluent will be used for watering of the greenbelt (man-made vegetation areas) surrounding the power plant and within the colony.

The chemical water treatment system is designed as oxygenation treatment. Full-flow condensate polishing is considered. Considering the factors such as result of iron removal and silicon cleaning and desalination, differential pressure and operation load of the condensate polishing system, the polishing device designed for the project is "2 x 50% pre-filter + 3 x 50% high-speed mixed bed and bypass" systems. One set of external regenerative device is common to two generating sets.

The principal process flow is as follows: Condensate from the main condensate pump → Pre-filter → High-speed mixed bed for external regeneration device → thermodynamic system.

Two mixed beds operate and one mixed bed is as standby one. High tower separation process is used for external regeneration.

**Polished condensate & feedwater** are subject to ammonification treatment and oxidization treatment. The ammonification and oxidization points are located in polishing water outlet mains and downcomer.

In order to inhibit corrosion and fouling of closed circulating cooling water systems, ammonia is dosed into cooling water. The chemical dosing system is designed as a system which has common solution tank, separate dosing pumps and common standby pumps.
This Project shall adopt the system of production of sodium hypochlorite by electrolysis of concentrated seawater generated by reverse osmosis seawater desalination to control the breeding of microorganisms in the condenser and prevent the occurrence of pollution, clogging and corrosion to the cooling equipment.

The system of production of sodium hypochlorite by electrolysis of concentrated seawater consists of the concentrated seawater lift pump, sodium hypochlorite generator, sodium hypochlorite storage tank, hydrogen diffuser, pickling unit, rectifier transformer and rectifier cabinet, etc. The system is planned to be provided with 2×60kg/h sodium hypochlorite generators and 2×50m³ storage tanks.

Three x sets of 1000m³ waste water basin is provided for the project. The main treatment methods used are flocculation, settlement, clarification, final neutralization and the design system capacity is 60t/h.

The remaining water for flushing conveyor gallery, ash silos and rainwater from coal yards are settled in the settling pond and lifted to high-efficiency water cleaner by a self-priming pump. The water is subject to settlement, flocculation, centrifugal separation and filtration and then discharged to the Clear water pond from the top of water cleaner. Finally, the water is pumped to the recycled water pond. The slurry is discharged by gravity flow from the bottom of high-efficiency water cleaner to the front end of slurry pond. The system capacity is 2 x 20 m³/h.

Oily water may be produced during maintenance in condenser floor. One set of Q = 1 m³/h mobile oil separator is provided.

The separate system is adopted for domestic sewage and rainwater in this project. It is proposed to set up the independent domestic sewage pipe network to collect the domestic sewage from all buildings in this construction phase, send it to the domestic sewage treatment device for treatment; the treated domestic sewage will be then filtrated & sterilized and finally used for plant-area road spraying and greening.

The following control measures are proposed to mitigate the impact on soil and sea water:

- Spill prevention trays will be provided and used at refuelling locations
- During on-site maintenance of construction vehicles and equipment, tarpaulin or other impermeable material will be spread on the ground to prevent contamination of soil
- Regular inspections will be carried out to detect leakages from construction vehicles and equipment
- Vehicles and/or equipment with leakage will not be used until repaired
- Fuels, lubricants, & chemicals will be stored in covered bunded areas, underlain with impervious lining
- Appropriate spill control arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas
- Measures will be taken to minimize soil contamination. Contaminated soil will be immediately collected to minimize the volume of contaminated soil. Heavily contaminated soil will be segregated from the rest of the soil. Various final disposal options for contaminated soil are available. These include incineration at facilities in Karachi, disposal through licensed hazardous waste contractors, encapsulation at site, and bioremediation at site or off-site location. Appropriate disposal method will be employed, however, until an acceptable method is found the contaminated soil will be stored at the site in secure containers.
- Through contouring and installation of embankments, where necessary, it will be ensured that storm water from the surrounding areas does not enter the construction site and pass to the sea water
- All unpaved exposed areas of the plant will be compacted to minimize water erosion
Run-off from all areas containing potentially hazardous materials will be isolated from the remaining site.

Soil banks from ditching operations will not be placed where they might impair natural drainage.

Channel runoff will be provided, where necessary, to avoid flooding.

No untreated effluents will be released to the environment.

Liquid waste will be collected and treated in an on-site wastewater treatment plant to comply with SEQS before releasing to the environment.

Good practice measure will be followed while handling coal at PQA and KP while transferring coal from ships.

Regular monitoring of the coal handling will be in place at the plant site berth if the sea transportation is selected.

Implementation of the proposed mitigation measures is not likely to leave any long-term residual impact on the soil. However, insignificant amounts of hydrocarbons may be left in the soil due to minor spills, where remedial measures are not possible.

Even after implementation of the control measures, it is possible that some littering may take place. Periodic monitoring and clean-up will be undertaken to minimize the residual impact.

5.7.1 Impact On Navigation And Hydraulics Of Channel

During construction of the Jetty, there may be occasional temporary obstruction to navigation during manoeuvring of the floating construction equipment (piling barge). This will however be coordinated with Port Qasim Authority. As the jetty is well separated from the main navigation channel, there is no likelihood of obstruction to shipping during routine construction.

No obstruction to navigation in the main channel of Port Qasim is envisaged. Port Qasim Authority regulates the traffic in the channel according to regulations.

The construction of a solid wharf has a maximum effect on the flow while the proposed Jetty is an open piled structure and will not have any significant effect on the hydraulics of the channel.

Limited dredging for the berthing pocket will be carried out. The Hydraulics Research Laboratory, Wallingford, UK, has been advisors to the PQA since the beginning and has performed hydraulic studies regarding the impact of dredging for the port construction and maintenance of navigable depths. The result of these studies has been instrumental in the selection of the site for coal handling jetty within Gharo Creek channel. It was concluded that the effect of increasing the width and girth of the creek channel at the terminal site will not have any significant effect on the hydraulics of flow compared to the overall dredging associated with the entire PQA port development.

During the operation, ships will be arriving at the Jetty. The movement of ships in the channel at low speeds has not affected the channel hydraulics over the past years. The overall traffic of ships to Port Qasim is estimated to increase significantly in the future.

The operation of the coal jetty therefore will not have any impact on channel hydraulics or navigation.

Mitigation Measures

No mitigation measures required.
5.7.2 Impacts On Ecology

The construction of proposed DPKPG-CPP and associated jetty does not involve removal of mangrove species from its microenvironment. Similarly, during operation phase terrestrial ecology will remain unaffected.

The dredging activity will however have some impact on the benthic ecology. Most studies on the impact of dredging on marine benthos show that dredging can result in a 30 to 70% reduction in species variety; some 40 to 95% reduction in the number of individual species and a similar reduction in biomass in dredged areas (Newell et al., 1998). Re-colonization and recovery of species is a complex process involving initial colonization by fast growing animals (opportunist) species. In stable environments these are replaced and supplemented by a wider species diversity of slow-growing (equilibrium) species after cessation of dredging. In more disturbed habitats the community is dominated by opportunistic species, which do not move towards an equilibrium community of repeated environmental disturbance.

The dredging process has significant potential impacts outside the boundaries of the dredging site. The dredged material comprises a large inorganic particulate load and also contains significant quantities of organic matter. Such material has a lower specific gravity than inorganic components of the dredged outwash and is detectable at distances of over 3 km downstream of a dredger. Material derived from the dredging process may also be carried as a benthic plume for significant distances along the sea bed. The impact of dredging within the intensively exploited anchor dredged site is limited to the dredged area. Impacts include suppression of species variety, population density and biomass as well as differences in species composition compared with the surrounding deposits. Generally, there is no suppression of species diversity, population density or biomass of benthic macro-fauna outside the immediate boundaries of the dredged sites.

Other environmental impacts may be summarized as follows:

1. Physical disturbance of nesting and spawning, destruction of habitats, especially disturbance of spawning habitats, physical removal of benthic faunal communities, physical removal of protected plants disturbance of fish, shrimps and benthic faunal feeding habitats;
2. Detrimental effects of suspended sediments, turbidity and sedimentation, especially disturbance of fish spawning and nursery habitats, disturbance of fish and shrimp larval development, effects on the behaviour of migrating organisms, effects on feeding of larval, juvenile and adult fishes and crustaceans, burial of benthic fauna communities, disturbance of benthic fauna development, enhancement of photosynthetic oxygen production of planktonic algae, and burial of benthic plants;
3. Degradation of water quality, especially in zones with low energy and in waters with sediments with high organic content, impairment of larval development of marine animals, impact on adult and crustaceans (e.g. bioaccumulation), impact on benthic organisms, enhancement of algal growth.

In the light of above description, the impact of dredging for the proposed coal Jetty will have very localized impact on the macro-fauna near the site. Moreover, re-colonization of some species may occur after the construction of the proposed coal Jetty when the stable environment will prevail except for routine handling of cargo.

When dredging and disposing of non-contaminated fine materials in estuaries and coastal waters, the major environmental impacts are associated with suspended sediments and increase in turbidity. All modes of dredging release suspended sediments into the water column, during excavation and during the flow of sediments from hoppers and barges. In many cases, the locally increased suspended sediments and turbidity
associated with dredging and disposal is apparent from the turbidity ‘plumes’ which may be seen trailing behind dredgers or disposal sites.

Turbidity plumes are caused by the re-suspension of sediments in the water column. If suspended at sufficient concentrations for long periods of time, the penetration of sunlight through the water column may be reduced. Light is fundamental to photosynthesis of aquatic plant life such as algae and species associated with coral, and other organisms. Furthermore, increase in turbidity can cause clogging of gills and feeding structures of certain species (e.g. shellfish and filter feeding species including worms and mollusks). Similarly, young fish can be damaged if suspended sediments become trapped in their gills and increased fatalities of young fish have been observed in heavily turbid water. Adult fish are likely to move away from or avoid areas of high suspended solids, such as dredging sites, unless food supplies are increased as a result of increase in organic material. Hence, turbidity can reduce productivity and in extreme cases can be fatal. For maintenance dredging, the environmental impact is on the near-field; it is temporary and generally lasts over the period of dredging operations.

The degree of re-suspension of sediments and turbidity from maintenance dredging and disposal depends on the following variables:

- Characteristics of sediments being dredged (size, density and quality of the material),
- Method of dredging (and disposal),
- Hydrodynamic regime in the dredging and disposal area (current direction and speed, mixing rate, tidal state), and
- Existing water quality and characteristics (background suspended sediment and turbidity levels).

Considerable dredging activity is proposed for the berthing pocket. Creation of turbidity plumes during dredging could adversely affect certain marine species. Dense plume of turbid water is expected depending upon the method employed for dredging. It is recommended that hydraulic dredging be employed to minimize the disturbance caused to the sea bed. The bed sediments to be dredged comprise fine materials, predominantly fine silty sands, silt and silty clay. It is the finer material which tends to remain in suspension for relatively long periods of time, thereby causing significant impacts on transparency of seawater. Initial site investigations indicate that the bed sediments are reasonably well consolidated. It would be reasonable to assume that an efficient trailing suction or cutter suction dredger would remove most sediment only re-suspending relatively small volumes of particulate matter in low layers of the water column. In the low energy conditions of the sheltered creeks, it is anticipated that a majority of re-suspended material would soon resettle on the bed while any turbidity created would have no adverse long-term impact.

The dredging of berthing pocket of Gharo Creek will have negative impact on the marine habitat and the benthos of the creek; this would adversely affect fisheries reproduction. However, carefully regulated construction program and disposal of spoil only in the designated areas as suggested and refilling of temporary canal would minimize and localize these impacts. In view of the greatly reduced the benthic habitat due to extensive dredging and disposal of spoils carried out for Port Qasim over the last decade, DPKPG will ensure the adoption of careful methods to further reduce the impact of construction on marine ecology of the site.

Removal of Benthos by Dredging: During the dredging operations, there will be an inevitable loss of some benthic species. Some of the species could be of importance in themselves, or as a source of food for other marine fauna, including fish. The substrate within the proposed dredging area at QP-2 site is consistent with that in the rest of the microenvironment. In addition, the sediment which will remain after
dredging is likely to be very similar to that which exists at present. It is likely that the species from adjacent areas will re-colonize the dredged area following dredging. The exact composition of species, in terms of abundance and distribution, may not re-colonize the area initially as the area will first be colonized by opportunistic species which are short-lived and reproduce rapidly. As the rate of siltation in the inner channel of the port is very low, yearly maintenance dredging is not required normally. Depending on the frequency of any maintenance dredging, this type of community may dominate or be replaced by longer-lived species.

**Smothering of Benthos during Dredging:** Sediments dispersed during maintenance dredging and disposal may resettle over the seabed and the animals and plants that live on and within the system. This blanketing or smothering of benthic animals and plants may cause stress, reduced rates of growth and reproduction besides being fatal in the worst case scenario. Generally sediments settle within the vicinity of the dredged area, where they are likely to have little effect on the recently disturbed communities, particularly in areas where dredging is a well-established activity. However, in some cases sediments are distributed more widely within the estuary or coastal area and may settle over adjacent sub-tidal or inter-tidal habitats possibly some distance from the dredged area. The most vulnerable species will be the sessile species such as sedentary worms and the slow moving species such as mollusks. The significance of this impact will depend on the amount of sediment in suspension, the sediment size distribution and the current movements around the dredging area.

The sensitivity of marine animals and plants to siltation varies greatly. In areas with high natural loads of suspended sediments, the relatively small increases in siltation away from the immediate dredging area are generally considered unlikely to have adverse impacts on benthic populations.

**Release of contaminants during dredging and disposal:** Dredging and disposal activities can potentially cause remobilization of contaminated sediment. Contaminated sediment may not be necessarily harmful to aquatic organisms living in the sediment due to contaminant's adsorption characteristics. However, if sediment conditions are changed such that contaminants can get released into the water column (either dissolved or as suspended particulate matter), then they may become bio-available and may cause toxic effects. The results of the sediment quality analysis indicate that the sediments to be dredged are not contaminated to any significant level. Therefore no adverse impacts are expected in terms of release of contaminants by dredging and uptake by aquatic organisms.

**Impacts on Marine Animals during Construction Phase:** The bottom sediments to be excavated for establishment of the coal jetty comprise fine materials predominantly fine silty sands, silty clay and silt. Due to re-suspension of sediments, turbidity plumes are formed in the water column. If the material remains suspended for a long period of time at higher concentrations, there is a possibility that the penetration of sunlight through the water column may be reduced. Moreover, the turbidity can cause the clogging of gills and feeding structures of fish and shell fish and filter feeding species including mollusks and worms. Hence, the enhanced turbidity will lead to reduced productivity and may be fatal in extreme cases.

It is a natural phenomenon that after construction phase is over the species from adjacent areas re-colonize at the site. The exact composition of species in terms of abundance and distribution may not re-colonize in the area initially but with the passage of time and stability in the ecology of the area, the habitat may assume similarity in nature prior to the construction by long lived species. Since the pipeline laying is a short term activity, the impact may not be very significant because the severity of impact is dependent on the amount of sediment in suspension, sediment size distribution and the current movement in the operation area. It is anticipated that the turbidity thus caused would not have significant impact.
The project site is not known as home to any rare or endangered species. Accordingly establishment of the terminal is not expected to disturb the ecology of the core area to significant level. The project is also not expected to release any pollutants during its normal operations. Its location and operation is not expected to affect the breeding habitats of marine animals or migratory paths of any bird species. No adverse impacts are anticipated on the marine life during operation.

The operations at the jetty will require special arrangements to safeguard against leakages which are hazardous when released into the atmosphere.

The liquid effluents from the offices will be treated to meet SEQ Standards; as such the possibility of contamination of the microenvironment hosting juvenile fish and other commercially important species is substantially reduced. The potential threat to the fish is from the untreated industrial and municipal sewage being discharged into the creeks, while the operation of DPKGP-CPP and associated coal jetty will have no impact on the marine ecology of the area.

**Mitigation Measures**

It is recommended that, as a minimum standard, the acceptable limit of 2,000 mg/l suspended sediment concentration of the World Bank guidelines should be adopted (World Bank Technical Paper 140). This limit is suggested to prevent covering valuable benthic species (e.g. shellfish) that are sensitive to increased suspended sediment concentration. Studies by Palermor et al (1990) and Appleby and Scaratt (1989) indicate that suspended sediment concentration of 500 mg/l and 1,000 mg/l at 500m distance from the dredger can be considered safe for fish because they are mobile and can avoid severe aquatic conditions. It is suggested that dredging should be restricted during critical spawning periods for shellfish.

No endangered species are reported to exist in the area. The impact of construction activity on the marine ecology will therefore be small, temporary and localized to the microenvironment.

Once construction activities are completed, there are no anticipated long-term impacts that will occur as a direct result of installation of berthing facilities. Given appropriate substrate, sunlight, and temperature, benthic communities will be able to re-establish within the affected area. There is the potential for long-term impacts due to increased ship traffic, particularly as a result of accumulation of pollutants in the water column and sediment, which is known to adversely affect biological communities. In order to minimize and avoid impacts related to introduction of pollutants and invasive species all bilge discharge procedures will follow standard MARPOL regulations.

### 5.7.3 Protected Areas

There are no designated protected areas in the vicinity of the project area. Similarly, this EIA study has not found any antiquity artifact in the microenvironment of area concerned. No sites of cultural heritage are known to exist at or in the immediate vicinity of the KE-CPP project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites. Therefore, there will be no impacts from the construction and operation of the facilities; as such, no mitigation will be required.

All construction and operation personnel will, however, be warned that any archaeological finding or artifact will not be disturbed if found and the concerned Govt. Agencies will be notified.

**Mitigation Measures**

In case any site(s) of archaeological significance is discovered during the construction phase of project; the contractor shall be liable to:
5.7.4 Worker’s Health And Safety

During the construction work, the contractor will be responsible for the worker’s safety, safe working practices and providing adequate and appropriate facilities for fire, medical, potable water supply and sanitation. Emphases should also be placed on health and safety training of the workers. It is recommended that safety instructions, handbook, charts, diagrams etc. be made in Urdu. The workers are to be given training for handling the hazardous material and goods. It is recommended that World Bank guidelines relating to worker’s health and safety be incorporated into health and safety requirement policy and plan.

This plan is to incorporate the following:

- Requirement on health and safety to prevent and reduce accidents and occupational diseases among workers.
- Periodic programme for fire safety and accident prevention
- Good housekeeping practices
- Regular and periodic course on general safety, health and hygiene
- Providing a site safety handbook
- Providing on site publicity on safety instruction through conventional notice boards

Labor Safety

Analysis of main hazardous factors in the production process of the project

Analysis of main hazardous and harmful factors: Hazardous substances present in the power plant project include: coal, high temperature and high pressure steam water, sodium hydroxide (NaOH), hydrochloric acid (HCl), sulfur hexafluoride (SF₆), hydrogen (H₂), ammonia (NH₃), hydrazine (hydrazine), sodium hypochlorite (NaClO), nitrogen (N₂), carbon dioxide (CO₂), and compressed air. Main hazardous factors present in the power plant project include: fire and explosion, followed by electrical hazards, falls, damage by machinery, damage by vehicles; main harmful factors include: dust, noise, heat, poison, lightning, floods, earthquakes and other natural disasters.

Links and places for implementation of labor safety measures

1. Explosion protection of boilers, pressure vessels and pressure pipelines;
2. Fire protection of oil systems and electrical facilities of various types of buildings (structures);
3. Safety accidents of electrical equipment;
4. Damage accidents by various types of rotating machinery;
5. Damage accidents by acid and alkali of chemical water treatment systems;
6. Safety facilities of platform, stair, and lifting holes;
7. Emergency lighting measures;
8. Measures against natural disasters such as lightning, floods, and earthquakes;
5.7.5 Fire and explosion protection

Fire safety design principles and measures of buildings (structures)

(1) Fire safety design principles of buildings (structures)

For this project, minimum spacing of main power buildings (structures) meets the minimum spacing requirements of the power plant on various types of buildings (structures). Fire wall in line with the requirements of relevant fire safety specifications is provided between main transformer and HV station transformer.

(2) Fire and explosion safety measures of main power building and arrangement of safe passage and entrance. The arrangement of horizontal and vertical passage and entrance of main power building meets requirements of relevant fire safety specifications and is able to ensure safe evacuation of production and operation personnel under fire danger situation.

All distribution equipment rooms, cable sandwiches and cable shafts are provided with fire doors.

Plant area firefighting and alarm facilities: Depending on the object of protection, this project is also provided with automatic sprinkler system, gas fire extinguishing system, automatic fire detection and alarm control system and portable fire extinguishers in addition to indoor and outdoor fire hydrants.

Firefighting measures of coal system: The bunker bay is provided with fire hydrant extinguishing system. Water curtain fire extinguishing system is provided between trestle and bunker bay. In addition, the transfer station, trestle and bunker bay are flushed clean via water flushing system, thus to reduce the chance of fire.

In addition, drift coal in coal handling system will be cleaned up from time to time, thus to avoid fire hazard. When the coal conveyor belt is not to be used for long period, remaining coal on the belt will be removed.

Fire and explosion protection measures of electrical installations

(1) Fire protection measures of the transformer: There is firewall between single-phases of main transformer; there is also firewall between main transformer and HV station transformer.

(2) Explosion protection measures of electrical installations: The ventilator and motor in the battery room will be of explosion-proof type.

Technical safety measures of pressure vessels and explosive devices

(1) Explosion protection measures of boiler: Boiler will be provided with furnace safety monitoring system. Both superheater and reheater are equipped with safety valve.

(2) Explosion protection measures of pressure vessel: For the purpose of explosion protection, deaerator, high-pressure heaters and low-pressure heaters are all equipped with safety valve

Measures against mechanical damage: During operation of the power plant, there are many rotating machinery and equipment; fulfilling measures against mechanical damage is very necessary for physical safety of operating personnel. The following measures against mechanical damage will be taken:

(1) Provide shields at exposed rotating part of rotating machinery and equipment.

(2) For machinery with long transportation distance, provide crossing ladder with railing at crossing point.

(3) For belt conveyor, provide start forecasting device and accidental start prevention device; on the way, provide pull switch for emergency braking.
Measures against fall damage

(1) At such overhead places of buildings (structures) as balconies, verandahs, interior corridors, interior patios, climbing roofs, outdoor stairs, platforms and floor openings, provide protective railings.

(2) At indoor and outdoor platforms, stairs, and overhead places subject to staying or passing of personnel, provide protective railings.

Measures against chemical injury

(1) Acid and alkali storage facilities will be of open layout; surrounding acid and alkali storage facilities, provide protective fence. At the areas for storage, metering and unloading of acid and alkali, provides hower, washing and drainage facilities.

(2) At indoor places subject to frequent passing, overhead acid and alkali pipes will be not allowed; in case overhead acid and alkali pipes are must, take protective measures at flanges and joints.

Labor safety agencies and facilities: For this project, labor safety and health monitoring station will be set up and provided with appropriate instrumentation equipment and safety education equipment.

Comprehensive evaluation: For this project, after taking safety and technical measures and providing personal protective equipment, it can effectively control both hazardous factors and harmful factors in the production process and provide production safety conditions, thus to control hazard level in the production process of the power plant within acceptable range; when this project is completed, production safety conditions can be guaranteed.

5.7.6 Disposal Of Waste

The construction activities will generate considerable amount of waste. An inventory of the waste will be prepared. The waste will includes metals (mainly iron and copper), concrete, wood, cotton, plastic, packing materials, electronic, and insulation material. Several types of hazards are associated with the wastes. For example:

- Sharp edges in metals
- Tripping hazards if material is left in the pathways
- Soil contamination from leaking oil from equipment
- Slipping hazard from oil on floors
- Potentially toxic content
- Dust and soot
- Respiratory disorders

All recyclable material, such as metals (mainly iron and copper), will be recycled through waste contractors. A comprehensive waste management plan will be instituted during which re-use opportunities for waste generated from the plant during routine operation and maintenance will be actively investigated. Hazardous waste identified, if any, will be stored in separate designated and contained facility and disposed of in accordance with the regulatory requirements and safe practices. An EPA certified contractor will be hired for disposal of any hazardous waste.

If the waste generated during the operational activities is disposed of in the creek, the marine life consisting of the marine benthic invertebrates, phytoplankton, mangroves and fish will suffer negative impacts especially if the waste contains oils, hazardous chemicals and toxic metals. If the edible species of fish and
crabs are contaminated, the negative health impacts will be transferred to other organisms in the food chain including humans.

The proposed KE-CPP Project is not expected to change the pollutant load and no untreated liquid effluent will be discharged into the creek. However, it is recommended that all measures outlined in the Waste Management Plan for Project construction and operation be implemented to ensure minimal pollution of marine waters.

The marine ecological resources including the mangrove plants, MBI, fish, crabs and shrimps may also suffer harm from the coal dust and ash dust generated as a result of project activities. Leakage from the prospective ash disposal site due to seepage or an accident may release toxic or hazardous materials into the creek water, negatively impacting marine biodiversity.

Good practice measures will be adopted including:

- Waste management measures outlined in the Waste Management Plan.
- Monitoring of liquid effluents from Project to ensure they meet the SEQS.
- Monitoring of gaseous emissions including coal and ash dust
- Monitoring to ensure that there is no leakage from the ash disposal site.

5.7.7 Ash Handling & Disposal

The annual ash produced from the coal boilers could be several hundred thousand ton based on the ash content of the coal. ASTM C618 defines two types of ash: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the ash. The chemical properties of the fly ash are largely influenced by the chemical content of the coal burned, anthracite, bituminous and lignite.

Market Quantities: The average utilisation rate of fly ash in the countries world over was 58% in 1997. In some individual countries, the utilization rate was as high as 100%. The overall utilization of fly ash has increased in the last few years. It is being used more and more in high quality areas, such as the production of concrete and cement (1993: 20%, 1997: 28%) where it is used as a substitute for natural resources. Fly ash is also utilised in a wide range of applications in the road construction and in the building industry (fig 5.2). In 2006, the US produced 125m tonnes of fly ash: 43% was used in commercial operations.

![Figure 5.11: Utilization of Flyash](image-url)
The status of fly ash in European and national regulations is summarised in Table 5.9.

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**Bulk Use:** Fly ash utilization includes (approximately in order of decreasing importance):

- Concrete production, as a substitute material for Portland cement and sand
- Embankments and other structural fills (usually for road construction)
- Grout and flow-able fill production
- Waste stabilization and solidification
- As a substitute material for clay
- Mine reclamation
- Stabilization of soft soils
- Road sub base
- For brick production
- Mineral filler in asphaltic concrete
- Agricultural uses; soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards.
- Other uses include the burning of fly ash in waste to energy plants; however the bottom ash and fly ash need to be mixed.

The use of fly ash as building material allows energy savings and the reduction of CO$_2$ emissions as one tonne of fly ash replacing cement saves one tonne of CO$_2$. Coal fly ash can also be processed to give a material used for landfill cover and isolating lining that has better technical and environmental characteristics than most natural clays. Fly ash is transported within countries and across frontiers mainly for these purposes.

Coal fly ash has also been proven to improve the yield from agricultural land and can be used as a pollution control agent, particularly for soil decontamination, sludge and effluent treatment and in hazardous waste stabilisation.
Chemical Content: Fly ash consists mostly of silicon dioxide (SiO₂), which is present in two forms: amorphous, which is rounded and smooth, and crystalline, which is sharp, pointed and hazardous; aluminium oxide (Al₂O₃) and iron oxide (Fe₂O₃). Fly ashes are generally highly heterogeneous, consisting of a mixture of glassy particles with various identifiable crystalline phases such as quartz and various iron oxides.

Fly ash consists mainly of:

- Silicon Dioxide (SiO₂)
- Aluminium Oxide (Al₂O₃)
- Iron Oxide (Fe₂O₃)
- Calcium Oxide (CaO)

Chiefly the type of coal burned in the combustion process, determines the chemical content of the ash, typical contents are summarized below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Bituminous</th>
<th>Sub-bituminous</th>
<th>Lignite</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂ %</td>
<td>20-60</td>
<td>40-60</td>
<td>15-45</td>
</tr>
<tr>
<td>Al₂O₃ %</td>
<td>5-35</td>
<td>20-30</td>
<td>20-25</td>
</tr>
<tr>
<td>Fe₂O₃ %</td>
<td>10-40</td>
<td>4-10</td>
<td>4-15</td>
</tr>
<tr>
<td>CaO %</td>
<td>1-12</td>
<td>5-30</td>
<td>15-40</td>
</tr>
<tr>
<td>LOI %</td>
<td>0-15</td>
<td>0-3</td>
<td>0-5</td>
</tr>
</tbody>
</table>

Not all fly ashes meet ASTM C618 requirements, although depending on the application, this may not be necessary. Ash used as a cement replacement must meet strict construction standards.

No standard environmental regulations have been established, in the United States 75% of the ash must have fineness of 45µm or less, and have been carbon content, measured by the loss on ignition (LOI), of less than 4%. In the U.S., LOI needs to be less than 6%.
The particles size distribution of raw fly ash is very often fluctuating constantly, due to changing performance of the coal mills and the boiler performance. This makes it necessary that, if fly ash is used in an optimal way to replace cement in concrete production, it needs to be processed using beneficiation methods like mechanical air classification. However, if fly ash is used also as a filler to replace sand in concrete production, non-beneficiated fly ash with higher LOI can be also used. Especially important is
ongoing quality verification of the mechanical and chemical parameters of the ash produced at the power station.

**Ash Storage:** In the past, fly ash produced from coal combustion was simply entrained in flue gases and dispersed into the atmosphere. This created environmental and health concerns that prompted laws which have reduced fly ash emissions to less than 1 percent of ash produced. Worldwide, more than 65% of fly ash produced from coal power stations is disposed of in landfills and ash ponds. Where fly ash is stored in bulk, it is usually stored wet rather than dry so that fugitive dust is minimized. The resulting storage ponds are typically large and stable for long periods, but any breach of their dams or bunding will be rapid and release significant amounts of stored ash. The need for supervision of the condition of bund storage is paramount.

As 2006, about 125 million tons of coal-combustion by-products, including fly ash, were produced in the U.S. each year, with about 43 percent of that amount used in commercial applications.

During the initial years ash will be used to reclaim land at the ash disposal area. The depth of the ash disposal site will be around 7-8 m to avoid ash dust formation from the wind. Proposed mitigation measure to avoid ash disposal & possible contamination to the seawater & ground water are:

- The ash pond will be properly lined with native soil
- Quantity and quality of ash will be monitored regularly
- Of-site disposal i.e., selling to Lucky cement is the preferred option
- The dry and wet ash will be handled separately

It must be recognised that fly ash from coal-fired power plants is the mineralised residue of the virtually complete combustion of a fossil fuel. It contains only minimal amounts of residual, non-biologically reactive carbon. Therefore, none of the following hazardous characteristics quoted in Annex III of the Basel Convention apply to coal fly ash:

- H 1 – Explosive
- H 3 – Flammable liquids
- H 4.1 – Flammable solids
- H 4.2 – Substances or waste liable to spontaneous combustion
- H 4.3 – Substances or waste which, in contact with water emit flammable gases
- H 5.1 – Oxidising
- H 5.2 – Organic Peroxides
- H 6.2 – Infectious substances
- H 10 – Liberation of toxic gases in contact with air or water

No permanent and no adverse effects have been observed when fly ash and its leachates are submitted to biological tests. The wide range of species that have been used and the total lack of any positive response to the biological tests lead to the conclusion that coal fly ash is not ecotoxic. Consequently, when compared to the list of hazardous characteristics, it can be concluded that fly ash is neither:

- H 12 – Ecotoxic (a “substance or waste which, if released, present or may present immediately or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems”), nor
- H 13 - rescue parameter (“Capable, by any means, after disposal, of yielding another material, e.g. leachate, which possesses any of the characteristics listed above (H 1- H 12)").

In addition, the numerous studies on health effects and on the toxic properties of fly ash prove that coal fly ash does not have any adverse effect on the environment or on humans. That means that fly ash can be considered to show none of the following hazardous characteristics:
- **H 6.1** - Poisonous (a “substance or waste liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact”)
- **H 8** - Corrosive (a “substance or waste which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport, ...”)
- **H 11** - Toxic (Delayed or chronic) (a “substance or waste which, if it is inhaled or ingested or if it penetrates the skin, may involve delayed or chronic effects, including carcinogenicity.”)

The utilisation of coal fly ash often actually contributes to global environmental protection and has ecological advantages. Its use as a replacement for minerals or manufactured products acts to preserve natural resources as well as to save energy and to reduce CO₂ emissions.

**Mitigation Measures:** As per design requirements, the ash storage yard for 2 x 350MW unit of the power plant is planned and designed according to the requirement that the ash, slag calculated by the design coal type shall be stored for three years.

It has been considered to construct the dykes at the seaward, east and west sides of the ash and slag storage yard, of which the total length is about 1400m; the average original elevation of the slag yard is 4.15m, and the designed elevation of the ash storage surface is 10.0m; the average elevation of the dyke top is temporarily determined to be 10.5m, and the inclined rubble structure is proposed; the ground of the ash yard is laid with impermeable membrane. Rock rip-rap is adopted for slope protection of dykes, and internal slope is applied with impermeable membrane and clay cushion; the top is constructed with the plain concrete pavement. According to preliminary geological exploration data, the surface of area where ash yard is located is of liquefied sandy soil, for which thickness is 7.5m and liquefaction grade is severe. For the area where liquefaction grade is severe, it is proposed to use anti-vibration and shock gravel pile for anti-liquefaction foundation treatment.

Recycling of ash will be the preferred option for ash disposal. A review of the utilization of fly ash produced in the coal powered plants in India shows that on an average the utilization of fly ash produced by the coal fired power plants is over 50%, with a number of plants achieving 100% utilization. In China, the nearly 70% of the fly ash produced is recycled. There are a number of potential users of ash produced by the project in the vicinity of KE-CPP. These include cement plants located at a distance of 100-150 km from the plant mostly on the main highway M-9 linking Hyderabad to Karachi (Fig 5.6). Production of cement concrete blocks where bottom ash can be used as an aggregate is also common and widespread in the Karachi area. As the ash recycling applications and market are not developed in Pakistan, DPKPG management will consult with cement factories and other construction industries to proper utilization of ash. Recognizing that utilization of ash will develop over time, an ash disposal area will be developed to store ash. Other uses of ash can also be explored. These include, for example, as an agriculture soil improvement product, filler material for structural applications and embankments, aggregate in road bases, sub-bases, and pavement.

**5.7.8 Socioeconomic Impacts**

The Project activities will result in both positive and negative impact on the existing socioeconomic environment of the Socioeconomic Study Area as well as the broader region. The impacts include:

- The reduction in power generation cost due to use of cheaper source and consequent benefit to the Karachites
- Employment opportunities mainly during the Project’s construction phase benefitting the labor force in Karachi. The Project will create additional job opportunities. However, it is expected that employment
opportunities created under the Project will be short-lived, as these would be mainly generated during the construction phase, and negligible in comparison to the labour-force of Karachi. Most of these positions will be skilled, having expertise in handling the new equipment and processes. Unskilled staff will not be required under the Project, leaving less scope to benefit the poor households.

- Marine traffic generated by the project between Port Qasim and the Project site interfering with the fishing activities in the area & potentially affecting the livelihoods of the angler communities.

- The impacts will be minor given the following: i) The area around Port Qasim is already heavily disturbed with shipping traffic and the marine flora and fauna species are adapted to the disturbances; and ii) The nearest angler communities, Goth Rehri and Goth Ibrahim Haidery fish more along the other parts of the coastline.

### 5.7.9 Impacts Rating

The following Checklist for the DPKPG-CPP Project provides the screening of potential environmental impact on different components of ecosystem.

<table>
<thead>
<tr>
<th>Screening Questions</th>
<th>Yes</th>
<th>No</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Project Siting</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Densely Populated</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Heavy With Development Activities?</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjacent To or Within Any Environmentally Sensitive Areas?</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cultural Heritage Site</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protected Area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wetland</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangrove</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estuarine</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffer Zone of Protected Area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Area For Protecting Biodiversity</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bay</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Potential Environmental Impacts Will The Project Cause…</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Impacts on the sustainability of associated sanitation and solid waste disposal systems and their interactions with other services (urban/rural).</td>
<td>X</td>
<td>Not envisaged Mitigation Measures Provided</td>
<td></td>
</tr>
<tr>
<td>Deterioration of surrounding environmental conditions due to rapid population growth, commercial and industrial activity, and increased waste generation to the point that both manmade and natural systems are overloaded and the capacities to manage these systems are overwhelmed?</td>
<td>X</td>
<td>Better management &amp; conservation practices will have to be followed</td>
<td></td>
</tr>
<tr>
<td>Degradation of land and ecosystems (e.g. loss of wetlands and wild lands, coastal zones, watersheds and forests)?</td>
<td>X</td>
<td>Not envisaged Better management &amp; conservation practices will nevertheless be followed</td>
<td></td>
</tr>
<tr>
<td>Dislocation or involuntary resettlement of people</td>
<td>X</td>
<td>Not envisaged</td>
<td></td>
</tr>
<tr>
<td>Dislocation of indigenous communities and Disadvantaged population</td>
<td>X</td>
<td>Not envisaged</td>
<td></td>
</tr>
<tr>
<td>Degradation of cultural property, and loss of cultural heritage and tourism revenues?</td>
<td>X</td>
<td>Not envisaged</td>
<td></td>
</tr>
<tr>
<td>Occupation of low-lying lands, floodplains and steep hillsides by squatters and low-income groups, and their exposure to increased health hazards and risks due to polluting industries?</td>
<td>X</td>
<td>Not envisaged</td>
<td></td>
</tr>
<tr>
<td>Water resource problems (e.g. depletion/ degradation of</td>
<td>X</td>
<td>Not envisaged, better management of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impact</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>--------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>available water supply, deterioration for surface and ground water quality, and pollution of receiving waters?</td>
<td>X</td>
<td>Ecological flow &amp; conservation practices will be followed</td>
<td></td>
</tr>
<tr>
<td>Air pollution due to emissions?</td>
<td>X</td>
<td>Very Minor</td>
<td></td>
</tr>
<tr>
<td>Social conflicts between construction workers from other areas and local workers?</td>
<td>X</td>
<td>Not expected. Better management practices will avoid conflict</td>
<td></td>
</tr>
<tr>
<td>Road blocking and temporary flooding due to land excavation during rainy season?</td>
<td>X</td>
<td>The situation will be mitigated through better management practices</td>
<td></td>
</tr>
<tr>
<td>Noise and dust from construction activities?</td>
<td>X</td>
<td>Moderate but will be minimized through better management practices</td>
<td></td>
</tr>
<tr>
<td>Traffic disturbances due to construction material transport and wastes?</td>
<td>X</td>
<td>Not expected</td>
<td></td>
</tr>
<tr>
<td>Temporary silt runoff due to construction?</td>
<td>X</td>
<td>Not envisaged but will be mitigated if some such situation emerges through better management practices</td>
<td></td>
</tr>
<tr>
<td>Hazards to public health due to ambient, household and occupational pollution, thermal inversion, and smog formation?</td>
<td>X</td>
<td>Not envisaged but will be mitigated if some such situation emerges through better management practices and implementation of Environmental Management Plan</td>
<td></td>
</tr>
<tr>
<td>Water depletion and/or quality degradation?</td>
<td>X</td>
<td>Better management practices and conservation practices will be followed in view of constraints on availability</td>
<td></td>
</tr>
<tr>
<td>Overplaying of ground water, leading to land subsidence, lowered ground water table, and salinization?</td>
<td>X</td>
<td>Not envisaged</td>
<td></td>
</tr>
<tr>
<td>Contamination of surface and ground waters due to improper waste disposal?</td>
<td>X</td>
<td>Solid and Liquid waste Disposal system will be in place to prevent possible contamination of water resources</td>
<td></td>
</tr>
<tr>
<td>Pollution of receiving waters resulting in amenity losses, fisheries and marine resource depletion, and health problems?</td>
<td>X</td>
<td>Solid and Liquid waste Disposal system will be in place to prevent possible contamination of receiving waters.</td>
<td></td>
</tr>
<tr>
<td>Overall Rating</td>
<td>2X 28 X</td>
<td>No significant Impact of KE-CPP on micro and macroenvironment</td>
<td></td>
</tr>
</tbody>
</table>
6.0 Consultation & Information Disclosure

This section presents the findings of the consultation meetings held with the project’s primary and secondary stakeholders as part of the Environmental Impact Assessment (EIA) process requiring information disclosure and sharing. For this purpose consultation meetings were held at the outset for scoping of the EIA study, followed by a series of meetings at the grassroots level.

6.1 Objectives

The objectives of these meetings were to:
- Share information with the gate keepers and area residents about the DPKPG – Coal Power Plant Project being established in Port Qasim Karachi,
- Inform the stakeholders of the positive and negative aspects identified for the project and the environmental issues likely to emerge while the Project is in the pre-construction, construction and operation stages.
- Request the stakeholders to share their knowledge/information on significant physical, biological and socioeconomic status of the micro and macroenvironment that must be taken into consideration during the different stages of the Project, and measures to be adopted to minimize the severity of impact;
- Assess the level of awareness on the environment and the proposed project, and
- Determine the impact of future development plans in the project area.

6.2 Consultation Framework

The consultation being a continuous process needs to be maintained throughout the project (Social Analysis Sourcebook: Incorporating Social Dimensions into Bank-Supported Projects: The World Bank. December 2003). The consultation framework adopted for the pre-construction, construction and subsequent phases of the DPKPG – Coal Power Plant Project is elaborated in the Table 6.1:

<table>
<thead>
<tr>
<th>Table 6.1: Consultation Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Phase</td>
</tr>
<tr>
<td>Pre-Construction</td>
</tr>
<tr>
<td>Construction</td>
</tr>
<tr>
<td>Operation</td>
</tr>
</tbody>
</table>
6.3 Consultation Process

Initially public consultation in form of group discussions was carried out at different locations of the project area during the preparation of the Environmental Impact Assessment (EIA) with a view to minimize adverse impact of the project through creating awareness among the communities on potential benefits of the project. The meetings with communities were held during the months of December 2014-15 and March 2016.

Group discussions and consultation meeting were conducted with stakeholders particularly with Information secretary PPP District Malir (resident of lath basti), Director Fishermen’s Co-operative Society Ltd, Vice Chairman of Fishermen Association for Rural Development, Ex-General Secretary Pakistan Fisher-folk Forum (PFF) Ibrahim Haidery, Health Specialist of Rehri Health Development Organization (RHDO) and Fisherman’s Association for Community Empowerment (FACE), Rehri.

For this purpose semi structured questionnaires were used for data collection. These questionnaires consisted of open and close ended questions. The consultation team consisted of Environment & Social issues specialists and enumerators. In most cases, the team was accompanied by a local representative. The local representatives were instrumental in the selection of venues and timings for the meetings and focus group discussions. Local CBOs played a vital role to mobilize the community to attend public consultation meetings.

The comments expressed by the participants at public consultation and focus group discussions were noted (an outline of issues and concerns expressed by individuals, the community, NGOs and public agencies is detailed in the following table and elsewhere in this section). Similarly, the comments made by stakeholders at scoping meeting were noted. These comments have been analyzed as socioeconomically viable statements of the participants and have been reflected in the detailed engineering design as much as possible.

Since these consultation meetings / FGDs were an open forum for all, there was a representation from all groups by language, age and income levels. This is a continuous process and will be continued until the issues pertaining to pre-construction, construction & operational phases of project are settled to the reasonable satisfaction of stakeholders, especially the affected local communities if any. The result of the consultation was a clear identification of the issues perceived to be important by the community and stakeholders and the need to respond to those issues in the EIA. Mitigation of potential environmental effects of concern to the community and other stakeholders has been incorporated into the project planning and will occur throughout the construction and operational phases of the project.

The stakeholders were briefed during scoping sessions about the background and objectives of the CPP Project, its needs, and the necessity of introducing the EIA process. Observations of the participants were noted and have been incorporated into the text of the EIA. At the consultation meeting the stakeholders and area representatives were informed that:

- The National Energy Policy 2013 requires development of strategy to i) ensure the generation of inexpensive and affordable electricity for domestic, commercial, and industrial use by using indigenous resources such as coal (Thar coal) and hydel power, ii) address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan, and iii) shift Pakistan’s energy mix towards cheaper fuel, and conservation of natural resources.
Pakistan is experiencing the worst ever energy crisis in its history, since the industrial production has slowed down to a grinding halt, the fuel resources have been exhausted and new finds are only slowly been commissioned, in the meantime the vegetative cover has been deforested and the land has been desertified. The availability of water resources has been erratic all along. The hydrological potential is decreasing both because of losses and lack of good governance. The gap between availability of electric power and demand has widened. On the one hand the current shortfall of 5,000 to 7,000 MW is continuing and on the other hand the circular debt arising out of withholding of payments by the public sector is hampering the cash fluidity which could sustain even the present shortfall.

Power outages have gone up from six hours to eight hours in the urban area and 14 hours to 18 hours in the rural. This is not all because in the winter the outage had increased to 12 hours in the urban & industrial area. This is the result of ad-hocism because the gap between supply and demand was of consumerism. Unfortunately additional power generation facilities were not introduced, alternative energy sources if identified were not adopted/implemented with the result that the existing power production units went idle during the last decade.

The Nexus of Climate Change - Environmental degradation - Poverty is caught in the cobweb of Social Pollution in that impoverishment of resources leads to environmental disasters which in turn lead to poverty and the vicious circle repeats when poverty leads to continuous impoverishment.

The status quo just cannot continue because the country is falling deeper and deeper into debt while the current resources are being impoverished at a very fast rate. Indigenous Coal has remained a disregarded resource and steam coal is being imported for cement and power production. The technology for utilization of lignite at Lakhra was inappropriately transferred with the result that only one of the three units could operate ever since its adoption. The present position is that the Lakhra Power Plant is unable to continue to generate electricity even at the current low capacity, inefficiency, non-availability of fuel and cash starvation. Such being the case the Government of Pakistan has in September 2013 introduced the policy on developing coal-fired thermal power plants gradually substituting the fuel with the coal reserve in the Thar coalfield.

Coal has traditionally been the most widely used source of energy in the world followed by oil and gas which are cleaner and more convenient fuels. However, the last two are much more expensive fuels compared to coal which is by far the cheapest, barring hydel and renewable energy.
Technological development has also helped make coal a cleaner fuel and it is still being widely used in the world for power generation and other purposes. China, US and India respectively produce 63%, 36% and 47% of their electricity from coal. Australia and Germany also use coal to produce substantial amounts of electricity. Pakistan has not paid much attention to coal development as a fuel for industry and power sector although we have estimated reserves of 187 billion tons which are said to be the second largest in the world.

![Figure 6.2 - Pakistan’s Energy Mix](image)

![Figure 6.3 - Coal – Worldwide in Electricity Generation](image)

- Coal is one of the world’s most important sources of energy, fuelling almost 40% of electricity worldwide. In many countries, this figure is much higher: Poland relies on coal for over 94% of its electricity; South Africa for 93%; China for 79%; and Australia for 78%. Coal has been the world’s fastest growing energy source in recent years - faster than gas, oil, nuclear, hydro and renewable sources.

- In order to contribute toward meeting Pakistan’s growing electricity demand, DPKPG proposes constructing a 2 x 350 MW coal base power station near Port Qasim Karachi. DPKPG has acquired 216 acres of land in the EIZ of PQA for the establishment of proposed coal power plant.

- The Project will involve the following components:
  - Super-critical boiler
  - Coal transportation, handling and storage
  - Water supply and waste water system
  - Ash handling system
- Emission control system
- Flue Gas Desulfurization (FGD) system
- Coal for the power plant will be received at the coal yard inside the plant. It will be processed before feeding into the boiler. Heat from the combustion of coal in the super-critical boilers will be used to generate steam at high pressure. 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 reheated by re-injecting into the boiler. The rotating steam turbine will operate the power generator, which will generate electricity.
- Flue gas from the boiler is normally laden with pollutants, oxides of nitrogen, particulate matter and sulphur dioxide. The gas will be passed through a series of treatment units before being discharged into the atmosphere. In the treatment system, pollutants from the gas will be removed.
- Cooling water is required for cooling purposes in the operations of the power plants. The water is obtained from the cooling water system. The water source for the proposed project will be the Arabian Sea.
- Bottom ash from the boiler and fly ash from the flue gas treatment system will be collected and disposed of through the ash handling system. The proposed project will require several supporting systems for plant operations. These include the seawater desalination system to provide water for feeding the boilers, the effluent treatment system, wastewater treatment plants and waste disposal systems for the wastewater and ash generated by the plants and associated facilities.

- Construction and Operation of the DPKPG - CPP will require the following environmental issues to be addressed:
  - Dredging
  - Site clearance leading to dust emission
  - Removal of vegetation leading of loss of vegetation cover
  - Erosion and sedimentation
  - Air quality impact from operation construction machinery
  - Noise and vibration
  - Waste management
  - Off-site impacts such as those related to borrow pits
  - Effluent from construction camp
  - Cultural impact related to presence of non-local workers
  - Transportation and storage of coal
  - Ash handling and disposal
  - Air emissions
  - Waste Water Discharge

- Concerns expressed by the public/stakeholders during different meeting & focus group discussions are presented below:
  - No developmental activity of the past has ever benefitted locals. Instead, after Port Qasim channel’s development, the fishermen have been forbidden to trespass the channel and have to travel a long distance to reach the open sea which costs so much that they can barely pay the fuel cost from the profit of fish caught. A plan should be worked out in consultation with PQA for local fishermen so that they can economically reach the deep/open sea as they used to go before development of PQA channel.
Since the development of Bhains Colony, the wastewater that falls untreated into the sea has severely polluted the water at the outfall of Lath Basti and fishes can no longer survive. A treatment plant must be installed for the wastewater before the outfall so that the water quality is restored. A wastewater treatment should be setup for the wastewater of Bhains Colony so that natural environment can be restored.

The polluted water contains chemicals and insects born out of cow dung which has severely impacted the livelihoods of all local fishermen as the service life of their boats which previously could last a decade, now lasts merely 2 years. All effluent wastes should be monitored at Bhains Colony farms and they should be heavily penalized for discharging any chemicals exceeding SEQS limits.

Whenever there is any development project underway, new promises are made, but all promises made in the past are forgotten shortly. DPKPG cannot force the fulfilment of promises made and broken by proponents of other projects, but assures that whatever promises it will make with the locals shall be duly fulfilled.

The locals are unskilled in fields other than fishing. As fishing is no longer possible after the government put a ban for the last 4 months they urgently want some form of employment. Capacity development programs shall be undertaken under the CSR policy of DPKPG and whenever possible, locals shall be preferred over outsiders for skilled/ unskilled jobs as per the qualifications and requirements.

There is no hospital anywhere nearby neither any ambulances standby or that can reach in less than an hour or two. In emergencies for example, the women have to wait hours before they can reach a hospital for deliveries.

A majority of children do not have any schools to go besides two, where teachers barely come for 2 to 3 hours only and have to teach without a roof and any proper facility. There is currently no school for girls in the area.

Since the development of Bhains Colony, Hepatitis A, B and C have spread like an epidemic and according to HANDS, an NGO working in the area, about 75% of the Lath Basti’s population is now suffering from it which is due to polluted water that comes from Bhains Colony.

Sewage system is one of the biggest issues of Lath Basti as it is near to non-existent. The women have to wait until dark to go outside and relieve themselves in the open. It is a bitter reality they have to face every day.

Another issue that has risen is the dumping of dirt in Rehri from reclamation activities. The authorities have taken no action over this dumping and instead, due to their high-level contacts, the developers have gotten away without any penalties.

The stakeholders were informed their concerns have been addressed through project design as well as environmental management and monitoring plan.

The village representatives gave firm assurance that there would be no hindrance to completion of the project from any stakeholder provided they are treated with respect and given whatever is their due. They would be happy if employment was offered to their youngsters and petty contract to local residents.

Concerns expressed by the stakeholders during scoping meeting are presented below:

Representative from Engro Polymers Limited expressed concerns regarding coal handling and transportation and subsequent disposal of ash. It was replied that a screw type unloader will be used with closed conveyor belts with dust suppression systems for minimum and internationally practiced transportation of coal. On question of maximum GLC it was explained that CPP will be so designed that fall-out of the emissions from the plant does not go beyond the
macrowenvironment of the project and that the maximum ground level concentration is well within the acceptable limits for ambient air quality. The incremental impact shall be assessed using mathematical modeling tools. A water treatment plant will be constructed at the plant site which will ensure the effluents meet the SEQS limits.

- Representative from Pakistan International Bulk Terminal (PIBT) recommended the utilization of PIBT (an under-construction port) to be used for importing coal and also asked about the type of fire prevention system to be installed for the conveyor. The proponent replied that they are currently the largest coal consumer in the country and in future the demand will further grow so it is economically more viable to operate without any dependency. Internationally accepted NFPA standards shall be followed for fire prevention and control.

- Representative from World Wide Fund for Nature (WWF) Pakistan inquired about the methodology for air dispersion and plume modeling to be used for the study and that whether marine benthic fauna and fishes would be included in the study. It was replied that thermal plume modeling shall be carried out using CORMIX and air modeling will be done using US-EPA approved applications for predicting the respective impacts. Fauna and flora including the marine benthic will all be studied.

- Representative from National Institute of Oceanography (NIO) asked that why is Thar coal not being considered instead of imported coal and showed concerns for the disturbance which will be caused by dredging activity and temperature rise. The proponent replied that they currently suffer from inadequate transport facilities offered by local transporters. If Thar coal is procured, there will not be enough transporters; besides Thar coal has consistency issues. There will be very little dredging done as existing PQA channel shall be used by the coal vessels. Besides, all dredged material will be used for land reclamation for the project.

- Representative from Thar Coal Energy Board (TCEB) informed about the myths surrounding the Thar coal quality and expressed that Thar it should be considered seriously as an option. Also suggested that trace elements may be extracted from coal ash and turn waste into an asset. Coal ash should be used as an aggregate in cement manufacture as is the international practice.

- Representative from Institute of Space Technology (IST) expressed concerns for pollution free transport of coal ash to cement factories for recycling. It was replied that The coal ash will always be transported in the same sealed trucks in which cement is transported.

The stakeholders were briefed on the Environmental Management Plan of which process of monitoring is an effective tool that keeps track of environmental performance throughout the lifecycle of the Project. The stakeholders and village representatives consulted in this connection assured their unhindered support towards completion of the Project.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Issues and Concerns</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakistan Steel BMR&amp;E</td>
<td>Coal is composed primarily of Carbon along with variable quantities of other elements mostly,</td>
<td>Coal Dust Emission</td>
</tr>
<tr>
<td>Directorate</td>
<td>sulfur, hydrogen, oxygen and nitrogen and is a cheaper fuel for dust, ash(extra ordinarily fine and acidic in nature containing considerable percentage of residual sulfur contents), accumulated gas cleaning dust and the flue gases</td>
<td>There are two primary sources of coal dust emission</td>
</tr>
<tr>
<td></td>
<td>Usually unidirectional winds blow in coastal areas to coal ash, coal dust and emission of flue gases</td>
<td>Coal Yard &amp; Coal handling system In order to minimize coal dust emissions from coal yard wind shield will be constructed around the coal yard. Furthermore, water sprinkling system will be installed to reduce fugitive coal dust from entering into the atmosphere. Coal handling system (comprising of coal conveyer, transfer house, coal bunker and other ancillaries)</td>
</tr>
</tbody>
</table>
should be treated, handled and disposed of properly with all checks and balance to avoid any damage/loss to the adjoining environment including marine life and its growth

After going through the content of referred letter, it looks that the project is of environment friendly nature where apparently most of the environmental issues and its mitigation strategy is covered in compliance to national and international environmental; standard. Acts, Rules and Regulations, however, there is always room for further betterment.

Ash Pond and ash handling system
An Electrostatic precipitator (ESP) shall be installed for capturing ash from exhaust gases. Wet type ash handling system will be constructed to reduce ash dispersion. Ash will be dumped into the Ash pond at site which will be compliant to IFC and World Bank standards.

The coastline of Bin Qasim area near current site is composed of sandy beaches and dunes (made up of loose dust particles) and dry windy weather naturally causes high dust particles in the atmosphere. There will be a reduction in natural dust emissions due to the project implementation because of backfilling, compacting, paving and green belt of the project. During construction strict compliance to EMP (Environmental Management Plan) will be ensured.

**Power plant Emissions**
Air dispersion modeling (ADM) has been carried out considering the baseline environment conditions and measuring the respective emission values. The following points were incorporated in the EIA as per the results obtained from ADM:

A stack height of 200m has been considered for this project to disperse flue gases at a safe level. Wet type limestone-gypsum Flue Gas Desulphurization (FGD) and Electrostatic precipitator (ESP) has been included in the scope of the project for reduction of SOx and coal ash emissions. The boiler will be equipped with low NOx burners in order to maintain emission values within IFC and SEPA allowed limits.

The project company shall strive for environmental excellence in performance following ISO 14000 / relevant practices.

**Siddiqsons Energy Limited**

<table>
<thead>
<tr>
<th>Siddiqsons Energy Limited</th>
<th>The details of Coal Jetty are not legible. As you are already aware, our SSEL Project envisages a will be enclosed type with bag-houses to capture any fugitive dust particle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Coal jetty has been designed keeping in view all the parameters and not affecting any other</td>
<td></td>
</tr>
</tbody>
</table>
We expect that detailed Thermal plume Studies for cooling water discharge in the mixing zone will be undertaken by you for the proposed project. We suggest the information should be shared with us. On our part, we are willing to support an exercise for cumulative impact assessment of discharge of both plants.

For general layout, plant area is considered as ladder arrangement. Updated plant grade level is shown here. Please feel free to contact us to receive a copy of the document.

Detailed Thermal Plume Study is carried out and found not suitable for us as does not comply with environmental standards. The project shall be using Cooling Towers for the cooling requirement.

Wet type limestone-gypsum Flue Gas Desulphurization (FGD) and Electrostatic precipitator (ESP) has been included in the scope of the project for reduction of SOx and coal ash emissions. The boiler will be equipped with low NOx burners in order to maintain emission values within IFC and SEPA allowed limits.

We have considered on site Coal jetty which will handle 50,000 DWT vessels for coal unloading at the site. The coal will then be transported from the onsite coal storage yard to the boiler area via a conveyer belt. Therefore, coal transportation via trucks has already been rejected due to insufficient road infrastructure at PQA.

**Coal Dust Emission**

There are two primary sources of coal dust emission:

- **Coal Yard & Coal handling system**
  - In order to minimize coal dust emissions from coal yard wind shield will be constructed around the coal yard. Furthermore, water sprinkling system will be installed to reduce fugitive coal dust from entering into the atmosphere.
  - Coal handling system (comprising of coal conveyer, transfer house,
of our staff, health of plant equipment and quality of our product which is sensitive to any black particle. In the scope mentioned about wind shield and sprinkler system, however in EIA it needs to be made mandatory requirement and sprinkle arrangement to be linked with fail safe mode to avoid operation without the safeguards.

Ash handling/storage and transportation arrangement: nature, amount and quality of ash make this point one of the key for us and other nearby industries. At the moment agenda point includes ash handling system however no point mentioned regarding storage area for the ash and its transportation routes. This should be the part of EIA. Dedicated facility to be identified outside industrial area for safe storage of ash and disposal safely. Before finalizing EIA, we need a feedback on the ash handling facility and transportation mechanism from the site.

Cumulative impacts on our plant: the environmental impact due to coal burning especially particulate level and ground level contamination of sulfur compounds to be analyzed by taking into account upcoming coal plants mainly Sinohydro coal bunker and other ancillaries) will be enclosed type with bag-houses to capture any fugitive dust particle.

**Ash Pond and ash handling system**

An Electrostatic precipitator (ESP) shall be installed for capturing ash from exhaust gases. Wet type ash handling system will be constructed to reduce ash dispersion. Ash will be dumped into the Ash pond at site which will be compliant to IFC and World Bank standards.

There will be a reduction in natural dust emissions as the current site is composed of sand dunes (made up of loose dust particles) and dry windy weather further aggravates dust particles in the atmosphere. During construction strict compliance to EMP (Environmental Management Plan) will be ensured. Since the current land site does not consist of any kind of plantation except of Mangroves trees, the construction of this power plant will add green belts and plantation at empty areas which will result in reduction of sand dust emissions significantly.

DPKPG has obtained Expression of Interest (EOI) from major Cements companies who are interested for the utilizing ash for making concrete. DPKPG is also open to any SEPA designated off site Ash storage area for dumping of Ash.

**Power plant Emissions**

Air dispersion modeling (ADM) has been carried out considering the baseline environment conditions and measuring the respective emission values. The following points were incorporated in the EIA as per the results obtained from ADM:

- A stack height of 200m has been considered for this project to disperse flue gases at a safe level.
- Wet type limestone-gypsum Flue Gas Desulphurization (FGD) and Electrostatic precipitator (ESP) has been included in the scope of the...
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Project Details</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engro Polymer &amp; Chemicals Limited</td>
<td>Coal storage area shielding</td>
<td>Air dispersion modeling must be done by taking into account all projects in area including Power China and taking Steel mill in operation ESP's &amp; FGD's be equipped (Electrostatic Precipitator should be part of critical interlock and not to be bypassed in any case) Ash handling system to be designed in environmentally friendly manner (both bed ash as well as fly ash) Ground level ash concentrations be included in EIA study We are not in favor to have Ash disposal area in PQ Karachi (Power China also moved their ash disposal area outside PQ Karachi) NOx control mechanism should include SCR/ SNCR</td>
</tr>
</tbody>
</table>
| ASG Metals Limited | ASG Metals Limited is operating steel plant of capacity 240,000 tons/year just adjacent to the location of the proposed power plant. The dust generated as a result of handling of pulverized coal always creates problem to electrical equipment especially in the case of humid environment as we are near the sea. The carbon dust to the electrical contacts and in the presence of moisture there is a possibility that sparking may occur damaging the electrical equipment resulting in break-down of power supply network | Don’t foresee any conflict with the power plant’s operation. *Coal Dust Emission* There are two primary sources of coal dust emission Coal Yard & Coal handling system In order to minimize coal dust emissions from coal yard wind shield will be constructed around the coal yard. Furthermore, water sprinkling system will be installed to reduce fugitive coal dust from entering into the atmosphere. Coal handling system (comprising of coal conveyer, transfer house, coal bunker and other ancillaries) will be enclosed type with bag-
Furthermore this dust may also damage the evaporating cooling tower as the fan of the cooling tower will suck the carbon dust along with the atmospheric air and this carbon dust will then act as abrasive agent and damage the blades of the cooling water fan saw well as other metallic structure of the cooling tower. The water will also be contaminated with carbon powder and this contaminated water definitely damages the cooling system of the equipment.

About 250 to 300 personnel are always on duty round the clock and any emission from the power plant like Niter, Oxides of Phosphorus and sulfur polluting the atmosphere may result health hazard situation to the personnel because the proposed power plant is just adjacent to our steel plant.

It is suggested, that the design of the plant must include equipment and adaptation of latest technology which helps ensuring an environment which is free from harmful gases and dust and maintained to conforming International Standards.

| Houses to capture any fugitive dust particle. |
| Ash Pond and ash handling system |
| An Electrostatic precipitator (ESP) shall be installed for capturing ash from exhaust gases. Wet type ash handling system will be constructed to reduce ash dispersion. Ash will be dumped into the Ash pond at site which will be compliant to IFC and World Bank standards. |
| There will be a reduction in natural dust emissions as the current site is composed of sand dunes (made up of loose dust particles) and dry windy weather further aggravates dust particles in the atmosphere. During construction strict compliance to EMP (Environmental Management Plan) will be ensured. Since the current land site does not consist of any kind of plantation except of Mangroves trees, the construction of this power plant will add green belts and plantation at empty areas which will result in reduction of sand dust emissions significantly. |

**Power plant Emissions**

Air dispersion modeling (ADM) has been carried out considering the baseline environment conditions and measuring the respective emission values. The following points were incorporated in the EIA as per the results obtained from ADM:

A stack height of 200m has been considered for this project to disperse flue gases at a safe level.

Wet type limestone-gypsum Flue Gas Desulphurization (FGD) and Electrostatic precipitator (ESP) has been included in the scope of the project for reduction of SOx and coal ash emissions.

The boiler will be equipped with low NOx burners in order to maintain emission values within IFC and SEPA allowed limits.
6.4 Community Engagement Responsibilities

DPKPG is committed as well as required under its environmental approvals from the Sindh Environmental Improvement Agency to:

- create “no threat to livelihood of local communities”
- repair/compensate any damages to community assets caused by project components
- employ an Independent Environmental Monitoring Consultant for the life of the project who will submit quarterly reports on DPKPG -CPP Project activities.

In addition, Environmental Management Plan identifies a Site Environmental Coordinator charged with monitoring and evaluating permit compliance and environmental impacts associated with constructing and operating the project.

DPKPG has to designate a Community Liaison Officer (CLO), reporting to the Project Manager, who is tasked to help manage and facilitate communications with the local community, including people making their living from agriculture and farming. The CLO’s duties include providing the main point of contact with the local community, and transmitting concerns and complaints to the projects’ management structure. The CLO is responsible for actively identifying and communicating with local community leaders, NGOs active in the area and loosely affiliated common-interest groups. The CLO is available to address questions about and concerns with project activities, and to provide information about jobs (especially during construction), opportunities to provide goods and services to the project, and opportunities for the project to pro-actively engage in promoting the health, welfare and quality of life for the local community. The CLO is charged with creating a positive relationship between the project, its contractors and the local community, managing and planning future public consultations, disclosure meetings and events, maintaining records, and leading dispute resolution proceedings. The CLO is responsible for implementation of the Community Grievance Procedure outlined below.

The CLO is responsible for communicating job and economic opportunities to the local community. His duties include establishing good relations with the local community and to act as a ‘clearing house’ for questions about how to apply for jobs, how to become qualified for bidding on provision of goods and services to the project, and similar economic opportunities. The CLO and stakeholders will together develop a list of economic opportunities targeted toward the local community to help create goodwill towards the project.

The following compensation plan has been adopted by DPKPG in response to project concerns expressed during the initial consultation process:

- Separate funds allocated to initiate public welfare programs.
- For all unskilled jobs, the project will attempt to fill those positions from local applicants.
- Local community leaders and first responders will be informed and updated regularly on emergency response procedures.
- The project’s Community Grievance Procedures will be easy to participate in and free of cost.

In addition to proposed project activities, the Project Contractor shall:

- be responsible for community affairs as it relates to industrial relations, human resources, procurement, and sub-contracting associated with the Contractor’s Work;
- establish community affairs office(s) as appropriate to support the Contractor’s community affairs activities. Such offices shall be located at sites that facilitate effective management of community affairs, industrial relations, recruitment and hiring without disrupting the Work;
- work with appropriate community leaders to reduce the adverse effects of their activities on the community, and to facilitate resolution of community unrest and disruptions resulting from Contractor’s performance of the Work;
• confirm that its personnel and the personnel of its sub-contractors are appropriately qualified and trained to be aware of and manage local cultural issues to the extent required to minimize and manage local community disruptions arising as a result of Contractor’s performance of its Work. DPKPG shall provide induction materials for new workers and necessary briefings for workers and Contractor(s) as required;
• comply with the Community Grievance Procedures detailed below;
• gain the prior approval of DPKPG before making any direct agreements with local communities.

6.5 Training On Community Relations

The CLO is responsible for ensuring that DPKPG and the Contractor(s) workers and subcontractors receive adequate training in project-specific community relations, so as to be aware of health, safety and security issues as well as the standard of conduct expected when engaging with the community. Induction training for all new workers shall be provided and will cover at a minimum:

• General liaison and interaction with communities;
• Cultural sensitivities;
• Awareness-raising on health, safety and security considerations;
• Project Code of Conduct.

Additional training on community relations will be delivered through:

• Tool Box Meetings;
• Safety, Security, Health and Environment Safety Committee Meetings;
• In-House Training / Seminars;
• Notice Boards; and
• Newsletters.

6.6 Stakeholder Engagement Plan Framework

6.6.1 Objectives And Principles

DPKPG will establish a Stakeholder Engagement Plan (SEP) that will be applicable for the entire project lifecycle. The Stakeholder Engagement Plan will consider the analysis, mapping and feedback of consultations that have been undertaken for the project thus far.

The SEP will take into consideration the applicable legal framework for public disclosure in Pakistan. The main objective of the SEP will be to increase the effectiveness of DPKPG’s relationships with all their stakeholders.

This framework provides details on the general principles for DPKPG’s stakeholder engagement as well as suggestions on the mechanisms and tools which can be used.

6.6.2 Principles Of Stakeholder Engagement

KE commits to the following principles for effective and long-term engagement:

• Providing meaningful information in a format & language that is readily understandable and tailored to the needs of the target stakeholder group(s);
• Providing information in advance of consultation activities and decision-making;
• Providing information in ways and locations that make it easy for stakeholders to access it and that are culturally appropriate;
• Respect for local traditions, languages, gender sensitivities, timeframes, and decision-making processes;
• Two-way dialogue that gives both sides the opportunity to exchange views and information, to listen, and to have their issues heard and addressed;
6.6.3 Implementation Plan

Based on the Framework for stakeholder engagement planning, DPKPG will develop a detailed implementation plan with the following suggested information:

- Identification of key stakeholders that DPKPG considers most relevant on the basis of those provided in the EIA and developing mechanisms to engage with the same;
- Structure a stakeholder engagement program that will describe the most culturally appropriate mechanisms to consult the prioritized stakeholders;
- Provide a schedule outlining dates and locations when various stakeholder engagement activities will be conducted;
- Indicate what staff and resources will be devoted to managing and implementing the company’s Stakeholder Engagement Program;
- Describe in detail the Grievance Mechanism that has been finalized by the senior management in consultation with local communities;
- Describe any plans to involve project stakeholders (including affected communities) or third-party monitors in the monitoring of project impacts and mitigation programs.

The Implementation Plan will include a clear plan of actions with deadlines and responsibilities in order to assure the maximum engagement level for all relevant stakeholders.

6.6.4 Grievance Management

DPKPG will adopt the Community Grievance Procedure outlined below, which requires interaction, consultation, targeted information and timely resolution of legitimate grievances. This approach is aimed at building a reputation of responsiveness, concern and responsibility among the community, with a view to building and sustaining acceptance and support for the construction and operation of the project.

DPKPG and its Contractor(s) shall foster a sense of working with the local community and demonstrate that the Project takes a proactive stance to grievances.

DPKPG’s grievance management system and database will comply with and has the flexibility to feed information into the Community Grievance Procedure. Proponent will also provide all Contractor(s) teams with training in Community Grievance Procedures.
In implementing DPKPG’s Community Grievance Procedure, the Contractor(s) shall:

- Record all grievances using the template Grievance Form;
- Assess & advise the resolution of the grievance in the time frame required by the assessment.
- All grievances will be investigated and a response (outlining a resolution) provided by DPKPG/Contractor(s) as soon as possible and not more than 30 days after receiving the grievance. If more time is required for resolution, the person raising the grievance and DPKPG shall be kept informed.
- While the Contractor(s) is not prevented from initiating the grievance resolution, any corrective action taken must be in coordination with DPKPG.
- DPKPG, through the CLO, will ensure that the details of the Community Grievance Procedure are publicized at community meetings and via posters and other means to all communities in the vicinity of the project.
- In addition, DPKPG and its Contractor(s) shall ensure that the local populations working / residing in the local area receive necessary information for contacting and initiating a grievance through meetings, pamphlets and similar community outreach programs under the direction of the CLO.
- DPKPG and its Contractor(s) shall ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of this Plan. The Contractor Plan shall describe the resources allocated to and responsibility for the execution of each task and requirement contained therein, and shall describe how roles and responsibilities are communicated to relevant personnel.

6.6.5 Commitment Register

DPKPG should develop a commitment register to record, implement and track any public commitment or request that is made to the project’s stakeholders. This includes any requests of direct development interventions, expectations on employment, petty procurement etc.
### 6.6.6 Roles And Responsibilities

Stakeholder Engagement will be on-going throughout the entire project lifecycle and will be coordinated across project activities and contractors by designated personnel the Community Relations team. The Community Relations team will support the EHS Coordinator in implementing the Environmental and Social Management and Monitoring Plan and will also lead the stakeholder engagement process which will have the following tasks:

- Interface between DPKPG, contractors, sub-contractors and the local community;
- Disclosure of project specific information for all components to village settlements within the footprint area and other external groups as required;
- Establish a mechanism to obtain, report, redress and monitor all grievances from the local community;
- Regular engagement with key informants and local leaders to ensure a transparent feedback process in to the project; and
- To plan, implement and evaluate community development programs.

The Community Relations Team will consist of Two (02) personnel who would coordinate with the overall Environmental and Social Manager. This will include the Community Relations Officer and the Human Resources Officer.

### 6.6.7 Community Development

DPKPG’s personnel have already commenced the process of early identification of community support projects, such as drinking water and sanitation, and providing investment for the same. These activities will
be streamlined under the framework of stakeholder engagement to develop a detailed Community Development Plan which looks into options of CSR activities and social investments and suggests models of interventions to suit the needs of the community.

To the extent possible the CSR activities should be relevant to the needs of the locality and in no case should be detrimental to the E&S sensitivities of the project area. These plans and activities are to be implemented in consultation with the local community. The plan will also include indicators for regular monitoring of these development activities in order to assess their impacts and to suggest changes in the approach.

6.6.8 Monitoring And Evaluation

DPKPG will monitor the principles and commitments of the stakeholder engagement process and will need to report on the status of implementation of different aspects, such as information disclosure, grievance redressal, etc.

Engagement levels can be monitored by developing a set of indicators which will include:

- Number and Type of Communications and Issues discussed;
- Frequency of communications;
- Type, subject and number of grievances;
- Sources of complaints;
- Average time taken to resolve and close grievances;
- Number of presentations and frequency on EHS and economic status of the company;
- Number and diversity of stakeholders involved per action;
- Comments on any disclosed documents/presentations;
- Level/degree of involvement for stakeholders;
- Partnerships with stakeholders;
- Number of mass media articles/announcements.

6.6.9 Performance Indicators

Table 6.3 outlines the indicators used for measuring and verifying performance in relation to community engagement. However DPKPG may modify or add to these indicators to enhance the Plan based on learning from the performance indicators.

<table>
<thead>
<tr>
<th>ID#</th>
<th>Performance Indicator</th>
<th>Measurement</th>
<th>Internal Assessment Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximize use of the Project Community Grievance Procedure.</td>
<td>100% of grievances (except those related to worker issues) channelled through the Community Grievance Procedure.</td>
<td>Monthly</td>
</tr>
<tr>
<td>2</td>
<td>Resolution of Community Grievances.</td>
<td>75% of grievances resolved (from the Project perspective) within 30 days, categorized according to cause of grievance.</td>
<td>Monthly</td>
</tr>
<tr>
<td>3</td>
<td>Disruptions to work.</td>
<td>Number of hours lost due to community disruption categorized according to cause of disruption (to be coordinated with Security departments to ensure consistent reports).</td>
<td>Monthly</td>
</tr>
<tr>
<td>4</td>
<td>Compensation payments.</td>
<td>Amount of compensation paid as a result of Project impacts</td>
<td>Monthly</td>
</tr>
</tbody>
</table>
Figure 6.6 - Stakeholders Consultation Meeting
7.0 **Environmental Management And Monitoring Plan**

7.1 **Introduction**

Environmental Management Plan (EMP) reviews the adequacy of various pollution control measures envisaged for DGKPG-CPP Project (presented in Section 3.0) in mitigating various environmental impacts identified and assessed in Section 5.0. Additional mitigatory measures, if required to ensure sustainable power development are also suggested. EMP has been prepared separately for construction and operation phases. It describes administrative aspects of ensuring that mitigatory measures are implemented and their effectiveness is monitored. It also includes green belt development plan.

Each of the mitigatory measure has been assessed with respect to:

- Adoption of state of art technological measures
- Identification of human resources for its effective implementation
- Allocation of financial resources for its effective implementation and
- Effectiveness of mitigatory measure in mitigation of impacts

EMP specifies various technological measures for pollution prevention, waste minimization, end-of-pipe treatment, attenuation etc. proposed to be undertaken to mitigate the environmental impacts on each sector of environment during each phase of the project, i.e. construction phase and operation phase. The responsibility for implementation for all mitigatory measures rests with DGKPG. Most of the mitigatory measures are integral part of the main plant package and are commissioned simultaneously with the commissioning of the main plant packages.

7.2 **Objectives & Scope Of EMP**

The Rationale of this EMP is to propose environmental protection commitments to protect the environmental values that may be affected by the development of the proposed project works and to assist the administering authorities to decide the appropriate approval conditions for the project. The EMP is required to achieve the following objectives:

- Outlining measures to be taken during the implementation and operation of the DGKPG-CPP to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels.
- Taking actions such as defining roles and responsibilities of the project proponent for implementation of EMP and identification of areas where these roles and responsibilities can be shared with other stakeholders.
- Defining the requirements for communication, documentation, training & management and implementation of mitigation measures.
- Taking actions required for assessing the effectiveness of mitigation measures employing the monitoring mechanism and identifying related parameters to confirm the effective implementation of these measures.

The scope of the EMP includes the following functional areas:

- *Management systems:* Those systems employed in the management of the DGKPG’s operational activities. It will include financial systems; engagement and supervision of contractors; purchasing policies, etc.
7.3 EMP Process

The EMP consists of the following areas and defines the methods and procedures for its implementation.

- Organizational structure; roles and responsibilities of project personnel;
- Specific requirements of implementation of EMP;
- Mitigation or impact management matrix;
- Monitoring plan with emphasis on specific parameters to monitor.

In the preparation of this plan several aspects concerning the siting, designing, construction and operation of bulk terminal have been taken into consideration. Additionally management related issues have been provided to guide through the procedures.

The DGKPG will establish Health, Safety & Environment (HSE) department which will handle all environment related concerns and issues. The HSE manager will be the Head of HSE department and will be responsible for reporting directly to the Chief Executive Officer. To support HSE management system, HSE officer(s) will be appointed to coordinate with the contractor during construction process and also monitor the activities at all the sensitive areas during the construction and operations stages of terminal.

7.4 Project Background

DGKPG proposes constructing a coal fired power station at 250 acres land available in the Eastern Industrial Zone of Port Qasim Authority. The proposed 2x350 MW coal power plant shall adopt supercritical boiler technology. The plant design is based on imported coal with the capability to burn local coal in the future. Coal will be imported from Indonesia, South Africa or Australia, with expected
calorific value of 20.14 MJ/kg. The ash content is expected to be 8-14%. The expected sulfur content is <1%. Ash generated during Project operation will be ultimately sold to cement plants. The major systems of the power project include:

- Coal Jetty
- Super-critical boiler
- Pulverised Coal (PC) generation plant
- An open coal storage area surrounded by wind shield
- Coal handling covered conveyors
- Water supply and waste water system
- Ash handling system
- Emission control system
- Flue Gas Desulfurization (FGD) system
- Dust prevention, and fire monitoring and prevention facilities.

Highest reliability & availability, convenience of operation and maintenance, neat and orderly arrangement, are of utmost importance. The functional requirements of the various systems and the pleasing physical appearance of the completed Plant shall also be taken into account. Due care shall be undertaken concerning the environmental impact due to plant operations and sufficient protective measures shall be incorporated in the design of the Plant for environmental protection especially on air pollution, water pollution and noise. The environment protection measures shall be undertaken in accordance with the Environment Protection Guidelines of World Bank / IFC and Environmental Protection and Emission Control Standards of Sindh EPA.

The potential environmental aspects that are likely to arise during designing, siting, construction and operation of the Coal Power Plant are related to:

- Land Use
- Dredged Materials Management
- Coal handling
- Air Emissions & Dispersion
- Wastewater & solid waste management
- Hazardous Materials and Oil Spill Management
- Noise Emission
- Biodiversity

The EIA has recommended mitigation measures to minimize the adverse impacts. These measures include the use of alternative options for siting, management and physical control, besides compensation for loss of mangroves, and are based on the understanding of sensitivity and behaviour of environmental receptors in the project area, the legislative controls that apply to the project and a review of good management practices while operating in sensitive environments.

### 7.5 Management Approach

The environmental management will require specific approach in order to handle the issues effectively. Manager HSE will assign the roles and responsibilities to be performed during the construction and operations stages of DGKPG – Coal Power Plant Project. It is expected that a certain degree of redundancy is inevitable across all management levels, but should be in the order to ensure that compliance with the environmental management plan can be cross-checked.
Compliance with EMP will be the responsibility of DGKPG Management at each stage of project. DGKPG Management will ensure that all executive activities during construction stage do not create adverse environmental effects. Contractor and sub-contractor will work in environment friendly manner under the supervision of HSE department of KE. All the regulatory agencies including Sindh EPA will be contacted as and when required to get advice for environmental management and they will be kept informed of the environmental conditions of the area periodically by DGKPG management and their contractors/sub-contractors.

The contractor will carry out field activities as part of the proposed DGKPG Project that includes relevant and subsidiary construction work. The contractor will have certain liabilities under the environmental laws of the country, which will be specified in the contract document with the DGKPG Management.

Some of the approaches to be followed during the environmental management practices are given below:

- Complying with the relevant legislation and regulations;
- Regularly reviewing of the impacts on the environment;
- Developing appropriate indicators to monitor core impacts;

Figure 8.1: Suggested Organizational Structure for Environmental Management
- Setting appropriate annual objective, targets and publicly reporting on progress;
- Monitoring supplier's environmental management arrangements;
- Using sustainable materials for office supplies and environmentally safe raw materials with recycling options where appropriate;
- Communicating openly with internal and external stakeholder on environmental issues.

### 7.6 Roles & Responsibilities

Environmental management will be the integral part of corporate policy of KE. Therefore, committing to reduce the environmental impacts will reflect the management approach and belief that good governance and performance in this area is synonymous with running a well-managed efficient business. Overall responsibility for environmental performance rests with the Chief Executive Officer of DGKPG while the daily management will be performed under the direction of Manager HSE. DGKPG’s HSE officer and contractor will execute environmental management under the supervision of Manager HSE during construction and operations. The contractor will carry out field activities as part of the proposed DGKPG project that includes relevant and subsidiary construction work. The contractor will have certain liabilities under the environmental laws of the country, which will be specified in the contract document with the DGKPG Management. The overall responsibility for all matters pertaining to environment will be that of the organisational head of assigned contractor.

A brief make-up of the roles and responsibilities of the system is given below:

1. **Chief Executive Officer of DGKPG**

   The Chief Executive Officer (CEO) of DGKPG will regulate environmental management plan. Some of the key roles and responsibilities of CEO are given below.
   - To consider and react to issues and solutions proposed by the HSE Department;
   - To cooperate and consult the relevant environmental agency to perform better;
   - To evaluate the progress of development and implementation of EMP;
   - To approve any change in decision-making and authorities in consultation with Manager HSE, if appropriate.

2. **Manager HSE**

   The success of EMP depends on proper and effective management provided by HSE manager. Following are some of the roles and responsibilities assigned to Manager HSE.
   - To ensure that the points of views of staff, contractors and HSE officers are considered and placed likewise in the EMP;
   - To identify issues and propose solutions for inclusion in the EMP review process;
   - To improve coordination and exchange of information between top management, employees, & contractors;
   - To contribute to actions required to deliver the management plan and ensure its continued development;
   - To review EMP every year, tracking issues and changing EMP in accord with the solutions and suggestions;
   - To monitor the progress of development and implementation of the EMP.
3. **HSE Officer**

The role of HSE officer will be authorized by HSE manager. The responsibilities of HSE officer will include:

- To integrate, as far as possible, the aims and objectives of different users within an agreed plan;
- To maintain a balanced, holistic approach to the solution of concerned issues in accordance with compliance of legislative requirements;
- To provide professional guidance on questions relating to the environment management and issues raised by contractors/relevant personals;
- To develop the EMP process by its implementation.

4. **Contractor**

The overall responsibility for all matters pertaining to environment will be that of the organisational head of assigned contractor. The role and responsibilities of the contractor consist of the following:

- To carry out construction activities in environmentally sound manner;
- To coordinate with the HSE officer to resolve issues arising during construction phase;
- To manage and implement environmental management practices as given in the impact assessment report as well as HSE polices adopted/prepared by KE;
- To administer construction crew and reduce the environmental risks;
- To appoint a dedicated environment officer to understand and handle environmental issues more easily in coordination with DGKPG’s HSE officer/coordinator.

5. **The Supervision Consultant**

The DGKPG shall appoint an Independent Monitoring Consultant (IMC) who will oversee that the construction activities are in consonance with the provisions of the EIA. He shall be responsible for the preparation of monthly reports on the project progress. The consultant will maintain records, decisions made at meetings, progress on civil works, certified achievements and milestones, financial records, and any deviations from or changes to the contract plans. The consultant will assist the DGKPG and contractor in preparing quarterly project progress reports, a project completion report, and monitoring and evaluation reports as required under the agreement.

### 7.7 Implementation Stages Of EMP

Success of EMP will rest with its implementation. For that matter it will be necessary to establish an HSE department and organise a team with direct responsibility for putting the plan into practice. This set-up needs to be provided with adequate resources and an office base to execute the EMP in three stages, which include planning and designing; construction and operation.

#### 7.7.1 Planning And Design Of Coal Power Plant Project

Implementation of EMP needs to take a start at the inception stage to handle the environmental issues much before they arise. The following are the three main components to consider in an EMP prior to start of construction:

1. **Design of Coal Power Plant**

   It describes the project in terms of location, geology, seismicity, magnitude; infrastructure facilities available and their deficiencies; along with the mechanism for doing so. If any design parameter changes
at the time of approval, DGKPG will assess the environmental impacts that may arise from such changes. If the impacts are found to be different and in excess of those mentioned in the report, DGKPG will develop effective mitigation measures to address the changes to minimise the residual impacts and seek approval for the required change from Sindh EPA.

2. Approvals

DGKPG and contractor will, besides obtaining NOC from Sindh EPA obtain relevant clearance and necessary approval from the government and other agencies prior to commencing construction and operation. Furthermore, issuance of NOC from Sindh EPA will require the DGKPG to plan for undertaking continuous monitoring, including self-monitoring and reporting. The approval from Sindh EPA shall not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force.


The requirements of environmental impact assessment with respect to mitigation measures shall be incorporated in the construction and operations plans and procedures. This will make it mandatory for the contractor to follow procedures and comply with environmental regulations.

7.7.2 Construction And Operation Phase

In order to implement EMP successfully during the construction and operation phase, it is necessary to adopt mitigation measures, monitoring plan and emergency procedures in letter and spirit. Training will be required at each step and phase. Changes in management processes will be documented and made available to the employees.

1. Mitigation Plan

The environmental impacts and remedial measures, as well as responsible persons designated to ensure adoption of the mitigation measures are given in the mitigation matrix Table-8.1. A mitigation matrix is basically a mitigation plan. These impacts and mitigation measures have already been given in detail in the earlier chapters. The matrix presented here additionally provides the responsibility clause for construction contractor and proponent for adoption of mitigation measures throughout the project.

2. Emergency Procedures

In order to organise and manage occupational hazards and environmental catastrophes such as flooding, natural incidents and accidents, DGKPG management will develop a contingency plan to deal with emergency situations that may arise during construction and operations as part of EMP. If required, non-conformities arising and remedies taken will be communicated and shared with the regulatory agencies.

3. Training

All employees will be trained appropriately to work on EMP effectively. Employees training will provide workers with information on minimising waste generation. The HSE officer/coordinator will determine the training requirements in consultation with contractor among the staff of both construction contractor, supervision consultant, Environment Specialist and DGKPG’s Manager HSE.

4. Monitoring and Review

Monitoring of different activities will be required to analyse the impacts of construction and operation on the environment. Self-monitoring and reporting tools will be adopted to carry out monitoring as per EPA rules and regulations.
HSE officer will coordinate with Manager HSE, who will be the in-charge of monitoring procedures. Monitoring techniques will be identified and the frequency of selected parameters for monitoring will be followed as per the monitoring plan given in Table 7.2. Manager HSE will keep a record of all non-conformities observed and report them along with actions to CEO for further action. Manager HSE will also report any impact anticipated along with his recommendations for further action. The contractor shall take note of the recommendations relating to issues arising during monitoring of construction activities.

**Review:** Environmental assessment of the proposed project has been made on the basis of the project description, site visits, existing environmental conditions and expected changes in environmental parameters due to construction activities as well as during operation of the KE. Review of activities will take place after conceding changes in project design, record keeping and management plans subsequent to impact assessment study.

The environmental monitoring program will comprise of compliance monitoring, effects monitoring and post project monitoring with the objectives as described for each case as follows:

**Compliance Monitoring** - to check compliance of the contractor(s) and the DGKPG with the EMP;

**Effects Monitoring** - to monitor impacts of the project activities in which there has been a level of uncertainty in prediction such as impacts on vegetation and to recommend mitigation measures if the impacts are assessed to be in excess of or different from those assessed in the ESIA; and

**Post Project Monitoring** - to monitor residual impacts and complete restoration of sites.

Environmental monitoring is normally undertaken during both the construction and operational phases to ensure the effectiveness of the proposed mitigation measures.

The compliance monitoring is principally a tool to ensure that the environmental control measures required in the EIA are strictly adhered to during the project activity. The objectives of compliance monitoring will be to:

- Systematically observe the project activities;
- Verify that the activities are undertaken in compliance with the ESIA and EMP;
- Document and communicate any non-compliance so that any corrective measures required can be taken in a timely fashion;
- Maintain a record of all incidents of environmental significance and related actions; and
- Prepare periodic reports of the environmental performance of the project.

The mitigation plan will be used to monitor compliance. Where required, checklists will be used when monitoring compliance. Compliance monitoring will be the responsibility of all organizations involved in the project, that is, KE, contractors, suppliers and supervision consultants. It will be carried out at the following levels:

- The DGKPG’s field staff;
- Supervision consultant’s supervisory staff;
- The construction contractors’ environment officers; and
- Suppliers.

Broadly, **effects monitoring** has the following objectives:
To verify that the impact of the proposed project is within acceptable limits;

To facilitate research and development by documenting those effects of the proposed project that can be used to validate impact-prediction techniques and provide a basis for more accurate predictions of future impacts;

To immediately warn the project proponent and the regulatory agencies of unanticipated adverse effects or sudden changes in impact trends so that corrective actions can be undertaken, which may include modifications in the proposed activities or inclusion of modified or additional mitigation measures; and

To provide information to plan and control the timing, location, and level of certain project activities so that their impact is minimized.

The common theme of the above objectives is the proper management of environmental risks and uncertainties. The EIA predicts the impact of the proposed project based on available information on the environment and the natural processes that link various environmental parameters. Based on this prediction, mitigation measures are introduced such that the predicted residual impact does not exceed acceptable levels. However, there is always an element of uncertainty in such predictions due to an insufficient grasp of the processes, limitations in prediction techniques, or inadequate data on the environment. This is true for the physical, biological, as well as socioeconomic environment. Consequently, it is possible that even if control measures are implemented fully, the negative impact will exceed acceptable limits. The recommended effects monitoring protocols are provided for the pre-construction, construction and operational phases of the proposed project respectively.

A team including the DGKPG Environmental Manager will conduct the monitoring program. A senior member of on site management staff will lead the monitoring team. Frequent round/surveillance of the area is to be conducted by the Independent Monitoring Consultant (IMC) for in-time detection of pollutants/polluter and remedial measures. IMC should also ensure compliance with procedures that are part of mitigating measures, such as low-speed, no engine-idling and no-horn disciplines on the access road.

The objective of post project monitoring will be to determine the level of residual impacts of the project activities on physical, biological and socio-economic receptors in the project area. The monitoring will start one month after the termination of all project-related activities in the project area. As a part of the post-project monitoring, restoration of sites will also be checked.

### 7.7.3 Closure And Decommissioning Phase

The power plant closure and subsequent decommissioning shall be carried out under supervision of DGKPG’s HSE Manager who shall be fully responsible for the safe and environmental friendly decommissioning of the plant. The DGKPG may hire a competent Contractor for this purpose.

The DGKPG’s HSE Manager shall:

- Be responsible for safe decommissioning and closure of the plant
- Commissioning of a reputable contractor for dismantling of the plant
- All hazardous waste shall be disposed off in compliance with the national and local laws
- All recyclable and reusable wastes shall appropriately be taken care of in order to reduce environmental impacts
A traffic management plan similar to the one developed for construction phase shall be developed and followed

The plant site shall be restored to original conditions as at the time immediately before its construction.

7.8 Changes To The EMP

The EIA and the EMP have been developed based on the best possible information available at the time of the Assessment. However, it is possible that during the construction and operation phase some aspects of the EMP will need to be changed owing to their non-applicability in a certain area of operation or the need for additional mitigation measures based on the findings of environmental monitoring during the construction and operation phase. Such changes are elaborated below to make them part of EMP.

7.8.1 Change In Operations

Any change in the operation of DGKPG if required, will be made in relevance to the EMP and all the impacts associated with changed process will be either similar to the existing impacts and if different, will be assessed and included in the mitigation management plan. This has, on the basis of nature of process change, been distributed into three categories.

First-Order Change: is one that leads to a significant removal of any operation from the project described in the chapter on description of project of this report and consequently requires a reassessment of the environmental impacts associated with the changes. In such an instance, reassessed environmental impacts of the proposed change will be sent to Sindh EPA for approval.

Second-Order Change: is one that entails project activities not significantly different from those described in the EIA 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 impacts of the activity will be reassessed. Additional mitigation measures if required will be identified and documented for being reported to Sindh EPA for their record.

Third-Order Change: is one that is of little consequence to the EIA findings. This type of change does not result in impact levels exceeding those already assessed in the EIA report; rather these may be made onsite to minimise the impact of an activity. The only action required in this regard will be to record the details of process change in the record register.

1. Change in Record Register

A record register will be maintained at project site at the start of construction activity. All the changes to be made will be recorded in this register. This will assist in the step-by-step environmental monitoring and decision-making. Record register will be the responsibility of DGKPG Manager HSE, and will be used internally.

2. Change in 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 representatives of KE, EIA consultant and contractor, to discuss and agree upon the proposed change to the EMP.

- Based on the discussion during the meeting, a report will be produced collectively, which will include the additional EMP clauses and the reasons for their addition.
Additional EMP clauses will be added to the original EMP as a second volume which will be distributed among DGKPG and construction contractor. All relevant project personnel will be informed of the addition.

### 7.9 Mitigation Plan

Mitigation measures are proposed for this project in order to control and lessen the impacts of all potential negative impacts that are either expected during the normal operation of the system or unexpected due to uncontrolled events that lead to accidents in the system. The feasibility or validity of the mitigation suggestions can be measured in terms of either decreasing the severity of the impact or the probability of its happening.

For each stage of the project, a different set of mitigation measures shall be applicable. There are four major stages of the project; Pre-Construction, Construction, Operation and Decommissioning.

#### Table 7.1: Mitigation Measures Proposed to be Implemented During Construction Phase

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water sprinkling in vulnerable areas</td>
<td>DGKPG + Contractor</td>
<td>Control of fugitive dust from construction areas</td>
<td>Increase in SPM emissions</td>
</tr>
<tr>
<td>Proper maintenance of vehicles &amp; construction equipment</td>
<td>DGKPG + Contractor</td>
<td>Control of NOx Emissions</td>
<td>Nil</td>
</tr>
<tr>
<td>Transportation of construction material in covered trucks, wherever possible</td>
<td>DGKPG + Contractor</td>
<td>Control of fugitive dust from construction areas</td>
<td>Increase in SPM emissions</td>
</tr>
<tr>
<td><strong>Noise Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper maintenance of vehicles, equipment and machinery</td>
<td>contractor</td>
<td>SEQS for Ambient Noise and Vehicular Emissions</td>
<td>Control of ambient and in plant noise levels</td>
</tr>
<tr>
<td>Provision of acoustic covers/enclosures on equipment and machinery, wherever possible</td>
<td>contractor</td>
<td>-</td>
<td>Control of ambient and in plant noise levels</td>
</tr>
<tr>
<td>Provision of ear muffs/earplugs to the workers in high noise areas and enforcement of its use</td>
<td>contractor</td>
<td>OHSA</td>
<td>Protection of workers</td>
</tr>
<tr>
<td><strong>Water Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channelization of effluents from construction area through existing network of drains</td>
<td>DGKPG + Contractor</td>
<td>SEQS for effluent</td>
<td>Control of suspended solids in effluents from construction area</td>
</tr>
<tr>
<td>Construction of temporary sedimentation tanks for the effluents from construction area</td>
<td>DGKPG + Contractor</td>
<td>SEQS for effluent</td>
<td>Control of suspended solids in effluents from construction area</td>
</tr>
<tr>
<td><strong>Socio-Economic Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision of environmentally safe camping area for the migrant labourers</td>
<td>DGKPG + Contractor</td>
<td>-</td>
<td>To provide clean &amp; healthy living environment to workforce</td>
</tr>
</tbody>
</table>
### Table 7.1: Mitigation Measures Proposed to be Implemented During Construction Phase

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrangements for water supply and sanitation</td>
<td>DGKPG + Contractor</td>
<td>-</td>
<td>To reduce stress on surrounding population</td>
<td>Stress on existing utilities, conflicts with local people</td>
</tr>
</tbody>
</table>

**Solid Waste Management**

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal of construction debris</td>
<td>Contractor</td>
<td>-</td>
<td>Control of pollution</td>
<td>Air/Water Pollution</td>
</tr>
<tr>
<td>Reclaiming of inbuilt area with appropriate vegetation/landscaping</td>
<td>Contractor</td>
<td>-</td>
<td>Create a good visual environment</td>
<td>Unpleasant surroundings</td>
</tr>
</tbody>
</table>

### Table 7.2: Mitigation Measures Proposed to be Implemented During Operation Phase

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Efficiency ESPs</td>
<td>DGKPG</td>
<td>Guidelines for CPP for Pakistan</td>
<td>To reduce the emission levels of PM$_{10}$ to 150 µg/Nm$^3$</td>
<td>Increase in PM emissions</td>
</tr>
<tr>
<td>200 m Tall Stack</td>
<td>DGKPG</td>
<td>-</td>
<td>Wider dispersion of PM, SO$_2$ and NOx</td>
<td>Nil</td>
</tr>
<tr>
<td>Coal Dust Extraction and Suppression Systems</td>
<td>DGKPG</td>
<td>-</td>
<td>Control of fugitive dust from coal handling plant</td>
<td>Increase in fugitive emissions</td>
</tr>
<tr>
<td>Sprinkling over bottom ash disposal area</td>
<td>DGKPG</td>
<td>-</td>
<td>Control of fugitive dust from ash pond</td>
<td>Increase in fugitive emissions</td>
</tr>
<tr>
<td>Reclamation of ash pond</td>
<td>DGKPG</td>
<td>-</td>
<td>Control of fugitive dust from ash pond</td>
<td>Increase in fugitive emissions</td>
</tr>
</tbody>
</table>

| **Water Environment**        |                |            |                    |                                        |
| Cooling water discharge      | DGKPG          | SEQS, 2014 | Cooling of hot water coming out of cooling systems to within 3°C | Increase in temp of water coming out of cooling systems |
| Main Plant Effluent Treatment Plant | DGKPG       | SEQS, 2014 | Removal of contaminants to conform to regulatory standards for discharge of effluents | Increase in parameters |
| Sewage Treatment Plant       | DGKPG          | SEQS, 2014 | Removal of contaminants to conform to regulatory standards for discharge of effluents | Increase in parameters |

| **Noise Environment**        |                |            |                    |                                        |
| Design of equipment          | DGKPG + Equipment Supplier | - | To control noise levels to SEQS limits for industrial noise | Increase in in-plant and ambient noise levels |
| Provision of acoustic enclosures/barriers/shields to reduce noise | DGKPG + Equipment Supplier | - | Attenuation of noise in source receptor pathway | Increase in in-plant and ambient noise levels |
| Provision of personal protective equipments like ear plugs and ear muffs | DGKPG | OSHA | Protection of sensitive receptor | Health impact on workers in high noise areas |

**Solid Waste Management**

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry collection of fly ash and supply of ash</td>
<td>DGKPG</td>
<td>-</td>
<td>Facilitate supply of dry ash to entrepreneurs</td>
<td>Reduction in quantity of ash</td>
</tr>
</tbody>
</table>
### Table 7.2: Mitigation Measures Proposed to be Implemented During Operation Phase

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>to entrepreneurs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash Utilisation</td>
<td>DGKPG + Other entrepreneurs</td>
<td>-</td>
<td>Reduce land requirement for ash disposal and pollution from ash disposal site</td>
<td>increased land requirement</td>
</tr>
<tr>
<td>Disposal of Unused Ash</td>
<td>DGKPG</td>
<td>-</td>
<td>Environmentally safe disposal of unused ash</td>
<td>-</td>
</tr>
<tr>
<td>Plant Rejects</td>
<td>DGKPG</td>
<td>-</td>
<td>Reuse within plant/sale to smaller industries for reuse through an EPA certified contractor / consultant</td>
<td>-</td>
</tr>
<tr>
<td>Municipal Solid Waste</td>
<td>DGKPG</td>
<td>-</td>
<td>Environmentally safe disposal of municipal waste from township</td>
<td>Air and water pollution, spread of disease vectors</td>
</tr>
</tbody>
</table>

**Others**

<table>
<thead>
<tr>
<th>Mitigation Measures Proposed</th>
<th>Responsibility</th>
<th>Regulation</th>
<th>Targets to Achieve</th>
<th>Risks and Consequence of Failure, if any</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afforestation and Green Belt Development</td>
<td>DGKPG</td>
<td>-</td>
<td>Ecological improvement, Attenuation of air pollutants (PM, SO$_2$ and NO$_x$) and noise in source receptor pathway</td>
<td>-</td>
</tr>
<tr>
<td>Control of Eire and Explosion Hazards</td>
<td>DGKPG + Vendor for Main Plant</td>
<td>-</td>
<td>Safety</td>
<td>Increased risk of fire and explosion</td>
</tr>
</tbody>
</table>

### Table 7.3: Mode of Implementation and Allocation of Resources for Mitigation Measures for Operation Phase

<table>
<thead>
<tr>
<th>Mitigation Measures</th>
<th>Mode of Implementation</th>
<th>Allocation of Financial Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Efficiency ESPs</td>
<td>Integral Part of Main Plant Packaged</td>
<td>Rs. 916.34 Million</td>
</tr>
<tr>
<td>Stack</td>
<td>Civil Construction Package</td>
<td>Rs. 1118.69 Million</td>
</tr>
<tr>
<td>Coal Dust Extraction and Suppression Systems</td>
<td>Integral Part of Main Plant Package</td>
<td>Rs. 32.89 Million</td>
</tr>
<tr>
<td>Reclamation of ash pond</td>
<td>Part of O&amp;M System</td>
<td>Rs. 449.95 Million</td>
</tr>
<tr>
<td><strong>Water Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling water discharge channel</td>
<td>Part of Main Plant Package</td>
<td>Rs. 2275.43 Million</td>
</tr>
<tr>
<td>Main Plant Effluent Treatment Plant – ETP</td>
<td>Part of Main Plant Package</td>
<td>Rs. 381.98 Million</td>
</tr>
<tr>
<td>Sewage Treatment Plant</td>
<td>Separate package</td>
<td>Rs. 22.87 Million</td>
</tr>
<tr>
<td><strong>Noise Environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of equipment</td>
<td>Included in Technical Specification</td>
<td>-</td>
</tr>
<tr>
<td>Provision of acoustic Enclosures/barriers/shields to reduce noise</td>
<td>-</td>
<td>Rs. 195.77 Million</td>
</tr>
<tr>
<td>Provision of personal protective equipments like ear plugs and ear muffs</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Solid Waste Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry fly ash collection and loading system</td>
<td>Part of main plant package,</td>
<td>Rs. 199.68 Million</td>
</tr>
</tbody>
</table>
For each stage of the project, a different set of mitigation measures shall be applicable. There are four major stages of the project; Pre-Construction, Construction, Operation and Decommissioning.

### Table 7.3: Mode of Implementation and Allocation of Resources for Mitigation Measures for Operation Phase

<table>
<thead>
<tr>
<th>Ash Handling including ash water recirculation</th>
<th>Part of Operation and Maintenance System</th>
<th>Rs. 203.44 Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash Dyke</td>
<td>Civil Construction Package</td>
<td>Rs. 1402.94 Million</td>
</tr>
<tr>
<td>Municipal Solid Waste</td>
<td>Hiring of contractor</td>
<td>Rs. 15.66 Million</td>
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<tr>
<td><strong>Others</strong></td>
<td></td>
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<tr>
<td>Afforestation and Green Belt Development</td>
<td>-</td>
<td>Rs. 31.79 Million</td>
</tr>
<tr>
<td>Control of Fire and Explosion Hazard</td>
<td>Part of Main Plant Package</td>
<td>Rs. 18.79 Million</td>
</tr>
<tr>
<td>Independent Monitoring</td>
<td>Hiring of IMC and EPA certified lab</td>
<td>6.0 Million (Annual)</td>
</tr>
<tr>
<td>Environmental Aspect</td>
<td>Environmental Impacts / Sensitive Receptors</td>
<td>Table 7.4 - DGKPG Environmental Impact Mitigation Plan</td>
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<tr>
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<tr>
<td>Traffic</td>
<td>Increased traffic flows leading to congestion on main roads during transportation of workers, raw materials and construction vehicles</td>
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<tr>
<td></td>
<td>Traffic/ trip and journey management</td>
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<td></td>
<td>Adaptation of car-pooling practices and use of group transport methods (Such as buses, 12 m vehicles)</td>
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<td></td>
<td>Avoiding road closures and diversions as much as possible</td>
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<td></td>
<td>Planning of project access roads to avoid interference with congested public main roads</td>
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<tr>
<td>Fire</td>
<td>Besides incurring huge economic losses and environmental damage, fires can be fatal</td>
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<td></td>
<td>NFPA or more stringent standards should be adapted to be complied throughout the project life</td>
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<td></td>
<td>Thermal IR cameras to be installed for coal yard and conveyor belt monitoring for detecting hotspots</td>
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<tr>
<td>Air Quality - Dust Emissions</td>
<td>Dust released in construction areas and near roads affects people and green cover within the project area</td>
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<td></td>
<td>Continuous spray of treated wastewater on unpaved roads in the project area</td>
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<td></td>
<td>Cleaning of vehicle tires when exiting the construction area</td>
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<tr>
<td></td>
<td>Storage and handling of spoil, soil and potentially dusty material to be carried out in a careful manner so as not to cause dust blown</td>
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</tbody>
</table>
## Table 7.4 - DGKPG Environmental Impact Mitigation Plan

<table>
<thead>
<tr>
<th>Environmental Aspect</th>
<th>Environmental Impacts / Sensitive Receptors</th>
<th>Proposed Mitigation Measures</th>
<th>Responsibility</th>
<th>Scheduling</th>
<th>Implementation Tool</th>
<th>Residual Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Issues</td>
<td>Interference of local community in construction site activities, handling general concerns and disturbance.</td>
<td>Covering all trucks carrying dusty material with tarp or other similar material&lt;br&gt;Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust&lt;br&gt;Establish and implement a complaint handling system and a communication system with the public&lt;br&gt;Assign a staff person for coordination with public.&lt;br&gt;A grievance redress mechanism has been provided at the end of this document which may be adapted or a similar one developed.&lt;br&gt;Announce in advance to the public about the location and timing of any possible road that needs to be blocked due to construction activities&lt;br&gt;Put visible legible warnings signs in local language for any kind of announcement including self-explaining signs for illiterate people.&lt;br&gt;Keep safe passages or walkways opened for pedestrians.&lt;br&gt;Put warning tapes or movable fences around construction sites</td>
<td>Increase awareness about project and at least tell its objectives, benefits, milestones, duration, map and time schedule.&lt;br&gt;Put visible legible warnings signs in local language for any kind of announcement including self-explaining signs for illiterate people.</td>
<td>DGKPG HSE Manager&lt;br&gt;EPC Contractor/Sub-Contractor</td>
<td>Pre-Construction, during Construction and during operation&lt;br&gt;During Construction</td>
<td>Stakeholder consultation&lt;br&gt;EMMP</td>
</tr>
</tbody>
</table>
### Table 7.4 - DGKPG Environmental Impact Mitigation Plan

<table>
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<tr>
<th>Environmental Aspect</th>
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<th>Residual Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accidents, Injuries and Emergencies</strong></td>
<td>Public, workers of construction contractors and DGKPG staff</td>
<td>Put warning signs on each construction excavation or lifting location announcing the type, limit and duration of hazard in the specific area</td>
<td>DGKPG HSE Manager</td>
<td>Pre-Construction</td>
<td>Action taking and Early Response</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergency Response Team headed by DGKPG EHS Manager</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
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<td></td>
<td></td>
<td>Provide safety trainings, prohibit work without proper safety equipment and reporting every incident and near miss.</td>
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<tr>
<td><strong>Manual Handling</strong></td>
<td>Ergonomic Hazards – Handling of heavy machine parts, blocks etc.</td>
<td>Appropriate manual handling procedures</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>Pre-Construction and During Construction</td>
<td>HSE Plan</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
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<tr>
<td></td>
<td></td>
<td>Lifting and handling training for supervisors</td>
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<td></td>
<td>Availability of appropriate equipment for handling all materials required to be moved during construction</td>
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<td></td>
<td>Conducting ergonomic hazard analysis for all aspects of construction work and provide appropriate training/equipment or measures to reduce the impacts</td>
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<tr>
<td><strong>Air Emissions – Power Plant</strong></td>
<td>SOx emissions can cause acid rain which has several negative effects on vegetation, wildlife and physical structures</td>
<td>Only low Sulfur content coal shall be imported (having about 0.4%)</td>
<td>EPC Contractor + DGKPG HSE Manager</td>
<td>Pre-Construction and During Construction</td>
<td>EPC Contract, Waste Management Plan and EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
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<td>50% of the Flu gas shall be desulfurized before being released into atmosphere (confirming to national emission standards)</td>
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<td></td>
<td>NOx emissions can cause acid rain, ground level Ozone and photochemical smog and several other complex interactions causing</td>
<td>Low NOx burners to be installed for reducing maximum NOx generation and bring emissions to nationally acceptable limits</td>
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<tr>
<td>deleterious effects on environment</td>
<td>An Electrostatic Precipitator (ESP) and Bag House filters shall be installed for collection of all of the Fly Ash generated.</td>
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<tr>
<td>Ash contains glassy material as well as trace metals that are harmful for all living organisms.</td>
<td>A silo and an ash pond is to be constructed for bottom and fly ash respectively.</td>
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<td></td>
<td>Bottom ash from boiler furnace, economizer hopper and mill reject hoppers shall be collected via a conveyor belt and sent to ash silo.</td>
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<td></td>
<td>Sprinklers shall be installed at the ash pond and silos to suppress entrainment of ash in air</td>
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<td>Coal dust can cause various lung diseases besides causing asset damage and substantive economic cost of clean-up.</td>
<td>Screw jacks shall be used to unload coal from vessel to conveyor belt to minimize dust generation in the first place</td>
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<td></td>
<td>Coal will be transferred from the jetty to storage yard via a covered conveyor belt</td>
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<td></td>
<td>Fine sprinklers shall be placed in the conveyor as well as in the coal yard to settle any entrained coal dust particles that will use recycled waste water for this purpose</td>
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<td></td>
<td>Coal yard will have its own dust suppression sprinklers that will keep the moisture content of top layer coal to an extent at which minimum dust emissions will occur</td>
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<td>A windbreak shall be installed around the perimeter of the coal</td>
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Residual Impacts
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<tr>
<td><strong>Water Quality</strong></td>
<td>Waste water can adversely impact the marine ecosystem by several means which can have short term as well as long term effects</td>
<td>Yard 0.5 m higher than highest coal pile to be made to prevent wind erosion that causes fugitive dust emission</td>
<td>EPC Contractor / Sub-Contractor, DGKPG HSE Manager</td>
<td>Pre-Construction, During Construction and During Operation</td>
<td>EPC Contract and EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td><strong>Landscape and Visual Impacts</strong></td>
<td>Loss of green cover due to excavation activities and disturbance of visual amenity in construction areas</td>
<td>The work area shall be limited to the minimum required for construction purposes</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
<td>Preventive measures are very important for minimization of this impact. However, in case these could not be avoided, the adoption of an effective rehabilitation plan will ensure that the residual impacts will be of low significance.</td>
</tr>
<tr>
<td><strong>Biological Environment - Flora</strong></td>
<td>Potential loss of trees and green cover (e.g. where roads will be paved, impact from poor waste management affecting existing vegetation and dependent flora etc.)</td>
<td>A procedure shall be prepared to manage vegetation removal, clearance and reuse</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
<td>Similar impacts as in the previous case; If these measures could not be adopted, the adoption of an effective rehabilitation plan will ensure that the residual impacts will be of low significance.</td>
</tr>
</tbody>
</table>
### Table 7.4 - DGKPG Environmental Impact Mitigation Plan

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<tr>
<td><strong>Chemical-Welding Fumes</strong></td>
<td>Workers' increased chances of getting pneumonia, occupational asthma and lung cancer among other ailments</td>
<td>Evaluation of both metals and the welding rods</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>During Construction</td>
<td>HSE Plan</td>
<td>No residual impacts if all measures taken appropriately.</td>
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<tr>
<td></td>
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<td>Adequate ventilation for welders</td>
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<tr>
<td></td>
<td></td>
<td>Develop a welding procedure</td>
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<td></td>
<td></td>
<td>Use of active chemical respirators where necessary (e.g. when welding on galvanized metals)</td>
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<tr>
<td><strong>Air Quality – Gaseous Emissions</strong></td>
<td>Gaseous releases in construction area and nearby roads affects people downwind and green cover within the project area besides long-term environmental impacts</td>
<td>Relocation of all stationary combustion equipment downwind and away from all public receptors and workers</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>During Construction</td>
<td>Traffic management and mobilization plan</td>
<td>Due to the rapid dispersive nature and prevailing weather conditions, the residual impacts will be of low significance</td>
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<td>Exhaust of all stationary equipment (e.g. generators) to be positioned high enough so as to assure proper emission dispersion</td>
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<td></td>
<td></td>
<td>Routine inspection and scheduled maintenance of combustion emission sources according to manufacturer's service manual</td>
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<td></td>
<td>Turning of all engines of machinery and equipment when idling</td>
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<tr>
<td><strong>Soil and Geology – relief</strong></td>
<td>Contamination from hydraulic oil, waste water and similar spillages; Soil</td>
<td>Whenever possible, rock soil shall be used as fill and aggregate for concrete.</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>During Construction</td>
<td>Spill management plan, Hazardous waste management</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
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<tr>
<td>contamination and erosion</td>
<td>erosion and siltation;</td>
<td>The time an area is left disturbed or exposed shall be minimized.</td>
<td></td>
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<td>plan, EMMP</td>
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<td></td>
<td></td>
<td>Hazardous materials shall be collected separately and disposed as per MSDS for each chemical and as per local regulations for waste disposal.</td>
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<td>On completion of works, all temporary structures, surplus materials and wastes shall be completely removed.</td>
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<td></td>
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<td>All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).</td>
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<td></td>
<td>Fuel tanks at construction and storage sites shall be provided with bunding (a minimum of 110%).</td>
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<td>All fertile top soils enriched with nutrients shall be stripped to a depth of 15 cm. and preserved in form of stockpiles not exceeding 2m height; soil shall be prevented from erosion and anaerobic decomposition and shall be used for rehabilitation of proposed plantation sites.</td>
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<tr>
<td>Groundwater Contamination</td>
<td>Indirect groundwater contamination due to accidental leaks from construction machinery, hydro testing waters, wastewater as well as other</td>
<td>Construct temporary cut-off drains across excavated area</td>
<td>EPC Contractor/Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
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<td>Check dams shall be constructed along catch drains in order to slow the flow and capture sediments</td>
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<tr>
<td>uncontrolled wastes</td>
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<td>Length of all runoff slopes shall be reduced.</td>
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<td>If dewatering practice is required, the generated groundwater shall be discharged into clean drainage channels.</td>
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<td></td>
<td></td>
<td>Fuel tanks and any liquid chemical stored at construction and storage sites shall be provided with bunding (a minimum of 110%).</td>
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<td></td>
<td>Implement the effluent management plan for effluents generated by any construction activity.</td>
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<tr>
<td></td>
<td></td>
<td>Hazardous materials shall be collected separately and disposed as per MSDS for each chemical and as per local regulations for waste disposal</td>
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<tr>
<td>Vibration</td>
<td>Physical hazard for workers using jack hammers and similar equipment</td>
<td>Adequate work scheduling to prevent long-term effects</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>HSE Plan</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
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<tr>
<td></td>
<td></td>
<td>Proper procedures to use equipment</td>
<td></td>
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<tr>
<td>Archaeology and Cultural Heritage</td>
<td>No foreseen possible impact on any archaeological and cultural impact as per studies of EIA baseline.</td>
<td>A procedure to be established and in place in case an archaeological finding is made during excavation works</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Marine Ecology and Seawater Quality</td>
<td>Damage to marine ecology and seawater quality may occur in case of release of discharge of land based effluents (drilling muds, oil spills, etc.)</td>
<td>Provision of booms in case of mud fluid or oil spill to sea</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Biological - Fauna</td>
<td>Beautiful birds in the area may be poached other than domestic animals of the</td>
<td>Contractual obligation to be kept to avoid illegal poaching and strict action to be taken in case of any</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EPC Contract</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
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<tr>
<td>nearby community</td>
<td>Incident</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EPC Contract</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
<td></td>
</tr>
<tr>
<td>Ponding of water</td>
<td>Mosquito breeding grounds may develop</td>
<td>Ponding of water should be prevented in any waste container by covering</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EPC Contract</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Construction camp facilities</td>
<td>Prevent pressure on local services</td>
<td>Adequate housing for all workers, Safe and reliable water supply, Hygienic sanitary facilities and sewerage treatment facilities, Storm water drainage facility, Proper fuel supply for domestic purpose to prevent any illegal wood consumption</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EPC Contract</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td>Solid wastes generated by the onsite camps / housing to be properly disposed</td>
<td>Ensure proper collection and disposal of solid wastes in the approved disposal sites, Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector, Establish waste collection, transportation and disposal systems, Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site, Ensure that all on-site wastes are suitably contained and prevented from escaping into neighbouring fields, properties, and waterways</td>
<td>EPC Contractor / Sub-Contractor</td>
<td>During Construction</td>
<td>EPC Contract</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
</tbody>
</table>
Table 7.4 - DGKPG Environmental Impact Mitigation Plan

<table>
<thead>
<tr>
<th>Environmental Aspect</th>
<th>Environmental Impacts / Sensitive Receptors</th>
<th>Proposed Mitigation Measures</th>
<th>Responsibility</th>
<th>Scheduling</th>
<th>Implementation Tool</th>
<th>Residual Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Hazards</td>
<td>Food Poisoning due to unsanitary conditions, poor controls on food, possible transmission of disease from food handlers</td>
<td>Procedures and systems in place to do regular checks on catering</td>
<td>EPC Contractor / Sub-Contractor and DGKPG HSE Manager</td>
<td>During Construction and operation</td>
<td>HSE Plan</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Periodic audits of catering facility by external party</td>
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<tr>
<td></td>
<td></td>
<td>Procedures and systems in place to ensure up to date Material Safety Data Sheets (MSDS) are in place</td>
<td>EPC Contractor / Sub-Contractor and DGKPG HSE Manager</td>
<td>During Construction and operation</td>
<td>HSE Plan</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequate placement and labelling of all hazardous substances</td>
<td></td>
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<td></td>
<td></td>
<td>First aid kits and showers as necessary for the type and safety measure of chemicals to be available nearby at all times</td>
<td>EPC Contractor / Sub-Contractor and DGKPG HSE Manager</td>
<td>During Construction and operation</td>
<td>HSE Plan</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementation of hazardous waste management plan</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Use of low noise generating machinery such as equipment with mufflers, engine covers etc.</td>
<td>EPC Contractor/ Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td>No residual effects on humans if preventive measures undertaken properly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and preferable use electric powered equipment instead of diesel powered and hydraulic tools instead of pneumatic whenever possible</td>
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<tr>
<td></td>
<td></td>
<td>Regular and proper maintenance of all noise generating machinery and vehicles according to the service manual be certified personnel</td>
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<tr>
<td></td>
<td></td>
<td>Providing PPE and appropriate</td>
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</tbody>
</table>
### Table 7.4 - DGKPG Environmental Impact Mitigation Plan

<table>
<thead>
<tr>
<th>Environmental Aspect</th>
<th>Environmental Impacts / Sensitive Receptors</th>
<th>Proposed Mitigation Measures</th>
<th>Responsibility</th>
<th>Scheduling</th>
<th>Implementation Tool</th>
<th>Residual Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical – Heat stress</strong></td>
<td>Exhaustion due to work in open areas during excavation, piling and other earth works</td>
<td>Training for proper use of such PPE to workers</td>
<td>EPC Contractor/Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td>No residual effects on humans if preventive measures undertaken properly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating noise producing equipment only during day time</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Regular rotation of staff exposed to higher noise</td>
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<tr>
<td></td>
<td></td>
<td>Adequate supply of water and replacement fluids to all workers and supervisors</td>
<td>EPC Contractor/Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heat stress abatement procedure</td>
<td>EPC Contractor/Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proper work scheduling during hot periods</td>
<td>EPC Contractor/Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training and awareness courses for all supervision staff and workers including first aid</td>
<td>EPC Contractor/Sub-Contractor + DGKPG HSE Manager</td>
<td>During Construction and Operation</td>
<td>HSE Plan</td>
<td></td>
</tr>
<tr>
<td><strong>Air Quality – Power plant emissions</strong></td>
<td>The air quality of an air shed can deteriorate rapidly if control measures fail or stop performing well</td>
<td>All Pollution Control equipment should be regularly inspected and maintained</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP, OEM Instructions</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If all redundant pollution control systems fail, plant should be immediately shut down until problem is resolved</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP, OEM Instructions</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All air emissions including Coal dust should regularly be monitored and if any parameter exceeds</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP, OEM Instructions</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top layer of Coal piles should be kept moist</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP, OEM Instructions</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td><strong>Fire</strong></td>
<td>Besides incurring huge economic losses and environmental damage, fires can be fatal</td>
<td>Keep the implemented systems maintained and up-to-date</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regular evacuation drills conducted for all staff in-case of a huge fire</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trainings provided to staff to use the right fire extinguisher</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coal fires as a result of self-</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Environmental Aspect</td>
<td>Environmental Impacts / Sensitive Receptors</td>
<td>Proposed Mitigation Measures</td>
<td>Responsibility</td>
<td>Scheduling</td>
<td>Implementation Tool</td>
<td>Residual Impacts</td>
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</tr>
<tr>
<td>Spills</td>
<td>Heating start very gradually (usually after several hours of steaming) The coal piles should be kept compacted to prevent oxidation and subsequent heating</td>
<td>Steaming coal should be removed from the pile and spread in thin layer until it cools down. Coal pile should never be inundated as it will increase the chances of fire due to heat of watering</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>Any spill has the potential to harm the environment besides posing a direct hazard to health and safety of humans</td>
<td>A complete spill management plan has been provided which may be adopted after minor amendments</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
<tr>
<td>Solid Waste</td>
<td>Solid wastes if improperly disposed is nuisance in itself besides imposing several new hazards</td>
<td>A generic waste management plan has been provided which may be followed after some amendments.</td>
<td>DGKPG HSE Manager</td>
<td>During Operation</td>
<td>EMMP</td>
<td>With the adoption of the given measures, the residual impacts will be minimum</td>
</tr>
</tbody>
</table>
7.10 Monitoring Plan

Environmental monitoring is the second part of an EMMP and it is the mechanism through which the effectiveness of the EMMP is gauged. The feedback provided by environmental monitoring is instrumental in identifying any problems and planning corrective actions.

7.10.1 Objectives Of Monitoring Plan

The main objectives of environmental monitoring during the operation of DGKPG Power Plant are:

- To provide a mechanism to determine whether the management is carrying out the project in conformity with the EMMP.
- To identify areas where the impacts of the projects are exceeding the criteria of significance and, therefore, require corrective actions.
- To document the actual project impacts on physical, biological, and socioeconomic receptors, quantitatively where possible, in order to design better and more effective mitigation measures.
- To provide data for preparing the monitoring report to be submitted to the Sindh EPA in accordance with the regulatory requirement.

Monitoring of activities during the operation of Power Plant will be necessary to assess the impacts of these activities on the environment. For this purpose, DGKPG will engage an Independent Monitoring Consultant (IMC) for implementing a monitoring program to monitor the:

- Air Emissions
- Effluent Quality
- Solid waste management
- Environmental performance of the facility

IMC will follow the monitoring frequency of selected parameters as per the monitoring plan given in the table below. It will record all non-conformities observed and report them along with actions to Project Management for corrective action and send final report to SEPA.

DGKPG HSE Manager shall take note of the recommendations relating to issues identified in the monitoring report. Similarly, the EHS department will consider the issues identified by IMC for the operations phase monitoring. Table below presents a proposed monitoring plan to monitor different environmental aspects during the operational phase of the Power Plant. This monitoring plan can be improved by the EHS Manager of DGKPG if found necessary to improve its effectiveness.

7.10.2 Performance Indicators

The environmental parameters that may be qualitatively and quantitatively measured and compared are selected as ‘performance indicators’ and recommended for monitoring during project stages. These monitoring indicators will be monitored to ensure compliance with the national or other applicable standards and comparison with the baseline conditions established during design stage. The list of indicators and their applicable standards to ensure compliance are given below.

**Construction Phase**

- Ambient air quality (PM$_{10}$, PM$_{2.5}$, SO$_2$, & NO$_2$) – Sindh Environmental Quality Standards, 2014
- Noise levels – Sindh Environmental Quality Standards, 2014

**Operation Phase**

- Stack emissions (SO$_2$, NOx, PM$_{10}$) – NEQS. Continuous emission monitoring on new boilers.
  Monthly testing on other boilers.
- Ambient air quality (PM$_{10}$, PM$_{2.5}$, SO$_2$, and NO$_2$) – Sindh National Environmental Quality Standards, (SEQS) 2014
- Noise levels – National Environmental Quality Standards, NEQS 2010
- Wastewater quality – National Environmental Quality Standards, NEQS 2000
- Coal consumption per unit of power generated (Kg/unit) – Comparison with design data
### Table 7.5 - Environmental Monitoring Plan

<table>
<thead>
<tr>
<th>Monitoring Aspect</th>
<th>Location</th>
<th>Parameters to Monitor</th>
<th>Monitoring frequency</th>
<th>Standards</th>
<th>Responsibility</th>
<th>Supervision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stack Emissions</td>
<td>At the stack</td>
<td>SO$_x$, NO$_x$, CO and Particulates.</td>
<td>Monthly</td>
<td>SEQS</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy Metals</td>
<td>Every 2 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Air</td>
<td>All operational areas including the residential area in the power plant vicinity.</td>
<td>PM10, PM2.5 and TSP for 24-hour filter based low volume sampler, Ambient 24-hour CO, SO$_x$, NO$_x$ and Lead using active sampler.</td>
<td>Monthly</td>
<td>SEQS</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Wastewater</td>
<td>All effluent discharge points</td>
<td>Under Normal conditions: Effluent flow, Temperature, pH, TSS, Oil and Grease</td>
<td>Monthly</td>
<td>SEQS</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Under Upset and start-up Conditions: Effluent flow, Temperature, pH, TSS (No. of hours of upset condition operation to be mentioned in the monthly report)</td>
<td>Hourly Basis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid Waste</td>
<td>Project Area</td>
<td>Solid waste quality, quantity and disposal methods / locations Visual checks to assess the situation.</td>
<td>Quarterly</td>
<td>N.A</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Fire &amp; Safety</td>
<td>All operational areas</td>
<td>Fire hazards &amp; safety protocols</td>
<td>Continuous</td>
<td>NFPA</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Vehicles and equipment</td>
<td>Anywhere inside DGKPG premises</td>
<td>Random speed checks</td>
<td>At different locations and different times</td>
<td>Traffic management plan</td>
<td>DGKPG Traffic Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td></td>
<td>Transport office or workshop</td>
<td>Records of maintenance</td>
<td>As per manufacturer’s instructions</td>
<td>Manufacturer’s recommendations</td>
<td>DGKPG Equipment Maintenance Department</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td></td>
<td>Within 100 m of equipment</td>
<td>Baseline noise emissions of new equipment</td>
<td>On commissioning of all new equipment</td>
<td>SEQS</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Noise</td>
<td>All operational areas</td>
<td>Noise intensity measurement dB(A)</td>
<td>Monthly</td>
<td>OSHA</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Hazardous spill</td>
<td>All operational areas</td>
<td>Spill on Land</td>
<td>Continuous</td>
<td>Spill Management / SOPs</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Traffic</td>
<td>Entry exit routes, road-</td>
<td>Traffic Management Plan</td>
<td>Continuous</td>
<td>Traffic Management Plan</td>
<td>DGKPG HSE</td>
<td>Independent</td>
</tr>
<tr>
<td>Monitoring Aspect</td>
<td>Location</td>
<td>Parameters to Monitor</td>
<td>Monitoring frequency</td>
<td>Standards</td>
<td>Responsibility</td>
<td>Supervision</td>
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</tr>
<tr>
<td>management</td>
<td>loading terminal area</td>
<td></td>
<td></td>
<td></td>
<td>Manager</td>
<td>Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Health and Safety of Workers</td>
<td>Operational areas</td>
<td>Accidents, PPEs, Diseases.</td>
<td>On quarterly basis</td>
<td>Health and safety procedures developed by HSE department</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Accidents</td>
<td>All areas</td>
<td>Inspection and record keeping</td>
<td>On quarterly basis</td>
<td>Health and safety procedures developed by HSE department, SOPs</td>
<td>DGKPG HSE Manager</td>
<td>Independent Monitoring Consultant (IMC)</td>
</tr>
<tr>
<td>Compliance monitoring</td>
<td>All areas</td>
<td>EIA Commitments, Mitigation Measures, Conditions of Environmental Approval, SOPs</td>
<td>Monthly</td>
<td>Environmental Management &amp; Monitoring Plan (EMMP)</td>
<td>Independent Monitoring Consultant (IMC)</td>
<td>Sindh EPA</td>
</tr>
</tbody>
</table>
7.11 Construction Management Plan (Draft)

The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the Table 7.6. The CMP will be submitted to the DGKPG for approval. The CMP will clearly identify all areas that will be utilized during construction for various purposes. For example, on a plot plan of the construction site the following will be shown:

- Areas used for camp
- Storage areas for raw material and equipment
- Waste yard
- Location of any potentially hazardous material such as oil
- Parking area
- Loading and unloading of material
- Septic tanks

<table>
<thead>
<tr>
<th>Table 7.6: Construction Management Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
</tr>
<tr>
<td>--------</td>
</tr>
</tbody>
</table>
| Vegetation clearance | Minimize vegetation clearance and felling of trees | Removal of trees should be restricted to the development footprint.  
Construction activities shall minimize the loss or disturbance of vegetation  
Use clear areas to avoid felling of trees  
A procedure shall be prepared to manage vegetation removal, clearance and reuse  
Inform the plant management before clearing trees  
Cleared areas will be revegetated |
| Poaching | Avoid illegal Poaching | Contractual obligation to avoid illegal poaching  
Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching |
| Discharge From construction sites | Minimize surface and ground water contamination  
Reduce contaminant and sediment load discharged into water bodies affecting humans and ecology | Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials  
Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot  
Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean. |
| Soil Erosion and siltation | Avoid sediment and contaminant loading of surface water bodies and agricultural lands. | Minimize the length of time an area is left disturbed or exposed.  
Reduce length of slope of runoff  
Construct temporary cutoff drains across excavated area  
Setup check dams along catch drains in order to slow flow and capture sediment  
Water the material stockpiles, access roads and |
<table>
<thead>
<tr>
<th>Excavation, earth works, and construction yards</th>
<th>Proper drainage of rainwater and wastewater to avoid water and soil contamination.</th>
<th>Prepare a program for prevent/avoid standing waters, which Construction Supervision Contractor (CSC) will verify in advance and confirm during implementation. Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponding of Water</td>
<td>Prevent mosquito Breeding</td>
<td>Do not allow ponding of water especially near the waste storage areas and construction camps. Discard all the storage containers that are capable of storing of water, after use or store them in inverted position. Reinstate relief and landscape.</td>
</tr>
<tr>
<td>Storage of hazardous and toxic chemicals</td>
<td>Prevent spillage of hazardous and toxic chemicals</td>
<td>Implement waste management plans. Construct appropriate spill containment facilities for all fuel storage areas. Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results.</td>
</tr>
<tr>
<td>Land clearing</td>
<td>Preserve fertile top soils enriched with nutrients required for plant growth or agricultural development.</td>
<td>Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m and with a slope of 1:2. Spread the topsoil to maintain the physio–chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions will include: Anaerobic conditions – turning the stockpile or creating ventilation holes through the stockpile; Erosion – temporary protective silt fencing will be erected.</td>
</tr>
<tr>
<td>Construction vehicular traffic</td>
<td>Control vehicle exhaust emissions and combustion of fuels.</td>
<td>Ensure the topography of the final surface of all raised lands are conducive to enhance natural draining of rainwater/flood water; Reinstate the natural landscape of the ancillary construction sites after completion of works. Use vehicles with appropriate exhaust systems. Establish and enforce vehicle speed limits to minimize dust generation. Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site. Level loads of haul trucks travelling to and from the site to avoid spillage. Use of defined haulage routes and reduce vehicle speed where required. Regular maintenance of all vehicles.</td>
</tr>
<tr>
<td>Minimize nuisance due to noise</td>
<td>Maintain all vehicles in good working order. Make sure all drivers comply with the traffic codes concerning maximum speed limit.</td>
<td></td>
</tr>
<tr>
<td>Avoid impact on existing traffic conditions</td>
<td>Prepare and submit a traffic management plan. Restrict the transport of oversize loads. Operate transport vehicles, if possible, in non-peak periods to minimize traffic disruptions.</td>
<td></td>
</tr>
<tr>
<td>Prevent accidents and spillage of fuels and chemicals</td>
<td>Restrict the transport of oversize loads. Operate transport vehicles, if possible, in non-peak periods to minimize traffic disruptions. Design and implement safety measures and an emergency response plan to contain damages from accidental spills. Designate special routes for hazardous materials transport.</td>
<td></td>
</tr>
</tbody>
</table>

### Construction machinery

#### Prevent impact on air quality from emissions
- Use machinery with appropriate exhaust systems.
- Regular maintenance of all construction machinery.
- Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages.

### Construction Activities

#### Minimize dust generation
- Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust.
- Increase the watering frequency during periods of high risk (e.g. high winds).
- Stored materials such as gravel and sand should be covered and confined.
- Locate stockpiles away from sensitive receptors.

| Reduce impact of noise and vibration on the surrounding | Appropriately site all noise generating activities to avoid noise pollution to local residents. Ensure all equipment is in good repair and operated in correct manner. Install high efficiency mufflers to construction equipment. Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment. |
| Avoid driving hazard where construction interferes with pre-existing roads. | Notify adjacent landholders or residents prior to noise events during night hours. Install temporary noise control barriers where appropriate. Avoid working during 21:00 to 06:00 within 500m from residences. |

#### Minimizing impact on water quality
- Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage. Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse.
| Siting and location of construction camps | Minimize impact from construction footprint | • Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view. |
| Construction Camp Facilities | Minimize pressure on local services | • Adequate housing for all workers  
• Safe and reliable water supply.  
• Hygienic sanitary facilities and sewerage system.  
• Treatment facilities for sewerage of toilet and domestic wastes  
• Storm water drainage facilities.  
• In–house community entertainment facilities. |
| Disposal of waste | Minimize impacts on the environment | • Ensure proper collection and disposal of solid wastes in the approved disposal sites  
• Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector.  
• Establish waste collection, transportation and disposal systems  
• Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site.  
• Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers. |
| Fuel supplies for cooking purposes | Discourage illegal fuel wood consumption | • Provide fuel to the construction camps for domestic purpose  
• Conduct awareness campaigns to educate workers on preserving the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection. |
| Site Restoration | Restoration of the construction camps to original condition | • To the extent possible, restore the camp site and all other areas temporarily used for construction to their conditions that existed prior to commencement of construction work. |
| Construction activities near religious and cultural sites | Avoid disturbance to cultural and religious sites | • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered.  
• It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management.  
• Maintain appropriate behavior with all construction workers especially women and elderly people  
• Resolve cultural issues in consultation with local leaders and supervision consultants |
| Best Practices | Minimize health and safety risks | • Implement suitable safety standards,  
• Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas,  
• Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full–face eye
7.12 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.

7.12.1 Framework for Grievance Redress Mechanism

The Owners will develop a stakeholder grievance redress mechanism.

7.12.2 Guidelines for Public Consultation, 1997

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 promote a stable relationship between the project management and the community.

7.12.3 Outline of Mechanism for Grievance Redress

The Owners will have an effective mechanism to ensure timely and effective handling of grievances related to the power plant, including those related to transportation of coal. It may include:

- A Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints; and,
- A Grievance Redress Committee (GRC), responsible to oversee the functioning of the PCU as well as the final non-judicial authority on resolving grievances that cannot be resolved by PCU;
- Grievance Focal Points (GFPs), which will be educated people from the fishing community that can be approached by the community members for their grievances against the Project. The GFPs will be provided training by the Owners in facilitating grievance redress.
7.13 Environmentally Sound & Safe Working Procedures

- Contractors, sub-contractors and contract workers will be made aware of Environmental Aspects as well as Emergency Response Plan prior to commencing the work. Prior to leaving the site contractors, sub-contractors and contract workers will ensure that their work area is in safe position. On emergency call they will report in assembly area.

- Written procedures or standards will be prepared for all activities, where the absence of such procedures and standards could result in not following HSE policy, the law or the contract.

- Safe Working Procedures will be based on the following four aspects of job safety:
  - Safe Place: the work site will be designed or controls put in place to ensure that the working environment provides no significant risk to personnel, property or the environment.
  - Safe Equipment: all equipment for any job, including tools, machinery and protective equipment will be specified or designed to ensure that it poses no significant risk to personnel, property or the environment. All equipment will comply with legislative standards of conformity and test.
  - Safe Procedure: Procedures will be designed for all aspects of the job to facilitate safe use of equipment at the work site to complete tasks with no significant risk to personnel, property or the environment. Design of a procedure will be based on step-by-step analysis of the tasks involved (Job Safety Analysis), identification of associated hazards and elimination of control of those hazards. Procedures should allow for work in ideal conditions as well as under aggravating conditions e.g. adverse weather.
  - Trained Personnel: Suitable job-specific, safety skills and supervision training will be provided to personnel involved in construction and operation activities so that they are able to use the procedure and equipment at the worksite with no significant risk to personnel, property or the environment.

- Safe Working Procedures will be available to contractors and sub-contractors, who will adopt the relevant labour laws of the country.

7.14 Waste Management Plan

Although the waste management may be contracted to a third party, a generic waste management plan is given below for DGKPG which may be followed appropriately. Waste generation is inevitable at every step of a project and proper mechanisms need to be in place in order to deal with every possible kind of waste that may be generated.

<table>
<thead>
<tr>
<th>#</th>
<th>Material Waste</th>
<th>Associated Risks</th>
<th>Recommended Procedure</th>
<th>Final Disposal Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rocks, cement, concrete</td>
<td>Non-hazardous bulk waste</td>
<td>Ensure safe storage till disposal</td>
<td>Landfill or reuse as for filling</td>
</tr>
<tr>
<td>2</td>
<td>Oil</td>
<td>May cause contamination of soil or waterways</td>
<td>Ensure disposal is carried out by certified recycling contractors</td>
<td>Recycling Contractors</td>
</tr>
<tr>
<td>3</td>
<td>Wood, Cotton, Plastic, Waste and Packing Materials</td>
<td>Burning of wood, paper, plastic and other materials can cause air pollution and littering due to improper disposal</td>
<td>Dispose all non–recyclable plastic wastes and other non– recyclable materials at proper waste disposal site</td>
<td>Recycling/Landfill</td>
</tr>
</tbody>
</table>
### 4. Electronics

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some electronics equipment may contain toxic and hazardous materials and pose a health risk if opened or dismantled.</td>
<td>Ensure contractor disposes equipment properly and equipment is opened only under guidance of qualified professional.</td>
</tr>
</tbody>
</table>

### 5. Steel, Iron, Copper, Brass and similar recyclable metals

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment and parts may be contaminated with oil or other liquids. This may pose hazards during recycling.</td>
<td>Separate contaminated parts and ensure disposal contractor cleans and removes contaminations before recycling.</td>
</tr>
</tbody>
</table>

### 6. Asbestos

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes irreversible lung damage such as asbestosis and lung cancer. A known carcinogen.</td>
<td>To be handled according to asbestos management plan.</td>
</tr>
</tbody>
</table>

### 7. Other Materials

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some waste materials may contain hazardous materials (such as mercury and lead) which can pose health risks if not handled or disposed of properly.</td>
<td>All hazardous substances such as Lead and Mercury should be identified and separated. It should be ensured that waste contractor disposes hazardous material in accordance with accepted methods.</td>
</tr>
</tbody>
</table>

### 8. Food waste

<table>
<thead>
<tr>
<th>Description</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can become hazardous if comes in contact with any hazardous waste such as infectious waste.</td>
<td>Should not be mixed with non-degradable waste and composted.</td>
</tr>
</tbody>
</table>

## 7.15 Spill Management

Liquid waste spills that are not appropriately managed have the potential to harm the environment. By taking certain actions, it can be ensured that the likelihood of spills occurring is reduced and that the effect of spill is minimized. To enable spills to be avoided and to help the clean-up process of any spill, the management staff of DGKPG 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 should be prepared for the operational phase of DGKPG Power Plant. The plan should 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 when a spill occurs (stop, contain, report, clean up and record)
- A map showing the locations of spill kits or other contingency measures

### 7.15.1 Avoiding Spills

By actively working to prevent spills, money and time can be saved by not letting resources go to waste. In addition, the environment is protected from contaminants that can potentially cause harm. All liquids must be stored in sealed containers that are free of leakage. All containers should be on sealed ground and in a covered area. Sharp parts must be kept away from liquid containers to avoid damage and leaks.
To prevent spills from having an effect on the plant site operations or the environment, bunding should be placed around contaminant storage areas. A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or a similar structure and is used to capture spilt liquid for safe and proper disposal.

### 7.15.2 Spill Kits

Spill kits are purpose built units that contain several items useful for cleaning up spills that could occur. Typical items are:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite)
- Absorbent pads, granules and/or pillows
- Booms for larger spills
- Mops, brooms and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner. Sufficient number of spill kits should be provided. Spill kits should be kept in designated areas that are easily accessible to all staff. Staff members are to be trained in using the spill kit correctly.

After cleaning up a spill, the materials used to clean up must be disposed of correctly. Depending on the spill material, the used material may be disposed in the hazardous waste facility or the landfill site.

### 7.15.3 Responding To Spills

- If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.
- To stop the spill from expanding, absorbent materials and liquid barriers should be placed around the spill and worked from the outside to soak up the spill. It is vital that spilt liquid is not allowed to reach storm water drains, sewer drains, natural waterways or soil.
- For large scale spills that involve hazardous materials, authorities may have to be alerted.
- Using the information from Material Safety Data Sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills should be cleaned up promptly.
- By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future.

### 7.16 Afforestation And Green Belt Development

Implementation of afforestation program is of paramount importance for any industrial development. In addition to augmenting green cover, it also checks soil erosion, makes the climate more conducive, restores water balance and makes the ecosystem more complex and functionally more stable. The green belt helps to capture the fugitive emissions and to attenuate the noise generated in the plant, apart from improving the aesthetics of the plant site. A 100 meter wide green belt has been planned all around the plant area. In addition, extensive afforestation activities shall also be undertaken within the project area for developing buffer zones. The main objective of the green belt is to provide a barrier between the plant and the surrounding areas. In addition, it is also aimed at the following:

- To reduce air pollution.
- To attenuate noise generated by various machines.
- To attenuate the effect of accidental release of toxic gases
- To reduce the effect of fire and explosion
- To improve the general environment and aesthetics of the area
- To provide suitable habitat for fauna
- To control soil erosion
- To obscure the proposed facilities from general view.

## 7.17 Emergency Response Plan

Emergency Response operations will be managed and monitored by the Emergency Response Team headed by the EHS Manager of DGKPG. The Response team will ensure that the operations are carried out in minimal time avoiding any fire, safety and security hazard and affecting the environment. The team will ensure:

- Evaluation of the situation to identify the most important steps, which must be taken first and can have an important bearing on the overall action to be taken.
- Deployment of required manpower and equipment.
- Organizing required logistical support so that there are no bottlenecks hampering the operation.
- See to it that injured persons are cared for.
- Respond to calls for ambulances for shifting the injured persons to neighbourhood hospitals/healthcare units.
- Isolate all sources of ignition and environmental hazards.
- Evacuation of people who are in immediate or imminent danger.
- EHS Manager and/or in-charge of the Campsite will exert positive leadership and give instructions calmly, firmly, explicitly, & courteously and obtain help of law enforcement agencies, if necessary.
- Block roads if necessary for safety of operations.
- Arrange for emergency notifications of water shed areas, public utilities, and the like to safeguard the public and property.
- Surveillance and monitoring operations.
- Retrieval and disposal of earth/debris and resources affected by the hazard at approximate site.
- Termination of clean-up operation.

## 7.18 Disaster Management Plan

This section contains the generic Disaster Management Plan (DMP) as required under item the laws and regulations of Pakistan. At the time of commissioning of the project, a detailed and site specific Disaster Management Plan shall be prepared and submitted to concerned stakeholders for information approval and the same shall be implemented at site.

### 7.18.1 Definition Of Disaster/Emergency

The word 'disaster' is synonymous with 'emergency'. An emergency occurring in the proposed Coal Power Plant is one that may affect several sections within it and/or may cause serious injuries, loss of lives, extensive damage to environment or property or serious disruption outside the plant.

It will require the best use of internal resources and the use of outside resources to handle it effectively. It may happen usually as the result of a malfunction of the normal operating procedures. It may also be precipitated by the intervention of an outside force such as a cyclone, flood, or deliberate acts of arson or sabotage.

### 7.18.2 Objectives Of Disaster Management Plan

An on-site disaster is caused by an accident that takes place in hazardous installations and the effects are confined to the factory premises involving the people working in the factory. The On-site Disaster
Management Plan dealing with eventualities, is the responsibility of the occupier, who is to prepare/implement necessary measures to contain the severity of cause of disaster to the bare minimum.

The obligation of an occupier of hazardous chemicals to prepare an Emergency Plan (referred as Disaster Management Plan in this report) are stipulated in Hazardous Substances Rules, 2014. Apart from the provisions in the Hazardous Substances Rules, the Factories Act, 1934 also requires that every occupier is to draw up an On-site Disaster Management Plan with detailed disaster control measures for the factory premises. The general public living in the vicinity are also to be informed and educated about safety measures and, actions required to be taken in the event of an accident.

The preparation of an On-site Disaster Management Plan and furnishing relevant information to the National Disaster Management Authority for the preparation of an Off-site Disaster Management Plan are statutory responsibilities of the occupier of every industry and other units handling hazardous substances.

The plan is developed to make best possible use of resources at its command and/or outside agencies for the following purposes.

- Prevention, Mitigation & Preparedness (Pre phase)
- Response, Rehabilitation & Recovery (Post phase)
- Safe guard others by evacuating them to safer places;
- Rescue of victims and treating them suitably to effect speedy recovery at hospital;
- Identify the personnel affected/dead;
- Inform relatives of those deceased/affected;
- Providing relevant records/data needed as evidence for subsequent enquiry;
- Rehabilitation of the affected persons;

### 7.18.3 Classification Of Disaster

A disaster occurring in the plant may affect/cause:

- several sections within it
- serious injuries/loss of lives,
- Extensive damage to property
- Serious disruption outside the works area
- It requires the best use of internal resources as well as outside resources to handle it effectively.

**On-Site Emergency**

An accident which takes place in an industry handling hazardous materials and its effects are confined to the factory premises involving only the people working in the factory.

**Off-Site Emergency**

If an accident takes place in an industry handling hazardous materials and its effects are felt outside the factory premises, the situation thus generated is called an Off-Site Emergency.

### 7.18.4 Possible Disasters In Thermal Power Plant

The following is a list of possible disasters in thermal power plant:

- Fast spreading fires
- Explosions
- Bursting of pipe lines/vessels
Uncontrolled release of toxic/corrosive/flammable liquids
Slow isolated fires
Breach of dams/ash dykes
Floods

**The Fire Hazards include**
- Coal handling plant
- Coal dust accumulation on
  - conveyor decks,
  - cable trays,
  - head & tail pulleys,
  - Crusher house and vibrating screen floors,
  - Bunker house,
- Belt sway, belt tension,
- Failure of belt joints,
- Snapping of belts,
- Partially damaged belt in operation,
- Smoldering fire in bunkers,
- Jamming of idlers and pulleys,
- Cables in cable galleries and on trays in all plant sections,
- Coal dust deposited on cable trays in mill area
- Fuel oil handling and oil tanks (HSD, HFO, Petrol)
- Transformer oil, turbine oil, control fluid, seal oil,
- Electrical system
- Heat path damaged insulation
- Dry grasses
- Accumulation of waste materials etc.

**The Explosion Hazard include**
- Hydrogen plant
- Transformer (oil cooled).
- Boiler (Coal/Oil fired).
- Coal dust in Mills and Boilers.

**Bursting Of Pipelines/Vessels**
- Water / Steam pipes due to high pressure/ temperature
- \( \text{H}_2 \) Gas lines and Acid lines.
- Acid/Alkali tanks
- \( \text{H}_2 \) Gas Cylinders
- Compressed air header.
- Compressed air receivers.
- \( \text{H}_2 \) Gas Holder.

**Release of Gases/Dust**
- Chlorine in water treatment plant
- Hydrogen in turbo generator area of main plant
- Pulverized coal dust from mills and associated piping
- Fly ash from chimneys and ash ponds, ESP hoppers and bottom ash system
- Coal dust in transfer points, CHP, Crusher & mill area.
- Flue gas from the ducts

**Release of Liquid**
- Acid and alkali tanks in water treatment plants
- Chlorine toners in WTPs
- Fuel oil tanks in fuel oil handling section
- Ash dyke
- Turbine oil and seal oil leakage

**Floods**
- Breach of balancing reservoir.
- Breach of ash dykes

### 7.18.5 Sections Prone To Emergencies
- Coal handling plant
- Main plant, including Boiler, ESP
- Water treatment plant, use of Chlorine gas
- Hydrogen generation plant
- Fuel Oil Handling areas

### 7.18.6 Components Of Disaster Management Plan
- Plant emergency organization
- Plant & area risk evaluation
- Notification procedures & communication systems
- Emergency equipments and facilities available
- Procedure for returning to normal operations
- Training and mock-drills for specialized services
- Regular tests of emergency organization and procedures
- Review of Plan and updates
- Emergency response procedures
- Detailed operating manual

**Risk Assessment & Vulnerability Mapping**
Consists of the following components:
- Maximum quantitative and qualitative assessment of hazards at any given point of time
- Location of hazardous operations and systems
- Properties of hazardous systems (MSDS)
- Location of isolation systems
- Special fire-fighting procedures
- Special handling requirements.

**Communication System**
Communication system envisaged at DGKPG-CPP includes:
- Public Address System in the main plant area.
- Telephone and Intercom, facilities at all desks and with officials.
• Intercom telephone connections with facilities of incoming P&T calls at residences to all officers and other important persons.
• P&T (STD) telephone, Fax, Telex facilities in the project.
• Cable TV facility for internal communication.
• Alarm systems
• Communication equipments
• Plant management, Local Officials, Response Agencies, Neighbouring industries, Neighbourhood population
• Names and telephone numbers of the designated officials and their alternates
• Designated persons for media contacts
• Procedures for notifying families of injured employees
• Central reporting office (ECC).

Emergency Equipment and Facilities
• Fire-fighting equipment
• Emergency medical supplies
• Toxic gas detectors
• Wind direction (wind sock)/speed indicators
• Self-contained breathing apparatus
• Protective clothing
• Other on-site equipments according to the local conditions
• Containment facilities around tanks/vessels
• Interfaces & lines of communication with off-site officials, neighbouring industries.

Training, Simulation and Mock Drills
• Knowledge of chemicals (properties, toxicity, etc.); and procedures for reporting emergencies
• Alarm systems and communication network
• Location of fire-fighting/first-aid equipment
• Use of fire-fighting/first-aid equipment
• Use of protective equipment (respirators, breathing apparatus, clothing, etc.)
• Decontamination procedure for protective clothing and equipment; demolition and repair

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Figure 7.2: Disaster Management Organization
- Evaluation procedures and rescue services
- Records of documented simulated emergencies which should be conducted frequently.

**Emergency Control Centre**

A permanent Emergency Control Center (ECC) shall be established, which will be manned by the Chief Incident Controller, the officials nominated as key personnel and Sr. Executives of outside Services called in for assistance. No other shall have access to the Control Center. ECC will be equipped with adequate means of communication (Intercoms, P&T Telephones, Telex and Fax, Wireless) to areas inside and outside the work together with relevant data of Personal Protective equipment and equipments to assist those manning the center and to enable them to plan accordingly. ECC will also contain the following data:

- Safety data pertaining to all hazardous materials likely to cause emergency.
- Procedure of major and special fire-fighting rescue operations and First Aid.
- Emergency call out list of persons drafted for, emergency control: key personnel from the, safety, First Aid, medical, P&IR Security and District Administrative Authorities.
- Emergency manuals.
- Blown up area maps.
- District phone directories
- Emergency lights.
- Wind direction and speed indicator.

**Evacuation and Assembly Points**

- In an emergency, it will almost certainly be necessary to evacuate personnel from affected areas.
- On evacuation, employees shall assemble at assembly points.
- Assembly point must be shown in Disaster Management Plan.

**Mutual Aid Scheme**

- An understanding for mutual aid between nearby industries to send assistance to each other in case of an emergency;
- Details of facilities offered by the mutual aid partners should be mentioned in the plan;
- Details of contact phone nos. of officers responsible for emergency action of mutual aid partners should be mentioned in the plan

**Mock Drill**

In order to evaluate the functioning and effectiveness of procedures laid in Disaster Management Plan, regular mock drills should be conducted. The Mock drills should be carried out step by step as stated below:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Step</strong></td>
<td>Test the effectiveness of communication system.</td>
</tr>
<tr>
<td><strong>Second Step</strong></td>
<td>Test the speed of mobilization of the Plant emergency teams.</td>
</tr>
<tr>
<td><strong>Third Step</strong></td>
<td>Test the effectiveness of search, rescue and treatment of casualties</td>
</tr>
<tr>
<td><strong>Fourth Step</strong></td>
<td>Test Emergency isolation and shut down and remedial measures taken on the system</td>
</tr>
<tr>
<td><strong>Fifth Step</strong></td>
<td>Conduct a full rehearsal of all the actions to be taken during an emergency.</td>
</tr>
</tbody>
</table>

Mock-drills will conducted to test the effectiveness of action plan/emergency preparedness. Periodicity of mock drill is at least once in every six months and the deficiencies found are to be recorded and corrective actions are to be taken immediately for effectiveness of the plan. Periodic mock drills will be conducted to test the following:
- Functioning of Emergency Control Center, very specifically availability of all facilities etc as mentioned in the Plan and its functional healthiness;
- To evaluate communication of the Disaster Plan to all segments of employees, to familiarize them about their responsibilities in case of any disaster including evaluation of behaviour of employees and others;
- To ensure that all facilities as required under the plan from within or from nearby industries / aid center under mutual assistance scheme or otherwise are available;
- To ensure that the necessities under material assistance scheme is properly documented and the concerned employees are fully aware in this regard;
- To ensure that employees are full aware to fight any emergency.

**Disaster Management Efficacy Drill**

This shall be conducted to test the following:
- All employees are trained about their responsibilities/duties. They all are aware about evacuation routes, direction of evacuation of equipments to be used during evacuation or the method of evacuation
- All employees are fully trained to rescue their colleagues, who are effected due to cause of disaster. In case they are unable to rescue their colleagues, they should know to whom they have to inform about such persons.
- All employees are fully trained in first aid use of desired equipments including breathing apparatus. First Aid box etc is available at the desired location.
- All warning alarms are functional. Public Address System is in healthy condition.
- All telephone lines/communication systems are provided in control rooms and there is no removal of the facilities (as prescribed) for the control rooms.

The Disaster Management Plan shall be periodically revised based on experiences gained from the mock drills.

**7.18.7 Roles & Responsibilities**

**DGKPG's Responsibility**

The Company shall take all such steps which are reasonably practicable to ensure best possible conditions of work, and with this end in view the company shall do the following:-

- To allocate sufficient resources to provide and maintain safe and healthy conditions of work
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are given to all employees.
- To provide wherever necessary protective equipment, safety appliances and clothing; and to ensure their proper use.
- To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge.
- To provide appropriate facilities for first aid prompt treatment of injuries and illness at work.
- To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters.
- To ensure proper implementation of fire prevention and an appropriate firefighting service, together with training facilities for personnel involved in this service.
To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise.

To organise collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.

To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.

To publish/notify regulations, instructions and notices in the common language of employees

To prepare separate safety rules for each type of occupation/process involved in a project.

To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe systems of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.

Responsibility for Implementation

The ultimate responsibility for ensuring the implementation of the policy on health and safety at work rests on the Corporate Personnel Division at the corporate level and the concerned Managers at the Project. The Officers in charge of safety will be functionally responsible to the Corporate headquarter for ensuring that the policy is promulgated, interpreted and carried out in the manner expected.

Immediate responsibility for safety at work is that of the Management/Executives of each department/section who are primarily responsible to prevent accidents involving members of their staff and other persons. It is their responsibility to issue clear and explicit working instructions, compliance with which will ensure safe working and to require the effective use of approved equipment.

Accepted rules, procedures and Codes of practice which are formulated with proper regard to health and safety consideration must be strictly observed by all concerned. Contracting Agencies executing works should be made responsible, through various measures including appropriate provisions in the contract, for discharging their safety obligations.

In designated areas of particular hazard the appropriate Executives are required to authorize, in writing, the commencement of any work and, before doing so, personally to satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorized, in writing as competent to perform these duties.

Safety Officers are appointed to advise Management on questions of safety at work including advice on the application in particular local situations of the system of work, implementation of Company's Rules and Relevant Codes of Practices in consultation with Area Engineer. They will be consulted in the interpretation of rules and codes being formulated by the Corporate Management and shall advise Management in the investigation and analysis of accidents and circulation of appropriate statistics.

Responsibilities of Site Manager (Chief Incident Controller)

Relieve the works incidence controller from the responsibility of overall main control.

Declare major emergency, if considered necessary and ensure outside emergency services are called in and near by industries are informed.

Directing shutting down and evacuation of plant, establish liaison with head of fire, safety, medical, HR, security and local police.
- Arrange for relief of personnel and catering facilities for affected in emergency.
- Ensure information/reporting to Corporate Office and Statutory authorities as per provisions of state Factory rules and Factory Act
- Emergency control centre shall be established and equipped with adequate means of communication to areas inside and outside.
- The emergency control room will be manned by the Chief Incident Controller, Work Incident Controller, key personnel and Sr.Officers of outside services called for assistance.
- It should have general map and guide for Assembly Points, location of Hazardous process/operation
- No other personnel shall have access to the ECC.

**Responsibilities of Site Manager (Work Incident Controller);**
- All probable emergency causing situations and take proper precautionary measures to prevent / control such situations;
- Ensure that all emergency team under him are informed about their functions before and during emergency;
- Direct all operations within the affected area with the following priority;
  - Secure the safety of personnel
  - Minimize damage to plant & environment
  - Minimize loss of material
- Ensure that all non-essential workers in the affected areas are evacuated to appropriate assembly point.
- Set up communication contact through telephone/messenger etc. with emergency control centre (ECC).
- Report significant developments to the chief incident controller.
- Assume duties of chief incident controller pending his arrival and in particular;
  - Direct the shut down and evacuation of plant and affected areas likely to be threatened by the emergency.
  - Ensure key personnel are informed and they are called in

**Key Personnel**
- Apart from WIC and CIC, other works personnel will have key role to play in providing advice and in implementing the decisions made by CIC.
- Key personnel includes
  1. Incharge of generation, electrical & mechanical maintenance, C&I, Chemistry (& WTP)
  2. Heads of HR, safety, PR, Medical, Security & Fire Department.

**Support Team to CIC and WIC**
- In addition to the teams already mentioned there will be one additional team known as support team.
- This team will assist CIC & WIC during an emergency. The responsibilities of the team given below;
  - Contacting statutory authorities.
  - Arranging for relievers and catering facilities.
  - Giving information to media.

**Responsibilities of Support Team**
- Arranging shelters for affected persons.
Contacting medical centres and nursing homes.

Providing all other support, as necessary.

Arranging for urgently required materials through cash purchase or whatever means.

Arranging funds for various relief measures as emergency purchase of materials.

Responsibilities of Key Personnel

Departmental heads

- The departmental heads will provide assistance as required by the works incident controller. They will decide which members of their departments are required at the incident site.
- Head of Tech. Services
  - On knowing the major emergency, he will proceed to the site and report to CIC.
  - He will provide technical information as required to CIC/WIC.

Head of Safety

- On knowing the emergency, he will immediately report to site and keep in touch with CIC
- He will make sure that all safety equipments are made available to the emergency teams.
- Participate in rescue operations.
- Maintain inventory of items in ECC.

In addition to the support teams mentioned above, there will be a team for each functional area, as described below:

| Task Force | • To identify source of hazard and try to neutralize/contain it.  
• To isolate remaining plant and keep that in safe conditions.  
• To organize safe shutdown of plant, if necessary.  
• To organize all support services like operation of the fire pumps, sprinkler system etc. |
| Maintenance Team | • Attend to all emergency maintenance jobs on top priority.  
• To take steps to contain or reduce the level of hazard created due to disaster.  
• To organize additional facilities as desired. |
| Fire Fighting Team | • To rush to fire sport and extinguish fire.  
• To seek help from outside firefighting agencies.  
• To evacuate persons effected. |
| Auto Base Team | • To make the auto base vehicles ready to proceed for evacuation or other duties, when asked for,  
• To send at least one mechanic at the site of incidence where he may help in attending minor defects in ambulance, fire fenders or other vehicles.  
• To arrange petrol/diesel supply.  
• Make all arrangements regarding transportation. |
| Communication Team | • To maintain the communication network in working condition.  
• To attend urgent repairs in the communication system, if required.  
• To arrange messengers for conveying urgent messages when needed.  
• To help communicate with external or internal authorities/officials. |
| Security Team | • To man all gates.  
• To ban entry of unauthorized persons.  
• To permit, with minimum delay, the entry of authorized personnel and outside agencies, vehicles etc. who have come to help.  
• To allow the ambulance/evacuation vehicles etc. to go through the gates without normal checks. |
| Administration Team | • To rescue the casualties on priority basis.  
• To transport casualties to first aid post, safe places or medical centers.  
• To account the personnel. |
### Safety Team
- To help in search for missing personnel.
- To pass information to the kith and kin of fatal or serious injured persons.
- To arrange required safety equipment.
- To record accidents.
- To collect and 'preserve evidences in connection with accident injuries.
- To guide authorities on all safety related issues.

### Medical Team
- To arrange first aid material/stretchers immediately and reach to site of incident
- To arrange for immediate medical attention.
- To arrange for sending the Casualties to various hospitals and nursing homes etc.
- To ask specific medical assistance from outside including through Medial Specialist in consultation with CIC/WIC.

### Monitoring Team
- To measure gas Concentrations, in case of gas leakage at various places

### Responsibility of the Employee
The establishment and maintenance of best possible conditions of work is, no doubt, the responsibility of Management, it is also necessary that each employee follows prescribed safe methods of work. He should take reasonable care for the health and safety of himself, or his fellow employees and of other persons who may be affected by his action at work. With this in mind, employees' should be health and safety conscious and:

<table>
<thead>
<tr>
<th>Report</th>
<th>Potential hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>Safety rules, procedures and codes of practice.</td>
</tr>
<tr>
<td>Use</td>
<td>With all reasonable care the tools, equipment, safety equipment and protective clothing provided by the Company; these items should be kept in good condition.</td>
</tr>
<tr>
<td>Participate</td>
<td>In safety training courses when called upon to do so.</td>
</tr>
<tr>
<td>Make Use</td>
<td>Of safety suggestions schemes.</td>
</tr>
<tr>
<td>Take</td>
<td>An active and personal interest in promoting health and safety at work.</td>
</tr>
</tbody>
</table>

### Reporting of Accidents and Dangerous Occurrences
With a view to ensuring prompt reports of accidents and dangerous occurrences to comply with requirements/obligations under different statues; and to inform the concerned authorities within the organization for keeping complete information of accidents for record and analysis and to take necessary, preventive actions, a procedure for reporting of accidents dangerous occurrences has been framed. Separate procedures have been formulated for accidents causing injuries/fatalities and for dangerous occurrences.
8.0 Conclusion

On the basis of the findings of the EIA Study, it is possible to conclude that:

- Operation of Datang Pakistan Karachi Power Generation - DPKPG (Private) Limited 2 x 350 MW Coal Power Plant will, on adoption of the mitigation measures, have no significant impact on the physical as well as socio-economic composition of the microenvironment and macroenvironment of the project area.

- The likely impact of construction and operation of the DPKPG’s 2 x 350 MW Coal Power Plant will be appropriately mitigated through proven technologies, careful planning and landscaping.

- The proposed DPKPG’s 2 x 350 MW Coal Power Plant will when commissioned become an integral part of the microenvironment of EIZ of PQA and a friendly component of its macroenvironment.

Mitigation will be assured by a program of environmental monitoring conducted to ensure that all measures are provided as intended, and to determine whether the environment is protected as envisaged. This will include observations on and off site, document checks, and interviews with workers and beneficiaries, and any requirements for remedial action will be reported to the EPA Sindh.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. DPKPG shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this EIA report are implemented in full, as described in the document;

- The Environmental Management and Monitoring Plan is implemented in letter and spirit.

This EIA Study finds that the proposed Project would fulfil the requirements of sustainable development by being socially equitable, and economically viable in improving the quality of life for all citizens of Karachi, without altering the balance in the resources of the ecosystem of the region.

The Study therefore recommends that the EIA should be approved with the condition that all mitigation measures recommended in EIA report, suggestions of stakeholders and recommendations of experts committee will be adhered to by DPKPG and the legal requirements as well as the Environmental Management & Monitoring Plan shall be implemented in letter & Spirit.
ANNEXURES
1. This flow diagram is for boiler 2 only, the boiler 1 is same as boiler 2.
2. The quantity in list of equipment is for one boiler.
3. The technical parameters in this drawing is for reference only.
Port Qasim 2x350MW Coal Fired Power Plant Project

Feasibility Study

Jetty
1. GENERAL
   1.1 GENERAL DESCRIPTION
   1.2 DESIGN BASE
   1.3 CODES & STANDARDS
   1.4 DESIGN SCOPE AND CONTENT
   1.5 MAJOR TECHNOLOGIC INDEX

2. PROJECT CONDITIONS
   2.1 PROJECT SITE
   2.2 METEOROLOGY CONDITIONS
   2.3 OCEAN HYDROLOGY
   2.4 CURRENT
   2.5 WAVE
   2.6 ENGINEERING GEOLOGY
   2.7 SEISMIC INTENSITY

3. GENERAL LAYOUT
   3.1 PRINCIPLE FOR GENERAL LAYOUT
   3.2 RELATIONSHIP BETWEEN GENERAL LAYOUT AND ADJACENT PROJECTS
   3.3 DESIGN MAIN TYPICAL VESSELS
   3.4 ELEVATION DESIGN
   3.5 CHANNEL AND AIDS TO NAVIGATION
   3.6 GENERAL LAYOUT ALTERNATIVE
   3.7 PORT VEHICLE AND TUGBOAT
   3.8 DREDGING

4. COAL HANDLING TECHNOLOGY
   4.1 DESIGN PRINCIPLE
   4.2 MAIN DESIGN DATA
   4.3 HANDLING SYSTEM
   4.4 HANDLING MACHINERY AND EQUIPMENT
   4.5 THROUGHPUT CAPACITY CALCULATION OF BERTH
   4.6 MAIN TECHNICAL AND ECONOMIC INDEX

5. MARINE STRUCTURE
   5.1 MARINE STRUCTURE OPTIONS AND SAFETY GRADE
   5.2 MAIN DIMENSIONS OF MARINE STRUCTURE
   5.3 DESIGN CONDITIONS
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4</td>
<td>COMBINATIONS OF ACTION EFFECTS</td>
<td>19</td>
</tr>
<tr>
<td>5.5</td>
<td>MARINE STRUCTURE OPTIONS</td>
<td>19</td>
</tr>
<tr>
<td>5.6</td>
<td>CALCULATION METHOD AND RESULTS</td>
<td>23</td>
</tr>
<tr>
<td>6.</td>
<td>AUXILIARY PROJECTS</td>
<td>24</td>
</tr>
<tr>
<td>6.1</td>
<td>POWER SUPPLY AND ILLUMINATION</td>
<td>24</td>
</tr>
<tr>
<td>6.2</td>
<td>WATER SUPPLY</td>
<td>25</td>
</tr>
<tr>
<td>6.3</td>
<td>DRAINAGE</td>
<td>27</td>
</tr>
<tr>
<td>6.4</td>
<td>FIRE FIGHTING</td>
<td>27</td>
</tr>
<tr>
<td>6.5</td>
<td>COMMUNICATION</td>
<td>29</td>
</tr>
<tr>
<td>6.6</td>
<td>CONTROL</td>
<td>30</td>
</tr>
<tr>
<td>6.7</td>
<td>BUILDING &amp; STRUCTURE</td>
<td>31</td>
</tr>
<tr>
<td>6.8</td>
<td>HVAC</td>
<td>33</td>
</tr>
<tr>
<td>7.</td>
<td>ENVIRONMENT PROTECTION</td>
<td>35</td>
</tr>
<tr>
<td>7.1</td>
<td>MAIN POLLUTION RESOURCE AND POLLUTANTS IN CONSTRUCTION PERIOD</td>
<td>35</td>
</tr>
<tr>
<td>7.2</td>
<td>MAIN POLLUTION RESOURCE AND POLLUTANTS IN OPERATION PERIOD</td>
<td>35</td>
</tr>
<tr>
<td>7.3</td>
<td>MEASURES FOR POLLUTION MITIGATION IN CONSTRUCTION PERIOD</td>
<td>36</td>
</tr>
<tr>
<td>7.4</td>
<td>MEASURES FOR POLLUTION MITIGATION IN OPERATION PERIOD</td>
<td>37</td>
</tr>
<tr>
<td>7.5</td>
<td>ECOLOGICAL IMPACTS AND MITIGATION MEASURES</td>
<td>38</td>
</tr>
<tr>
<td>8.</td>
<td>CONSTRUCTION CONDITIONS,METHODS AND SCHEDULE</td>
<td>40</td>
</tr>
<tr>
<td>8.1</td>
<td>GENERAL DESCRIPTION</td>
<td>40</td>
</tr>
<tr>
<td>8.2</td>
<td>CONSTRUCTION CONDITIONS</td>
<td>40</td>
</tr>
<tr>
<td>8.3</td>
<td>CONSTRUCTION METHOD</td>
<td>40</td>
</tr>
<tr>
<td>8.4</td>
<td>CONSTRUCTION OVERALL ARRANGEMENT</td>
<td>43</td>
</tr>
<tr>
<td>8.5</td>
<td>CONSTRUCTION DURATION</td>
<td>43</td>
</tr>
<tr>
<td>9.</td>
<td>QUOTATION DESCRIPTION</td>
<td>45</td>
</tr>
<tr>
<td>9.1</td>
<td>OVERVIEW</td>
<td>45</td>
</tr>
<tr>
<td>9.2</td>
<td>THE TOTAL INVESTMENT</td>
<td>45</td>
</tr>
<tr>
<td>9.3</td>
<td>BASIS FOR QUOTATION</td>
<td>45</td>
</tr>
<tr>
<td>9.4</td>
<td>FEES INCLUDED</td>
<td>45</td>
</tr>
<tr>
<td>9.5</td>
<td>CORRELATIVE DESCRIPTION</td>
<td>46</td>
</tr>
<tr>
<td>10.</td>
<td>CONCLUSION AND SUGGESTION</td>
<td>52</td>
</tr>
<tr>
<td>10.1</td>
<td>CONCLUSION</td>
<td>52</td>
</tr>
<tr>
<td>10.2</td>
<td>SUGGESTION</td>
<td>52</td>
</tr>
<tr>
<td>11.</td>
<td>APPENDIX A DRAWINGS</td>
<td>53</td>
</tr>
<tr>
<td>12.</td>
<td>APPENDIX B BOREHOLE LOG</td>
<td>54</td>
</tr>
</tbody>
</table>
1. GENERAL

1.1 General Description

To fulfill the electric energy demand in Karachi Pakistan, Karachi Electric Supply Company Limited (KE), China Datang Overseas Investment Co., Ltd (CDTO) and China Machinery Engineering Corporation (CMEC) had planned to build, own and operate a coal fire steam power plant, Port Qasim 2×350MW Coal Fired Power Plant Project.

The proposed project area is located in the city of Karachi, Pakistan. It is about 10km away from Port Qasim. The geography location are 24° 46’ N, 67° 23’ E.

1.2 Design Base

Detailed Topographic Survey Of Area At Bin Qasim For Ke Coal Fired Power Plant, August 2015, provided by KE company.

Borehole Log For 1400MW Coal Fired Power Plant, Jan 2016, provided by KE company.

1.3 Codes & Standards

The following design codes & standards have been observed:

- Chinese codes & standards;
- British Standard Code of Practice for Maritime Structures (BS 6349);
- “Technical Standard for Port and Harbour Facilities in Japan”, Bureau of Ports and Harbour, Ministry of Transport, Japan (OCDI 2002);
- “Approach Channels A Guide for design”, published by PIANC, IAPH, IMPA and IALA;

1.4 Design Scope and Content

1.4.1 Design Scope

The design division between the jetty and power plant is as follows:

- The division of coal handling system is located at the first Transfer Tower on land. The first Transfer Tower on land will be designed by Power Plant Designer.
- The division of conveyor trestle, water supply and drainage, fire fighting, power supply, illumination, control system, wired telephone system, fire alarm system, CCTV and broadcasting system is located at the external
wall of the first Transfer Tower on the land.

- The division of marine structure is located at the top line of revetment.

### 1.4.2 Design Content

The design content includes: general layout, selection of handling equipment and technological process of coal handling, marine structure of jetty, auxiliary buildings, water supply and drainage, power supply, illumination, lightning protection, control system, communication, environmental protection, etc.

### 1.5 Major Technologic Index

In this study two options had been considered,

The major technology index of each options are shown in Table 1-1.

**Table 1-1 The major technologic index of the jetty**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Units</th>
<th>Quantity</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Option I</td>
<td>Option II</td>
</tr>
<tr>
<td>1</td>
<td>Number of berth</td>
<td>Num.</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Dimension of jetty: Quay deck</td>
<td>m</td>
<td>265×22</td>
<td>265×22</td>
</tr>
<tr>
<td></td>
<td>Trestle</td>
<td>m</td>
<td>1020×9</td>
<td>564×9</td>
</tr>
<tr>
<td>3</td>
<td>Dredging quantity</td>
<td>10³m³</td>
<td>225</td>
<td>320</td>
</tr>
<tr>
<td>4</td>
<td>Construction and decorating of the building</td>
<td>m²</td>
<td>986.4</td>
<td>986.4</td>
</tr>
<tr>
<td>5</td>
<td>Whole capacity of equipments</td>
<td>kW</td>
<td>3900</td>
<td>3600</td>
</tr>
<tr>
<td>6</td>
<td>Maximum daily living water consumption</td>
<td>m³/d</td>
<td>512</td>
<td>512</td>
</tr>
<tr>
<td>7</td>
<td>Maximum daily production water consumption</td>
<td>m³/d</td>
<td>194</td>
<td>194</td>
</tr>
<tr>
<td>8</td>
<td>One time fire fighting water consumption</td>
<td>m³</td>
<td>316.8</td>
<td>316.8</td>
</tr>
</tbody>
</table>
2. PROJECT CONDITIONS

2.1 Project site

This plant is located about 4.5km to the east of Port Qasim, Karachi City. Karachi is located at southern part of Sindh in Pakistan, bordering on Arabian Sea, situated in the zone from the south of Kohistan Plateau to the coastal plain with a general elevation of 1.5~40m. The city has an area of about 3530km². Most parts are flat plains, there are low hills and butte in eastern and northern part of the urban area while it has lots of swamps along the coastal area. Two rivers Malir and Lyari run through eastern and western parts of the urban area respectively. Both rivers are seasonal streams and have relatively wide river bed. Port Qasim, located on downstream of Feidigeli Branch River at west side of the Indus River Delta in southern Pakistan, is the second largest port in Pakistan. It has a straight-line distance of 30km from its northwestern part to Karachi. The geography location of the proposed project are 24° 46′ N, 67° 23′ E.

![Figure 2-1 Location of the project site](image)

2.2 Meteorology Conditions

The area is subject to seasonal south west monsoon conditions between June and September. There is a risk of cyclones in the area.

2.2.1 Temperature

- Annual mean temperature: 25.9°C
- Highest temperature: 47.8°C
- Lowest temperature: 3°C
2.2.2 Relative humidity

- Annual mean relative humidity: 70%.

2.2.3 Precipitation

- Annual mean precipitation: 203mm
- Highest monthly precipitation: 428mm

2.2.4 Wind

According to Karachi Airport Meteorology observatory measured Maximum wind velocity is 140 km/h, Karachi Airport Meteorology observatory wind direction is adopt 8 directions. The wind rose is shown in figure 2.

![Wind Rose](image)

**Figure 2-2 Karachi Airport wind rose**

Statistics of meteorological data at Karachi Airport Meteorology Observatory is shown in table 1.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>NE</th>
<th>E</th>
<th>SE</th>
<th>S</th>
<th>SW</th>
<th>W</th>
<th>NW</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>winter</td>
<td>3</td>
<td>17</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>7</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>summer</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>30</td>
<td>56</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>year</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>19</td>
<td>36</td>
<td>4</td>
<td>27</td>
</tr>
</tbody>
</table>

**Table1 Statistics of meteorological data at Karachi Airport Meteorology**
### 2.3 Ocean hydrology

#### 2.3.1 Referred datum

In the report, all the elevations are referred to CD (Chart Datum).

#### 2.3.2 Tide level and tidal characteristic

The tides in the area are predominantly semi-diurnal with a strong diurnal inequality. Mean sea level is 2.03m above Chart Datum. The main tidal characteristics are shown as below:

- Highest astronomical tide: 4.01m
- Mean higher high water level: 3.4m
- Mean lower high water level: 2.7m
- Mean sea level: 2.03m
- Mean higher low water level: 1.4m
- Lowest astronomical tide: -0.6m

#### 2.3.3 Design water level

The design water level is shown as below:

- Extreme high water level: 4.5m
- Design high water level: 3.57m
- Design low water level: 0.2m
- Extreme low water level: -0.9m
2.4 Current

As per analysis on current data of Port Qasim tide station collected in 2012, the tide current has a relatively high flow when in spring tides, to be specific, 0.5-1.5m/s. The tidal currents are alternating currents, floating in the same direction as the watercourse, namely floating eastwards in flood tides and floating westerns in ebb tides.

2.5 Wave

According to the investigation in the Port of Bin Qasim and other people who live near by the site, and the sea map published by Hydrographer of the Pakistan Navy, the sea near the site has only one narrow and long channel to connect with outside Arabia sea. The wave near the site is very little even during big storm. The power plant will not be influenced by wave.

2.6 Engineering Geology

In feasibility study stage 9 borehole had been carried by the owner, BH01 to BH05 total 5 boreholes are used for jetty, BH06 to BH09 4 boreholes are used for channel.

According to the borehole Log provided by the KE company, the strata in this investigating area are mostly composed of Sand, Gravel, Conglomerate, mudstone and sandstone.

The borehole Log shown in Appendix B.

2.7 Seismic Intensity

As per the “Building Code of Pakistan (Seismic Provisions-2007)(BCP SP-2007)” the propose project site belongs to seismic zone 2B (shown in Fig 2-3), the PGA with exceedance probability of 10% in 50 years of the plant site area is 0.18g (shown as Fig 2-4).

![Seismic Zoning Map of Site](image_url)
Figure 2-4 Basic Earthquake Acceleration Map of Site Area
3. GENERAL LAYOUT

3.1 Principle for General Layout

(1) The general layout of jetty should conform to the general layout of power plant and take fully consideration of nature condition such as wind, wave, current, bathymetry contour etc. and local construction facility, in order to ensure safety and convenience for operation.

(2) The jetty dimension should take fully consideration of mooring, handling technical, disposition of structures.

3.2 Relationship between General Layout and Adjacent Projects

The general layout of jetty is coordinate with the general layout of power plant and there is no other project around. The proposed jetty is 5.0km away from the Qasim port.

3.3 Design Main Typical Vessels

The main dimensions of design typical vessels are shown in table 3-1.

<table>
<thead>
<tr>
<th>Typical Vessel</th>
<th>Total Length</th>
<th>Mounded Width</th>
<th>Mounded Depth</th>
<th>Draft</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50,000DWT Bulk Carrier</td>
<td>209</td>
<td>32.3</td>
<td>17.1</td>
<td>12.4</td>
<td></td>
</tr>
</tbody>
</table>

3.4 Elevation Design

(1) Elevation datum system

This project adopts CD as elevation datum.

(2) Design Water level

Design high water level: 3.57m (1% of duration accumulation frequency)

Design low water level: 0.2m (98% of duration accumulation frequency)

Extreme high water level: 4.5m (Extreme high water with recurrence interval of 50 years)

Extreme low water level:-0.9m (Extreme high water with recurrence interval of 50 years)

(3) Jetty Surface Elevation

The jetty is located in the river, where is well shielded. The river is influenced by tide, and the jetty surface elevation is calculated as following:

\[ E = \text{calculation water level} + \Delta w \]
Where:

E—Jetty Surface Elevation;

\( \Delta w \)—Clearance heigh.

According to the calculation, the jetty surface elevation is \( E = 3.57 + (1.0 \sim 2.0) \) = 4.57~5.57m, Check the jetty surface level in condition of extreme high water level, the jetty surface elevation is \( E = 4.5 + (0.0 \sim 0.5) \) = 4.5~5.0m.

As comprehensive consideration, the jetty surface elevation is taken as 5.5m.

(4) Design sea bottom elevation alongside the berth

The design water depth alongside the berth is calculated as follow:

\[ D = T + Z_1 + Z_2 + Z_3 + Z_4. \]

\( D \)—The design water depth alongside the berth;

\( Z_1 \)—Min. underkeel clearance (m).

\( Z_2 \)—Wave tolerance(m), \( Z_2 = KH_{4\%} - Z_1. \)

\( K \)—Coefficient, 0.3 should be taken for the following sea and 0.5~0.7 should be taken for the beam sea.

\( H_{4\%} \)—Wave height alongside the berth (m), which allows berthing, wave height with 4% accumulation rate of wave train.

\( Z_3 \)—Aft draft increased due to uneven stowage of vessel (m).

\( Z_4 \)—Depth for siltation(m).

the wave tolerance, the aft draft increased due to uneven stowage of vessel and depth for siltation;

Design water depth alongside the berth is shown in Table 4-2.

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>T</th>
<th>( Z_1 )</th>
<th>( Z_2 )</th>
<th>( Z_3 )</th>
<th>( Z_4 )</th>
<th>( D )</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50,000DWT Bulk Carrier</td>
<td>12.4</td>
<td>0.4</td>
<td>0</td>
<td>0.15</td>
<td>0.4</td>
<td>13.35</td>
<td></td>
</tr>
</tbody>
</table>

Design sea bottom elevation alongside the jetty=design low water level—the design water depth alongside the berth.

Design sea bottom elevation alongside the berth is shown in Table 4-3.
Port Qasim 2×350MW Coal Fired Power Plant Project

Table 3-3  Design sea bottom elevation alongside the berth (Unit: m)

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>LWL</th>
<th>D</th>
<th>Bottom Elevation</th>
<th>Design value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>50,000DWT Bulk Carrier</td>
<td>0.2</td>
<td>13.35</td>
<td>-13.15</td>
<td>-13.2</td>
<td></td>
</tr>
</tbody>
</table>

3.5 Channel and Aids to Navigation

The proposed project is located in the inside of Gharo Creek, the distance from the proposed location to Qasim Port is about 5.0km for Option I and 6.0km for Option II, the distance from the proposed location to Sinohydro Port is about 1.5km for Option I and 2.5km for Option II. Qasim port connect the Arabian sea by Qasim channel and Sinohydro Port connect Qasim port by Sinohydro channel, all those channel are satisfy the 50,000DWT navigation requirement. For the proposed project the nature water depth is about 7~9m, can not meet the 50,000DWT navigation requirement, therefore a new channel to connect this project and the Sinohydro channel shall be considered.

3.5.1 Channel

(1) Channel width

The effective channel width should be composed of width of sailing path, width clearance between ships and width clearance between ship and channel base. The width of one-way channel should be determined with formula as follow:

For one-way channel: \( W = A + 2c \)

\( A = n(L \sin \gamma + B) \)

Where \( W \): Effective width of channel (m);

\( A \): Width of sailing path (m);

\( n \): Multiple of ship’s drift(m),

\( \gamma \): Yaw angle caused by wind and current(°),

\( c \): Width clearance between ship and channel base end line(m).

As calculated, the channel width for 50,000DWT bulk carrier is taken as 148m.

(2) Channel depth

The water depth of channel is classified into the navigation depth and designed depth, which should be calculated with the following formula:

\( D_0 = T + Z_0 + Z_1 + Z_2 + Z_3 \)
\[ D = D_0 + Z_4 \]

Where

- \( D_0 \): Navigation water depth of channel;
- \( T \): Loaded draft of design ship;
- \( Z_0 \): Sinking value of ship’s hull during navigation (m);
- \( Z_1 \): Min. underkeel clearance during navigation (m);
- \( Z_2 \): Wave tolerance,
- \( Z_3 \): Trimming depth clearance during ship’s loading operation,
- \( D \): Designed water depth of channel,
- \( Z_4 \): Depth clearance of siltation.

For 50,000DWT bulk carrier, navigation water level is taken as 1.2m.

As calculated, the design bottom elevation for 50,000DWT bulk carrier is -12.5m.

### 3.5.2 Aids to Navigation

**Option I**

According to layout of this project, 11 buoys are arranged along the channel and harbour basin, and 2 steel pipe beacons are respectively arranged at the end of berth.

**Option II**

According to layout of this project, 15 buoys are arranged along the channel and harbour basin, and 2 steel pipe beacons are respectively arranged at the end of berth.

### 3.6 General Layout Alternative

There are two options of general layout in this design. One 50,000 DWT bulk carriers shall be built in both options, and the coal is transported by 50,000 DWT bulk carriers to the proposed jetty. In option I, the jetty locates at southwest water area of the plant while in option II the jetty locates at south water area. Dredging volume, access bridge length, and current condition of two options will different with each other resulting from different locations of the jetty.

#### 3.6.1 Layout of Jetty Water Area

**(1) Apron Line of Jetty**
Combined with the layout of power plant, and according to the existing topographic map and bathymetric chart, the bank slope at the proposed jetty site is steeper. So the apron line of jetty is laid out parallel to the coastline and bathymetric contour, near -5m bathymetric line, where is also near the toe of slope. In option I, the azimuth of the apron line of jetty is 79°~259°. In option II, the azimuth of the apron line of jetty is 54°~234°.

(2) **Length of Berths**

According to the requirements of berthing and handling technology, for the 50,000 DWT bulk carriers, the length of berth is calculated as follow: \( L_b = 25 + 209 + 31 = 265 \) m.

(3) **Layout of Jetty**

In option I, the jetty is composed by the quay deck, access bridge (including belt conveyor and vehicle bridge) and so on. Combined with the handling technology, the dimension of quay deck is 240×22m. The quay deck is connected with rear land area through an access bridge, of which width is 9m including 4.3m belt conveyor bridge and 4.7m vehicle bridge. The belt conveyor bridge is from the transfer station on platform to the first transfer station at land area, the length is 578m. The vehicle bridge is connected to land road, and the length is 444m. Switchboard room and other auxiliary function rooms are set behind the unloader platform where is also the connecting site of access bridge and the unloader platform.

In option II, the jetty is composed by the quay deck, access bridge (including belt conveyor and vehicle bridge), mooring dolphin and so on. The dimensions of quay deck and mooring dolphin are the same with option I. The vehicle bridge is connected to land road, and the arrangement of access bridge is the same as the option I except that the length of belt conveyor bridge and vehicle bridge is 1137m and 1020m respectively.

(4) **Berthing Water Area of Wharf Apron**

The width of berthing area alongside the berth should be two times of the ship width. And the width of berthing water alongside the berth is 64.6m for 50,000DWT bulk carrier.

(5) **Turning Area**

The turning basin is arranged in front of the jetty. The width and the length of the turning ellipse are 1.5 times and 2.5 times the overall length of the design vessel. The width of the turning ellipse is 313.5m, and the length of the turning ellipse is
3.6.2 General Layout of Land Area

The land area is designed by the power plant institute. The access bridge is connected to the land road and the conveyor is connected to the first transfer tower on land.

3.7 Port Vehicle and Tugboat

Two 2600kw tugboats shall be considered for the 50,000DWT bulk carrier berthing or leaving.

The vehicles will be equipped by the power plant.

3.8 Dredging

In option I, at the channel, berthing area, turning basin and channel shall be dredged, the total dredging volume is about 2,250,000 m³.

In option II, at the channel, berthing area and turning basin shall be dredged, the total dredging volume 3,200,000 m³.
4. COAL HANDLING TECHNOLOGY

4.1 Design principle

(1) Considering the various types of cargo, vessel and complex cargo characteristic, handling equipments shall meet the requirements of expediting the vehicle turnover, matching the capacities of every production and reducing the operating cost.

(2) Under the condition of meeting the requirement of production capacity, equipments with mature technology, advanced capacity, reliable operation, high efficient and convenient maintenance shall be adopted.

(3) In order to maintain and manage conveniently, the kinds of equipments shall be reduced and kept the same as possible.

4.2 Main design data

4.2.1 Annual freight volume

Refer to table 4-1 for the annual freight volume.

<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Annual freight volume (10^3/y)</th>
<th>Flow</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>2,900</td>
<td></td>
<td>Import</td>
</tr>
</tbody>
</table>

4.2.2 Design typical vessel

Refer to Chapter 3.3.

4.2.3 Annual operation days

Annual operation days of the jetty: 320 days.

4.2.4 Production unbalanced coefficient

Berth production unbalanced coefficient: 1.3

4.2.5 Working shift

Working shift: 3.

4.3 Handling system

4.3.1 Handling technology options

Considering the cargo type, volume, vessel type and others, one bulk coal import berth shall be constructed.

For Option I and Option II one 50,000DWT jetty of power plant will be constructed, there is no lightering operation. Two bridge type grab ship unloaders with rated capacity of 1,000t/h each and four clearance machines
shall be provided to unload ship. Troughed belt conveyors (B=1,600mm, 
V=3.15m/s) shall be provided to handle ore bulk horizontally.

4.3.2 Handling technological process

Bulk carrier → Bridge type grab ship unloader → Belt conveyor BC-1→ 1# 
Transfer station → Belt conveyor BC-2 → Transfer station of Power Plant.

4.4 Handling Machinery and Equipment

The specification and number of handling machine and equipment are listed in the 
following Table 4-2.

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Specification</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bridge-type grab unloader</td>
<td>Q=1,000t/h, L=16m</td>
<td>Set</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Clearance machine</td>
<td></td>
<td>Set</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Belt conveyor BC-1</td>
<td>B=1.6m, V=3.15m/s</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Belt conveyor BC-2</td>
<td>B=1.6m, V=3.15m/s</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Electronic belt weigher</td>
<td>B=1.6m</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify device</td>
<td>B=1.6m</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Electric hoist</td>
<td>Q=10t</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Magnetic separator</td>
<td>B=1.6m</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sampler machine</td>
<td>B=1.6m</td>
<td>Set</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

4.5 Throughput capacity Calculation of berth

Formula of throughput capacity Calculation of berth

\[
P_t = \frac{T_y \cdot G \cdot K_B}{t_d + t_f} \quad G \quad K_B \quad t_d \quad t_f \quad P_t
\]

Where,

- \(P_t\) — Annual throughput capacity.
- \(T_y\) — Annual operation days of berth. Taken as 320 days.
- \(G\) — Actual cargo carrying capacity of design typical vessel (t). Taken as 50,000t 
for 50,000 DWT bulk ship.
- \(t_f\) — Time required for unloading the ship (h).
\( P \) — Designed typical ship-hour rate (t/h). Taken as 1,000.

\( I_d \) — Hours of one day, taken as 24h.

\( \Sigma t \) — Sum of non-productive time around the clock (h). Taken as 4.5.

\( I_f \) — Sum of time for auxiliary operation and technical operation of ship and time for berthing and unberthing operation of the ship (h). Taken as 6 for 50,000DWT bulk ship.

\( K \) — Berth production unbalanced coefficient. Taken as 1.3.

The results of throughput capacity are 4,374,000t/y for option I and II.

4.6 **Main technical and economic index**

Main technical and economic index are shown as Table 4-3.

<table>
<thead>
<tr>
<th>No</th>
<th>Major technical &amp; economic indexes</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Annual traffic volume</td>
<td>(10^3/y)</td>
<td>2,900</td>
<td>Coal import</td>
</tr>
<tr>
<td>2</td>
<td>Throughput capacity</td>
<td>(10^3/y)</td>
<td>4,374</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Numbers of berths</td>
<td>Nos</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Berth production unbalanced coefficient</td>
<td>/</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Design typical ship-hour rate</td>
<td>t/h</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>The time of unloading one vessel</td>
<td>Day</td>
<td>2.814</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Work shift</td>
<td>Shift</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Number of drivers and workers</td>
<td>Nos</td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>
5. MARINE STRUCTURE

5.1 Marine Structure Options and Safety Grade

According to the general layout, for each option the maritime structure included one 50,000DWT bulk carrier quay deck, one approach trestle and one substation platform.

The safety grade of structure shall be grade II.

5.2 Main Dimensions of Marine Structure

The dimensions and design elevations of marine structure for options are shown in Table 5-1.

<table>
<thead>
<tr>
<th>General layout options</th>
<th>Item</th>
<th>Top elevation (m)</th>
<th>Length × Width (m × m)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option I</td>
<td>Quay deck</td>
<td>5.5</td>
<td>265×22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trestle</td>
<td>5.5</td>
<td>1020×9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substation Platform</td>
<td>5.5</td>
<td>30.5×14.5</td>
<td></td>
</tr>
<tr>
<td>Option II</td>
<td>Quay deck</td>
<td>5.5</td>
<td>265×22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trestle</td>
<td>5.5</td>
<td>444×9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substation Platform</td>
<td>5.5</td>
<td>30.5×14.5</td>
<td></td>
</tr>
</tbody>
</table>

5.3 Design Conditions

5.3.1 Design Water Level and Design Elevations

Design high water level: 3.57m
Design low water level: 0.20m

5.3.2 Design Vessel Type

Design vessel types are specified in Chapter 3.

5.3.3 Engineering Geology

Refer to Chapter 2.

5.3.4 Earthquake

Refer to Chapter 2.

5.3.5 Design Loads

(1) Distributed load

Distributed load for quay deck and for trestle is 20 kPa.
(2) Handling machinery load

Two bridge type grab ship unloader will be set on the quay deck, the load of it as follow: rail gauge is 16m, wheel span is 14m, wheel number is 32, the minimum wheel distance 0.85m, and the maximum wheel load is 300kN.

The Evenly distributed load on belt conveyor trestle is taken as 5kN/m².

(3) Mobile equipment load

Mobile equipment load for quay deck: 30 t truck and 70 t mobile truck crane working load.

Mobile equipment load for trestle: 30 t truck and 70 t mobile truck crane traveling load.

(4) Vessel Load

①Mooring force

The mooring force is caused by wind and current. The design wind speed is taken as 22m/s and the current velocity is taken as 2.0m/s. The calculation results of mooring force are shown in Table 5-2.

<table>
<thead>
<tr>
<th>Options</th>
<th>Design vessel type</th>
<th>Design wind speed (m/s)</th>
<th>Design current velocity (m/s)</th>
<th>Calculation Results of Mooring force (kN)</th>
<th>Bollard Select (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option I and II</td>
<td>50,000DWT</td>
<td>22</td>
<td>2.0</td>
<td>849.1</td>
<td>900</td>
</tr>
</tbody>
</table>

②Berthing force

The characteristic value of ship's berthing impact shall be determined in accordance with the effective impact energy of ship calculated through design displacement at full load and normal speed when ship is berthing, characteristic curve of the rubber fender and rigidity of the berthing structure.

The effective impact energy E0 when ship is berthing may be calculated with the following formula:

\[ E_0 = \frac{\rho}{2} MV^2 \]

Where, E0 - Effective impact energy when ship is berthing (kJ);

\( \rho \) - Effective kinetic energy coefficient, taken as 0.75;
5.4 Combinations of Action Effects

5.4.1 Action Effects

The loads on quay deck include dead weight of structure, current force, wind load, vessel load (mooring force and berthing impact), cargo handing machine load, movable machinery load, evenly distributed load on jetty deck, band conveyer machine load, etc.

The loads on trestle include dead weight of structure, current force, movable machinery load, band conveyer machine load, etc.

5.4.2 Combinations of Action Effects

Accidental combination of action effects under accidental status shall be used based on the regulations of the present Load Code for Harbour Engineering (JTS 144-1-2010). The limit-state of the bearing capacity and the normal serviceability limit states shall be considered in the design.

5.5 Marine Structure Options

5.5.1 Design Principles

(1) The maritime structure should be able to satisfy the service requirements of the wharf.

(2) The structure shall be preferably suitable for the geological conditions and able to reduce foundation settlement and differential foundation settlement.

(3) The structure should be constructed economically with advanced technology and easy construction methodology. The local construction conditions shall be considered.

(4) The design life of marine structure is 30 years.

5.5.2 Marine structure selection

According to the nearby project, the soil layer of the project area from top to the bottom may be sand, silt and silt rock. The capacity of sand and silt is weak it can’t be used as the jetty foundation, the silt rock is widely distributed, and it also has a high capacity, can be used as jetty foundation. Because the embedded depth of silt rock is large, so pile foundation shall adopt for marine structure.
Pile for quay deck

As the designed vessel type is 50,000 DWT bulk carrier and the designed ship load is large, steel pipe pile, PHC pile and bored pile may be selected as the foundation. For PHC pile, there is not manufacture can produced in Pakistan, it should be import from China or other country, the weight of PHC pile is very high it is very difficult to transport and easily be damaged either. More over welding technique will be adopted in the splice of PHC piles, when welding the high temperature may break the concrete around the welded seam and affect the life time of the marine structure, so PHC pile can not be used in this project. For steel pile, the pile will be drilled into the strata by a special pile hammer, in order to meet the capacity requirement, in this project area the strata is sand and mudstone which the average SPT is more then 50, especially for mudstone is very difficult for steel pile drilling in, in this condition if steel pile adopted as foundation in the pile toe a lengthening bored pile will be necessary, this scheme means pile drilling equipment and pile borehole equipment will all be used, the construction is very complex and the cost is very high either. After considered all above, bored pile will be used for this project as the quay deck foundation.

Pile for approach trestle and substation platform

The existing sea bed elevation of approach trestle and substation platform is from 0.2~1.5, this area is intertidal zone, the construction work can’t use ship or other off-shore equipment, so bored pile which can be easily taken on the land is adopt as foundation.

Superstructure

The superstructure of pile-supported beam and slab structure mainly includes the precast element structure and cast-in-situ structure. Cast-in-situ structure all the concrete formwork, steel rebar placed and concrete casted shall be on the sea, too much on site work will lead to low construct efficiency. Precast structure most of the element will be precast in prefabricated plant, and erection in site, the rate of performance fast. Consider the characteristic of marine structure, transverse beam and surface will adopt cast-in-suit element, and others will adopt precast element.

5.5.3 Marine Structure Options

For this project two Options of general layout are proposed in the report, Option I and Option II. For each option the quay deck location, length of approach trestle, dredging volume in channel are different. Option I the quay deck is located in the south west of the power plant and Option II the quay deck is about 1.2km far
from the Option I. Basic on the borehole Log the soil strata is similar in this two options, meanwhile consider the marine structure options select, in this report the marine structure for option I and Option II is same which is bored pile support slab and beam structure.

5.5.3.1 Quay deck

The dimensions of quay deck for option I and II is 265m length and 22m width, it include handing platform, transfer tower platform and mooring platform.

The handing platform is pile-supported beam, slab structure, its dimension is 220 m × 22 m, the bents spacing is 8 m. There are 4 Φ1300mm bored piles for each bent, and one Φ1300mm bored pile will be arranged under each crane beam between two bents. The superstructure is consisted of cast-in-situ surface, precast slab, precast crane beam, precast longitudinal beam and cast-in-suit transverse beam. SC1600H rubber fenders will be provided at the front of the platform and 900kN bollards shall be installed at the surface. The cross section of the quay deck is shown in Figure 5-3.

![Figure 5-3 Cross Section of Quay Deck (Option II)](image-url)
The structure of mooring platform is a high pile dolphin structure, whose dimension is 20m × 22m. Its foundation is Φ1300mm bored piles too. Superstructure is reinforced concrete dolphin.

The structure of transfer tower platform is a high pile dolphin structure, whose dimension is 10m × 10m. Its foundation is Φ1300mm bored piles too. Superstructure is reinforced concrete dolphin. 900kN bollards will be installed at the surface. The steel bridge will be used to connect the mooring platform and handing platform.

5.5.3.2 Approach Trestle

The marine structure of the trestle is of pile-supported beam, slab structure. The dimension for Option I is 1020 × 9 m, and for Option II is 444 × 9 m.

The spacing of bents is 10 m. Its foundation is Φ900mm bored piles. There are 2 vertical piles in each bent. The superstructure consists of wearing course, hollow slab, and cast-in-place transverse beam. The cross section of the trestle is shown in Figure 5-2.
5.6 Calculation Method and Results

5.6.1 Calculation Method

The results of the wharf structure is calculated by AUTODESK ROBOT STRUCTRUAL ANALYSIS 2014.

5.6.2 Calculation Results

Calculation results of Option I and Option II of the wharf structure are summarized in Table 5-3.

<table>
<thead>
<tr>
<th>Item</th>
<th>Calculation results</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max design value of bearing capacity of individual pile</td>
<td>4825 KN</td>
<td></td>
</tr>
<tr>
<td>Corresponding design value of moment of individual pile</td>
<td>1063 KN.m</td>
<td></td>
</tr>
<tr>
<td>Max design value of moment of individual pile</td>
<td>1737 KN.m</td>
<td></td>
</tr>
<tr>
<td>Corresponding design value of bearing capacity of individual pile</td>
<td>2216 KN</td>
<td></td>
</tr>
</tbody>
</table>
6. AUXILIARY PROJECTS

6.1 Power Supply and Illumination

6.1.1 Power Source

Two high voltage power lines will be provided by the power plant as power source for the jetty. The rated high voltage is 6.3kV, 50Hz; the rated low voltage is 0.4kV/0.23kV. The frequency is 50Hz. The power connection point is nearby land transfer tower.

6.1.2 Arrangement of Central substation & Jetty Substation

A Jetty Substation will be placed nearby water intake pump room for jetty equipments and lighting. Two 6.3KV lines from the power plant will be the power source for the jetty. The jetty substation consists of switchboard room, control room and duty room. Single bus segmented wiring connection will be adopted in HV and LV single line diagram.

6.1.3 Loads

The main loads of this project are conveyors, ship unloaders, iron remover, harbour illumination, buildings and sewage treatment facilities, maintenance facilities, etc.

<table>
<thead>
<tr>
<th>Equipment capacity (kW)</th>
<th>Active power (kW)</th>
<th>Reactive power (kVar)</th>
<th>Calculated load (kVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jetty Substation</td>
<td>3900</td>
<td>2400</td>
<td>1800</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment capacity (kW)</th>
<th>Active power (kW)</th>
<th>Reactive power (kVar)</th>
<th>Calculated load (kVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jetty Substation</td>
<td>3600</td>
<td>2100</td>
<td>1500</td>
</tr>
</tbody>
</table>

6.1.4 Cable Laying

Low voltage power cables select ZR-YJV-0.6/1kV flame retardant XLPE insulated PVC sheathed power cable. High voltage power cables select ZR-YJV-6/10kV flame retardant XLPE insulated PVC sheathed power cable. All Cables mainly laying in cable tray, local laying in protection pipes.

6.1.5 Illumination

This project exploits energy-efficient gas discharge lamps as the illumination source.
Flood lamps will be provided at the jetty platforms, 8m street lamps and 3m lamps are provided for the conveyor on trestle.

The illuminance is designed as per the relevant codes and standards.

6.1.6 Lightning Protection and grounding

Lightning belts are provided at the roof side of buildings.

Flat steel network are provided for lightning and grounding. Main rebars in the platform piles and access bridge piles will be used as grounding electrodes. Ship unloaders are equipped with steel rail for grounding. Street lamps rely on the foundations for grounding. Rebars in the column foundations are used for building grounding. The grounding resistance satisfies the demands of relevant codes and standards.

6.1.7 Maintenance Facilities

The maintenance power box will be provided on the jetty platform and along the conveyors for supplying power to the maintenance equipment, electrical maintaining tools and test instruments. HV cabinets, LV panels and transformers should be regularly maintained by the power plant.

6.2 Water Supply

6.2.1 Water Source

The potable water, service water and firefighting water are from the corresponding water distribution systems in the power plant. The pipe connections are at the connection of the access bridge and land area.

The parameter at the jetty design boundary:

Potable water pipe of option 1: diameter is DN150, flow is 25m³/h, and pressure is 0.30MPa.

Potable water pipe of option 2: diameter is DN100, flow is 25m³/h, and pressure is 0.30MPa.

Service water pipe: diameter is DN100, flow is 18m³/h, and pressure is 0.45MPa.

Fire fighting water pipe: diameter is DN250, flow is 78L/s, and pressure is 0.50MPa.

The pressures mentioned above are calculated from the elevation of the land at the design boundary.
There are three water supply systems on the jetty: potable water system, service water system and fire fighting system.

Potable water system: Potable water shall be supplied to the user and ship.

Service water system: Wash hydrants shall be provided for wash and ship unloaders.

6.2.3 Water Consumption

The daily potable water consumptions are shown in table 6-3, the daily service water consumption is shown in table 6-4.

<table>
<thead>
<tr>
<th>Table 6-3 Potable water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6-4 Service water consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td></td>
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<tr>
<td>4</td>
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<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

6.2.4 Piping Material and Installation

Potable water pipe shall use lining plastic hot-dip galvanized steel pipe, with threaded connection.

Service water pipe shall use seamless steel pipe, with threaded connection.

The potable water pipe, service water pipe and pipe support shall be with anti-corrosion treatment.

Pipes shall be installed along the pipe supports.
6.3 Drainage

The storm water and sewage shall be discharged separately.

6.3.1 Drainage System

The sewage in the comprehensive building shall be sent to the sewage treatment station in the power plant.

Drainage ditches shall be provided to collect initial rainwater to the wastewater pool. Refer to the part of environment protection for the design after the wastewater pool.

6.4 Fire Fighting

6.4.1 Fire fighting system

(1) Project Description

Construction scale: One 50,000DWT coal berth

(2) Design Scope

The design of jetty platform, access bridge, transfer tower and comprehensive building.

6.4.2 Identification of Fire Hazard

The fire hazard of coal jetty shall be classified as Class C.

6.4.3 The Number of Fires at the Same Time

According to the construction scale, the number of fires at the same time is considered to be one.

6.4.4 Fire Precaution

Jetty platform, Access Bridge and buildings shall be reasonable design to ensure the human evacuation.

The fire resistance rating of the buildings is class II. Fire compartment shall be divided reasonably, and at least one exits of building shall be provided at each fire compartment.

The dust suppression with water shall be provided at the dust place to avoid fire hazard.

Working earthing and protective earthing shall be provided for the electric accessories. Lighting conductors, which connect to ground system, shall be
installed on the roof of the main buildings.

Air conditioner and mechanical ventilation equipment shall be installed in the switchboard to reduce the temperature and the electric fire.

6.4.5 The Design of Fire Fighting System

（1）Fire Fighting Water Source

See 8.3.1.

（2）Fire Fighting Water Consumption

The water flow of fire hydrant system on jetty is 5L/s. The duration is 3h, and one time firefighting water consumption is 54m³.

Automatic sprinkler system shall be installed in the belt conveyor. The intensity is 8L/min.m², flow is 59L/s, the duration is 1h, and one time firefighting water consumption is 212.4m³.

Drencher system shall be installed between the transfer tower and belt conveyor. The intensity is 2L/s.m, flow is 14L/s, the duration is 1h, and one time firefighting water consumption is 50.4m³.

The maximum firefighting water consumption of the project is the belt conveyor. The total firefighting water flow is 78L/s, and one time firefighting water consumption is 316.8m³.

（3）Fire Fighting System

Fire fighting systems for coal jetty include fire hydrant system, automatic sprinkler system and drencher system.

Fire hydrants shall be provided in transfer tower, jetty platform and access trestle.

Automatic sprinkler system shall be installed in the transfer tower and belt conveyor. Automatic sprinkler system includes wet alarm valve, closed sprinkler and so on.

Drencher system shall be installed between the transfer tower and belt conveyor. Drencher system includes deluge valve, open sprinkler, etc.

（4）Piping Material and Installation

Fire hydrant water pipe shall use seamless steel pipe, with welded connection.

Automatic sprinkler pipe and drencher water pipe shall use hot-dip galvanized
steel pipe, with threaded and groove connection.

The pipe and pipe support shall be with anti-corrosion treatment.

Pipes shall be installed along the pipe supports.

（5）The distribution of fire Extinguishers

MF/ABC8 dry powder fire extinguishers shall be distributed in the substation, transfer tower and comprehensive building.

6.5 Communication

6.5.1 Design Scope

According to the characteristics of the project and the requests of relevant codes and standards, the communication design of jetty region include wired communication and line, wireless communication, public address system, CCTV system, fire alarm system etc.

6.5.2 Wired Communication

No automatic phone exchange station will be provided on the jetty region, and the relative phone function is connected from communication station of the rear power plant. At this stage, 30 pairs of telephone cable shall be led from the rear to feed the jetty telephone service. Only disposal of automatic telephone on the jetty region including laying the communication line in relative jetty area are considered.

6.5.3 Wireless Communication

The communication between watercraft and jetty area will be carried with VHF ship to shore radio, which will be placed in the integrated building of the rear power plant. The allocation of VHF ship to shore radio must be approved by the relevant authority of local wireless department.

Communication between the mobile workers on jetty region is carried with VHF wireless interphones. The allocation of VHF wireless interphones must be approved by the relevant authority of local wireless department.

6.5.4 Public Address System

Public address system in jetty region will rely on the rear power plant. In this design, the terminals will be considered in ash jetty, coal handling jetty, jetty access bridge, jetty substation and etc.

6.5.5 CCTV System
In order to be convenient for monitoring handling work on the jetty region, CCTV system will be allocated on the jetty region, which will be formed a uniform monitoring system with the rear power plant. Video signal and images shall be sent back to the plant via fiber optic cable. The cameras shall be erected in ash jetty, coal handling jetty, jetty access bridge, jetty substation and etc.

6.5.6 Fire Alarm System

In order to ensure the security of production, the fire alarm system will be allocated on the jetty region. The linearity temperature cable shall be mounted along both sides of belt-conveyor. The dot fire detectors shall be mounted in the substations and other buildings. The manual alarm call points and spectraalert horn/strobe shall be installed in proper positions. The alarm control manner is automatic alarm, manual affirm then put out the fire. In addition, all of the firefighting facilities shall be interlocked with the fire alarm system. There is a FAS regional control panel in the substation and FAS of jetty is only a sub-system and connected to the plant.

6.6 Control

In order to improve the efficiency and reliability of coal handling system, PLC system shall be considered to control the entire coal handling process in the project.

6.6.1 Structure of Control System

The jetty part of the system consists of remote IO station, field instruments, field control boxes, and etc. The remote IO station is included as a sub-station of coal handling system in the rear. It should be controlled and managed by the rear plant for unity.

The remote IO station shall be set in the substation of jetty. The remote IO station shall have the communication link with the coal handling master station in the rear by fiber-optic cable.

Field instruments include: pull cord switch, prevent deviation switch, slipping switch, tear switch, sound-light alarm, and etc.

Prevent deviation switch: prevent deviation switch has two levels of protection, they are slight deviation and serious deviation. When it is on slight deviation, the system will alarm through the field sound-light alarm and the light on the field control box. When it is on serious deviation, the belt conveyor will be stopped immediately by hard-chain.

Speed switch: velocity switch is installed beside the drive wheel of belt conveyor. It is mainly responsible for sending the stall and fracture information to the field
control box. And then, the system will alarm through the field sound-light alarm and the light on the field control box.

Tear switch: each belt conveyor shall be equipped with tear switch. When tear occurs to the belt, the belt will be stopped immediately by chain.

Local control box includes: local/central control switch, start button, stop button, emergency stop buttons, and etc.

6.6.2 Control Modes of Control System

The main function of the control system is to send out process control instructions via operation station in the central control room, to receive the status of field equipment and instruments, to issue the emergency stop commands, etc. There are three control modes for the control system:

(1). Central control mode: It is the key running mode of control system. Under this mode, controls are done by the central control room of the rear plant automatically and it could reduce the procedure of the staff.

(2). Central jog control mode: Controls are done by the central control room of the rear plant manually. Central control mode and central jog control mode are converted to each other by software.

(3). Local non-interlocked control mode: All operation are based on the by buttons of local control boxes. It’s only used for the trial run and maintenance.

When system starts, the equipment will start one by one against the direction of materials transportation. When system stops, the equipment will stop one by one along the direction of materials transportation.

When error occurs to one of the devices, all of the equipment in the front of error point with backward direction shall be stopped. While for the devices behind the error point, they shall keep running until all of the cargo has been cleared.

6.6.3 Control Cable

The control cable mainly adopts the flame retardant ZR-KVVP-600/1000V Cu core PVC insulated and sheathed Cu wire woven screen flame retardant control cable. The cable is mainly laid along the cable tray at the side of the belt conveyor.

6.7 Building & Structure

6.7.1 Building

(1) General Description
The project is a new-built project. According to the general layout, the buildings include Jetty substation, #1 Transfer station, Coal sampler building and Admin building. The total construction area is 986.4 m². The Main Building Table refers to Table 8.1-1.

(2) Design Option of Key Buildings

#1 Transfer station is the production building of this project. It is 2 layers and steel structure. The layout includes transfer station and dust collector room. It is designed according to the production and building fire prevention requirements. The building's figure is succinct.

(3) Construction and Decoration of the Buildings

The project wall adopts clay brick wall and profiled steel sheet. The roofing adopts high polymer modified bituminous waterproof membrane and profiled steel sheet roofing. The ground adopt anti-slip ceramic tile and cement mortar ground. The floor adopt anti-slip ceramic tile and cement mortar floor. The interior wall adopts emulsion paint veneer wall. The exterior wall adopts emulsion paint veneer wall and profiled steel sheet. The interior doors adopt aluminum alloy doors. The exterior doors adopt aluminum alloy doors, steel doors and fire doors. The windows adopt aluminum alloy windows and steel shutter.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Construction area(m²)</th>
<th>Structural system</th>
<th>The others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jetty substation</td>
<td>282.6</td>
<td>Reinforced concrete structure</td>
<td>27.5mx10m (1 layer)</td>
</tr>
<tr>
<td>2</td>
<td>#1 Transfer station</td>
<td>315.2</td>
<td>Steel structure</td>
<td>15mx10m (2 layers)</td>
</tr>
<tr>
<td>3</td>
<td>Coal sampler building</td>
<td>79.4</td>
<td>Steel structure</td>
<td>6mx6m (2 layers)</td>
</tr>
<tr>
<td>4</td>
<td>Admin building</td>
<td>309.2</td>
<td>Reinforced concrete structure</td>
<td>32mx9.4m (1 layer)</td>
</tr>
</tbody>
</table>

6.7.2 Building Structure

(1) Design Scope

Jetty substation, #1 transfer station, coal sampler building and admin building;

BC-1 belt conveyor trestle, BC-2 belt conveyor trestle;

The supporting columns of Cable tray, The pipe racks on the west side of the access bridge.

(2) Above Ground Structure Design
Jetty substation and admin building are reinforced concrete frame structure with cast-in-situ reinforced concrete floor and roof.

#1 transfer station and coal sampler building are steel structure with steel profiled sheet concrete composite slab floor and roof.

The steel structure shall be used for BC-1 belt conveyor trestle, BC-2 belt conveyor trestle, the supporting columns of Cable tray and the pipe racks on the west side of the access bridge.

(3) Foundation Design

#1 transfer station, Jetty substation and BC-1 belt conveyor trestle shall be located on jetty platform.

BC-2 belt conveyor trestle (except for the portion on land), the supporting column of Cable tray and the pipe rack on the west side of the access bridge shall be located on access bridge.

Admin building, coal sampler building and BC-2 belt conveyor trestle (the portion on land) adopts pre-stressed high strength concrete pipe pile foundation.

(4) Structure Tables

Structure scheme are shown in Table 6-7.

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Scale</th>
<th>Structural Scheme</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The supporting column of Cable tray</td>
<td>H=1.6m</td>
<td>Shape steel column</td>
<td>Include support of water supply and drainage pipe on the east side of the trestle</td>
</tr>
<tr>
<td>2</td>
<td>The pipe rack on the west side of the access bridge</td>
<td>H=1.0m</td>
<td>Shape steel column</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BC-1 belt conveyor trestle</td>
<td>L=219m, W=5.3m, H=5m</td>
<td>Steel structure</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BC-2 belt conveyor trestle</td>
<td>L=50+70m, W=3.8m, H=0~10m</td>
<td>Steel structure</td>
<td>Foundation is D500 PHC pile.</td>
</tr>
</tbody>
</table>

6.8 HVAC

6.8.1 Ventilation and Air Conditioning

(1) Air conditioning system and mechanical ventilation fans shall be both installed in the MV room and LV room in jetty substation. The axial fans are used
to reduce indoor temperature in normal times, and natural air inlet is through the manual adjustment louvers, air changes are not less than 12 times per hour. When the mechanical ventilation could not meet the cooling requirement, turn off the fans and louvers and turn on the split air conditioners to reduce temperature.

(2) Split air conditioner shall be installed in admin building, duty room and control room in jetty substation for cooling.

(3) The exhaust fans shall be provided for toilet and the air changes are no less than 10 times per hour.

6.8.2 Service Hot Water

To meet the hot water requirement for shower room in admin building, an air source heat pump system shall be installed on the roof. The system consists of heat pump units, hot water tank, water pump, automatic control system, valves and pipes, etc.

6.8.3 Dust Removal

(1) Mechanical dust removal

The pulse bag dust collector system shall be installed in #1 transfer station. The dust collecting system collects dust from the guide chute of belt conveyer system by negative pressure. Bag dust collectors are installed in the dust collector room. The dust collecting system is interlocked with belt conveyer system and it is controlled in manual, automatic and centralised by PLC cabinet.

One air compressor is installed in the dust collector room to provide cleaning air.

(2) Spray dust suppression

The spray dust suppression system shall be provided to suppress dust at the top of the dump hopper on ship unloaders and the head of belt conveyer in #1 transfer station. The dust suppression system is controlled in manual, automatic and centralised by PLC cabinet.

The spray dust suppression equipment on the ship unloaders should be installed by manufactory.
7. ENVIRONMENT PROTECTION

7.1 Main Pollution Resource and Pollutants in Construction Period

(1) Atmosphere Environment

Fugitive dust emission occurs due to construction activities including equipment usage, construction material transporting, earthworks and stockpiling of materials etc., particularly during dry and windy days.

Tail gases from construction machines and transport vehicles will increase the atmospheric NOx, CO and hydrocarbons.

(2) Water Environment

Potential high-SS flows in the construction site may arise from construction related activities including placement of the piles of jetty etc.

Bilge discharge of construction ships may deteriorate the water environment with main pollutants of oil and grease. The concentration of pollutants of oil and grease can reach 5000mg/L.

Domestic sewage discharge from constructors and construction ships, which contains COD 400mg/L, NH3-N 30mg/L and BOD5 250mg/L, is likely to cause high concentrations of COD, BOD5, SS and NH3-N in water environment.

(3) Acoustic Environment

Operation noise is mainly generated by the operation of construction equipment including pile driver etc. Haulage trucks and construction ships may also generate traffic noise. The noise pressure level can reach 76 to 110 dB(A).

(4) Solid Waste

Solid wastes during construction period include construction solid wastes and domestic garbage.

7.2 Main Pollution Resource and Pollutants in Operation Period

(1) Atmosphere Environment

Handling equipment and ships exhaust tail gases with main pollutants of CO, hydrocarbons and NOx.

Fugitive dust emission occurs during coal handling and conveying which may increase atmospheric TSP.

(2) Water Environment
Discharge of domestic sewage from jetty staffs, which contains COD 400mg/L, NH3-N 30mg/L and BOD5 250mg/L, is likely to cause high concentrations of COD, BOD5, SS and NH3-N in water environment.

Discharge of bilges water of arriving ships may deteriorate the water environment with main pollutants of oil and grease. The concentration of pollutants of oil and grease can reach 5000mg/L.

High-SS flows occur due to flushing at coal jetty platform with the amount of 17.05m3 per time. The SS concentration reaches 1000mg/L. Initial rainwater at coal jetty platform may also bring high-SS wastewater with concentration of about 150 mg/L.

(3) Acoustic Environment

Noise is mainly generated by conveying and handling machines and arriving and departing ships.

(4) Solid Waste Generation

Solid wastes during operation period include domestic garbage produced by jetty staffs. Production wastes will be produced from coal handling and conveying. And arriving vessels will bring domestic garbage and maintenance wastes.

7.3 Measures for Pollution Mitigation in Construction Period

(1) Measures for Atmosphere Environment Pollution Mitigation

Periodically sprinkling and sweeping the construction area, stock piles and unpaved access can reduce fugitive dust emission.

Construction materials can be stockpiled together and covered to control dust emission. The haulage vehicles can also be covered to control dust emission. Overload of haulage vehicles should be forbidden to avoid building material drop.

Construction equipment and vehicles shall be properly maintained and serviced, and high-quality oils should be applied if possible.

(2) Measures for Water Environment Pollution Mitigation

Low-impact construction plan of underwater construction works should be preferred such as use turbidity barriers around underwater construction area if possible and effective underwater construction equipment should be applied.

Construction scheme should be scheduled and planed reasonably such as shortening the construction period as much as possible, avoiding underwater construction works at inclement weather and spawning and nesting period of aquatic species such as fish and shrimp etc., and controlling the region of underwater construction to minimize water
environment pollution.

The collection and disposal of domestic sewage from constructors can rely on power station construction site. Domestic sewage and bilge petroleum wastewater from construction vessels should be collected and disposed by qualified treatment company according to local maritime department and environmental protection department.

(3) **Measures for Acoustic Environment Pollution Mitigation**

Low-noise machines and equipment should be preferred for construction. All the machines and equipment should be maintained at good condition to reduce produced noise.

The operation of high-noise construction works, machines and equipment should be scheduled reasonably, especially avoiding night operation.

High-noise machines and equipment should be operated with noise reduction measures such as acoustic booth or barrier.

(4) **Treatment of Solid Waste**

The collection and disposal of domestic garbage from constructors can rely on power plant construction site.

The construction solid wastes from jetty should be reused in power plant construction works or rely on power plant construction site for collection and disposal.

7.4 **Measures for Pollution Mitigation in Operation Period**

(1) **Measures for Atmosphere Environment Pollution Mitigation**

Jetty platform and access bridge should be swept regularly to control dust emission.

Dust suppression systems should be installed to control dust during the handling and conveying of coal, such as setting up windshield along belt conveyor at jetty apron while enclosing other part of belt conveyor system by corridor, installing sprinkler and windshield at discharge funnel, and installing dust suppression plant in transfer station etc.

Electromechanical machines and equipment can be applied instead of oil-engine ones to relieve atmospheric pollution. Alternatively, environmental friendly oil-engine machines and equipment which produce lower amount of pollutants can be applied with high-quality gasoline to decrease atmospheric pollution.

(2) **Measures for Preventing Pollution of Water Environment**

Vessel wastewater including domestic sewage and petroleum wastewater should be
collected and treated by qualified treatment company according to local maritime department and environmental protection department. Discharge of petroleum wastewater in surrounding water area of the jetty is forbidden.

Domestic sewage at office building onshore can be pretreated and collected at septic tank and then flow to sewage treatment system in the power plant for disposal. Domestic sewage produced offshore can be collected by mobile toilet set at jetty substation platform, and then sent to sewage treatment system in the power plant for disposal regularly.

Wastewater pools should be set under coal jetty platform to collect initial rainwater and flushing wastewater at jetty platform. Then wastewater can be pumped to coal wastewater treatment system in the power plant for further disposal.

(3) Measures for Acoustic Environment Pollution Mitigation

The operation time of high noisy machines and equipment should be controlled and operated under noise reduction measures. Night operation should be avoided as far as possible.

(4) Treatment of Solid Waste

Garbage bins should be set at coal jetty to collect domestic garbage produced by jetty staffs and the can be sent to the power station for further disposal.

Domestic garbage and oil bearing waste from arriving vessels should be collected and treated by qualified treatment company according to local maritime department and environmental protection department. Discharging without proper treatment is forbidden.

7.5 Ecological Impacts and Mitigation Measures

(1) Impacts Assessment

Underwater construction works such as jetty foundation construction are expected to disturb pelagic and benthic organisms by increasing TSS concentrations of water column and creating noise vibrations. However, the impact is restricted to the project footprint and has short-term persistence.

During operation period, wastewater including coal wastewater and domestic sewage etc. in this project will be collected and treated properly with almost no direct discharge, which cause little ecological impact.

(2) Mitigation Measures

Construction vessels and construction technologies which have lesser adverse impact
on water environment should be preferred.

Construction scheme should be scheduled and planned reasonably such as shortening the construction period as much as possible, avoiding underwater construction works at inclement weather and controlling the region of underwater construction to minimize water environment pollution.
8. CONSTRUCTION CONDITIONS, METHODS AND SCHEDULE

8.1 General Description

The project recommend scheme mainly consists of one coal unloading quay deck, one trestle and auxiliary facilities.

The structure of quay deck and trestle all is high pile-supported beam and slab structure.

8.2 Construction Conditions

8.2.1 Existing Conditions

Water supply, electricity supply, communication and other temporary facilities can be based on the temporary facilities of the power plant during construction period.

8.2.2 Pre-casting Yard Conditions

There is not a large-scale concrete components precast factory nearby. Pre-casted parts of marine structure could be constructed in the temporary precast field which will build near project area.

8.2.3 Construction Materials

The mainly construction material is sand and stone used to construct the jetty. According to the investigation, there are rock quarry nearby which can meet the needs of engineering construction. Steel bar, cement and other building materials can be purchased in nearby areas.

8.3 Construction Method

8.3.1 Construction Characteristics

The quay deck and trestle all is high-pile beam-slab structure.

According to the nature characteristic of the site, the quay deck can be constructed from water area and the trestle can be constructed from land area.

The key control point of the project and difficulty of construction, the controlling factor of quality and duration of the project is the construction of pile foundation. Therefore, the construction company should be equipped with precast production, lifting and installation equipment, and other construction equipment.

As the large number of offshore works, the construction should be carefully planned, closely preparation, and good construction organization. The construction company should make practical processes, and give full utilization
of construction machinery to strengthen management processes. Especially, the company should strengthen the important and the difficult engineering management, to ensure construction quality, safety and schedule.

8.3.2 Construction Technology

(1) Marine Structure Construction sequence
The quay deck construction sequence diagram is shown in 8-1, and the trestle construction sequence diagram is shown in 8-2.

(2) Machine installation sequence
Machine order → Machine installation → Test → Completion and check for acceptance

(3) Building Construction sequence
Foundation construction → Major structure construction → Exterior wall construction → Roofing construction → Water and electricity supply installation → Decoration of indoor and outdoor → Completion and check for acceptance
Figure 8-1 Quay Deck Construction Sequence
8.4 Construction Overall Arrangement

The construction of the quay deck, the trestle, and the dredging basin can be conducted by assembly-line.

8.5 Construction Duration

Because it has a large quantity of offshore construction works, the construction processes are easily subjected to wind and wave effects, the construction schedule should be carefully planned, strengthen management, to ensure construction quality and construction safety. According to the construction of the project scale, structure type
and construction conditions, the construction duration is about 32 months.
9. QUOTATION DESCRIPTION

9.1 Overview
The investment includes: dredging of harbor basin and navigation channel, aids to navigation, tugboat procurement, marine structure, handling system equipment procurement & installation, building of production & auxiliary facilities, power supply & illumination, communication, control system, water supply & drainage fire fighting, HVAC, environment protection, temporary work etc.

9.2 The Total Investment
The total investment of option I is $253,781 \times 10^3$ USD.
The total investment of option II is $255,485 \times 10^3$ USD.

9.3 Basis for Quotation
- Quotation is made as per the construction methodology, bill of quantities and equipment schedule
- Quotation based on equipment and facilities prices in the Chinese market.
- Sand, crushed stone and main material price is collected in Pakistan
- Quotation is made as per the ocean shipping cost from China to Pakistan collected at present.

9.4 Fees Included

9.4.1 The project static investment costs includes
- Direct and indirect cost of construction, installation and procurement of equipment:
- Mobilization & demobilization cost of construction equipment and workboat (considering of 1 pile driving barge, 1 dredging barge, 1 floating crane, and 1 mud barge);
- Mobilization & demobilization of staff and labor (considering 320 Chinese constructor labors, and construction period of 32 months);
- Temporary works (includes temporary construction camp, temporary prefabricate yard and other construction temporary works costs);
- Joint-commissioning cost (technical support and necessary cost of consumables during the no-load of handling system);
- Topographical and geological survey & exploration cost (drilling holes for the
jetty area and channel area of the construction drawing stage, survey cost for channel and jetty area);

- Design fee;
- Research & trial cost (port area hydrological data collection cost);
- Seabed sweep cost (according to the area of seabed sweep);
- Engineering insurance premium (including project all risks insurance, equipment, personnel injury and third-party liability insurance and transportation all risks insurance);
- HSE cost (environmental protection cost, medical treatment cost, health care expenses during the period of construction);
- Marine transportation insurance (Marine transportation insurance for port service tugs, calculated at 0.15% of ship purchase cost);
- Profit (4% of Direct cost of construction);
- Withholding tax (Pakistan withholding tax, 6% of the construction and installation engineering cost);
- Contingency cost (4% of direct cost of construction, risks mainly includes geology deviation, terrain deviation, and hydrological deviation, etc.).
- Export rebate (10% of equipment purchase price).

9.4.2 The project dynamic investment costs includes

- Custom duty;
- Financial administration fees;
- IDC;
- Owner's contingency cost;
- Bank loan interest of construction period.

9.5 Correlative Description

- The land acquisition and sea area acquisition cost are not included in the quotation.
- Equipment procurement: the equipment of handling system and utility works are purchased in China, and are transported to Pakistan site by ocean shipping.
Materials procurement: the materials of utilities works, rubber fenders, steel pile and steel structure are purchased in China, are transported to Pakistan site by ocean shipping.

The construction equipment & workboats are presumed to be mobilized to site from China.

The dredging spoiling distance is considered as 10Km, and the correlative cost of dredged material dumping area doesn’t take into account in the quotation.

The dredged material is considered as sand and mud, and there is no reef.

The cost of piling test includes static load test and big-strain and motive load test.

The rate of contingency cost is calculated as 4%.

Exchange rate: USD: CNY= 1:6.5
### Estimated Table for Option I

#### Unit, 10^3 USD

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10. CONCLUSION AND SUGGESTION

10.1 Conclusion

The two options proposed in this report all is feasible, the construction complexity is in same level, only in dredging volume Option II is about 1.00 million more than Option I, therefore the dredging influence to environment for Option II is higher than Option I, moreover the longer new channel in Option II means more operations work. For the investment and operation cost for Option II and Option I is similar, after considered the advantage and disadvantage for both two options, Option I is recommend in this report.

10.2 Suggestion

The channel for this project will utilize the Sinohydro channel, the owner shall connect the Sinohydro project Owner to make sure the Sinohydro channel schedule, using permission and using cost etc.
### 11. APPENDIX A DRAWINGS

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<th>Drawing Name</th>
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<td>General Layout of Navigation Channel-Option II</td>
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<td>Plan of Marine Structure</td>
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<td>Cross Section of Marine Structure</td>
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12. APPENDIX B BOREHOLE LOG
Port Qasim 2×350MW Supercritical Coal-fired Power Plant Project, Pakistan

2-D Mathematical Model Test of Cooling Water Heat Dispersion

CHINA MACHINERY ENGINEERING CORPORATION

April, 2016
工程咨询单位资格证书

单位名称：交通运输部天津水运工程科学研究所

资格等级：甲级

服务范围

港口河海工程

规划咨询、编制项目建议书、编制项目可行性研究报告、评估咨询

航道工程

编制项目建议书、编制项目可行性研究报告、评估咨询

海港工程

规划咨询、编制项目建议书、编制项目可行性研究报告、评估咨询

水上桥梁

编制项目建议书、编制项目可行性研究报告、评估咨询

生态保护和环境工程

编制项目建议书、编制项目可行性研究报告、评估咨询

以上各专业均涵盖本专业相应职能部门在内的全部内容，取得编制项目可行性研究报告、项目评估报告的单位，具备编制固定资产投资项目评估报告的能力，取得咨询评估报告的单位，具备对固定资产投资项目评估报告进行评审批复的能力。

证书编号：工咨甲20220070004

证书有效期：至2016年08月29日

中华人民共和国住房和城乡建设部制

Lloyd's Register LRQA

认证证书

兹证明下列公司之质量管理体系：

交通运输部天津水运工程科学研究所

中华人民共和国，天津市滨海新区
塘沽新港二号路2618号

通过劳氏质量认证有限公司之认证

符合下列质量管理体系标准：

ISO 9001:2008
GB/T 19001-2008

该质量管理体系适用于：

提供内河港航、海岸河口、海洋等方面的科研、技术咨询

和培训；提供水工建造、海洋资源利用、环境影响评价、

环境工程、风工程、岩土工程的科研、技术咨询和培训；

提供相应的仪器设备、信息技术的开发、咨询和服务；

提供环境工程、水运工程设计服务；提供测绘和勘察服务。

提供水运工程及其辅助和配套工程监理。

首次授予日期：1999年2月5日

证书有效期至：2017年2月28日

劳氏质量认证（上海）有限公司

代表劳氏质量认证有限公司

证书编号：QAC0991047
Table of Content

1 GENERAL ..............................................................................................................................1

2 CODES AND STANDARDS ...............................................................................................3

3 ESTABLISHMENT OF MATHEMATICAL MODEL..........................................................4

4 RESULT OF 2-D MATHEMATICAL MODEL TEST ...........................................................9
   4.1 SIMULATION CONDITION .........................................................................................9
   4.2 2-D MATHEMATICAL MODEL RESULT ....................................................................9
   4.3 COMPLEMENTARY CASES RESULTS .......................................................................39

5 RELATED BACKGROUND DESCRIPTIONS COLLECTED FROM EIA REPORT ..................54

6 MODEL TEST RESULT AND CONCLUSION ....................................................................58

APPENDIX: CERTIFICATE OF SOFTWARE PERMISSION ..............................................65
1 General

As the authorized consultant company by China Machinery Engineering Corporation (CMEC), Tianjin Research Institute for Water Transport Engineering Ministry of Transport, P.R.C (hereinafter referred to TIWTE) has carried out 2-D Mathematical Model Test of Cooling Water Heat Dispersion study works on Port Qasim 2X350MW Supercritical Coal-fired Power Plant Project (refer to Qasim project) basing on the bathymetry and hydrometry survey during Jan and Feb, 2016.

The location of the project is 9.5km away from Port Qasim in the east in Karachi. Karachi is located in southern Sindh Province, Pakistan. The geographic coordinates of the Port Qasim 2×350MW Coal-fired Power Plant Project (hereinafter referred to as Qasim project) is located at 24°46'57″ N, 67°26'6″E (seen in Fig.1.1), the plan layout is as shown in Fig.1.2 and Fig.1.3.

2×350MW coal-fired power generation units will be constructed for the project. Sea water is used for direct cooling water supply system. Circulating water temperature rise is not more than 7ºC, and the background water temperature is 28ºC. Circulating water discharged from two units is about 36.83m³/s.

In addition, a new Siddiqsons 1x350MW power plant (hereinafter referred to as S project) to be built on the west side of these two units site. In S project, circulating water temperature rise is also deemed not more than 7ºC, and the background water temperature is 28ºC. Circulating water discharged from S project is 18.06m³/s.
Fig.1.1-2 View of location of project area

Fig.1.2-1 Power Plant Layout of Scheme I

Fig.1.2-2 Power Plant Layout of Scheme II
2 Codes and Standards

The codes and standards to be implemented in this report are based on below:

1) Field observation data such as hydrology, meteorology, terrain, etc.

2) Technical requirements for numerical simulation of the circulating warm water discharge of the 2x350MW supercritical coal fired power plant project in Qasim port, Pakistan


4) “Tidal current and sediment simulation technology in coastal and estuarine” (JTS/T231-2-2010) issued by the Ministry of communications in China.

5) “Harbor hydrological code” (JTS145-2-2013) issued by the Ministry of communications in China.

6) “Deep Provision on the content of the preliminary design document of thermal power plants. 5427-2009 DL/T

7) “Technical specifications for design of small thermal power plants” 50049-2011 GB.

8) “Technical specification for hydraulic engineering design of thermal power plants” 5339-2006 DL/T.

9) “Design code for the general design of the harbor” JTJ211-99.
3 Establishment of Mathematical Model

The geography data of the model includes sea chart Port Qasim and Approaches origin (1:10000) provided by PQA (Seen in Fig. 3.1), MIKE C-MAP, the measured bathymetric data locally as well as project layout drawing provided by the Design Institute authorized by China Machinery Engineering Co., Ltd (Seen in Fig.3.2).

Fig. 3.1 Sea Chart of PQA Provided Port Qasim and Approaches Origin (1:10000)

Fig. 3.2-1 Plane Layout of Plan I
In order to improve the computational efficiency and ensure enough resolution in project area, unstructured triangular mesh with local refinement is adopted. The mesh chart of the 2-D mathematical model is shown in Fig. 3.3 and Fig. 3.4 respectively. The model including the sea area beyond -36 isobaths, from north to south is approximately 83.7 km, from west to east is approximately 54.0 km. Model calculation utilizes as follows:

1. Local encryption triangular grid.
2. The longest spacing is 1000m.
3. The shortest spacing is 5m.
The mathematical model verification work has been carried out by TIWTE. Mathematical model results of simulated tide level processes, and sea current speed as well as direction series during spring and neap tide are well coincidental with local measured data. The flood and ebb tide field are shown in Fig.3.5 and Fig.3.6 respectively.
Fig.3.5 Simulated flood tide current field nearby the project
Fig. 3.6 Simulated ebb tide current field pattern nearby the project
4 Result of 2-D Mathematical Model Test

4.1 Simulation condition

9 calculation cases are considered and the conditions of the simulation cases are shown as follows (seen in Tab.4.1).

The warm water discharged from S project is merged together with Qasim project at the same area in Case 9 as well as the intakes layout of both two projects are remained the same location. The locations of the intakes and outlets of Qasim project and S project are shown in Tab.4.2.

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Table 4.2 Locations of water intakes and water outlet of Qasim project and S project

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4.2 2-D mathematical model result

The 2-D mathematical model was used to simulate the heat dispersion of cooling water in a whole tidal cycle within 20 days.

The temperature rise envelope of high tide, low tide, flood maximum, ebb maximum of typical spring tide and neap tide are shown in Fig.4.1-Fig.4.16, and the envelope areas are shown in Tab.4.3. The average temperature rises of Qasim project intake are
shown in Tab.4.4. The temperature rise process of Qasim project intake is shown in Fig.4.17-4.25. The temperature rise process of case9 is shown in Fig.4.26.

Fig.4.1-1 Temperature rise of high tide of neap tide of plan I and open channel intake under S project not operating (Case 1)

Fig.4.1-2 Temperature rise of low tide of neap tide of plan I and open channel intake under S project not operating (Case 1)
Fig. 4.1-3 Temperature rise of flood maximum of neap tide of plan I and open channel intake under S project not operating (Case 1)

Fig. 4.1-4 Temperature rise of ebb maximum of neap tide of plan I and open channel intake under S project not operating (Case 1)

Fig. 4.2-1 Temperature rise of high tide of spring tide of plan I and open channel intake under S project not operating (Case 1)
Fig. 4.2-2 Temperature rise of low tide of spring tide of plan I and open channel intake under S project not operating (Case 1)

Fig. 4.2-3 Temperature rise of flood maximum of spring tide of plan I and open channel intake under S project not operating (Case 1)

Fig. 4.2-4 Temperature rise of ebb maximum of spring tide of plan I and open channel intake under S project not operating (Case 1)
Fig. 4.3-1 Temperature rise of high tide of neap tide of plan II and open channel intake under S project not operating (Case 2)

Fig. 4.3-2 Temperature rise of low tide of neap tide of plan II and open channel intake under S project not operating (Case 2)

Fig. 4.3-3 Temperature rise of flood maximum of neap tide of plan II and open channel intake under S project not operating (Case 2)
Fig.4.3-4 Temperature rise of ebb maximum of neap tide of plan II and open channel intake under S project not operating (Case2)

Fig.4.4-1 Temperature rise of high tide of spring tide of plan II and open channel intake under S project not operating (Case2)

Fig.4.4-2 Temperature rise of low tide of spring tide of plan II and open channel intake under S project not operating (Case2)
Fig.4.4-3 Temperature rise of flood maximum of spring tide of plan II and open channel intake under S project not operating (Case2)

Fig.4.4-4 Temperature rise of ebb maximum of spring tide of plan II and open channel intake under S project not operating (Case2)

Fig.4.5-1 Temperature rise of low tide of neap tide of plan I and pipe intake under S project not operating (Case3)
Fig.4.5-2 Temperature rise of low tide of neap tide of plan I and pipe intake under S project not operating (Case3)

Fig.4.5-3 Temperature rise of flood maximum of neap tide of plan I and pipe intake under S project not operating (Case3)

Fig.4.5-4 Temperature rise of ebb maximum of neap tide of plan I and pipe intake under S project not operating (Case3)
Fig. 4.6-1 Temperature rise of high tide of spring tide of plan I and pipe intake under S project not operating (Case3)

Fig. 4.6-2 Temperature rise of low tide of spring tide of plan I and pipe intake under S project not operating (Case3)

Fig. 4.6-3 Temperature rise of flood maximum of spring tide of plan I and pipe intake under S project not operating (Case3)
Fig.4.6-4 Temperature rise of ebb maximum of spring tide of plan I and pipe intake under S project not operating (Case3)

Fig.4.7-1 Temperature rise of high tide of neap tide of plan II and pipe intake under S project not operating (Case4)

Fig.4.7-2 Temperature rise of low tide of neap tide of plan II and pipe intake under S project not operating (Case4)
Fig.4.7-3 Temperature rise of flood maximum of neap tide of plan II and pipe intake under S project not operating (Case4)

Fig.4.7-4 Temperature rise of ebb maximum of neap tide of plan II and pipe intake under S project not operating (Case4)

Fig.4.8-1 Temperature rise of high tide of spring tide of plan II and pipe intake under S project not operating (Case4)
Fig. 4.8-2 Temperature rise of low tide of spring tide of plan II and pipe intake under S project not operating (Case 4)

Fig. 4.8-3 Temperature rise of flood maximum of spring tide of plan II and pipe intake under S project not operating (Case 4)

Fig. 4.8-4 Temperature rise of ebb maximum of spring tide of plan II and pipe intake under S project not operating (Case 4)
Fig. 4.9-1 Temperature rise of high tide of neap tide of plan I and open channel intake under S project operating (Case5)

Fig. 4.9-2 Temperature rise of low tide of neap tide of plan I and open channel intake under S project operating (Case5)

Fig. 4.9-3 Temperature rise of flood maximum of neap tide of plan I and open channel intake under S project operating (Case5)
Fig. 4.9-4 Temperature rise of ebb maximum of neap tide of plan I and open channel intake under S project operating (Case5)

Fig. 4.10-1 Temperature rise of high tide of spring tide of plan I and open channel intake under S project operating (Case5)

Fig. 4.10-2 Temperature rise of low tide of spring tide of plan I and open channel intake under S project operating (Case5)
Fig. 4.10-3 Temperature rise of flood maximum of spring tide of plan I and open channel intake under S project operating (Case 5)

Fig. 4.10-4 Temperature rise of ebb maximum of spring tide of plan I and open channel intake under S project operating (Case 5)

Fig. 4.11-1 Temperature rise of high tide of neap tide of plan II and open channel intake under S project operating (Case 6)
Fig. 4.11-2 Temperature rise of low tide of neap tide of plan II and open channel intake under S project operating (Case 6)

Fig. 4.11-3 Temperature rise of flood maximum of neap tide of plan II and open channel intake under S project operating (Case 6)

Fig. 4.11-4 Temperature rise of ebb maximum of neap tide of plan II and open channel intake under S project operating (Case 6)
Fig.4.12-1 Temperature rise of high tide of spring tide of plan II and open channel intake under S project operating (Case6)

Fig.4.12-2 Temperature rise of low tide of spring tide of plan II and open channel intake under S project operating (Case6)

Fig.4.12-3 Temperature rise of flood maximum of spring tide of plan II and open channel intake under S project operating (Case6)
Fig. 4.12-4 Temperature rise of ebb maximum of spring tide of plan II and open channel intake under S project operating (Case 6)

Fig. 4.13-1 Temperature rise of high tide of neap tide of plan I and pipe intake under S project operating (Case 7)

Fig. 4.13-2 Temperature rise of low tide of neap tide of plan I and pipe intake under S project operating (Case 7)
Fig.4.13-3 Temperature rise of flood maximum of neap tide of plan I and pipe intake under S project operating (Case7)

Fig.4.13-4 Temperature rise of ebb maximum of neap tide of plan I and pipe intake under S project operating (Case7)

Fig.4.14-1 Temperature rise of high tide of spring tide of plan I and pipe intake under S project operating (Case7)
Fig. 4.14-2 Temperature rise of low tide of spring tide of plan I and pipe intake under S project operating (Case7)

Fig. 4.14-3 Temperature rise of flood maximum of spring tide of plan I and pipe intake under S project operating (Case7)

Fig. 4.14-4 Temperature rise of ebb maximum of spring tide of plan I and pipe intake under S project operating (Case7)
Fig. 4.15-1 Temperature rise of high tide of neap tide of plan II and pipe intake under S project operating (Case 8)

Fig. 4.15-2 Temperature rise of low tide of neap tide of plan II and pipe intake under S project operating (Case 8)

Fig. 4.15-3 Temperature rise of flood maximum of neap tide of plan II and pipe intake under S project operating (Case 8)
Fig. 4.15-4 Temperature rise of ebb maximum of neap tide of plan II and pipe intake under S project operating (Case8)

Fig. 4.16-1 Temperature rise of high tide of spring tide of plan II and pipe intake under S project operating (Case8)

Fig. 4.16-2 Temperature rise of low tide of spring tide of plan II and pipe intake under S project operating (Case8)
Fig. 4.16-3 Temperature rise of flood maximum of spring tide of plan II and pipe intake under S project operating (Case 8)

Fig. 4.16-4 Temperature rise of ebb maximum of spring tide of plan II and pipe intake under S project operating (Case 8)

Tab. 4.3 Temperature rise envelope area of high tide, low tide, flood maximum, ebb maximum of typical spring and neap tide

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### Tab.4.4 Average temperature rise at the intake of Qasim project

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<td></td>
<td>Pipe</td>
<td>Plan I</td>
<td>1.17</td>
</tr>
</tbody>
</table>

**Unit:** ℃

**Fig.4.17** Temperature rise process of Case 1 in whole tide cycle

**Fig.4.18** Temperature rise process of Case 2 in whole tide cycle

**Fig.4.19** Temperature rise process of Case 3 in whole tide cycle
Fig. 4.20 Temperature rise process of Case 4 in whole tide cycle

Fig. 4.21 Temperature rise process of Case 5 in whole tide cycle

Fig. 4.22 Temperature rise process of Case 6 in whole tide cycle

Fig. 4.23 Temperature rise process of Case 7 in whole tide cycle

Fig. 4.24 Temperature rise process of Case 8 in whole tide cycle
Fig. 4.25 Temperature rise process of case 9 in whole tide cycle

The isotherm of average temperature rise of case 7 and the local view of estuary are shown in Fig.4.26 and Fig.4.27. The maximum temperature rise of case 7 and the local figure of estuary are shown in Fig.4.28 and Fig.4.29. The isotherm of average temperature rise of case 9 and the local view of estuary are shown in Fig.4.30 and Fig.4.31. The maximum temperature rise of case 9 and the local figure of estuary are shown in Fig.4.32 and Fig.4.33. The average temperature rise of both Case 7 and Case 9 decrease below 3°C within 100m range outside the estuary of outlet creek.

Fig. 4.26 The isotherm of average temperature rise of case 7
Fig. 4.27 The isotherm of average temperature rise of case 7 (estuary of creek)

Fig. 4.28 The isotherm of maximum temperature rise of case 7

Fig. 4.29 The isotherm of maximum temperature rise of case 7 (estuary of creek)
Fig. 4.30 The isotherm of average temperature rise of case 9

Fig. 4.31 The isotherm of average temperature rise of case 9 (estuary of creek)

Fig. 4.32 The isotherm of maximum temperature rise of case 9
Based on the results of case 9, the average temperature rise would exceed 1 °C when the warm water discharged from S project is merged into the outfall of Qasim project. The pipe of intake is recommended to move to south 200 m and be set on the edge of the contour of 1 °C (seen in Fig. 4.34), and the location is at 337560.85 east, 2740800.31 north.

4.3 Complementary cases results

6 cases were considered to 2-D Mathematical Model Test in this section. Siddiqsons plant (referred to S project) is not operating in case C1, and operating in the case C2. Qasim-outlet is moved eastward, and the Qasim-intake remains the original layout. Pipe-type intake is used in C1 and C2 (shown in Fig. 4.35). Siddiqsons plant is not operating in case C3, and operating in case C4. Open channel intake is used in case C3 and case C4 (shown in Fig. 4.36). In case C5 and C6, Siddiqsons-outlet is moved
eastward and combined together with Qasim-outlet. Pipe-type intake is used in C5 and open channel is used in C6 (shown in Fig. 4.37).

The average temperature rises of case C2 and C4 are 1.10°C and 1.18°C respectively, still slightly higher than 1°C, which is mainly influenced by the outflow hot water from S project. In case C5 and C6, as the outlets of Q-project and S-project are moved even east, the average temperature rise at Q-intake decrease to 0.78°C and 0.82°C respectively.

**Tab. 4.5 Average temperature rises of Qasim-intake in 6 cases**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Intake layout</th>
<th>Q-intake</th>
<th>Q-outlet</th>
<th>S project</th>
<th>Average Temperature Rise (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Pipe</td>
<td>Original layout</td>
<td>Not operating</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>Pipe</td>
<td>Original layout</td>
<td>East (Textile Area)</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>Open channel</td>
<td>Original layout</td>
<td>Not operating</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Open channel</td>
<td>Original layout</td>
<td>Original layout</td>
<td>1.18</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Pipe</td>
<td>East</td>
<td>East</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>Open channel</td>
<td>East</td>
<td>East</td>
<td>0.82</td>
<td></td>
</tr>
</tbody>
</table>

Total hours statistics of CW drainage water with 3°C temperature rise exceed regulatory mixing-zone (100m) boundary is indicated in Tab. 4.6. In case 7 and case 9, pipe-type intake is used and S-project is operating. The outlet of S-project in case 7 is in west and combined with Q-project outlet to the eastern creek in Case 9.

**Tab. 4.6 Total hours statistics of CW drainage water with 3°C temperature rise exceed 100m-mixing-zone boundary**

*Unit: hour*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Perday</th>
<th>Per month</th>
<th>Per year</th>
<th>Percentage/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring tide</td>
<td>Neap tide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 7</td>
<td>9</td>
<td>19</td>
<td>407</td>
<td>4886</td>
</tr>
<tr>
<td>Case 9</td>
<td>12</td>
<td>20</td>
<td>453</td>
<td>5434</td>
</tr>
<tr>
<td>C1</td>
<td>2</td>
<td>10</td>
<td>199</td>
<td>2392</td>
</tr>
<tr>
<td>C2</td>
<td>2</td>
<td>9</td>
<td>181</td>
<td>2169</td>
</tr>
<tr>
<td>C3</td>
<td>2</td>
<td>8</td>
<td>162</td>
<td>1946</td>
</tr>
<tr>
<td>C4</td>
<td>2</td>
<td>8</td>
<td>162</td>
<td>1946</td>
</tr>
<tr>
<td>C5</td>
<td>4</td>
<td>12</td>
<td>250</td>
<td>3000</td>
</tr>
</tbody>
</table>
Fig. 4.35 Layout of case C1

Fig. 4.36 Layout of case C2

Fig. 4.37 Layout of case C3&C4
Fig. 4.38 Layout of case C5

Fig. 4.39 Layout of case C6
Fig. 4.40 Temperature rise process of case C1 in whole tide cycle

Fig. 4.41 The isotherm of average temperature rise of case C1

Fig. 4.42 The isotherm of average temperature rise of case C1 (near Qasim-outlet)
Fig. 4.43 The isotherm of maximum temperature rise of case C1

Fig. 4.44 The isotherm of maximum temperature rise of case C1 (near Qasim-outlet)
Fig. 4.45 Temperature rise process of case C2 in whole tide cycle

Fig. 4.46 The isotherm of average temperature rise of case C2

Fig. 4.47 The isotherm of average temperature rise of case C2 (near the outlet)
Fig. 4.48 The isotherm of maximum temperature rise of case C2

Fig. 4.49 The isotherm of maximum temperature rise of case C2 (near the outlet)
Fig. 4.50 Temperature rise process of case C3 in whole tide cycle

Fig. 4.51 The isotherm of average temperature rise of case C3

Fig. 4.52 The isotherm of average temperature rise of case C3 (near the outlet)
Fig. 4.53 The isotherm of maximum temperature rise of case C3

Fig. 4.54 The isotherm of maximum temperature rise of case C3 (near the outlet)
Fig. 4.55 Temperature rise process of case C4 in whole tide cycle

Fig. 4.56 The isotherm of average temperature rise of case C4

Fig. 4.57 The isotherm of average temperature rise of case C4 (near the outlet)
Fig. 4.58 The isotherm of maximum temperature rise of case C4

Fig. 4.59 The isotherm of maximum temperature rise of case C4 (near the outlet)
Fig. 4.60 Temperature rise process of case C5 in whole tide cycle

Fig. 4.61 The isotherm of average temperature rise of case C5

Fig. 4.62 The isotherm of average temperature rise of case C5 (near the outlet)
Fig. 4.63 The isotherm of maximum temperature rise of case C5

Fig. 4.64 The isotherm of maximum temperature rise of case C5 (near the outlet)
Fig. 4.65 Temperature rise process of case C6 in whole tide cycle

Fig. 4.66 The isotherm of average temperature rise of case C6

Fig. 4.67 The isotherm of average temperature rise of case C6 (near the outlet)
5 Related Background Descriptions Collected from EIA Report

The following background description from EIA report have been abstracted and described in order that the investors and the corresponding party have the elementary information on local social and ecology circumstance:

- Sindh Fisheries Ordinance 1980

This ordinance mainly regulates fishing in any public waters for any purpose. The regulated waters include the coastal areas and rivers. The section 8 of this ordinance specifically prohibits the dumping of untreated industrial or domestic sewage waste into a water body, unless treated and made harmless for fish and other aquatic life.
Coastal Communities

Rehri (a coastal fishing village in the east of the project location is about 4,060 years old), after the Kotri Barrage in 1958, the freshwater disappeared from many parts of Indus Delta and many people from the affected parts settled in and around Rehri Village. These coastal communities have long been dependent on the coastal resources to meet their demands of food, fodder, fuel wood, sea-salt, timber for their temporary hutments (Jhuggi) and generation of income and for economic activities. Almost all of the populations of the coastal areas are engaged in fishing, fishing trade and as laborers in fishing industries, forest products, fishing boats, boat engine mechanics and camel raising, etc. Within these coastal communities, the drinking water supply is inadequate or absent. Public health care is minimum and sanitation is poor.

There are a number of coastal communities including permanent fishing villages along the coast, especially the fishing villages, Southeastern coast, Karachi, Port Qasim area, East Karachi. The mangrove ecosystem is of economic and ecological significance to the entire coastal area and for the dependent human settlements.

Most of the local population of the coastal communities is directly or indirectly involved in fishing business. The livelihood main stay of the village folk is coastal fishing using small sized nets to catch mullets, small size fishes, juvenile shrimp and crabs etc. The coastal fishermen catch about 3,000 metric tons of fish, 2,000 metric tons shrimp and about 2,500 metric tons of crabs to earn their livelihood. Most of the small size fish is also used for making fish meals and manure. The fish constitute the main diet of all coastal communities in the area. The increase in the number of fishermen population and the fishing labour force in the area have been mainly due to a large number of local communities that have migrated from Keti Bundar and adjacent parts of Indus Delta and have permanently moved to Korangi- Gharo Creek system due to loss of the agriculture activity and for better economic opportunities. Most of them opted for fishing and fisheries related professions. These migrations have increased the existing pressures of coastal resources.
The coastal areas at the end of Gharo Creek are being used to produce sea-salt for the last 50 years. An estimated 480,000 kg sea-salt/year is being produced from the two main sea-salt producing factories in the area. The mangrove forest has been providing good potential sites for honey production.

Indus Delta mangrove ecosystem provide protection to the coastline from wind, waves and water currents, reduce sedimentation of navigational channels, reduce impacts of storm surges and cyclones and promote eco-tourism. The direct economic importance of the mangroves is attached to its capacity as a fisheries production area, sustenance and support for coastal and offshore fisheries, and nursery areas for young fish species and shrimps. The second most significant indirect economic activity supported by the study area is providing nutrient regeneration to support fishery production.

The mangrove forest has been providing good potential sites for honey production. Both the villagers and the fishermen collect it from the mangrove forest. It is estimated that about 1,000 kg of honey per year can be produced from the Korangi-Gharo Creek system. The quantity produced per year is negligible because it is based on beehives in the wild. On the average about less than 2% of the mangrove wood collectors from the coastal villages are engaged in honey collection (1-2 kg per head) as part time business mostly during March to April period, the flowering period of mangroves.

- Coastal Ecology

The natural setting of creek coastal ecosystem of the project area has been characterized as Dwarf common plants, Grasses, Mangrove plants, Mangrove associated microorganisms. According to Flora of Pakistan (1972) eight species of mangroves have been reported from Pakistan. Though of these species, only four continue to thrive. Data on the Phytoplankton along the shelf and coastal waters of Pakistan is scarce. According to IUCN, more than 200 species of diatoms, more than 59 species of coccolithophorids, and more than 120 species of dinoflagellates are known to occur in the Arabian Sea. This community includes powerful swimmers,
which are exclusively carnivore in nature like predaceous fishes, mullets, croakers, snappers, carangids breams, perches, and sea snakes.
6 Model Test Result and Conclusion

2D mathematical model is established and verified well. The heat dispersion is simulated, and the conclusions are obtained as following:

(1) When the tidal current direction is from east to west, the cooling water flows out of the outlet, and flows into the intake area of Qasim project, which increases the temperature around the area. When the tidal current direction is from west to east, the cooling water of S project would flows into intake area of Qasim project.

(2) The temperature rise of Qasim project intake is $1.00\degree C$ when S project is not operation, the intake of Qasim project adopts the open channel layout, and the channel adopts the plan I layout (Case 1). The temperature rise of Qasim project intake is $1.04\degree C$ when S project is not operating, the intake of Qasim project adopts the open channel layout, and the channel adopts the plan II layout (Case 2). The temperature rise of Qasim intake is $0.89\degree C$ when S project is not operating, the intake of Qasim project adopts the pipe layout, and the channel adopts the plan I layout (Case 3). The temperature rise of Qasim project intake is $0.98\degree C$ when S project is not operating, the intake of Qasim project adopts the open channel layout, and the channel adopts the plan II layout (Case 4). The temperature rise of Qasim project intake is $1.56\degree C$ when S project is operating, the intake of Qasim project adopts the open channel layout, and the channel adopts the plan I layout (Case 5). The temperature rise of Qasim project intake is $1.63\degree C$ when S project is operating, the intake of Qasim project adopts the open channel layout, and the channel adopts the plan II layout (Case 6). The temperature rise of Qasim project intake is $1.39\degree C$ when S project is operating, the intake of Qasim project adopts the pipe layout, and the channel adopts the plan I layout (Case 7). The temperature rise of Qasim project intake is $1.54\degree C$ when S project is operating, the intake of Qasim project adopts the pipe layout, and the channel adopts the plan II layout (Case 8). The temperature rise of Qasim project intake is $1.17\degree C$ when S project is operating in the mean time the warm water from S project is merged into the outfall of Qasim project, the intake of Qasim project adopts the pipe layout, and the channel adopts the plan I layout (Case 9).
(3) The average temperature rise of Case 7 and Case 9 decrease below 3°C within 100m range outside the estuary of outlet creek. The average temperature rises of case C1, case C2, case C3, case C4, case C5 is 0.55°C, 1.10°C, 0.57°C, 1.18°C, 0.78°C and 0.82°C respectively.

(4) Based on the simulation results above, the effect of S project not operating is better, channel layout plan I is better and pipe intake is better than open channel. When the warm water from S project is merged into the outfall of Qasim project, the average temperature rise of Qasim intake is not more than 1.17°C. The pipe of intake of Qasim project is recommended to move to south 200m more and be arranged at the edge of the contour of 1°C based on case 9, which shall not affect the navigation.

(5) CW drainage water maximum diffusion area of 3°C temperature rise at Qasim project outfall

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Maximum Diffusion Area(km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>0.3028</td>
</tr>
<tr>
<td>C2</td>
<td>0.3657</td>
</tr>
<tr>
<td>C3</td>
<td>0.3047</td>
</tr>
<tr>
<td>C4</td>
<td>0.3256</td>
</tr>
<tr>
<td>C5</td>
<td>0.6432</td>
</tr>
<tr>
<td>C6</td>
<td>0.5883</td>
</tr>
<tr>
<td>Case 7</td>
<td>1.2424</td>
</tr>
<tr>
<td>Case 9</td>
<td>1.7086</td>
</tr>
</tbody>
</table>

The above mentioned figure shows that CW drainage water heat diffusion area is larger than what the local environment standard requests.
The isotherm of 3°C temperature rise at outfall for different cases are shown in Fig 6.1-Fig 6.8:

![Fig. 6.1 The diffusion area at Qasim-outlet of 3°C temperature rise for case C1](image1)

![Fig. 6.2 The diffusion area at Qasim-outlet of 3°C temperature rise for case C2](image2)
Fig. 6.3 The diffusion area at Qasim-outlet of 3°C temperature rise for case C3

Fig. 6.4 The diffusion area at Qasim-outlet of 3°C temperature rise for case C4

Fig. 6.5 The diffusion area at Qasim-outlet of 3°C temperature rise for case C5
Fig. 6.6 The diffusion area at Qasim-outlet of 3°C temperature rise for case C6

Fig. 6.7 The diffusion area at Qasim-outlet of 3°C temperature rise for case 7

Fig. 6.8 The diffusion area at Qasim-outlet of 3°C temperature rise for case 9
(6) Time summary statistics of CW drainage water with 3°C temperature rise exceed regulatory mixing-zone(100m) boundary

Total hours summary statistics of CW drainage water with 3°C temperature rise exceed regulatory mixing-zone(100m) boundary is indicated bellows:

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Per day</th>
<th>Per month</th>
<th>Per year</th>
<th>Percentage/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring tide</td>
<td>Neap tide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>2</td>
<td>10</td>
<td>199</td>
<td>2392</td>
</tr>
<tr>
<td>C2</td>
<td>2</td>
<td>9</td>
<td>181</td>
<td>2169</td>
</tr>
<tr>
<td>C3</td>
<td>2</td>
<td>8</td>
<td>162</td>
<td>1946</td>
</tr>
<tr>
<td>C4</td>
<td>2</td>
<td>8</td>
<td>162</td>
<td>1946</td>
</tr>
<tr>
<td>C5</td>
<td>4</td>
<td>12</td>
<td>250</td>
<td>3000</td>
</tr>
<tr>
<td>C6</td>
<td>4</td>
<td>15</td>
<td>306</td>
<td>3670</td>
</tr>
<tr>
<td>Case 7</td>
<td>9</td>
<td>19</td>
<td>407</td>
<td>4886</td>
</tr>
<tr>
<td>Case 9</td>
<td>12</td>
<td>20</td>
<td>453</td>
<td>5434</td>
</tr>
</tbody>
</table>

Unit: hour

The time analysis shows that the temperature rise influence of CW drainage water will last long-term period.

(7) From the numerical modeling results and analysis, TIWTE can get that:

i) If some engineering measures could be taken, it is possible to reduce the outfall temperature rise influence (even below 1°C) to Qasim project intake;

ii) According to local site condition, no proper layouts could meet the requirement of the temperature rise limit at 100m-mixing zone.

(8) Influenced area of CW drainage water with 3°C temperature rise

From the above analysis result, the 3°C temperature rise CW water diffusion area of all simulation cases is larger than what the local relevant environment standard expected and requested (100 m-mixing-zone) at the end.
Base on the reasons listing above, CW drainage water will has long-term action and some effects (the negative effects might occur) on local ecology circumstance unavoidably, for instance, environment problems, the fishery production, even influence the local inhabitants livelihood which is nearby Qasim project if the once-through cooling circulation system is applied.

Although the above analysis has provided the conclusions in technical aspects, while, as a complete report, TIWTE suggests the following potential risks and problems shall be concerned by the investors and the corresponding parties, and will not be described in details in this report because the below topics might exceed the technology itself.

- Obstructive action or against from the environmental organization, the authority and etc.
- Legal risks, disputes, civil compensation, media broadcasting and the other consequent negative influence.
- Other unforeseeable influence.
Appendix: Certificate of Software Permission

Certificate of Authenticity

This is to certify that

DHI MIKE Software is authentic

Software Key No.: MZ-7744, including:
MIKE 21 PP, HD, AD, ECO Lab, PA, SA, MIKE Animator; 2005 version

Software Key No.: MZ-10371, including:
MIKE C-MAP, CMAP Database(areas in Zone 6); 2005 version

Software Key No.: MZ-11203, including:
MIKE 21 PP, HD, BW, MIKE Animator; 2009 version

Software Key No.: MZ-11206, including:
MIKE 21 PP, HD, ST, NSW, MIKE Animator; 2005 version

Software Key No.: MZ-11208, including:
MIKE 21C PP, HD; 2006 version

Software Key No.: MZ-16311, including:
MIPACK, MP, MOST, MUSTRIP, MIUSTRIP, MIUSTRIP-2009 version

Software Key No.: MZ-19581, including:
MIKE 21C PP, HD, ST; 2009 version

Software Key No.: MZ-19905, including:
MIKE 21 FM PP, HD, ST, MT, BW, SW, MIKE Animator; 2011 version

Software Key No.: MZ-19906, including:
MIKE 21 FM PP, HD, ST, MT, BW, SW, MIKE Animator; 2011 version

Software Key No.: MZ-19928, including:
MIKE 3 FM PP, HD, AD; 2011 version

Software Key No.: MZ-22011, including:
MIKE 3 FM PP, HD, AD, ECO Lab, SA, PA/PT, ST, MT, MIKE Animator; 2011 version

Software Key No.: MZ-22012, including:
MIKE 21 FM PP, HD, AD, ECO Lab, SA, PA/PT, ST, MT, MIKE Animator; 2011 version

Certificate date: 19 June 2013

Username: Tianjin Research Institute of Water Transport Engineering (TWTE)
### Log BH-1

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Logged By:** SK  
**Rev.:** MZS

**Project Info.:**  
**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**GWL Info.:**  
**Depth:** 50 (m)  
**GWL:** - (m)

**Drill Date:** 04.01.2016  
**Easting:** 672342.06  
**Northing:** 244634.16  
**Logged By:** SK  
**Rev.:** MZS

**Sample Types:**  
- Disturbed SPT Sample  
- Undisturbed Water Sample  
- Shelby / U4 Groundwater Level  
- Core Cutter

**Abbrivations:**  
- LL: Liquid Limit  
- PI: Plastic Index  
- NPI: None PI  
- C: Cohesion  
- Cc: Cohesion (CU)  
- Cs: Cohesion (CU)  
- C': Cohesion (CU)  
- w: Moisture Content  
- qu: Unconfined Compression qu  
- pc: Pre-Consolidation Pressure  
- psi: Friction Angle  
- psi': Friction Angle (CU)  
- K: Permeability Coeff.  
- S: Slow  
- F: Fast

---

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Lithology Description</th>
<th>Field Tests</th>
<th>USCS</th>
<th>Sieve Analysis</th>
<th>Atterberg Limits</th>
<th>Direct Shear Test</th>
<th>Consolidation</th>
<th>Chemical Tests</th>
<th>Remarks &amp; Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yellowish brown, very dense, coarse to medium grained, traces silt &amp; gravels</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CONGLOMERMATE</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yellowish brown, very weak, closely jointed, very poor, highly fractured</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MUDSTONE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greyish brown, extremely weak, closely jointed, poor, highly fractured &amp; weathered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Sample Type:** Disturbed  
**USCS:** SP  
**Sieve Analysis Test:** SP 98.2 1.8 NLL - NPI 4.8 1.39 1.46

---

**Remarks & Comments:**
## Log BH-1

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Depth:** 50 (m)  
**GWL:** - (m)  
**Drill Date:** 04.01.2016

### Borehole Info.
- **Elevation:** Easting: 672342.06  
- **Location:** Northing: 244634.16  
- **Logged By:** SK  
- **Rev. By:** MZS

### Sample Types
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

### Lithology Description
- **MUDSTONE**  
  Greyish brown, extremely weak, closely jointed, poor, highly fractured & weathere

### Field Tests

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Lithology Description</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>Disturbed</td>
<td>MUDSTONE</td>
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### USCS

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<th>PI</th>
<th>PL</th>
<th>LL</th>
<th>w (%)</th>
<th>Bulk Density (gr/cm³)</th>
<th>Dry Density (gr/cm³)</th>
<th>C (kg/cm²)</th>
<th>φ (°)</th>
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### Chemical Tests

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<th>Remarks &amp; Comments</th>
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Log BH-1

**Depth:** 50 (m)  
**GWL:** (m)  
**Elevation:**  
**Drill Date:** 04.01.2016  
**Logged By:** SK  
**Project Info.:**  
**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Project Info.:**  
**Log BH-1**  
**Sample Info.:**  
**Sample Type:** MUDSTONE  
**Lithology Description:** Greyish brown, extremely weak, closely jointed, poor, highly fractured & weathered  
**Sample Type:** SANDSTONE  
**Lithology Description:** Brownish grey, extremely weak, very closely jointed, very poor, highly fractured & weathered, fine grained, very friable  

**Borehole Info.:**  
**Depth:** 50  
**Elevation:** 672342.06  
**GWL:**  
**Eastng:** 244634.16  
**Northing:**  
**Drill Date:** 04.01.2016  
**Logged By:** SK  
**Revis By:** MZS  

**Company Info.:**  
Soil Testing Services  
Geotechnical Engineers and Material Testing Laboratory  

**Sample Types:**  
- Disturbed SPT Sample  
- Undisturbed Water Sample  
- Shelby / U4 Groundwater Level  
- Core Cutter  

**Abbriviations:**  
- LL: Liquid Limit  
- PI: Plastic Index  
- CL: Liquid Limit  
- C: Cohesion  
- CS: Cohesion (CU)  
- PH: Friction Angle  
- PH*: Friction Angle (CU)  
- FI: Atterberg Limits  

**Chemical Tests:**  
- CD: Consolidated, Drained  
- CU: Consolidated, Undrained  
- PC: Pre-Consolidation Pressure  
- F: Fast  

**Atterberg Limits:**  
- LL: Liquid Limit  
- PI: Plastic Index  
- PL: Plastic Limit  
- ML: Plastic Modulus  

**USCS:**  
- CL: Clay  
- CH: Silt  
- CM: Sand  

**Grain Size Distribution:**  
- Sieve Analysis Test  
- Direct Shear Test  
- Consolidation Test  

**Remarks & Comments:**
### Log BH-2

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**Depth:** 40 (m)  
**GWL:** - (m)  
**Log Date:** 22.12.2015

**Elevation:**  
**Eastings:** 672344.98  
**Northings:** 244646.19  
**Logged By:** SK  
**Rev. By:** MZS

---

### Soil Testing Services  
Geotechnical Engineers and Material Testing Laboratory

---

### Borehole Info.  
- **Depth:** 40  
- **GWL:** -

---

### Sample Types
- Disturbed SPT Sample
- Unconfined Compression
- Slow

---

### Abreviations
- LL : Liquid Limit  
- C : Cohesion  
- w : Moisture Content  
- SPT : Standard Penetration Test  
- USCS : Unified Soil Classification System  
- PI : Plastic Index  
- PI : None PI  
- C' : Cohesion (CU)  
- PC : Pre-Consolidation Pressure  
- C : Cohesion  
- Cc : Cc  
- F : Fast  
- Cs : Cs  
- qu : Unconfined Compression  
- k : Permeability Coeff.  
- CS : CL  
- PH : pH  
- S : Slow  
- PL : Plastic Limit  
- FI : Friction Angle  
- UU : Unconsolidated, Undrained  
- SM : Standard Sample  
- P : Fast  
- CL : Clay  
- C : Cohesion  
- S : Slow  
- pc : Pre-consolidation Pressure  
- CS : CL  
- PH : pH  
- S : Slow  
- SM : Standard Sample  
- P : Fast  
- CL : Clay  
- C : Cohesion  
- S : Slow  
- pc : Pre-consolidation Pressure  
- CS : CL  
- PH : pH  
- S : Slow

---

### Field Tests
- **Depth (m):** 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
- **Sample Type:** SPT
- **Lithology Description:**
  - **CLAY**  
    - Grey, sandy, silty
  - **SAND**  
    - Greyish, loose to medium dense, gap graded, some silt, traces gavel
  - **SAND**  
    - Yellowish brown, very dense, medium to fine grained, traces silt
  - **SAND**  
    - Yellowish brown, very dense, coarse to fine grained, some silt

---

### Soil Samples
- **Atterberg Limits:**
  - **Depth (m):**
  - **Lithology Description:**
  - **Symbol:**
  - **Field Tests:**
  - **Atterberg Limits:**
  - **Consolidation:**
  - **Chemical Tests:**

---

### Remarks & Comments
- **Depth (m):** 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
- **Remarks & Comments:**

---

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Log BH-2

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Lithology Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>SAND</td>
<td>Yellowish brown, very dense, coarse to fine grained, some silt</td>
</tr>
<tr>
<td>15</td>
<td>SAND</td>
<td>Yellowish brown, very dense, coarse to medium grained, traces silt &amp; gravel</td>
</tr>
<tr>
<td>20</td>
<td>GRAVEL</td>
<td>Yellowish brown, very dense, silty, coarse to fine grained sand</td>
</tr>
<tr>
<td>25</td>
<td>CONGLOMERATE</td>
<td>Extremely weak, very poor, highly fractured &amp; weathered, very closely jointed</td>
</tr>
</tbody>
</table>

(continued ...)

**Log BH-2**

- **Project:** 1400MW Coal Fired Power Plant
- **Client:** K-Electric
- **Location:** Bin Qasim, Karachi
- **Job No.:** K15-1147-101

**Borehole Info.**
- **Depth:** 40 (m)
- **GWL:** - (m)
- **Drill Date:** 22.12.2015
- **Logged By:** SK

**Soil Testing Services**
Geotechnical Engineers and Material Testing Laboratory

---

**Sample Types**
- Disturbed
- Undisturbed
- Shelby / U4
- Core Cutter

**Abreviations**
- LL: Liquid Limit
- C: Cohesion
- Cs: Cs
- w: Moisture Content
- CD: Consolidated, Drained
- PL: Plastic Limit
- Pn: Friction Angle
- Cs: Cs
- un: Unconfined Compression
- UU: Unconsolidated, Undrained
- PP: Plastic Index
- C': Cohesion (CU)
- C': Cohesion (CU)
- qu: Pre-Consolidation Pressure
- F: Fast
- CU: Consolidated, Undrained
- PI: None PI
- PI: None PI
- K: Permeability Coeff.
- S: Slow

---

**Field Tests**

- **Symbol**
- **USCS**
- **Gravels** (g/cm3)
- **Sand** (g/cm3)
- **Silt** (g/cm3)
- **Clay** (g/cm3)
- **PI** (%)
- **PL** (%)
- **LL** (%)
- **w** (%)

**Gravels**
- **G': Cohesion (CU)
- **Ppp': Friction Angle (CU)
- **qdp': Pre-Consolidation Pressure**

---

**Remarks & Comments**

- **SPT Sample**
- **Water Sample**
- **Groundwater Level**
- **None PI**

---

**Chemical Tests**

- **Depth (m)**
- **Remarks & Comments**

---

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---

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---

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**Log BH-2**

**Project**: 1400MW Coal Fired Power Plant  
**Client**: K-Electric  
**Location**: Bin Qasim, Karachi  
**Job No.**: K15-1147-101

**Depth**: 40 (m)  
**GWL**: - (m)  
**Elevation**: Easting: 672344.98  
**Drill Date**: 22.12.2015  
**Logged By**: SK  
**Rev. BY**: MZS

**Borehole Info.**
- **Depth**: 40 (m)  
- **Elevation**: Easting: 672344.98  
- **GWL**: - (m)  
- **Easting**: 672344.98  
- **Nortthing**: 244646.19  
- **Drill Date**: 22.12.2015  
- **Logged By**: SK  
- **Rev. BY**: MZS

**Sample Info.**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample Type</th>
<th>Lithology Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>SPT Sample</td>
<td>MUDSTONE</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>Greyish brown, extremely weak, poor, highly fractured &amp; weathered, closely jointed</td>
</tr>
</tbody>
</table>

**Atterberg Limits**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Granular (%)</th>
<th>Plastic (%)</th>
<th>Liquid (%)</th>
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</thead>
<tbody>
<tr>
<td>SPT</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**Chemical Tests**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Calcium (%)</th>
<th>Sodium (%)</th>
<th>pH</th>
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<tbody>
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<td></td>
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</table>

**Field Tests**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>USCS</th>
<th>C : Cohesion</th>
<th>C' : Cohesion (CU)</th>
<th>w : Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations**

- **SPT**: Standard Penetration Test  
- **C**: Cohesion  
- **Cc**: Cohesion (CU)  
- **w**: Moisture Content  
- **USCS**: Unified Soil Classification System  
- **GWL**: Ground Water Level  
- **PI**: Plastic Index  
- **CL**: Clay Limit
**Log BH-2**

**Project Info.**
- Project: 1400MW Coal Fired Power Plant
- Client: K-Electric
- Location: Bin Qasim, Karachi
- Job No.: K15-1147-101

**Borehole Info.**
- Depth: 40 m
- GWL: - m
- Elevation: Easting: 672344.98
- Drill Date: 22.12.2015
- Northing: 244646.19
- Logged By: SK
- Rev. By: MZS

**Company Info.**
- Soil Testing Services
  - Geotechnical Engineers and Material Testing Laboratory

---

**Sample Types**
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

**Abreviations**
- LL: Liquid Limit
- C: Cohesion
- SPT: Standard Penetration Test
- PI: Plastic Index
- CS: Coefficient of Soil
- C: Cohesion
- Expansion
- CL: Clay
- SP: Silt
- SM: Sand
- UU: Unconsolidated, Undrained
- MS: Mudstone
- SG: Sandstone
- DH: Depth (m)
- GWL: Groundwater Level (m)
- USCS: Unified Soil Classification System

---

**Lithology Description**

**MUDSTONE**
- Greyish brown, extremely weak, poor, highly fractured & weathered, closely jointed

**SANDSTONE**
- Greyish brown, extremely weak, poor, highly fractured & weathered, closely jointed

---

**Field Tests**

| Depth (m) | USCS | Gravel (%) | Sand (%) | Clay (%) | LL (%) | PL (%) | PI (%) | Dry | Bulk | Test Type | C (kN/m²) | F (o) | Gs | Cs | qu | UU | CD | PI | Phi' | K | Permeability Coeff. | S | Slow |
|----------|------|------------|----------|----------|--------|--------|--------|-----|------|-----------|-----------|------|----|----|----|----|----|----|----|----|---|-------------------|---|------|
| 30       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 31       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 32       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 33       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 34       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 35       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 36       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 37       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 38       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 39       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |
| 40       |      | 0          | 100      | 0        | 0      | 0      | 0      | 0   | 0    | 0         | 0         | 0    | 0  | 0  | 0  | 0  | 0  | 0 | 0  | 0  | 0 | 0  | |

---

**Remarks & Comments**

End of Log @ 40 (m)

---

**Notations**
- Co: Cohesion
- CL: Clay
- SP: Silt
- SM: Sand
- UU: Unconsolidated, Undrained
- MS: Mudstone
- SG: Sandstone
- DH: Depth (m)
- GWL: Groundwater Level (m)
- USCS: Unified Soil Classification System

---

**Chemical Tests**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>CL</th>
<th>SO3</th>
<th>PH</th>
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**Company Information**
- Soil Testing Services
  - Geotechnical Engineers and Material Testing Laboratory

---

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### Log BH-3

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**Drill Date:** 25.12.2015  
**Logged By:** SK  
**Rev. By:** MZS

**Project Info.:**  
- **Project:** 1400MW Coal Fired Power Plant  
- **Client:** K-Electric  
- **Location:** Bin Qasim, Karachi  
- **Job No.:** K15-1147-101

**Borehole Info.:**  
- **Depth:** 40 m  
- **Elevation:**  
- **GWL:** - m  
- **Easting:** 672331.2071  
- **Northing:** 244646.3147  
- **Drill Date:** 25.12.2015  
- **Logged By:** SK  
- **Rev. By:** MZS

**Company Info.:**  
- **Soil Testing Services**  
- Geotechnical Engineers and Material Testing Laboratory

---

**Sample Types:**  
- Disturbed SPT Sample  
- Undisturbed Water Sample  
- Shelby / U4  
- Core Cutter

**Abreviations:**  
- LL: Liquid Limit  
- C: Cohesion  
- PI: Plastic Index  
- NPI: None PI  
- CD: Consolidated, Drained  
- UU: Unconsolidated, Undrained  
- Fs: Friction Angle  
- qu: Unconfined Compression  
- fi: Friction Angle (CU)  
- ph: Friction Angle (CU)  
- K: Permeability Coeff.

---

**Sample Identification:**  
- **Depth (m):** 0  
- **Sample Type:** CLAY  
- **Lithology Description:** Brownish grey, very soft to soft, sandy silty

---

**Sample Identification:**  
- **Depth (m):** 0  
- **Sample Type:** SAND  
- **Lithology Description:** Grey, very loose to loose, silty fine

---

**Sample Identification:**  
- **Depth (m):** 0  
- **Sample Type:** SAND  
- **Lithology Description:** Yellowish brown, medium dense, medium to coarse grained

---

**Field Tests:**  
- **Symbol:**  
- **Atterberg Limits:** C, CL, PI, PL  
- **Atterberg Limits:** LL, PL, PI, w  
- **Unit Weight:** Dry, Bulk  
- **Atterberg Limits:** C, CL, PI, PL, w  
- **Consolidation:** C'  
- **Consolidation:** Pc  
- **Chemical Tests:** Cd, Cu, SC, CL

---

**Sieve Analysis:**  
- **Test Type:** USCS  
- **Test Type:** Direct Shear Test

---

**Remarks & Comments:**  
- CLAY:  
- SAND:  
- SAND:  

---

**Notation:**  
- Sample Identification  
- Field Tests  
- Remarks & Comments

---

**Printed On:** 27/01/2016  
By: TC-PC/ZAEEM

---

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# Log BH-3

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Elevation:**  
**Drill Date:** 25.12.2015  
**GWL:** - (m)  
**Easting:** 672331.2071  
**Northing:** 244646.3147  
**Logged By:** SK  
**Rev. BY:** MZS

---

## Borehole Info.

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>GWL (m)</th>
<th>Sample Type</th>
<th>Lithology Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0</td>
<td>SAND</td>
<td>Yellowish brown, medium dense, medium to coarse grained</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>SAND</td>
<td>Yellowish brown, very dense, medium to coarse grained</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>SAND</td>
<td>Yellowish brown, very dense, medium to coarse grained, embedded with clayey silt &amp; gravels &amp; boulders</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>SAND</td>
<td>Yellowish brown, very dense, medium to coarse grained</td>
</tr>
<tr>
<td>(continued ...)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

## Field Tests

- **SPT**
- **USCS**
- **Atterberg Limits**
- **Dry Unit Weight**
- **Direct Shear Test**
- **Consolidation**

---

## Chemical Tests

- **CL**
- **SO3**
- **PH**
- **CD**
- **UU**
- **CU**

---

**Remarks & Comments**
Log BH-3

**Depth**: 40 (m) **Elevation**: Easting: 672331.2071 Northing: 244646.3147

**Project**: 1400MW Coal Fired Power Plant **Client**: K-Electric **Location**: Bin Qasim, Karachi **Job No.**: K15-1147-101

**Project Info.**

- **Project**: 1400MW Coal Fired Power Plant
- **Client**: K-Electric
- **Location**: Bin Qasim, Karachi
- **Job No.**: K15-1147-101

**Borehole Info.**

- **Depth**: 40 (m)  **GWL**: - (m)  **Easting**: 672331.2071  **Nording**: 244646.3147
- **Drill Date**: 25.12.2015
- **Logged By**: SK
- **Rev. By**: MZS

**Sample Types**

- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

**Lithology Description**

- **MUDSTONE**: Yellowish brown & greenish grey, extremely weak to weak, highly weathered & fractured
- **SANDSTONE**: Grey, extremely weak, highly weathered & fractured, friable fine grained

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<th>Depth (m)</th>
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<th>SANDSTONE</th>
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**Remarks & Comments**

- MDC - 4 Q2.39 -
**Log BH-4**

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**Elevation:**  
- Depth: 40 (m)  
- GWL: - (m)

**Drill Date:** 29.12.2015  
**Logged By:** SK  
**Rev. By:** MZS

### Depth (m) vs. Lithology Description

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<td>Yellowish brown, very dense, gravelly (medium to coarse grained sand with some gravels)</td>
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<td>SAND</td>
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<td>BOULDERS</td>
<td>Yellowish brown, very dense, sandy gravel</td>
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<td>70-80</td>
<td>SAND</td>
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### Field Tests

- **SP**
- **USCS**

### Atterberg Limits

- **LL (%):** Liquid Limit  
- **PI (%):** Plastic Index  
- **PL (%):** Plastic Limit  
- **CL (%):** Clay Limit

### Unit Weight

- **Dry:**  
- **Bulk:**

### Unit Weight (g/cm³)

- **Sand:**
- **Gravel:**

### Direct Shear Test

- **C (kg/cm²):** Cohesion  
- **C’ (kg/cm²):** Consolidated, Undrained Cohesion  
- **Pc (kg/cm²):** Pre-Consolidation Pressure  
- **Ps (kg/cm²):** Consolidated, Undrained Cohesion

### Consolidation

- **Ps’ (kg/cm²):** Friction Angle (CU)  
- **Pf (kg/cm²):** Friction Angle

### Chemical Tests

- **Cl:** Chloride  
- **SO₃:** Sulfate

### Remarks & Comments

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**Sample Types**  
- Disturbed  
- Undisturbed  
- SPT Sample  
- Water Sample  
- Shelby / U4  
- Core Cutter

**Abbriviations**  
- LL: Liquid Limit  
- PL: Plastic Limit  
- PI: Plastic Index  
- C: Cohesion  
- C’: Consolidated, Undrained Cohesion  
- w: Moisture Content  
- qu: Pre-Consolidation Pressure  
- F: Fast  
- S: Slow

---

**Printed On 27/01/2016 By TC-PC/ZAEM**
**Log BH-4**

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Prep. By:** SK  
**Rev. By:** MZS

**Log Info.:**  
**Depth:** 40 (m)  
**Elevation:** 672317.2958  
**Drill Date:** 29.12.2015  
**GWL:** -  (m)  
**Easting:** 244636.1762  
**Northing:** 672317.2958  
**Logged By:** SK  
**Job No.:** K15-1147-101

**Soil Testing Services**  
Geotechnical Engineers and  
Material Testing Laboratory

---

### Lithology Description

**SAND**  
Yellowish brown, very dense, medium to coarse grained

**CONGLOMERATE**  
Greyish brown, weak to medium strong, highly weathered & fractured, premature

**MUDSTONE**  
Greyish brown & greyish green, extremely weak, highly weathered & fractured

---

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### Field Tests

- **SPT**
- **USCS**

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### Sieve Analysis

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<th>LL (%)</th>
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### Atterberg Limits

- **ML**
- **PL**
- **LL**

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### Bulk Unit Weight

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<th>Depth (m)</th>
<th>ML (gr/cm³)</th>
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<th>LL (gr/cm³)</th>
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### Chemical Tests

- **CL**
- **SO4**
- **PH**

---

**Remarks & Comments**

- MDC - 4 (28.06 - 29.2)
- Depth: 40 m
- Easting: 672317.2958
- Northing: 244636.1762
- GWL: -
- DRILL DATE: 29.12.2015
- Logged By: SK
- Rev. By: MZS

---

**Printed On:** 27/01/2016

NovoLAB (HID) 2.5.2015.816

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Page 3 of 4
**Log BH-4**

**Project Info.**
- Project: 1400MW Coal Fired Power Plant
- Client: K-Electric
- Location: Bin Qasim, Karachi
- Job No.: K15-1147-101

**Borehole Info.**
- Depth: 40 (m)
- Easting: 672317.2958
- Northing: 244363.1762
- Drill Date: 29.12.2015
-Logged By: SK
- Reviewed By: MZS

**Soil Testing Services**
Geotechnical Engineers and Material Testing Laboratory

---

**Lithology Description**
- **MUDSTONE**
  - Greyish brown & greyish green, extremely weak, highly weathered & fractured

---

**Field Tests**

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**Sieve Analysis**

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**Atterberg Limits**

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**Direct Shear Test**

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**Consolidation**

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**Chemical Tests**

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**Remarks & Comments**

- MDC - 5 (30 76 - 31 10)
- MDC - 10 (30 01 - 36)
- MDC - 11 (38 00 - 38 2)

---

**Abbr.:**
- SPT: Standard Penetration Test
- USCS: Unified Soil Classification System
- LL: Liquid Limit
- PL: Plastic Limit
- PI: Plastic Index
- w: Moisture Content
- C: Cohesion
- Cc: Cohesion
- Cs: Cohesion
- Pc: Pre-Consolidation Pressure
- F: Fast
- K: Permeability Coefficient
- CL: Clay
- SO₃: Sodium
- PH: pH
- FI (o): Factor of Safety
- C': Effective Cohesion
- Cs': Effective Cohesion
- P': Effective Pre-Consolidation Pressure
- qu': Unconfined Compression
- F': Fast
**Log BH-5**

**Project Info.**
- Project: 1400MW Coal Fired Power Plant
- Client: K-Electric
- Location: Bin Qasim, Karachi
- Job No.: K15-1147-101

**Borehole Info.**
- Depth: 50 (m)
- GWL: - (m)
- Elevation: Easting: 67230.0214
- Drill Date: 14.01.2016
- NWL: - (m)
- Drill Type: Northing: 244626.9518
- Rev.: MZS

**Sample Types**
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

**Abreviations**
- LL: Liquid Limit
- C: Cohesion
- PI: Plastic Index
- Cs: Cc
- w: Moisture Content
- PL: Plastic Limit
- C': Cohesion (CU)
- Cs': Cc (CU)
- qu: Unconfined Compression qu
- Pn: Friction Angle
- Pc: Pre-Consolidation Pressure
- Ph: Friction Angle (CU)
- F: Fast
- NPI: None Pl
- K: Permeability Coeff.
- S: Slow
- w: Moisture Content

---

**Lithology Description**

- **CLAY**
  - Grey, very soft, silty
- **SAND**
  - Grey, very loose, silty fine grained
  - Yellowish brown, dense to very dense, medium to coarse grained, silty clay as binder
### Log BH-5

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Depth:** 50 (m)  
**Elevation:** Easting: 67230.0214, Northing: 244626.9518

---

**Sample Types**  
- Disturbed SPT Sample  
- Undisturbed Sample  
- Shelby / U4 Groundwater Level  
- Core Cutter

---

**Lithology Description**  
- **SAND**  
  - Yellowish brown, dense to very dense, medium to coarse grained, silty clay as binder
  - **SAND**  
  - Yellowish brown, very dense, silty fine to coarse with little gravels, silty clay as binder

---

**Field Tests**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Lithology Description</th>
<th>USCS</th>
<th>Atterberg Limits</th>
<th>Direct Shear Test</th>
<th>Consolidation</th>
<th>Chemical Tests</th>
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<tbody>
<tr>
<td>SPT</td>
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**Sieve Analysis**

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**Soil Testing Services**  
Geotechnical Engineers and Material Testing Laboratory
Log BH-5

Project: 1400MW Coal Fired Power Plant
Client: K-Electric
Location: Bin Qasim, Karachi
Job No.: K15-1147-101

Depth: 50 (m)
GWL: (m)
Drill Date: 14.01.2016
Logged By: SK
Elevation: Easting: 67230.0214
Nording: 244626.9518
Rev. By: MZS

Borehole Info.

Depth: 50 (m)
GWL: (m)

Sample Type
Lithology Description

CONGLOMERATE
Yellowish brown, weak to medium strong, highly weathered & fractured

MUDSTONE
Yellowish brown, extremely weak, highly weathered & fractured, interbedded with sand

MUDSTONE
Yellowish brown to greenish grey, extremely weak, highly weathered & fractured

Field Tests
Symbol
Depth (m)

Sieve Analysis
USCS

Gravel (%)
Sand (%)
Silt (%)
Clay (%)
LL (%) P L (%) P (%) w (%)

Atterberg Limits

Dry
Brik

Unit Weight (gr/cm3)

Consolidation

Test Type
C (kg/cm2)
Fl (o)
Cc
Pc (kg/cm2)

Direct Shear Test

C' (kg/cm2)
Pc (kg/cm2)

Chemical Tests

Cl

Atterberg Limits

PI (%)
PL (%)
LL (%)

w (%)

Atterberg Limits

Bulk
Dry

Unit Weight

 global

Fin (m)
C (kg/cm2)

Test Type

Consolidation

Pc (kg/cm2)

Chemical Tests

S:

Remarks & Comments

Page 3 of 5

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Printed On 27/01/2016 By TC-PC/24EEM
**Log BH-5**

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Logged By:** SK  
**Rev. BY:** MZS

**Project Info.:**  
**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**Borehole Info.:**  
**Depth:** 50 (m)  
**Elevation:** Easting: 67230.0214  
**Drill Date:** 14.01.2016  
**Logged By:** SK  
**Rev. BY:** MZS

**Sample Types:**  
- Disturbed SPT Sample  
- Undisturbed Water Sample  
- Shelby / U4 Groundwater Level  
- Core Cutter

**Abbr.:**  
- LL: Liquid Limit  
- SPT: Standard Penetration Test  
- PI: Plastic Index  
- C: Cohesion  
- Cc: Cohesion (CU)  
- w: Moisture Content  
- C': Cohesion (CU)  
- F: Fast  
- PC: Pre-Consolidation Pressure  
- K: Permeability Coeff.  
- Cs: Cohesion  
- Cs': Cohesion (CU)  
- P: Plastic Limit  
- S: Slow  
- qu: Unconfined Compression qu  
- PH: Potential pH  
- G: Gamma  
- UU: Unconsolidated, Undrained  
- UU: Unconsolidated, Undrained  
- CD: Consolidated, Drained  
- EL: Easting Limit  
- NW: Northing Limit

**Sieve Analysis Test:**

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**Chemical Tests:**

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<td>10</td>
<td>20</td>
<td>30</td>
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</table>

**Remarks & Comments:**

**Lithology Description:**

- **MUDSTONE**  
  Yellowish brown to greenish grey, extremely weak, highly weathered & fractured

- **MUDSTONE**  
  Greenish grey, extremely weak, highly weathered & fractured, embedded with sandstone

- **SANDSTONE**  
  Greystish brown, extremely weak, highly weathered & fractured, friable fine grained

- **MUDSTONE**  
  Greenish grey, extremely weak, highly weathered & fractured

**Depth (m) | GWL (m) | Sample Type | Lithology Description | Field Tests | Symbol | Depth (m) | Sieve Analysis Test | Atterberg Limits | Direct Shear Test | Chemical Tests | Remarks & Comments**

**SPT**

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**Direct Shear Test:**

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**Consolidation:**

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**Chemical Tests:**

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**Remarks & Comments:**

**NDC - 07.39**

**NDC - 10.38.00 - 38**
**Log BH-5**

Project: 1400MW Coal Fired Power Plant  
Client: K-Electric  
Location: Bin Qasim, Karachi  
Job No.: K15-1147-101

**Depth:** 50 (m)  
**GWL:** - (m)  
**Elevation:**  
**Drill Date:** 14.01.2016  
**Logged By:** SK  
**Rev. By:** MZS

---

**Lithology Description**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>MUDSTONE</td>
<td>Greenish grey, extremely weak, highly weathered &amp; fractured</td>
</tr>
<tr>
<td>SANDSTONE</td>
<td>Brownish grey, extremely weak, highly weathered &amp; fractured, friable fine grained</td>
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</tbody>
</table>

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**Sieve Analysis**

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**Atterberg Limits**

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**Direct Shear Test**

<table>
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<th>Test Type</th>
<th>Depth (m)</th>
<th>C (kg/cm²)</th>
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**Chemical Tests**

<table>
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---

**End of Log @ 50 (m)**
SAND
Yellowish brown, very dense, medium to coarse grained
some gravel with clayey silt as binder

End of Log @ 11 (m)
SAND
Yellowish brown, very dense, medium to coarse grained, some gravel with silty clay as binder
**Log BH-7**

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101

**Borehole Info.**  
- **Depth:** 11 (m)  
- **Elevation:** 672256.89  
- **Eastings:** 672256.89  
- **Nothings:** 244622.84  
- **Logged By:** SK  
- **Rev. BY:** MZS

**Lithology Description:**  
Yellowish brown, very dense, medium to coarse grained, some gravel with silty clay as binder

**End of Log @ 11 (m)**
### Log BH-8

**Project:** 1400MW Coal Fired Power Plant  
**Client:** K-Electric  
**Location:** Bin Qasim, Karachi  
**Job No.:** K15-1147-101  
**Drill Date:** 13.01.2016  
**Logged By:** KS  
**Rev. BY:** MZS

**Sample Info:**
- **Sample Type:** Disturbed SPT Sample  
- **Sample Source:** Shelby / U4

**Lithology Description:**
- **SAND**  
  - Yellowish brown, medium dense, fine to medium grained with some coarse grained sand
  - Depth: 0.0 m  
  - Elevation: 672321.32

**Field Tests:**
- **Symbol:** SP  
- **Depth (m):** 0.0  
- **USCS:**
  - **Gravel (%):** 99.6  
  - **Sand (%):** 0.4  
  - **Silt (%):** NLL  
  - **Clay (%):** NPI  
  - **PL (%):** 19  
  - **CL (%):** 1.4  
  - **CD (%):** 1.67

**Sieve Analysis Test:**
- **Gravel:** 99.6%  
- **Sand:** 0.4%  
- **Silt:** NLL  
- **Clay:** NPI

**Atterberg Limits:**
- **LL (%):** 1.6  
- **PL (%):** 1.39

**Dry Unit Weight (g/cm3):** 2.2

**Bulk Unit Weight (g/cm3):** 2.0

**Remarks & Comments:**

---

**Abbreviations:**
- **LL:** Liquid Limit  
- **PL:** Plastic Limit  
- **CL:** Consistency Limit  
- **C:** Cohesion  
- **C':** Cohesion (CU)  
- **C:** Cohesion (CU)  
- **Cc:** Cohesion  
- **Cc:** Cohesion  
- **w:** Moisture Content  
- **w:** Moisture Content  
- **C':** Cohesion  
- **C':** Cohesion  
- **Dry:** 1.4  
- **Test Type:** Consol. Drained

---

**Diagram:**
- Depth (m) vs. Lithology Description

---

**Chemical Tests:**
- **pH:** 8.1  
- **SO4:** 0.02  
- **Cl:** 0.04

---

**Test Type:**
- **Consolidation:**
  - **Pc (kg/cm²):** 19  
  - **Cv (kg/cm²):** 18.6

---

**Log BH-8 continued on page 2 of 2...**
**Log BH-8**

**Project Info.**
- Project: 1400MW Coal Fired Power Plant
- Client: K-Electric
- Location: Bin Qasim, Karachi
- Job No.: K15-1147-101

**Borehole Info.**
- Depth: 11 (m)
- GWL: - (m)
- Elev. Easting: 672321.32
- Northing: 244618.93

**Logged By:** KS
**Rev. By:** MZS

**Sample Types**
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

**Abreviations**
- LL: Liquid Limit
- PI: Plastic Index
- CL: Consistency Limit
- CD: Consolidated, Drained
- CO: Consolidated, Undrained
- Pn: Plastic Number
- P'S: Plastic Number (CU)
- C'S: Cohesion (CU)
- C’: Cohesion
- Fs: Friction Angle
- Fs’: Friction Angle (CU)
- K: Permeability Coeff.

**SAND**
Yellowish brown, dense to very dense, fine to medium grained with some coarse sand

**Remarks & Comments**
End of Log @ 11 (m)

---

**Field Tests**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Lithology Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAND</td>
<td>Yellowish brown, dense to very dense, fine to medium grained with some coarse sand</td>
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**Depth (m) | GWL (m) | Sample Type | Lithology Description**

---

**Field Tests**

<table>
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<th>Symbol</th>
<th>Depth (m)</th>
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<th>Parameter</th>
<th>Value</th>
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**Unit Weight**

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<td>w’</td>
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**Chemical Tests**

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<td>CO2</td>
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**Remarks & Comments**

End of Log @ 11 (m)
Log BH-9

Project: 1400MW Coal Fired Power Plant
Client: K-Electric
Location: Bin Qasim, Karachi
Job No.: K15-1147-101

Depth: 11 (m)
GWL: - (m)

Elevation:
East: 672345.43
Northing: 244629.45

Drill Date: 12.12.2015
Logged By: MA
Rev. BY: MZS

Borehole Info.

Depth (m) | GWL (m) | Sample Type | Lithology Description |
--- | --- | --- | --- |
0 | 0 | SAND | Yellowish brown, medium dense, medium to coarse grained |
2 | 2 | SAND | Yellowish brown, medium dense, coarse grained with some clayey silt |
4 | 4 | SAND | Yellowish brown, very dense, coarse grained with some clayey silt, traces of fine gravels |
6 | 6 | SAND | Yellowish brown, very dense, coarse grained |
8 | 8 | | |
10 | 10 | | |

Sample Types:
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

Field Tests

<table>
<thead>
<tr>
<th>USCS</th>
<th>Symbol</th>
<th>Depth (m)</th>
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<tr>
<td></td>
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</table>

Atterberg Limits

- LIQUID LIMIT (LL)
- PLASTIC LIMIT (PL)
- PLASTIC INDEX (PI)
- MOISTURE CONTENT (w)
- UNIT WEIGHT (g/cm³)
- DIRECT SHEAR TEST
- CONSOLIDATION

Chemical Tests

- CI | SO₃ | PH
- CD | PC | Cs
- C' | Cs

Remarks & Comments

- Remarks & Comments
- Depth (m)
**Log BH-9**

**Project Info.**
- **Project:** 1400MW Coal Fired Power Plant
- **Client:** K-Electric
- **Location:** Bin Qasim, Karachi
- **Job No.:** K15-1147-101

**Borehole Info.**
- **Depth:** 11 (m)
- **GWL:** - (m)
- **Elevation:**
  - Easting: 672345.43
  - Northing: 244629.45
- **Drill Date:** 12.12.2015
- **Logged By:** MA
- **Rev. By:** MZS

**Company Info.**
- Geotechnical Engineers and Material Testing Laboratory

**Sample Types**
- Disturbed SPT Sample
- Undisturbed Water Sample
- Shelby / U4 Groundwater Level
- Core Cutter

**Abbriviations**
- LL: Liquid Limit
- CL: Cohesion
- PI: Plastic Index
- PI': Friction Angle (CU)
- C': Cohesion (CU)
- Cc: CONSOLIDATED, DRAINED
- Cw: CONSOLIDATED, UNCONSOLIDATED
- Mu: MOISTURE CONTENT
- UU: UNCONSOLIDATED, UNCONSOLIDATED
- CU: CONSOLIDATED, UNCONSOLIDATED

**Sieve Analysis**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>USCS</th>
<th>Sand (%)</th>
<th>Silt (%)</th>
<th>Clay (%)</th>
<th>PI (%)</th>
<th>w (%)</th>
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**Atterberg Limits**

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**Field Tests**

- *SPT*:

**Lithology Description**

- **SAND**
  - Yellowish brown, very dense, coarse grained

**Remarks & Comments**

- End of Log @ 11 (m)

**Table**

<table>
<thead>
<tr>
<th><strong>Sample Type</strong></th>
<th><strong>Sample Type</strong></th>
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<tbody>
<tr>
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<td>Undisturbed</td>
<td>Water Sample</td>
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<td>Shelby / U4</td>
<td>Groundwater Level</td>
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<td>Core Cutter</td>
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**Atterberg Limits**

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<th>PL (%)</th>
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**Field Tests**

- *SPT*:

**Lithology Description**

- **SAND**
  - Yellowish brown, very dense, coarse grained

**Remarks & Comments**

- End of Log @ 11 (m)
Mr. Saquib Ejaz Husain  
Divisional Manager (Environment)  
EMC Pakistan Pvt. Ltd

March 30, 2016

Subject: Environmental Impact Assessment (EIA) study of 2x350MW coal power plant in Port Qasim Karachi

Dear Sir,

Please refer to your letter No EMC/EIA/KE/16/3112 dated 10th March 2016 seeking our concerns/suggestions. In this regard it is informed that ASG Metal Limited is operating steel plant of capacity 240,000 ton/year just adjacent to the location of proposed coal power plant. The steel plant includes sophisticated equipment based on recycling technology thus main consumption of energy is ELECTRICITY.

The power supply net work includes SWITCHGEAR YARD with 50/40KVA step down transformer to step down from 132 KV to 11KV and medium voltage control panels and other electrical and electronic control system spread all over the plant.

The plant also includes huge water circulating net work which includes sophisticated pumps as well as high capacity evaporating cooling tower.

The mechanical equipment is mainly relate to hot rolling mill which has open water cooling system and centralized lubrication system.

It is a fact that dust specially dust generated as a result of handling pulverized coal always creates problem to electrical equipment especially in the case of high humid environment as we are near the sea. The carbon dust to the electrical contacts and in the presence of moisture there is a possibility that sparking may occur damaging the electrical equipment resulting in break-down of power supply net work.

Furthermore, this dust may also damage the evaporating cooling tower as the fan of the cooling tower will suck the carbon dust along with the atmospheric air and this carbon dust will then act as abrasive agent and damage the blades of the cooling tower fan as well as other metallic structure of the cooling tower. The water will also be contaminated with carbon powder and this contaminated water definitely damages the cooling system of the equipment.

Furthermore, about 250 to 300 personal are always on duty round the clock and any emission from the power plant like Niters, Oxides of Phosphorous and Sulphur polluting the atmosphere may result health hazard situation to the personal because the proposed power plant is just adjacent to our steel plant.
It is, therefore, suggested that the design of the plant must include equipment and adaptation of latest technology which help ensure dust free and harm gasses free environment and maintain the environment conforming to International Standard.

We will appreciate if we also be kept informed about the steps taken and technology adopted in the techno-economic feasibility as well as at the design stage as clean atmosphere in the vicinity of our plant is our main concern and we have already expended reasonable cost on environmental protection by putting very special dust collecting and processing system at our steel plant.

It is hoped that co-ordination will exist at the planning and design stage with ASG Metal Ltd., to ensure clean atmosphere for our workers, plant and machinery.

Thank you and best regards,

Khalid Khan

Chief Executive Officer
To

The Project Director
Conservation, development & management of
Indus delta mangrove to check sea intrusion
Karachi

Subject: STAKEHOLDER CONSULTATION ..... ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY OF 2X350 MW COAL POWER PLANT IN PORT QASIM KARACHI.

Please find enclosed herewith letter No.EMC/EIA/KE/16/3112 dated 10.03.2016 received from Divisional Manager (Environment), EMC Pakistan Pvt. Ltd. on the subject mentioned above.

You are requested to please submit your comments/inputs into the subject matter to this office for taking further necessary action. Soft copy may please be emailed at dfophyd@gmail.com.

Chief Conservator of Forests
Sindh at Hyderabad

CC:

Mr. Saquib Ejaz Hussain  
Manager (Environmental Studies)  
EMC Pakistan Pvt. Ltd.  

Subject: Stakeholder Consultation for Environmental Impact Assessment of K-Electric's proposed 2 x 350MW Coal-Fired Project ("KE Project")

Dear Sir,

We appreciate your approach to incorporating input from stakeholders while conducting EIA studies for the proposed project. We also take this opportunity to express our appreciation for K-Electric's interest in undertaking a project of this scale. We wish them best in all their endeavors.

Below please find our initial input based on the limited information provided in your letter:

- The details of Coal Jetty are not legible. As you are already aware, our SSEL Project envisages a cooling water intake structure in close proximity of proposed coal jetty. Clear and detailed information on the proposed jetty will be crucial for both projects.

- Please provide proposed plant grade levels. Since both projects are adjacent, drainage during construction as well as operational phase will depend on final specifications.

- We expect that detailed Thermal Plume Studies for Cooling Water discharge in the mixing zone will be undertaken by you for the proposed project. We suggest the such information should be shared with us. On our part, we are willing to support an exercise for cumulative impact assessment of discharge of both plants.

- We are interested to know the Environmental Control Systems (FGD and ESP) and emission control levels that are envisaged for this project.

We look forward to above details in your response. As mentioned, we remain available and committed to support the proposed project.

Best Regards

Shahid Mehmood  
Project Director  
Siddiqsons Energy Limited
Mr. Saquib Ejaz Hussain,
Divisional Manager (Environment)
EMC, Pakistan Pvt. Ltd.
503, Anum Estate, Main Shahra-e-Fatah
Karachi
e-mail: nadeem@emc.com.pk, mail@emc.com.pk

Sub: STAKEHOLDER CONSULTATION
ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY OF
2 X 350 MW COAL POWER PLANT IN PORT QASIM KARACHI

Dear Sir,

No. EMC/EIA/KE/16/3112 dated 10 March 2016, addressed to the CEO, Pakistan Steel, Bin Qasim, Karachi, refers.

On behalf of CEO, Pakistan Steel, I pay thanks for your letter, referred above, to share the comments/ideas on the contents of preliminary study, covering environmental impact assessment for installation of 2 X 350 MW coal fired power plant in Eastern Industrial Zone of Port Qasim Authority.

In this regards, comments from Pakistan Steel (PSM) are given as under:

i) Coal is composed, primarily, of carbon alongwith variable quantities of other elements mostly, sulphur, hydrogen, oxygen and nitrogen and is a cheaper fuel for power plants, however, a very precise and effective system is needed to handle coal dust, ash (extra ordinarily fine and acidic in nature containing considerable percentage of residual sulphur contents), accumulated gas cleaning dust and the flue gasses.

ii) Usually unidirectional winds blow in coastal areas so coal ash, coal dust and emission of flue gasses should be treated, handled and disposed of properly with all checks and balance to avoid any damage/loss to the adjoining environment including marine life and its growths.

iii) After going through the contents of referred letter, it looks that the project is of environment friendly nature where apparently most of the environmental issues and its mitigation strategy is covered in compliance to national and international environmental standards, Acts, Rules and Regulations, however, there is always room for further betterment.

Sincerely,

Syed Imtiaz ul Hassan Shamsi
AEO (BMREE)

3rd Floor, Operations Building, Pakistan Steel Mill, Bin Qasim, Karachi
Phone: 9221-34750391, Fax: 9221-34750835 & 9221-34750156, E-Mail: bmre@pakistansteel.com.pk
SAQUIB EJAZ HUSSAIN
Divisional Manager (Environment)
EMC Pakistan Pvt. Ltd

29th March' 2016

Dear Sir,

Reference to your letter dated 10th March 2016 on stake holder consultation for EIA study of 2X350 MW coal power plant in Port Qasim, the response of Lotte Chemical Pakistan Ltd is as below:

1) Transportation of Coal from the jetty: In the circulated agenda this is not part of the scope. We understand that jetty will be at Port Qasim, in this case a special study is required with reference to transportation of coal from jetty to the proposed site. Current infrastructure is not adequate for transportation of around 2 Million Tones of Coal per year (equivalent to power generation) through trucks and it will have serious impact on our commutation and movement of raw materials. The cumulative impact of this movement with Synohydro and other industries need to be studied and alternate like conveyor or jetty behind the plant need to be proposed to avoid serious safety, environment and operation issue after commissioning of the plant.

2) Storage of Coal and protective systems: Dust during handling and storage is serious concern for health of our staff, health of plant equipment and quality of our product which is sensitive to any black particle. In the scope mentioned about wind shield and sprinkler system, however in EIA it need to be made mandatory requirement and sprinkle arrangement to be linked with fail safe mode to avoid operation without the safeguards.

3) Ash handling/storage and transportation arrangement: Nature, amount and quality of ash make this point one of the key for us and other nearby industries. At the moment agenda point include ash handling system however no point mentioned regarding storage area for the ash and it's transportation routes. This should be part of EIA. Dedicated facility to be identify outside industrial area for safe storage of ash and disposal safely. Before finalizing EIA, we need a feed back on the ash handling facility and transportation mechanism from the site.

4) Cumulative Impacts on our Plant: The environment impact due to coal burning especially particulate level and ground level contamination of sulphur compounds to be analyzed by taking into account upcoming coal plants mainly Synohydro.

Please include above points in the EIA study and keep undersign posted on the response.

Yours Faithfully,

Adnan Ul Haque
Technical Manager,
Lotte Chemical Pakistan Ltd.
Ref: EMC/EIA/KE/16/3112
Dated: 10th March, 2016

HSE Manager
Lotte Chemical Pakistan Ltd.
Port Qasim, Karachi

SUBJECT: STAKEHOLDER CONSULTATION
Environmental Impact Assessment (EIA) Study of 2 x 350 MW Coal Power Plant in Port Qasim Karachi

Dear Sir,

In order to contribute toward meeting Karachi’s growing electricity demand, K-Electric Limited (KE) intends to establish a coal fired power station in the Eastern Industrial Zone of Port Qasim Authority. The project aims at construction and operation of 2x350 MW Coal based supercritical thermal power plant to reduce the dependency on high sulphur fuel oil and to introduce cheaper alternative fuel for power generation diversity, increase the efficiency and provide reliable low cost power to the Karachi City.

The 2x350 MW coal power plant shall adopt supercritical boiler technology. The major systems of the power project include:

- Coal Jetty
- Super-critical boilers
- Pulverised Coal (PC) generation plant
- An open coal storage area surrounded by wind shield with stacker & reclaimer
- Coal handling covered conveyors
- Water supply and waste water system
- Ash handling system
- Emission control system
- Flue Gas Desulfurization (FGD) system
- Dust prevention, and fire monitoring and prevention facilities.

KE has appointed EMC Pakistan Private Limited for conducting the Environmental Impact Assessment study of the proposed coal power plant project to assess the likely environmental and social impacts that may result from Project activities and to identify measures to mitigate the negative impacts. The EIA process and report will respond to the national regulatory standards & internationally accepted guidelines.
The major components of the EIA include: (i) Comprehensive baseline studies to characterize the existing socioeconomic and biophysical environment; (ii) A public consultation process to ensure that project stakeholders are informed of the project development plan and have an opportunity to influence it; (iii) A comprehensive analysis of the environmental and social impacts of the project, both negative and positive; and, (iv) The development of the impact mitigation plans and an environmental management plan.

A brief overview of the conceptual components of an EIA Process that meets both Pakistan and international standards is given below.

<table>
<thead>
<tr>
<th>Conceptual Components of an EIA process</th>
<th>Main Purpose</th>
<th>Activities related to Stakeholder Consultation</th>
</tr>
</thead>
</table>
| Scoping                                | - Identify the issues on which the EIA should focus  
- Identify the project alternatives that should be evaluated during the course of the EIA. | - Identify institutional and community stakeholders  
- Engage stakeholders and record issues raised  
- Provide feedback to the EIA team to incorporate stakeholders concern in baseline investigations and impact assessment |
| Baseline investigations                | - Collect background information on the environmental and social setting of the project | - Incorporate additional issues raised during the baseline survey |
| Impacts assessment studies             | - Define the potential impacts of the project  
- Undertake specialist investigations to predict changes to the environment due to the project  
- Determine the significance of the potential impacts  
- Identify measures for the management of the impacts  
- Determine the residual impacts of the project after incorporation of the management measures  
- Evaluate the overall acceptability of the project (from environmental and social perspectives). | - Assess issues raised by stakeholders |
| Mitigation Measures and management plan| - Environmental mitigation and monitoring plan will describe the measures proposed to ensure implementation of the mitigation measures identified during the impacts assessment. It will include, for example, specific designs and plans, training requirements, resources requirement, monitoring details (sampling locations, methodology and frequency), Review and reporting requirements | - Assess the acceptability and practicability of the proposed mitigation measures |
Conceptual Components of an EIA process

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<tr>
<td>EIA Report Preparation</td>
<td>* After the studies, the EIA team will put together the detailed assessment of impacts and mitigation measures. This may involve liaison with various specialists to ensure correct interpretation of information and compile EIA report.</td>
<td>* Provide stakeholders with feedback on the EIA specifically communicate how the project proposes to address the issues raised by the stakeholders</td>
</tr>
<tr>
<td>EIA submittal to regulatory authorities and decision making</td>
<td>* Submittal and review of the EIA report by regulatory authorities and other interested stakeholders. The reviewers will inform about the decision on the acceptability of the project from environmental and social perspectives and the condition of approval for the development</td>
<td>* Attend the public hearings and respond to the issues raised during the public hearings.</td>
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In compliance with the requirements of SEPA Act, 2014 and SEPA (Review of IEE/EIA) Regulations, 2014, EMC Pakistan Pvt. Limited is carrying out stakeholder consultation with pertinent organizations to provide an opportunity to the stakeholders to voice their concerns/give suggestions.

You are kindly requested to share your concerns and/or suggestions on the project either in writing at the above address or electronically at the following addresses: saquib@emc.com.pk, nadeem@emc.com.pk at your earliest.

Your prompt response will enable us to incorporate your valuable comments in the EIA report. If we do not receive any response, we will presume that your good-self has no specific concern on the project.

Sincerely,

Saquib Ejaz Hussain
Divisional Manager (Environment)
EMC Pakistan Pvt. Ltd
For more information on the EIA contact:

Saquib Ejaz Hussein
EMC Pakistan Pvt. Ltd
503, Anum Estate, Main Shahrze Faisal,
Karachi, Pakistan
Tel: 021-34321532, 0345-2447202
Fax: 021-34311467
Email: saquib@emc.com.pk

Syed Nadeem Anf
EMC Pakistan Pvt. Ltd
503, Anum Estate, Main Shahrze Faisal,
Karachi, Pakistan
Tel: 021-34321532, 34311465
Fax: 021-34311467
Email: nadeem@emc.com.pk