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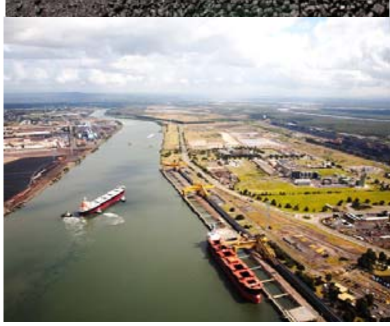

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

MINISTRY OF POWER, ENERGY & MINERAL RESOURCES

POWER DIVISION

BANGLADESH POWER DEVELOPMENT BOARD

Final Report On

Consulting Services on Coal Sourcing, Transportation and Handling of (2x660) MW Coal Based Thermal Power Plants Each at Chittagong and Khulna, and 8320 MW LNG and Coal Based at Maheshkhali

CEGIS Center for Environmental and Geographic Information Services
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Dhaka

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Center for Environmental and Geographic Information Services

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Executive Summary

Government of Bangladesh has adopted Millennium Development Goal (MDG) and set a target to reach the level of middle-income group country by 2021. To attain such goal energy security of the country is decisive.

Sustainable power supply is a major precondition for the socio-economic development as well as livelihood improvement. The Government has given top priority to the development of power sector considering its importance in overall development of the country. To this end, the Bangladesh Government has set the goal of providing electricity to all citizens of the country by 2020. At present about 50% of the total population of Bangladesh has access to electricity and per capita Electricity generation is only 272 KWh.But reliable and quality supply of power is still a faraway. In financial year 2012, total installed electricity generation capacity is 8,100 MW including 3,771 MW from private sector.The electricity demand growth of the country is 10% per annum. Country's maximum electricity demand will be 13,000 MW in 2017 and 34,000 MW in year 2030. To meet up these, the Government of Bangladesh has formulated a Power System Master Plan (PSMP).

Presently, 79% of total electricity is generated by using natural gas. This high dependency on waning natural gas reserves threats sustainability of the power generation system. Power System Master Plan (2010) emphasizes on diversification of fuel use for power generation and recommends, by 2030, 50% of power generation by using coal (considering waning natural gas reserves of Bangladesh). The coal based power generation is a least cost option at present economy. Accordingly, Bangladesh Power Development Board (BPDB) has planned to install three mega coal based thermal power plants in Bangladesh. BPDB has entrusted CEGIS with the responsibility of carrying out detail and comprehensive study on sourcing, transportation and handling of coal for the proposed three mega power plants (1320 MW Coal Based Thermal Power Plant each at Khulna and Chittagong, and 5320 Coal Based Thermal Power Plant at Maheshkhali). The purpose of this coal sourcing, transportation and handling report is to facilitate the feasibility study of the said power plants.

Approach and methodology

The principle objective of this study is to suggest sustainable options of possible coal sourcing, transportation, and handling facilities to the port and the proposed power plant sites. The study has been executing by a team of multidisciplinary professionals of specialized fields as mentioned in the ToR. The overall study has been carried out to identify possible sources of coal with required quality and sustainable quantity evaluating present standard and practices in the world. For understanding global coal business, coal sourcing mechanism, transportation and handling system, and exploring coal sourcing and transportation opportunity, the study team have made visits to South Africa, Australia, Indonesia and Singapore. In addition, the foreign experts have made visits to Mozambique with the same objectives. Expert judgment, site specific information, river morphology, bathymetry, exploratory study on coal transportation options, coal requirement, environmental investigation and cost assessment have also been carried out. The study also attempted to identify national laws, conventions, policies relevant to coal sourcing, transportation, and handling, those have been presented in the report.

Stakeholder consultations

A series of stakeholder consultation meetings has been carried out with different government and non-government organizations including Bangladesh Power Development Board, Barapukuria Coal Mine Company Ltd., Mongla Port Authority, Chittagong Port Authority, Mongla Cement Industry, Bangladesh Cement Manufacturer's Association, Shipyards, Shipping agents, Bangladesh Navy, Bangladesh Inland Water Transport Authority, and Key Informants. The perception and expert opinion of the stakeholders have been followed in executing the overall study and formulating the final recommendation.

International coal market

Coal is still a major primary energy used for electricity generation. The global trading volume of coal was 916 million ton in 2009 and is still growing rapidly. Among this, seaborne trade covers 94%. The seaborne coal market is traditionally divided into two sub-markets: the Atlantic market, and the Pacific market. Asian region falls under Pacific market. Asia is the largest importer and exporter of the international coal trade. The biggest importing countries are China, India, Southeastern Asia, e.g. Japan and Korea and the main exporting countries are Indonesia, Australia, Russia, Colombia/Venezuela and South Africa, respectively. Due to association with different socio-political issues, energy prices are always volatile. However, coal price used to be relatively stable. Recently, there was a sharp price hike in 2008. The market is now again reaching toward the equilibrium.

In South Africa, Indonesia and Australia, production cost of coal generally ranges from 40 – 47 USD/ton and the export price (FOB) including, local transportation (mine to port of export), trading surcharge, insurance, etc stands in between 100 to 120 USD/ton (adjusted to 5500 kcal/kg CV coal, GAR basis).

Indigenous coal deposits

Northwest part of the country is well known for a good reserve of coal. So far, five coal deposits have been discovered with in-situ coal deposits of about 2.5 billion ton. Besides, there is a good probability of discovering new Coal Deposits in and around the previously discovered Coal Deposits of Bangladesh. Presently, Barapukuria is the only mine with limited production. The possibility of new mine development before commissioning of the proposed power plants is also limited. At present situation, sourcing of coal from indigenous sources may not be possible initially. Nevertheless, at least for the Khulna Power Plant, considering the cost of coal, transportation, etc of the imported coal, all out effort may be made to develop the indigenous coal mine and related infrastructures. As such, government should look into the hindrances of mine development e.g. the water management of public acceptance issues and mine.

International visits

With the aim of understanding global coal trading system, coal sourcing, transportation and handling system, and collecting necessary information and data on coal reserve, production, export policy, international visits were made to South Africa, Australia, Indonesia and Singapore. The team consists of officials from the Ministry of Power, Energy and Mineral Resources (MoPEMR), Bangladesh Power Development Board (BPDB) and experts from CEGIS. At the same time, the foreign experts have also visited Mozambique, a new entrant in world coal market with the same objectives. During the visits a wide range of consultation and discussion meetings were made with different coal traders, coal suppliers, coal producers, mine operators, coal terminal operators, shipping agents, ship brokers, solicitors, quality control and inspection agents, etc. In addition to earning knowledge, and collection of necessary data and information, these meetings were helpful to establish communication between GOB and different stakeholder playing important role in coal trading system.

Suitable coal sources

South Africa, Australia and Indonesia are the countries within the reachable distances from Bangladesh, which have accredited coal export history.

The resource situation in **South Africa** can be summarized as followed:

- Country with traditional coal mining (30.15 billion tone of proved reserve with Reserve to Production (RP) ratio of 119)
- The coal quality suits well the demand of the Client (96% bituminous coal, Sulfur content less than 1%).
- The logistics (railway and harbor) fulfill the requirements.
- Additional slots for high volume (like coal) rail transport in South Africa are difficult to get.

The resource situation in **Australia** can be summarized as followed:

- Coal of sufficient quality and required quantity is available (76 billion tons prove reserves with RP ratio of 180).
- The coal quality suits well the demand of the Client (51% anthracite and bituminous coal, and 49% sub-bituminous, Sulfur content less than 1%).
- The "Big Four,(BHP-Billiton and Mitsubishi, Rio Tinto, Xstrata and Rio Tinto)" creates an in-transparent market controlling major coal export share and coal transportation infrastructures.
- The logistics (railway and harbor) fulfill the requirements.
- Flood events often interrupt continuous coal supply.

The resource situation in **Indonesia** can be summarized as followed:

- Indonesia has huge coal resources (104.94 billion ton resources, 13.48 billion ton probable reserves, and 5.5 billion ton proved reserve) but mostly of lignite and sub-bituminous quality.
- The quality might be suitable but lower calorific values and higher moisture content increases the absolute supply and transportation costs.
- The close proximity to Bangladesh means low seaborne transportation cost.
- Local issues like influences of local peoples, business environment, political situation, unstable energy policy, reliability of coal producers/suppliers/shippers are the major challenges.

Other sources

- **India**, is the nearest neighbor country having close relation with Bangladesh, is third largest coal producer but exports very little low-grade coal. It is the fourth major coal importing country.
- **China** is the third largest coal producing country but at the same time it is the second largest coal importing country.

- **Mozambique** is a new entrant in world coal market. A huge investment in related infrastructures development and mine is going on. It has very good potential to be one of the major coal exporting country

Comments on suitable coal quality

The study reviewed and analyzed resources, reserve, production, export and import of different grades of coal by individual countries. Considering the present trend in world coal market, depletion of world coal reserve, decreasing shipping rate, and discount (rate) advantage for below Richard Bay (RB) standard coal, the study suggests to source coal of 5,500 Kcal/kg calorific value (Net as Received basis) for the proposed power plants. Besides, considering location of the plant (nearer to Ecological Critical Area, *e.g.* Sundarbans, Sonadia Island, etc), and environmental regulations, the study suggests coal having low Sulfur content (average 0.6%).

Comments on potential coal sources

The study prefers South Africa as a reliable and sustainable coal source considering reserves, productions, coal export policy, and reliability of the coal supply infrastructures. Second preference goes to Australia. Indonesia could be suitable source of coal if challenges related to Indonesian local issues (influences of local peoples, business environment, political situation, unstable energy policy etc), coal transport infrastructures, and reliability of coal producers, suppliers are properly taken care off. Besides, Mozambique is a new entrant in the world coal market with huge investment in mining and related infrastructural development that should be considered for future. Along with the coal import, indigenous coal mining development should also be considered for future in line with the Power System Master Plan (2010) and the Road Map for Coal Sourcing suggested under this study.

Long term off take agreement linked with coal price index or quarterly price negotiation with coal producers might be the easiest and reliable mode of coal procurement. Mine leasing might be considered for future after achieving adequate experience in mining operation and coal business.

Coastal river and bathymetry

Under the present condition, a vessel having 5-6 m draught can berth at Mongla Port taking full advantage of high tide. At present, Akram point (44 nautical miles south of Mongla Port Jetty) has water depth between 15 m to 20 m but due to shallow depth at outer bar the vessel more than 25000 DWT cannot approach up to Akram Point. There are some shoals in the Outer Bar that limit approaching of vessel having draught over 8.5 m. The same vessel can proceed up to Harbaria (12 nautical miles downstream of Mongla Port Jetty) taking tidal advantage. Presently, vessel of maximum 5m - 6m draught can proceed up to port jetty with taking tidal advantage. Further upstream of Mongla port the draught is better and improving. Up to south end to the project area draught varies 4 m to 7 m. But in some places, shoals restrict draught. Further upstream of the south end of the project, draught decreases due to some shoals and submergible sandbars. In case of Sibsa River, water depth of 8 m is available up to Nalian Hat that is 13.5 nautical mile downstream from the Project site through Chunkuri River. However, in Chunkuri River, draught is in between 3.0 m to 3.5m only.

The Chittagong TPP project site is located at the mouth of Karnaphuli River where 6 m to 7m water depth is available. Taking tidal advantage, vessel of maximum 9.1 m draught can proceed up to the Chittagong Port as well as the project site. In the area of Alfa Anchorage of the Chittagong Port, water depth is above 10m.

Maheshkhali TPP project site is nearer to deep sea. At present, the seashore area is very shallow and consists of numerous mud flats, shoals, and islands. The deep sea is only 7 km from the shoreline. Hence, an approach channel has to be developed by dredging.

Dredging assessment

Analyzing existing hydrographic maps showing riverbed bathymetry and draught required for suggested vessel, dredging requirements have been assessed with identifying tentative alignment of dredging. Dredging at Outer Bar and Base Creek to project site would be very critical and important for both the project as well as Mongla Port. Dredging of 30 million m^3 at Outer Bar (Length 20km, channel width 160m and design depth 12 m C.D) and 2.1 million m^3 from Base Creek to Mongla Port Jetty and Project site (channel width 100m, length 16 km and design depth 5.5 m) have been suggested for effective coal transportation. The total capital dredging would cost 115 million USD and yearly maintenance dredging would cost 30 million USD. IF the allowable draught for 80,000 DWT mother vessel can be maintained at Outer Bar through dredging (capital and maintenance dredging), it would save transportation cost about 40 to 45 million USD (varies with coal requirement) each year.

No capital dredging will be required for Chittagong Power Plant. At present Chittagong Port Authority is planning for dredging at outer bar of the Karnaphuli River, which would also be beneficial for the power plant project.

Massive dredging will be required for developing an approach channel from the deep sea to the shore area of the Maheshkhali Project. The approach channel might be of 7km long, 400m wide (considering PIANC guideline for 80,000 DWT vessels) and 15m CD design depth. As such, 37.8 million m^3 dredging will be required and will cost around 132 million USD. The dredging requirement as well as the cost might be reduced considering the proposed channel a single lane *i.e.* 200m wide. In such case, maintenance of the channel will also be easier but only one vessel will be able to ply through the channel at a time. However, decision has to be taken considering the future expansion of the project, volume of the traffic, scope of the proposed coal terminal. If the coal terminal is to be considered as a national coal center, in such case traffic volume will be high and it would require double lane *i.e.* 400m wide channel.

Sea state

Attempts were made to collect all available data on sea calmness, wind environment, wave environment, and hind casted wave characteristics. Wind speed varies from 9km/hr to 12 km/hr. In general strong wind prevails during March to September of a year while the predominant, wind direction is south to north. Rest of the year, it flows from north.

On an average, the high water level (HWL) varies from +4.5 to + 5 m and the low water level (LWL) varies from – 2m to +0.5 m. In general, the chart datum (LAT) is considered as -2.69 (in reference to mean sea level) in Bangladesh coast.

Wave rose diagrams show that both shallow and deep-water waves are dominant from the south direction. Besides, deep water and shallow water wave height and wave period of 25year, 50year and 100-year return period were collected. However, it is recommended to carry out a detail oceanographic study including data collection on sea state of the project site for a complete hydrologic year to assimilate data required for transportation function.

Coal transportation

The study evaluated different alternatives for transportation of coal up to proposed site for each of the three power plants. Finally, the most suitable transportation plan for each of three power plants suggested is follows:

Transportation of coal for Khulna Power Plant from source country to Akram Point by vessel of 80,000 DWT (subject to beam width and length of the vessel) and then further transshipment by purpose built shallower draught coal carrier of 5000 to10,000 DWT having draught of 5.5 m.About 59 voyages will be required each year to transport annual coal requirement by vessel of 80,000DWT from source to Akram Point anchorage. Accordingly, considering round trip time (including loading, unloading, bad weather, etc), minimum number of mother vessel (80,000 DWT) would be five (5), Seven (7) and eight (8) for transportation of coal from Indonesia, South Africa and Australia respectively. Beside, minimum lighter vessel (purpose built coal carrier) requirements will be nine (9), five (5) and four (4) for vessels of 3000, 5000 and 10,000 DWT respectively. Under this plan, the transportation cost will be 21.3 USD/ton for Kalimantan, Indonesia, 36.0 USD/Ton for Richard Bay, South Africa and for Newcastle, Australia.

The study also noted an opportunity of using Sibsa – Chunkuri River System for transshipping coal up to Khulna project site from Akram Point as an alternate route. However, a detail study might be carried out with detail hydrographical survey, river cross section survey, morphological analysis and environmental analysis on Sibsa-Chunkuri River System.

For Chittagong Power Plant, suggestion goes to transportation of the coal by 50,000DWT vessel from source to Alfa Anchorage of the Chittagong Port with further transshipment by lighterage operation. With this arrangement, about 95 voyages of mother vessels will be required to supply the required amount of the coal up to the project site. To unload a 50,000 DWT vessel and discharge the coal at project site, ten (10) voyages will be required for 5000 DWT lighter or five (5) voyages will be required for 10,000 DWT lighter. To ensure supply of required amount of coal, coal carried in a mother vessel of 50,000 DWT at Alfa Anchorage has to be transshipped up to the project site within 3.8 day. Finally, the coal transportation cost will stand 25.6 USD/ton for Indonesian sources, 43.9 USD/ton for South African Sources and 44.5 USD/ton for Australian sources. These costs are higher compared to Khulna Thermal Power Plant (TPP) as the lighterage cost in Chittagong is higher and vessel proposed for Chittagong considering existing river condition is smaller than Khulna TPP. For Khulna TPP, the transportation plan has been proposed considering capital dredging and maintenance dredging and the dredging cost has not been included in the freight rates.

For Maheshkhali TPP, it is proposed to build a coal terminal targeting 80,000 DWT vessels. Hence, the vessel of 80,000 DWT will directly discharge coal at project site coal terminal. Accordingly, the transportation cost will be only 14.4 USD/ton for Indonesian source, 29.6 USD/ton for South African source and 28.8 for Australian source. In compare to Chittagong and Mongla, Maheshkhali is closer to Australia but more far away from South Africa. As a result, transportation cost from Australia to Maheshkhali is less than the cost of South Africa to Maheshkhali.

Force majeure

Each year, lighterage operation might be suspended for a short periods due to bad weather such as heavy rain, depression and cyclone. It is estimated, bad weather might suspend shipping activities in Mongla Port area for maximum of 40 days in a year. A single spell of bad weather condition might be maximum five (5) consecutive days in Khulna region, and six (6) consecutive days in Chittagong and Maheshkhali region respectively. Taking consideration of this force majeure, coal should be stocked at stockyard.

Coal transportation under long-term agreement with Coal Transportation Agent might be the easiest and sustainable mode of coal transportation. Similar agreement might also consider lighterage operation (barging and ship-to-ship transfer) to transship coal from mother vessel to project site (for Khulna and Chittagong Project).

Aids to navigation

For smooth shipping and barging activities, the approach channels (Approach to Karnaphuli, Approach to Passur, Approach to proposed coal terminal at Maheshkhali), rivers (Karnaphuli up to Chittagong TPP project site, and Passur up to Khulna TPP Project site) need to properly marked by lighted buoy and beacons for continuous day and night navigation. The estimated cost for aids to navigation would be 489 thousand USD for Khulna TPP, 307 thousand million USD for Chittagong TPP and 175 thousand USD for Maheshkhali TPP.

Coal terminal

The study explores scope of coal terminal construction. The study finds, coal terminal at project site would be much more effective in terms of coal transportation saving time and cost compared to the terminal at Mongla Port Site. The study suggests construction of coal terminal at project site for Khulna Power Plant considering existing river condition and cost effectiveness of coal transportation. However, a detail study has to be carried out to forecast future change of the Passur River channel and sustainability of the dredging of the river for long term. After that, the decision has to be made on location of coal terminal.

Coal terminal at project site has been suggested for Chittagong and Maheshkhali Power Plant. The Jetty dimension of Khulna Power Plant coal terminal and Chittagong Power Plant coal terminal has been proposed as 540 m x 30 m while the deck level at + 6.0 m C.D is recommended. In each case, unloading system has been suggested for two rail mounted grab unloader with rated capacity of 1000TPH each. For Chittagong, an approach jetty of 30m long needs to be constructed to connect the berth with the shoreline.

For Maheshkhali Power Plant, jetty dimension of 720 m x 30m has been proposed. The coal terminal has to be developed and provided with calm harbour basin and approach channel. For unloading the coal, four (4) rail mounted grab unloaders with 1000 TPH rated capacity each have been proposed. It is to be noted that, a calm harbor basin and approach channel have to be build constructing breakwater for Maheshkhali Power Plant.

For each power plant, shoreline facilities, and bank protection works will be needed. The tentative cost of coal terminal construction has also been indicated in the report. It is estimated, for Khulna, the cost will be around 35.2 million USD, for Chittagong, the cost will be around 37.8 million USD and for Maheshkhali the cost will be around 58.4 million USD. The cost includes, jetty construction, shoreline facilities and revetment. This figure excludes cost of breakwater structure construction that might be done by the separate study during detail design.

Ash utilization

Possible annual ash production from the proposed power plant will be annually around 0.5 million ton from each of Chittagong and Khulna and around 1.85 million ton from Maheshkhali (considering max. 15% ash generation, and coal inflow at 85% plant load, 40% plant efficiency and 290 days operation). Among the total generated ash, 20% would be bottom ash and 80% would be dry fly ash. At present only cement industries in Bangladesh require 2.1 million tons fly ash per annum and the demand is growing with rising demand of cement. Besides, some other possible market of the ash (both fly ash and bottom ash) has been identified. There will be vast scope of utilizing the generated ash in embankment construction, arsenic-removing technology for drinking water and in agricultural field as fertilizer. The transportation of the generated ash would easily be transported to any part of the country by rivers and roads, which would be much easier and cost effective for users compared to import from any foreign country.

Coal and ash handling

The study adopted the coal handling system and ash handling system suggested in the draft feasibility study report by NTPC. The same can also be adopted for Chittagong. The conceptual system will also be same for Maheshkhali but the capacity will be different. Suggestions have been made for better management.

Cost of Coal

The price of energy including coal is rapidly fluctuating and very tricky to predict. However, for consideration of coal price in the Feasibility Study (FS), it is suggested to consider coal price (CIF) as **140 USD/per ton** up to proposed Khulna TPP, **145 USD/ton** for Chittagong TPP and **132 USD/ton** for Maheshkhali TPP.

Abstract of the investment cost for coal transportation

The capital dredging cost for Khulna TPP at Outer Bar and Base Creek to project site for suggested coal transportation system has been estimated at **115million USD** and maintenance-dredging cost would be **30 million USD** for first year. For Maheshkhali, the dredging cost will be around **132.13 USD** if the channel width is considered as 400m. On the other hand, cost will stand **69. 12 million USD** if the width is considered as 200m. However, standard practice is 400m. No dredging will be required for Chittagong TPP.

The indicative total cost for coal terminal construction at project site stands **35.2million USD for Khulna TPP, 37.8 million USD** for Chittagong TPP and **58.4 million USD for Maheshkhali TPP**.

The aid to navigational cost would be **0.49 million USD for Khulna, 0.31 million USD for Chittagong and 0.175 million USD for Maheshkhali power plant**.

Environmental Issues and Concerns

The study identifies some environmental issues and concerns relevant to the coal transportation and handling. The likely impacts on environment and Sundarbans Ecosystem that may arise due to noise, oil spillage; discharge of ballast water and bilge water, coal dust, dropping of coal during transshipment etc can be avoided and/or mitigated by proper implementation of the suggested Environmental Management Plan. The agencies (e.g. DG Shipping, Port Authorities, BIWTA, etc) responsible for enforcement of relevant national environmental laws (ECA 1995, ECR 1997, etc), IMO Conventions, should regular inspect and monitor shipping and barging activities within the Bangladesh territory for ensuring minimum environmental pollution from shipping and barging complying with above mentioned laws and IMO Conventions.

Conclusion

The study finally concluded that, at present, South Africa, Australia and Indonesia are the potential sources for the proposed power plants. Preferences might be given to South Africa and Australia considering sustainability of supply. In future Mozambique would be a suitable source also. In parallel to coal import, initiative has to be taken to develop indigenous coalmines.

It is suggested to construct coal terminal at each plant site for smooth coal transportation and handling. To attain at least cost coal transportation, the channel from outer bar to Akram Point and Base creek to project site has to be improved by dredging. Similarly, dredging would also be required for Maheshkhali TPP for developing an approach channel from deep sea to project site. The following are the suggested coal transportation plan;

- Khulna TPP: Transportation of coal by Handymax vessel (80,000DWT). As such, the mother vessel shall anchor at Akram point then further transportation by purpose built shallower draught coal carrier/barge (5,000 to 10,000 DWT). Ship-to-ship transfer shall be made by floating transfer vessel.
- Chittagong TPP: Transportation of coal by Handymax vessel (50,000 DWT). As such, the mother shall anchor at Alfa Anchorage of the Chittagong Port. Then further transshipment by lighter. Own gear of the mother vessel may be preferred for ship-to-ship transfer.
- Maheshkhali TPP: Direct discharge of coal at plant site coal terminal by Handymax vessel (80,000 DWT).

Recommendation

From the experience of the study, international visits, and examination of different cross cutting issues, as well as experience of the consultant, the Coal Sourcing and Transportation Study recommends the following:

- ❑ **Contracting**

- o The Coal Strategy should consider the coal production of the national coal producing organizations as well. A long-term time schedule has to be generated integrating the national and the international coal sources.
- o It is recommended to have direct contracts to the mining companies for the acquisition of import coal. Off-take agreements may be an alternative as well. The mining scene should be monitored to find suitable JV opportunities.
- o Two or three coal supply contracts directly signed with mining companies are recommended. Sometimes traders cannot be avoided (e.g. Richards Bay). Two or three shipping contracts according to the supply agreements have to be signed as well.
- o The government should support the project during the phase of contract establishment. Support of the Embassy of Bangladesh at Jakarta, Indonesia and High Commission of Bangladesh at Canberra, Australia and South Africa to establish the first contact to the major mining companies would be very much appreciated.
- o Establish contact to the marketing departments of up to ten mining companies with the target to select three companies for further contract negotiations (e.g. three Australian, three South African, two Indonesian, and two Mozambican companies).
- o The **negotiations** of any long term contract should target at:

    - discounts for coal qualities below RB standards (6,000 kcal/kg) long term delivery commitments
    - discounts on shipping rates for high volatile contents of the coal and processing costs.
- Hedging and swapping should not be excluded but additional risk due to the contracting should be avoided. Optimal use of options should be considered.

- **Coal supply chain**

- The coal supply price and the charter rates are subject to fluctuations due to macro- and microeconomic changes. For the reason a very thorough evaluation of the particular country and company situation is recommended in order to achieve an optimal result for the Client.
- Continuous and serious monitoring of the individual cost centers, of the time schedule and on the fulfillment of the technical specifications is necessary.
- For this reason it is further recommended to the Client to establish an internal professional team focusing on these contract issues on a permanent basis. The Client should invest in the development of such internal "Core Team" for two reasons, cost reasons and for overall convenience.
- As an alternative to this approach, the Client could decide to involve a trading company. However, considering the additional costs due to the involvement of a trading company will not be a viable alternative.

- **Contract monitoring**

- The "Core Team" should be developed and prepared to monitor during the entire contract period
    - the fulfillment of the technical specifications including quality monitoring and sampling
    - Monitoring the environmental compliance of loading, shipping, transferring, barging and unloading activities
    - the time scheduling
    - the contract extensions or negotiations of new contracts
    - any development in the coal market to be able to react on any change

- **Equipment availability**

- Since barges of the required size and with the appropriate structural features are not readily available in Bangladesh, it is recommended to inform the locally active shipping companies early enough that such business opportunity is coming up. This will give them the chance to ramp up their equipment to qualify for this future work.
- When constructing the barges, efficient design for shallower draught coal barges should be considered.

- **Dredging and coal terminal facilities**

- The required works for dredging and installation of the coal terminal facilities should be considered critical and made as early as possible to have the possibility for delivery of large parts of the power station equipment directly to the site by ocean going vessels or large barges

- **Follow up studies should be carried out covering**

- Preparation on Coal Procurement and Coal Transportation Policy

- Set up and capacity building of a professional team in BPDB (Core Team) for the management of the coal supply activities and the contract monitoring by external consultant
- Institutional arrangement for coal sourcing and transportation (Core Team in BPDB)
- Implementation of coal procurement and transportation and preparation of Coal Supply and Transportation Agreement Documents (Core Team in BPDB)
- Ash utilization Policy
- Mining concept for national coal resources
- Public awareness campaign at location of mines and power plants

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Acronyms and Abbreviations

AD	Air Dried
AFRA	Average Freight Rate Assessment
AFT	Ash Fusion Temperature
AIRS	Atmospheric Infrared Sounder
AR	As received
BA	Bottom Ash
BACT	Best Available Control Technology
BG	Broad Gauge
BIWTA	Bangladesh Inland Water Transportation Authority
BMD	Bangladesh Meteorological Department
BPDB	Bangladesh Power Development Board
Btu	British thermal unit
CD	Chart Datum
CEGIS	Center for Environmental and Geographic Information Services
CF	Capital Factor
CIF	Cost, Insurance and Freight
CHP	Coal Handling Plant
CHPP	Coal Handling and Processing Plant
COADS	Comprehensive Ocean Atmosphere Data Set
CPA	Chittagong Port Authority
CSR	Coke Strength after Reaction
CSD	Cutter Suction Dredger
CV	Calorific Values
DFS	Definitive Feasibility Study
DG	Director General
DoE	Department of Environment
DSP	Deep Sea Port
DWT	Dead Weight Tonnage
EA	Environmental Assessment
ECA	Ecological Critical Area
ECA	Environment Conservation Act
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan

EP	Equator Principle
ESMF	Earth System Modeling Framework
ESP	Electrostatic Precipitator or Precipitation
FC	Fixed Carbon
FGD	Flue Gas Desulphurization
FOB	Free on Board
FTV	Floating Transfer Vessel
FR	Final Report
GAR	Gross As Received
GCV	Gross Calorific Value
GIIP	Good International Industry Practice
GIS	Geographic Information System
GSB	Geological Survey of Bangladesh
GSI	Geological Survey of India
HCSD	High Concentration Slurry Disposal
HGI	Hand grove Grind ability Index
HHV	Higher Heating Value, kJ/kg
HVCCC	Hunter Valley Coal Chain Coordinator
ICMA	Indonesian Coal Market Association
IEA	International Energy Agency
IM	Inherent Moisture
IMCO	Intergovernmental Maritime Consultative Organization
IMO	International Maritime Organization
INMRSAT	International Maritime Satellite Organization
ITC	Instructions to Consultants
JICA	Japan International Cooperation Agency
KII	Key Informant Interview
LLWL	Lowest Low Water Level
LNG	Liquefied Natural Gas
MEAs	Multilateral Environmental Agreements
MoPEMR	Ministry of Power Energy and Mineral Resources
MPA	Mongla Port Authority
MPFWB	Mongla Port Fair Way Buoy
MSC	Maritime Safety Committee
Mtpa	Million ton per annum
MW	Mega Watt
NAR	Net As Received

NCIG	Newcastle Coal Infrastructure
NOx	Nitrogen Oxides
NPLCT	North Pulau Laut Coal Terminal
NPV	Net Present Value
OD	Operation Directives
OP	Operation Policy
PC	Pulverized Coal
PDS	Proposal Data Sheet
PLC	Program Logic Controller
PSMP	Power System Master Plan
RBCT	Richards Bay Coal Terminal
RP	Reserve to Production
ROM	Run of Mine
SA	South Africa
SC	Supercritical
SOLAS	Safety of Life at Sea
SOx	Sulfur Oxides
TFS	Tradition Financial Services
ToR	Terms of Reference
TM	Total Moisture
ToP	Take or Pay
TPH	Ton per Hour
TPP	Thermal Power Plant
TSHD	Trailing Suction Hopper Dredger
ULCC	Ultra Large Crude Carrier
UNCAT	United Nations Conference on Trade and Development
VM	Volatile Mater
VLCC	Very Large Crude Carrier
WCI	World Coal Institute

Unit Conversion

General Unit

- 1 meter = 3.28 foot
- 1 kilometer = 0.621371192 mile
- 1 nautical mile = 1.852 kilometer
- 1 kilogram = 2.20 pound
- Imperial or Long ton (It) =1016.05 kg = 2240 lb
- Short (US) ton (st) = 907.19 kg = 2000Ib
- 1 square mile = 640 acres = 2.590 km^2
- 1 hectare = 10^{-2} km^2 = 2.471 acres
- 1 metric ton = 0.9842 long ton = 1.102 short ton = 2204.6 pound (lb)
- 1^0C = 274.15K=33.8^0F
- 1 km/hr = 0.6214 mile/hr
- 1 kg/m^3=0.0624 Ib/ft^3 = 0.001 ton/m^3
- 1 mg/m^3 = 1 µg /l
- 1 mg/L = 1 g/m^3 ≈ 1 ppm (w/w)
- 1 µ g/L = 1 mg/ m^3 ≈ 1 ppb (w/w)

Energy Units

- 1 Cal = 4.19 J
- 1 Btu = 1055.87J
- 1 Btu = 251.9958 cal
- 1 J = 0.239 cal
- 1 J = 1 WS
- 1 kWh = 3412 Btu.
- 1MW=1000KW=10^6 W
- 1 kWh = 3.6 x 10^6 J
- 1 kWh = 859.85 kcal
- 1 horsepower = 746 W
- 1 GWyr = 8.76 x 109 kWh.
- 1MJ/kg = 1 GJ/t
- 1 kcal = 4,187 J
- 1 kWh = 1.36 hp-h (horsepower hours)
- 1 hp-h = 2,510 Btu
- 1kW = 20.64 ton cal/day
- 1kcal/kg = 0.004187MJ/kg
- 1 kcal/kg = 1.8 Btu/Ib
- 1 MJ/kg = 238.8 kcal/kg
- 1 MJ/kg = 429.9MJ/kg
- 1 Btu/Ib = 0.5556 kcal/kg
- 1 Btu/Ib = 0.002326 MJ/kg

Coal Conversion Table

AR (As Received): Includes total moisture (TM)

AD (Air Dried): Includes inherent moisture (IM) only

DB (Dry Basis): Excludes all moisture

DBF (Dry Ash Free): Excludes all moisture and ash

Proximate Analysis of Coal (*e.g.* % of Moisture, Ash (A), Volatile Matter (VM), Fixed Carbon (FC), Sulfur (S), and Calorific Value (CV) can be expressed-

To obtain : - multiply	AD	DB	AR
AR	$\frac{100 - IM\%}{100 - TM\%}$	$\frac{100}{100 - TM\%}$	
AD		$\frac{100}{100 - IM\%}$	$\frac{100 - TM\%}{100 - IM\%}$
DB	$\frac{100 - IM\%}{100}$		$\frac{100 - TM\%}{100}$

Conversions – Gross/Net (per ISO, for As Received)

kcal/kg : Net CV = Gross CV- 50.6 **H** – 5.85**M** – 0.191**O**

MJ/kg : Net CV = Gross CV- 0.212 **H** – 0.0245**M** – 0.0008**O**

Btu/Ib**:** Net CV = Gross CV- 91.2 **H** –10.5**M** –0.34**O**

Where M, H and O are % of Moisture, Hydrogen and Oxygen respectively (from the ultimate analysis)

Bituminous Coal (containing 10% M and 25% VM)

The difference between GCV and NCV is approximately 260 kcal/kg (equivalent to 1.09 MJ/kg = 470 Btu/Ib)

Power Generation

1 MWh = 3600 MJ

1 MW (thermal power) [MWth] = approx 1000 kg steam/hour

1 MW (electrical power) [Mwe] = approx MWth/3

A 660 MW coal fired power station operating at 40% efficiency, 85% load factor and 290 operating days will consume approximately

Bituminous coal (CV 6000 kcal/kg NAR): 1.4 million ton/annum

Sub-bituminous coal (CV 5500 kcal/kg NAR): 1.5 million ton/annum

Sub-bituminous coal (CV 5000 kcal/kg NAR): 1.7 million ton / annum

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Chapter 1: Introduction

1.1 Background

The Government of Bangladesh has adopted the Millennium Development Goal. Moreover, the present government sets a vision to elevate the economy of the country to a mid-income group by 2021.

Sustainable power supply is a major precondition for the socio-economic development of Bangladesh. Adequate and uninterrupted supply of electricity attracts both domestic and foreign investments. The Government therefore, has given top priority to the development of power sector considering its importance in overall development of the country to achieve the Millennium Development Goal as well as vision 2021. To this end, the government has set the goal of providing electricity to all citizens by 2020.

At present, 50% of the total population of Bangladesh has access to electricity but reliable and quality supply of power is still a faraway. Moreover, the demand of electricity has been increasing overwhelmingly over the years. The Government assigns top priority to the development of power sector realizing its importance in economy, industrial and social development of the country. To this end, the government has set the goal of providing electricity to all citizens by 2020. In FY 2012, total electricity generation capacity is 8,100 MW including 3,771 MW from private sector and electricity demand growth 10% per annum. Government forecasts that the maximum electricity demand would be 13,000MW in 2017 and 34,000 MW in 2030. To meet up this, the Government of Bangladesh has formulated a Power System Master Plan (2010).

Taking consideration of high dependency on natural gas (79% of power generation comes from natural gas based units), and its limited supply, Power System Master Plan (PSMP 2010) recommends diversification of fuel used for electricity generation and opt coal as a prime energy for electricity generation. The national energy policy (1995) has also recommended to limit the utilization of natural gas for electricity generation up to maximum 45% and to look for alternative fuel e.g. coal, hydropower. The recommended limit has already been exceeded by using 55% of the total produced national gas for electricity generation. As such, the PSMP targets composition of power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such oil, nuclear power and renewable energy. The coal based generation is the least cost option in consideration to present economy.

Accordingly, BPDB plans installation of three mega coal based thermal power plants. This consulting service has been awarded to CEGIS to suggest suitable coal sources and transportation system along with coal handling system for the three proposed thermal power plants of BPDB. The first two of the three – in Chittagong and Khulna, 2 x 1320 MW thermal power plant will be completely based on coal as primary fuel and the third one- Maheshkhali 8320 MW plant will be as well as Coal and Liquefied Natural Gas (LNG) based (5,320 MW coal based and 3000 MW LNG based). In this regard, huge quantity of coal will be required for producing 7,960 MW electricity under these three projects. The success of these three mega projects completely relies on the sustainable and available coal source and smooth supply, transportation and handling system. In addition, meeting up of environmental and safety legislation in this regard is necessary for obtaining environmental clearance certificate from Department of Environment (DoE) of Bangladesh and for maintaining safe environmental condition.

Comprehending the emergency of the work and complexity of the study, BPDB has entrusted the Center for Environmental and Geographic Information Services (CEGIS), a public trust under the Ministry of Water Resources for carrying out this comprehensive study on coal sourcing, maritime transportation, inland transshipment and handling at port and plant site. Accordingly, a contract has been signed between BPDB and CEGIS on 19 September 2011.

1.2 Objectives of the study

The principal objective of the consulting service is to suggest an optimal option of possible coal sourcing, transportation, and handling facilities at port and plant sites for the envisaged power plants in Chittagong, Khulna and Maheshkhali (locations shown in Map 1.1). The eventual objective is to develop the projects through interested investors including private participants on Tariff Based Competitive Tendering.

With the aim of providing advisory services envisaged in the ToR the following specific objectives have been identified that shall have to be achieved under this study:

i. To arrive at an optimal option of possible coal sourcing, in consideration to coal quality, coal availability, and unit cost;

ii. To plan a most suitable, cheapest and easiest coal transportation system including maritime transportation, inland transshipment, mode of coal transportation and transshipment agreement, and unit cost of coal transportation;

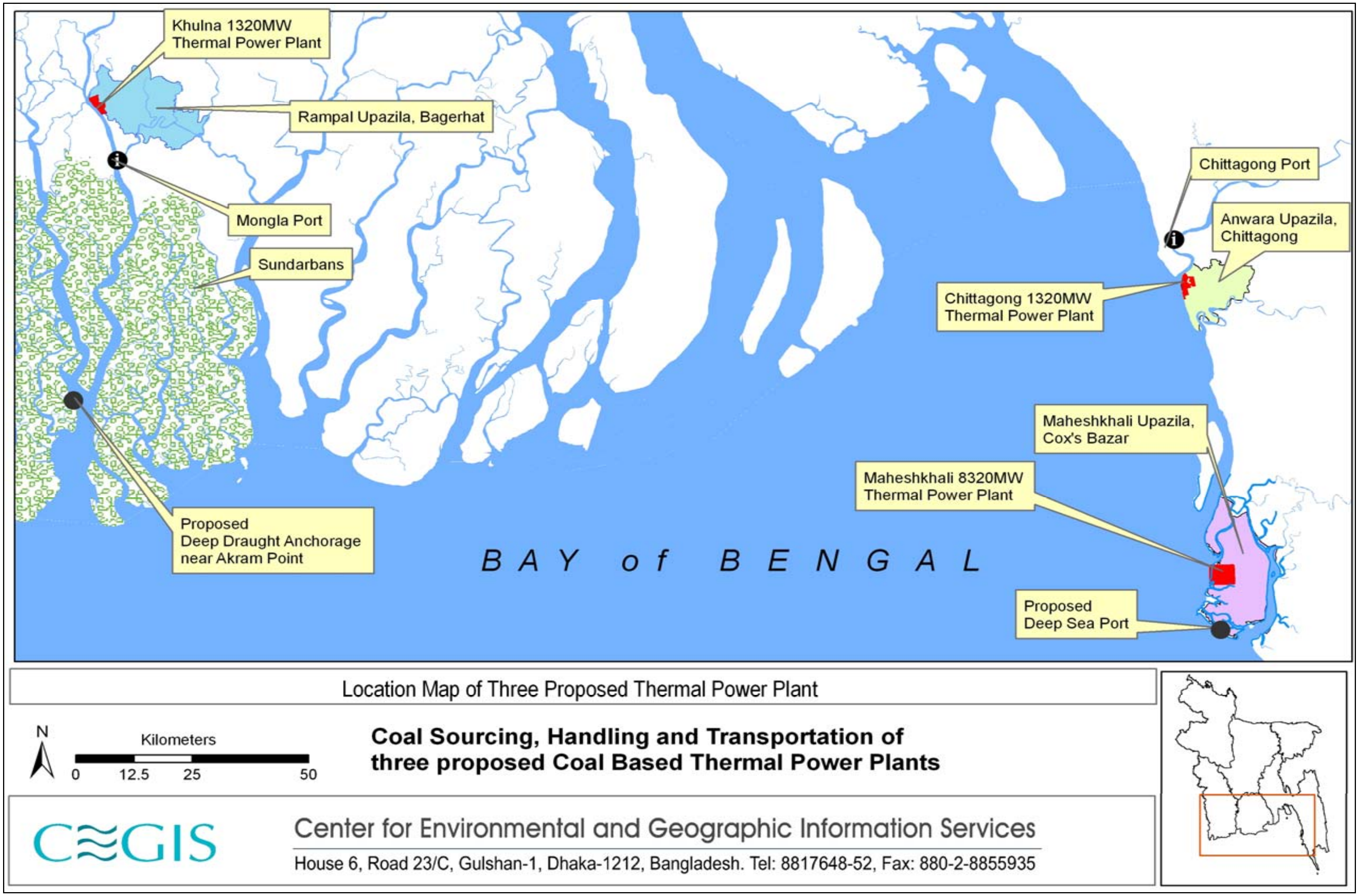
iii. To plan and describe logistics to be required for coal unloading, and handling at ports of landing or project sites; and

iv. To find scope of ash utilization and plan tentative ash handling system

v. To evaluate environmental and ecological concerns and issues connected with coal sourcing, transportation and handling.

1.3 Rational

With the aim of ensuring reliable electricity generation, BPDB has contemplatively planned to construct and commission three coal-based mega thermal power plants. BPDB has opted coal as primary fuel over other fuels due to its availability and cost effectiveness. Issue of environmental pollution will be addressed by choosing efficient technology. BPDB estimates around 76,000 MT coal will be required a day for the operation of these three power plants. Implementation of these three envisaged project depend on the reliable source of coal. Without sustainable coal supply, efficient coal transportation and efficient handling system, operation of these three projects shall not be possible. With the aim of feeding feasibility studies and environmental studies of these three projects, this study attempts to identify an optimal option of coal sourcing, transportation and its handling at port as well as plant sites. It is envisaged that the outcome of this study will help the planning engineers and decision makers to finalize the plan of constructing the said three-mega power plants.



Map 1.1: Locations of the proposed three coal based TPPs

1.4 Scope of the study

Comprehending the activities detailed in the Terms of Reference (ToR), the following scopes have been identified:

1.4.1 Study on Coal Sourcing

i. Potential sources of high quality coal;
ii. Coal specification (quality) of available sources;
iii. Unit cost of coal at port of loading;
iv. Analysis of relevant environmental issues;
v. Market analysis for coal purchasing i.e. short or long-term lease with mine owners, open market purchase, etc.

1.4.2 Study on Maritime Transportation of coal

i. Identifying shortest possible route of maritime transportation of coal from source/mine mouth to Project site;
ii. Planning best transportation system including required logistic required for transportation;
iii. Identifying transport option considering deadweight capacity and fleet size of bulk carrier for maritime transportation for each proposed power plant;
iv. Identifying the best mode of coal transportation agreement including chartering terms and conditions;
v. Estimating voyage time, quantity and freight cost;
vi. Identifying force majeure that may hinder transportation;
vii. Analyzing of legal and administrative aspects of maritime transshipment.

1.4.3 Study on Inland river transshipment of coal

i. Identification of Inland water transportation routes;
ii. Planning transshipment system including lighterage operation and logistics required for transportation;
iii. Identifying best inland river transshipment option from mother vessel to port and project site considering vessel capacity, fleet size, inland navigational aids and logistics, mode of transshipment agreement including chartering terms and condition;
iv. Estimating cycle time and vessel quantity;
v. Identifying force majeure that may hinder inland water transshipment operation;
vi. Analysis of legal and administrative aspects of inland coal transshipment

1.4.4 Study on River and Coastal Morphology, and Hydrodynamic Processes

i. Analysis of recent admiralty charts;

ii. Analysis of river and coastal bathymetric data;

iii. Analysis of current, wave, and wind data;

iv. Explore scope of dredging for improving the navigability;

v. Analyzing sea state and present numerical data on wave, current, tide and storm surge

1.4.5 Logistics for coal unloading and handling at port and project site

i. Exploration of existing logistics available in Mongla Port and Chittagong Port for bulk cargo handling;

ii. Optimal utilization of existing facilities and possibility of modernization of existing port required for proposed project.

iii. Exploration of scope of constructing new coal terminal;

iv. Identifying and describing necessary logistics including berthing facilities, jetties, unloading system, coal stockyard, coal transfer system, stock yard management system, etc required for coal unloading and handling;

v. Selection of optimal unloading system considering number of days for unloading, type and specification of cranes, capacity of the associated conveyor belt and cost;

vi. Working out the dimension and layout of marine facilities such as trestle, offshore berths and their cost of construction

1.4.6 Study on ash utilization and Handling System

i. Examining options of ash utilization and export;

ii. Recommending a suitable ash handling and disposal system and management;

iii. Identifying and describing logistics required for ash export including handling system at ports and plan sites.

1.4.7 Evaluating Environmental issues and concern

i. Reviewing relevant environmental policy, rules and administrative framework;

ii. Evaluating coal specification of different sources with the aim of suggesting best suitable coal;

iii. Predicting environmental impacts of coal transportation, unloading and handling;

iv. Suggesting mitigation and Environmental Management Plan for:

- Coal transportation, unloading and handling system;
- Coal yard management including mitigation measures of self-combustion and dust generation propensity of coal.

1.5 Limitation of the study

Duration of this study, which is only three months, is the major limitation of the study. Establishing contact with coal exporters and mine owners of different international countries through proper channel requires long span of time. Besides, analysis of different cross cutting issues, numerical modeling and environmental analysis are time-consuming tasks. The study period as per the ToR, is very short, which might limit in-depth analysis of some important issues and components. Hence, it is suggested to extend the duration of the study up to at least four months.

The coal price considered under this study is based on yearly average price of 2011. Coal price in world trade market is very volatile. Competitive market condition and global political environment make the coal price unpredictable. Besides, price forecast for next 30years was not possible under the scope of the study. Thence, the coal price suggested is only for feasibility study purpose. But in real field, when the coal procurement is to be initiated, the suggested price might not be applicable.

Unavailability of information on coal conveyor belt (length, numbers of transfer points, route, etc) from Mongla Port to Project site is also a major limitation that limits comparison between river transportation and land transportation of coal.

Another major limitation of the study is to find out adequate engineering information regarding the proposed Chittagong and Maheshkhali power plants as the feasibility study has not been completed yet. Project locations of Chittagong and Maheshkhali might be possible to shift.

1.6 Study Team Composition

As per guidance of the ToR, the multidisciplinary team approved by the Proposal Evaluation Committee has been mob ilized with suitable allocation of the time. For the overall interest of the study, CEGIS has engaged few more professionals in addition to the provided person-months to facilitate the core team. Table 1.1 presents the team members with their designation.

Table 1.1: Team composition

Sl. No.	Name of the professional	Designation
National		
1	Giasuddin Ahmed Choudhury	Team Leader/ Policy Expert
2	Md. Maqbul-E-Elahi	Coal Sourcing Expert/ Deputy Team Leader
3	Md. Sayedul Hoque Khan	Maritime Transportation Expert
4	Abdur Razzaque	Local Transportation Expert
5	Malik Fida Abdullah Khan	Numerical Modeler
6	Dr. Maminul Haque Sarker	Morphologist/Dredging Specialist
7	Md. Waji Ullah	Coastal Engineer/Water Resources Engineer
8	Mohammed Anisur Rahman	Railway Engineer
9	Sultan Ahmed Chowdhury	Port Engineer
10	Md. Abdur Razzaque Sardar	Mechanical Engineer
11	Md. Fazlul Haque	Electrical Engineer
12	Mujibul Huq	Environment Expert
13	Dr. Dilruba Ahmed	Sociologist
14	Mohammed Mukteruzzaman	Fishery Biologist
15	Ashoke Kumar Das	Ecologist
16	Md. Aminul Islam	Economist
17	Mollah Md. Awlad Hossain	GIS/RS Expert

18	M. Habibur Rahman	Autocad Expert
19	Most. Nazneen Aktar	Junior Engineer 1
20	Jakia Akter	Junior Engineer 2
21	Md. Shibly Sadik	Junior Environmental Specialist
22	Jahid Hassan Dhali	Field Researcher and Surveyor 1
23	Shahadat Hossain	Field Researcher and Surveyor 2
International		
1	Dr. rer.nat Brend Vels	Coal Sourcing Expert
2	Jurgen Heinrich	Coal Handling and Maritime Transportation Expert

In addition to the above core team, the professionals listed below have also been engaged for completing the study smoothly within the given timeframe.

Sl. No.	Name of the professional	Designation
1	Md. Sarfaraz Wahed	Project Leader and Water Resources Engineer
2	Dr. Abdur Rahim, PEng.	Neval Architect and Oceanographer
3	Syeda Mohsina Muhit	Junior Environmental Law Specialist
4	Sabria Afreen	Junior Engineer
5	Pronab Kumar Halder	Junior Environmental Specialist

1.7 Structure of the report

The report contains fifteen chapters and the chapter details are discussed below:

Chapter 1 describes the introduction containing background, objectives, rational, and scope of the study.

Chapter 2 presents the project location and description of project.

Chapter 3 is on the policy and legislative framework describing the relevant national and international policies, legislation and international conventions, treaties and protocols (ICTPs).

Chapter 4 contains detail of approach and methodology followed in this study.

Chapter 5 comprises stakeholder consultation while carrying out the study.

Chapter 6 briefs international coal markets, cost of coal, global coal deposits, coal producing, importing and exporting countries. It also reviews the international coal markets

Chapter 7 outlines national coal reserves and deposits. The chapter describes details of present status of national coal mines and their potential development.

Chapter 8 shares experience of international visits along with suggestion and opinions of different coal producers, coal traders, coal suppliers, coal terminal operators, shipping agents, etc.

Chapter 9 presents best suitable sources containing unit coal cost of potential sources, unit cost of coal transportation, best suitable sources, coal resources and reserves of best suitable sources, coal resources and quality, coal reserve and production, coal suppliers of suitable coal source. At the end it suggests best suitable sources that might be considered for feasibility study purpose.

Chapter 10 describes river and coastal bathymetry and dredging assessment.

Chapter 11 illustrates coal transportation describing bathymetry of river and sea, navigability of inland water ways, maritime transportation, inland transshipment, surface transportation by rail and surface transshipment by conveyor belt.

Chapter 12 outlines coal terminal for coal handling and transportation.

Chapter 13 describes coal unloading and handling system of three coal based thermal power plants.

Chapter 14 includes the processes of ash handling and its utilization.

Chapter 15 gives abstract cost of coal (FOB and CIF price), and capital investment required for dredging and construction of coal terminal.

Chapter 16 deals with environmental issues related to coal transportation, unloading and handling.

Chapter 17 describes the Environmental Management Plan (EMP) with mitigations measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts and a monitoring plan is also provided.

Chapter 18 is the concluding chapter.

Chapter 19 contains the list of the references

Annexes (I to XIII): In addition to the main report, Terms of Reference (ToR), List of the Potential coal suppliers, Details of the Maritime Transportation Cost Estimations, and tentative layouts of the proposed coal terminals, A Road Map for Coal sourcing, concept of mine development, organizational setup of the Coal Sourcing and Transportation Team (The Core Team) have been presented in the Annexes.

Chapter 2: Project Location and Description

2.1 Khulna Coal Based Thermal Power Plant

2.1.1 Project location

The proposed Khulna 1320 MW Coal Based Thermal Power Plant is to be constructed in Rampal Upazila of Bagerhat district (Map 2.1). The project is located in between latitude 22^{0} 37’ 0’’N to 22^{0}34’30’’N and longitude 089^{0}32’0’’E to 089^{0}34’5’’E and at about 23km south from the Khulna City, 11.5 km North-east from Rampal Upazila Headquarter, 14 km North-east from Mongla port, 12 km South-West from Khan Jahan Ali Air Port and 14km north-westward from the Sundarbans (Map 2.2). The location is 4km away from the declared Ecological Critical Area (ECA) of Sundarbans[1]. Table 2.1 shows aerial distances of the surrounding important locations and structures from the proposed project site (center point of the project site).

Table 2.1: Aerial distance of different point of interest from the proposed project location

Sl no.	Point of interest	Distance in Km
1	Proposed Khan Jahan Ali Air Port	12.12
2	Zero point of Khulna City	23.33
3	Rampal Upazila Head quarter	11
4	Mongla Port	14.16
5	Naval pilot station	9.76
6	Chalna	3.18
7	Khan Jahan Ali Bridge on Rupsha river	19.92
9	Road distance: Kaigar Daskati Boat point – Bagha Bazar	14.46
10	Sundarbans Reserve Forest boundary	14
11	ECA boundary of Sundarbans	4
12	Akram point of Sundarbans	67
13	Proposed Deep sea anchorage near Akram point	70
14	World Heritage site of Sundarbans	69.6
15	Hiron Point of Sundarbans	97

Sources: EIA of Khulna Thermal Power Plant (CEGIS, 2012)

Plate 2.1: Proposed site of Khulna Coal Based Thermal Power Plant

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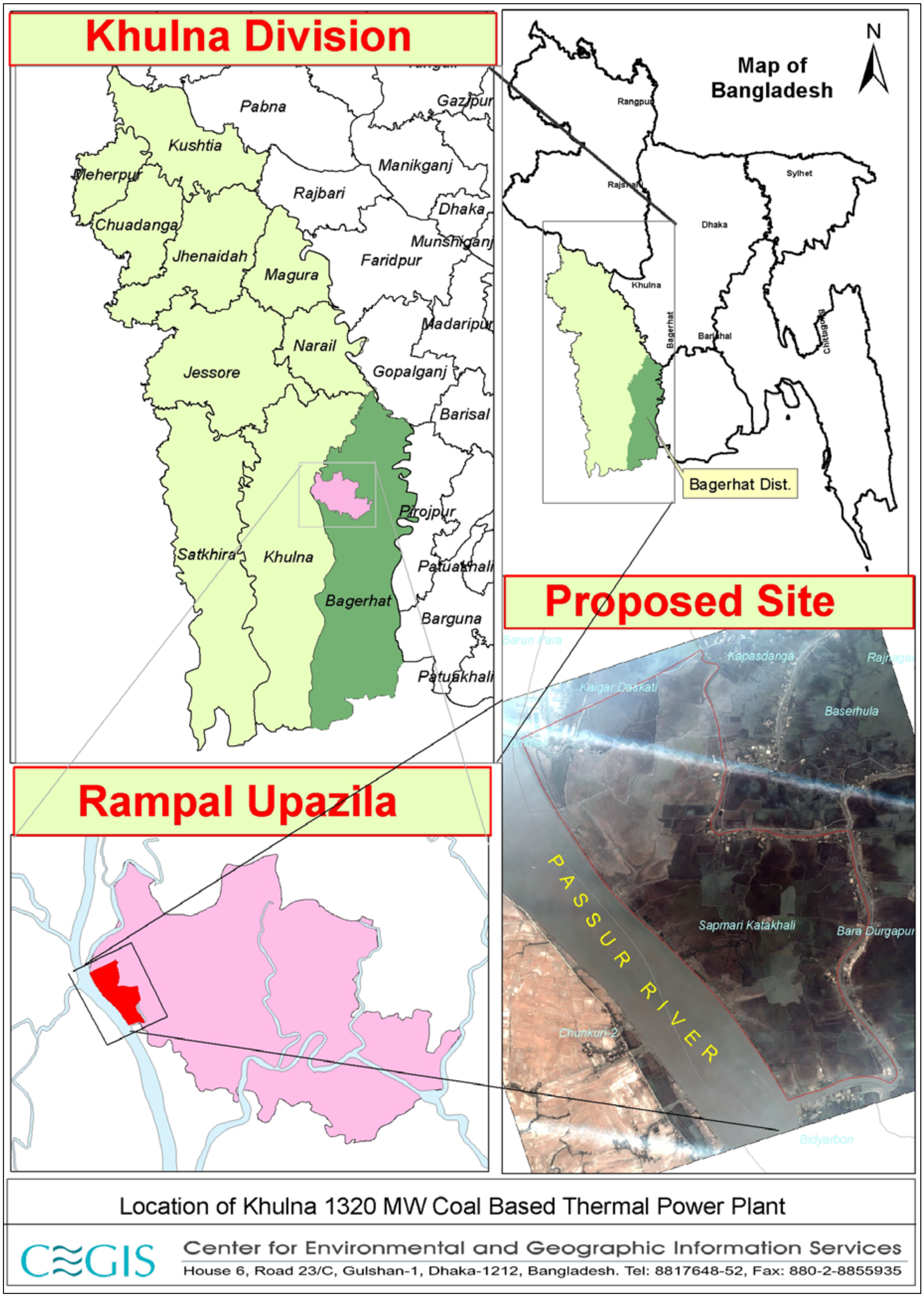
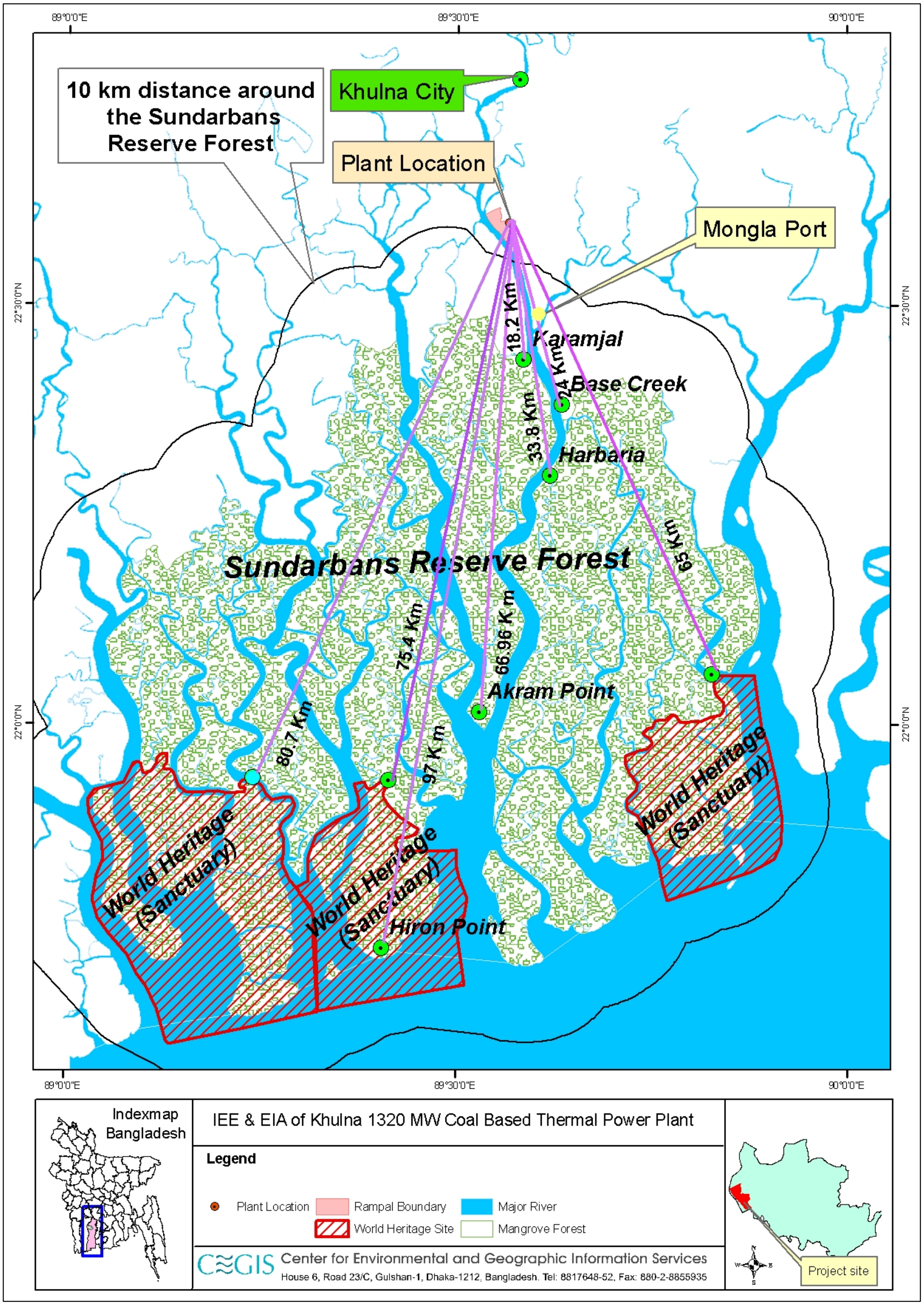
[1] [1] The entire Sundarbans and its adjoining areas of 10 Km buffer outside the forest boundary has been declared as ECA through a notification issued under ECR, 1997 on 1999



Map 2.1: Location of the proposed Khulna Coal Based Thermal Power Plant.



Map 2.2: Map showing distance of surrounding important features from the proposed Khulna Coal Based Thermal Power Plant.

2.1.2 Project description

Basically, the project consists of a coal fired thermal power plant with two units of 660MW each and induced draft cooling tower stations of the wet type, circulating cooling water station including proper intake piping and discharge channel, and stacks of 275 m each. The Power Plant will be designed in such a way so that the construction of another additional unit of 1320MW can be made possible.

The main project facilities comprise of a power house and auxiliary facilities that include a switch yard, raw water reservoir, water pre-treatment system, demineralization plant, desalinization plant (Surface Water Reverse Osmosis), circulating cooling water pump house, coal handling system (Conveyor belt and stockpiles), ash handling and disposal system, effluent treatment plant and residential township for project staff. Other project facilities that will be constructed by BPDB include embankment along the river, 12 m wide two lane approach road, 6.75m wide single lane access roads, 3.5 km wide patrol roads and water supply pipeline from the nearest river to the project site. In addition, space for FGD has been kept for provision of future use if required.

The proposed 2x660 MW (net power output) supercritical bituminous pulverized coal (PC) plant will be constructed at a Greenfield site. This plant is designed to meet Best Available Control Technology (BACT) emission limits. The plant is a single-train design.

The step up voltage level has been considered as 400KV as the capacity of the project has been considered as 1320 MW. The 400 KV power transmission lines for evacuation of power from the Project will be built by PGCB, Bangladesh.

The primary fuel will be bituminous coal with a Gross Calorific Value (GCV) of 5800 to 6100 Kcal/kg. The capacity factor (CF) for the plant is 85 percent without sparing of major train components. A summary of plant performance data for the supercritical Pulverized Coal (PC) plant is presented in Table 2.2 below:

Table 2.2: Basic plant information of the proposed coal based thermal power plant at Khulna.

Component	Design condition
Plant type	Supercritical PC
Net power output	1320 MW
Primary fuel (type)	Bituminous and Sub-bituminous Coal having GCV of 6100 Kcal/Kg (after mixing) and low Sulfur content (0.6%)
Coal flow (at 100% plant load factor)	12,920 T/Day
Annual coal requirement (as received in FS Repor)	4.72 MT/year (considering 100% load factor, 30% plant efficiency)
Ash production	15%
Temperature of flue gas at stack	$125^{O}C$
Flue Gas Flow	$4.47x10^{6}$ Nm^3/hr
Maximum emission of SOx	819g/s
Maximum emission of NO	490g/s
Particulate matter	150 mg/Nm^3
Stack height	275 m
Water Intake	9,150 m^3/hr (less than 0.5% of net tidal flow of lowest flow condition)
Water discharge after treatment	5,150 m^3/hr

Source: Feasibility study report, NTPC, 2011

2.2 Chittagong Coal Based Thermal Power Plant

2.2.1 Project Location

The proposed Chittagong 1320 MW Coal Based Thermal Power Plant will be constructed in the Anwara Upazila of Chittagong district (Map 2.3). The project is located in between latitude 22º11´1´´N to 22º14´12´´N and longitude 091º 47´55´´E to 091º51´5´´E and is situated at about 12.25 km south-east from the Chittagong City Corporation Area, 11.37 km south-east from the Chittagong Port, 8.4 km north-west from Anwara Upazila Headquarter. Table 2.3 shows the areal distance of different point of interest from the proposed project site.

Table 2.3: Aerial distance of different point of interest from the proposed project location.

Sl no.	Point of interest	Distance
1	Chittagong City Corporation area	12.25 km
2	Chittagong Sea Port	10.73 km
3	Naval Station	13.46 km
4	Anwara Upazila Headquarter	8.39 km
5	Shah Amanat International Airport	4.16 km (Center to Center)
6	Stack (of 275m height) location	7.10 km
7	Chittagong-Cox's Bazar High way	10.35 km

Sources: CEGIS study, 2011

2.2.2 Project Description

The project consists of a coal-fired power plant with two units of 500-660 MW each and two forced draft wet type cooling tower stations with stack height of 275 m each. The power plant will be designed in such a way so that the construction of further 1300 MW Units will be possible.

The main project facilities Comprise of a power house and auxiliary facilities that include a switch yard, raw water reservoir, water pre-treatment system, demineralization plant, circulating cooling water pump house, coal handling system (stockpiles and unloading system), ash handling and disposal system and residential township for project staff. Other project facilities that will be constructed by BPDB include some km long water supply pipeline from the nearest river to the project site

The proposed (2 x 660) MW (net power output) super-critical bituminous pulverized coal (PC) plant will be constructed at a Greenfield site. This plant is designed to meet Best Available Control Technology (BACT) emission limits. The plant is a single-train design. Power transmission lines for the evacuation of power from the Project will be built PGCB, Bangladesh.

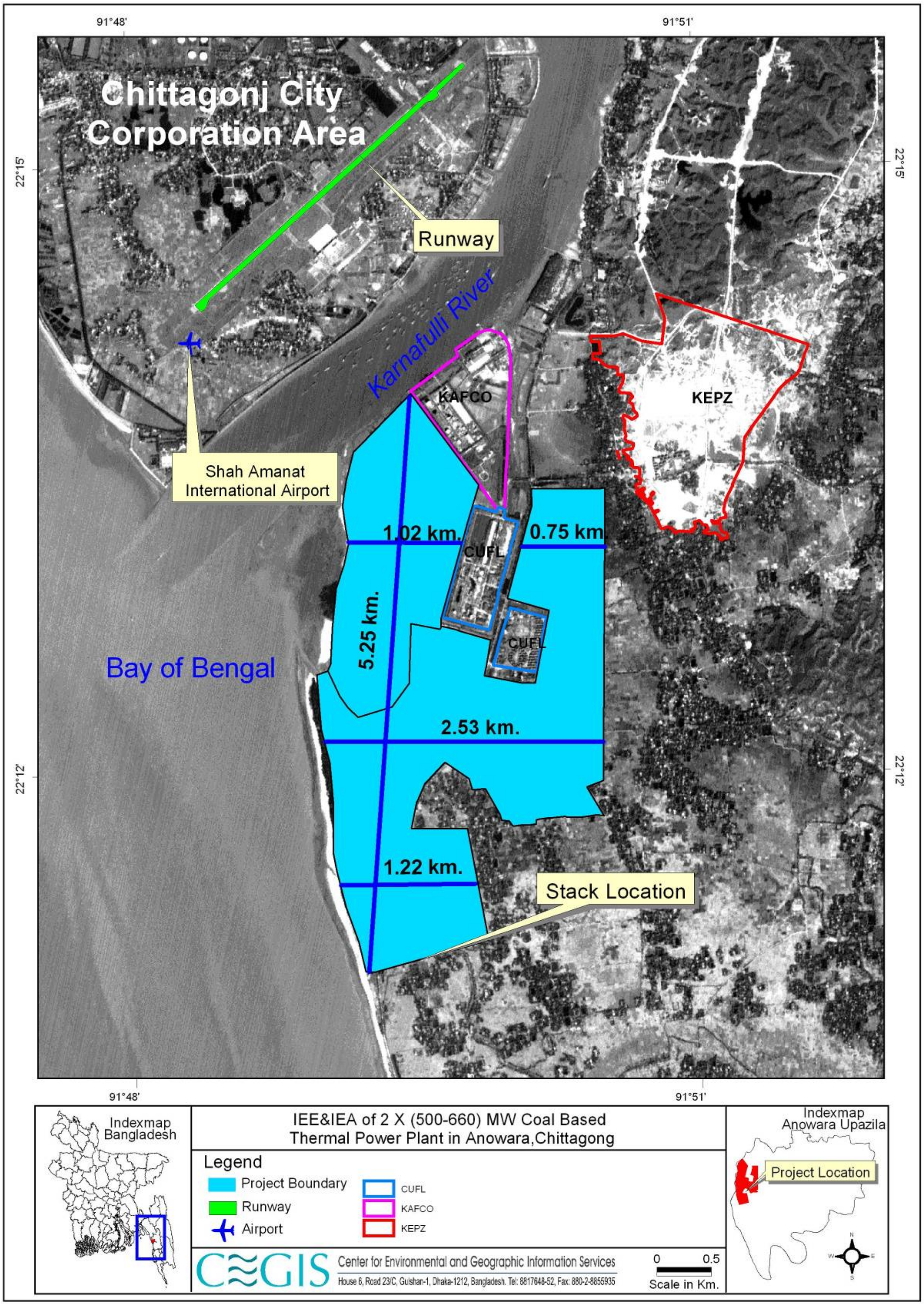
The primary fuel will be bituminous coal with a Gross Calorific Value (GCV) of 5800 to 6100 Kcal/kg. The capacity factor (CF) for the plant is 85 percent without sparing of major train components. A summary of plant performance data for the super-critical PC plant is presented in Table 2.4.

Table 2.4: Conceptual plant information and design condition

Component	Design condition
Plant type	Ultra-supercritical/Supercritical PC
Carbon capture	No
Net power output	1300 MW
Net plant HHV efficiency (%)	39.1
Primary fuel (type)	Coal having GCV of 6100 Kcal/Kg (after mixing) and low Sulfur content (0.6%)
Coal flow	13000 MT/Day
Ash production	11.1%
Flue gas flow	4.47 x $10^6 Nm^3/hr$
Temperature of flue gas at stack	140^0 C
Emission SO_2 (max)	80 mg/Nm^3
Emission NOx (max)	450 mg/Nm^3
Particulate matter	150 mg/Nm^3
Stack height	275 m
Circulating cooling water	120,000 m^3/day
Boiler water for steam generation	4,800 m^3/day
Service water system	9,600 m^3/day
Drinking water system	1,800 m^3/day

Source: IEE report on Chittagong Coal based TPP, CEGIS, 2010

Plate 2.2: Proposed site of Chittagong Thermal Power Plant



Map 2.3: Site layout plan of the proposed coal based power plant project

2.3 Maheshkhali Coal and LNG Based Thermal Power Plant

The proposed Maheshkhali 8320 MW Coal and LNG Based Thermal Power Plant will be constructed near the proposed deep-sea port area in Cox's Bazar District. The proposed power plant area is situated within Amabassaya, Hoanok, and Panir Chara Mauza of Hoanok Union and Gharibhanga Mauza of Kutubjhom union under Maheshkhali Upazila (Map 2.4). The proposed power plant will cover an area of about 5000 acres. The land acquisition processes is ongoing.

The proposed power plant will be of 8320 MW rated capacity comprising of 10 plant units. Among the 8320 MW, 5320 MW will be producing from imported coal and the rest 3000 MW will be producing from imported Liquefied Natural Gas (LNG). The basin plant information are given in following table

Table 2.5: Basic plant information of Maheshkhali Coal and LNG Based Thermal Power Plant

Sl No	Components	Basic information
1	Plant Units and Capacities	Four (4) coal based units of 1000 MW: 4 x 1000 MW = 4000 MW Two (2) coal based units of 660 MW: 2 x 660 MW = 1320 MW Four (4) LNG based units of 750 MW: 4 x 750 MW = 3000 MW
2	Total Capacity	8320 MW
3	Primary Fuel	Coal and LNG
4	Land area	5000 acre
5	Power evacuation	Through 800 KV sub-station
6	Other plant infrastructures	Coal Terminal, LNG Terminal, and Township,

Source: BPDB

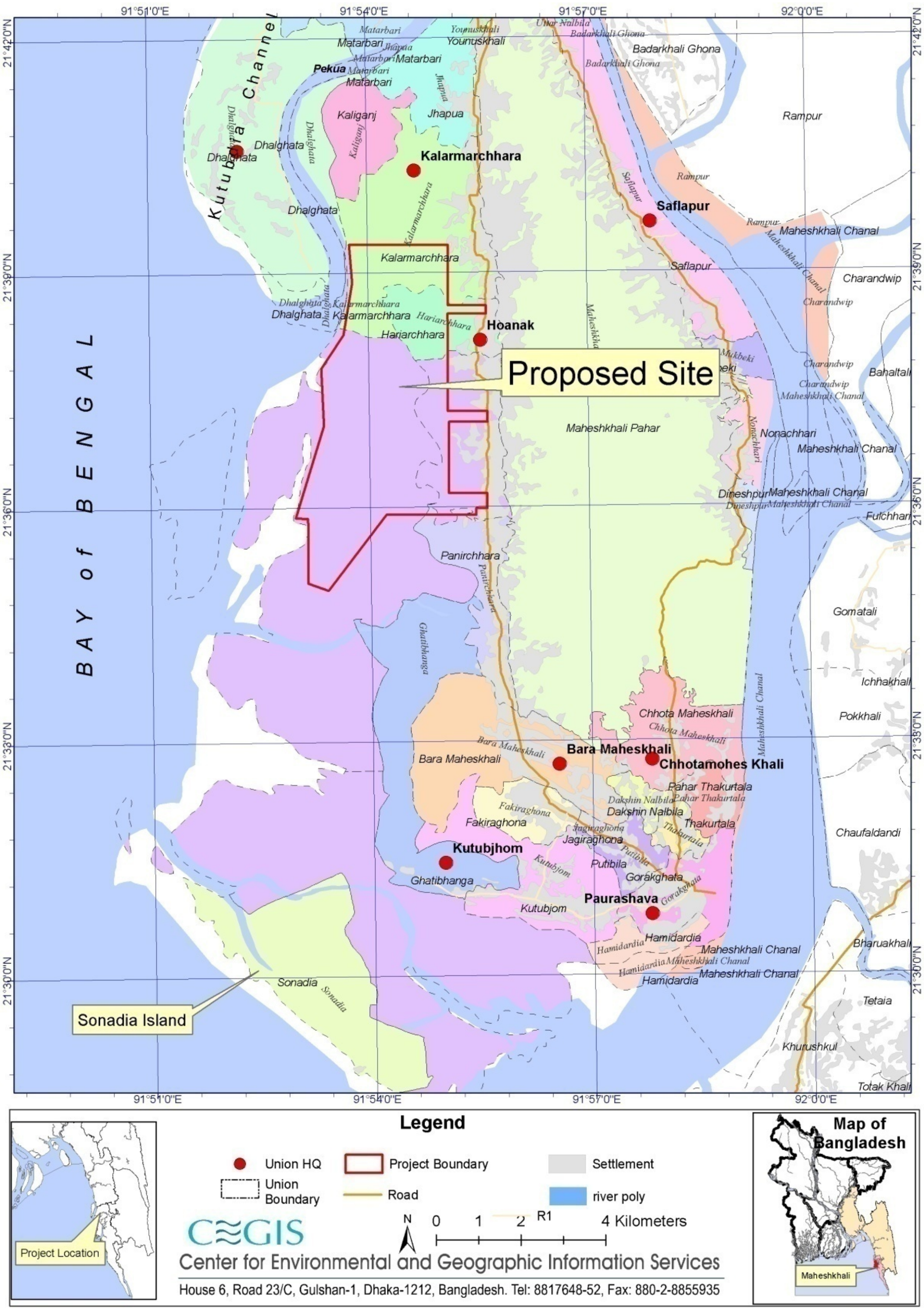
The proposed location is nearer to the proposed Deep Sea Port to be developed in Sonadia Island. Table 1.2 shows aerial distances of nearby important cities and locations from the center of the proposed project area.

Table 2.6: Aerial distance from site

Area	Distance (Km) (center to center)
Chittagong City	85
Cox's Bazar City	15
Maheshkhali Upazila Sadar HQ	11
Maheshkhali Jetty end (Gorakghata)	12
Deep sea (water depth +13m CD) to western shoreline of the project	6
Cox's Bazar Airport	17
Sonadia Island	10
Proposed Deep Sea Port Jetties	10
Kutubdia Island	28

Source: Reconnaissance field survey, 2012

BPDB also considers another candidate site located in Anowara Upazila of Chittagong as an alternative (Map 2.4).



Map 2.4: Location map of proposed power plant site in Maheshkhali

Chapter 3: Policy and Legislative Framework

All development projects are governed by some legal and institutional requirements. Therefore, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before they actually execute a program or plan.

In Bangladesh, there are statutory laws related to environmental clearance, mode of transportation, import and export of goods, river navigation, dredging and ports. There are also many rules and regulations that provide specific provision for the principle laws, and additional secondary legislation.

3.1 National Policy and Legal Obligations

Attempts were made to identify national laws, policy relevant to coal sourcing, transportation, and handling. These rules are being reviewed to identify statutory requirement to be complied. The following Policies, Acts and Rules have been reviewed for this study:

Table 3.1: Applicable Regulations and Standards for Coal Sourcing, Handling and Transportation.

Issue	Bangladeshi Legislation or Regulation
Governance of Power Generation and Management System	• Bangladesh Energy Regulatory Commission Act, 2003 • Power System Master Plan, 2010 • National Energy Policy
Coal Sourcing	• Bangladesh Coal Policy (Draft) • Power System Master Plan, 2010 • Import and Export Control Act, 1950
Coal Transportation	• Terrestrial Water and Maritime Zones Act 1974 & Rules 1977 • The Ferries Act, 1885 • Ports Act, 1908 • Bangladesh Merchant Shipping Ordinance 1983 • The Prevention of the Interference With Aid to Navigable Waterways Ordinance, 1962 • Mongla Port Authority Ordinance, 1976 • Chittagong Port Authority Ordinance, 1976
Prevention of pollution, and Protection of Environment, Sundarbans and Protected Areas	• Mongla Port Authority Ordinance, 1976 • Chittagong Port Authority Ordinance, 1976 • Ports Act, 1908 • The Forests Act, 1927 • Environmental Conservation Act, 1995 and the Amendments thereafter • Environmental Conservation Rules, 1997 • The Environmental Court Act, 2000
Health and Safety	• Fatal Accidents Act, 1855 • Dock Labourers Act, 1934 • Dangerous Cargoes Act, 1953 • Imports and Exports (Control) Act, 1950

Issue	Bangladeshi Legislation or Regulation
	• Public Safety Ordinance, 1953 • Fire prevention and Extinguish Act, 2003
Procurement in Bangladesh	• The Public Procurement Regulations, 2003 and Revisions thereafter
Transport, Handling and Storage of Dangerous Goods	• Environmental Conservation Act, 1995 (Amendments thereafter) • Ports Act, 1908 • Petroleum Act, 1934 • Dangerous Cargoes Act, 1953

3.1.1 Bangladesh Energy Regulatory Commission Act, 2003

Bangladesh Energy Regulatory Commission Act was enacted in 2003. The aim of the act is to make provisions for the establishment of an independent and impartial regulatory commission for the energy sector in Bangladesh. The objective is to create an atmosphere conducive to private investment in the generation of electricity and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors; to protect consumers' interest and to promote the creation of a competitive market.

The commission has started its operation shortly after enactment of the Act and now it is functioning full-fledged implement its objective.

3.1.2 Power System Master Plan, 2010

The main objective of this study is to formulate a Master Plan for the attainment of stable power supply in the People's Republic of Bangladesh up to year 2030 in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan, and identification of the potential power plant sites based on the fuel diversification study. Therefore, this study includes a comprehensive power development master plan where the study of the fundamental conditions of the development (demand forecast, procurement of primary energy resources, optimum power development plan, future optimum power supply structure including the positioning of gas-fired power plants, and so on) are added.

The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from the natural gas of the country and rest by hydro electricity and coal. The power sector master plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel etc as well as non-renewable energy sources.

In this Master Plan, the target composition of power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such as oil, nuclear power and renewable energy.

3.1.3 National Energy Policy

National Energy Policy of Bangladesh approved in 1995 and gazette in 1996. This is a comprehensive energy policy which contents renewable energy, non-renewable energy and power sector.

The Policy, estimated total energy requirement of the country with time and per capita income. From the energy balance of the Policy report, a guide was given for the possible contribution of different energy sources. Both public and private initiative was emphasized for the energy sector development in Bangladesh. Incentives were declared for the private investment in the energy sector. In this policy, coal is considered under non-renewable energy. Private initiatives have been encouraged for exploration and development of coal. Until now, the energy sector activities are being carried out under this policy guideline.

Initiative was taken to prepare individual policy for coal since 2005, but not yet finalizes and approved by the appropriate authority. Still, a committee has been working for drafting a coal policy for Bangladesh for last three months. It is expected, the committee will submit their recommendations to the government within next two to three months.

3.1.4 Draft Coal Policy

The Draft Coal Policy (version 1) was published on 1st December 2005 by the Energy and Mineral Resources Division of Ministry of the Power, Energy and Mineral Resources. After that, it was revised for several times. The latest one is the Bangladesh Draft Coal Policy, 2010. The latest Draft Coal Policy (2010) outlines gas shortage, power generation, coal development, investment for coal sector, import coal, environment etc in Bangladesh. Therefore, this policy will become useful data in relating the domestic coal supply. This policy states that coal will be used for power generation instead of gas as an alternative fuel to maintain national energy stability.

3.1.5 Import and Export Control Act, 1950

The Government may prohibit, restrict or otherwise control the import or export of goods of any specified description, or regulate generally all practices (including trade practices) and procedures connected with the import or export of such goods. No goods of the specified description shall be imported or exported except in accordance with the condition of a license to be issued by the Chief Controller.

3.1.6 Territorial Water and Maritime Zones Act, 1974

It is mentioned in s.3(1) the Government may, by notification in the official Gazette, declare the limits of the sea beyond the land territory and internal waters of Bangladesh which shall be the territorial waters of Bangladesh specifying in the notification the baseline-

a) From which such limits shall be measured; and

b) The waters on the landward side of which shall form part of the internal waters of Bangladesh

In s.3 (4), No foreign ship shall, unless it enjoys the right of innocent passage, pass through the territorial waters. In s.3 (5), foreign ship having the right of innocent passage through the territorial waters shall, while exercising such right, observe the laws and rules in force in Bangladesh. In s.3(6), the Government may, by notification in the official Gazette, suspend, in the specified areas of the territorial waters, the innocent passage of any ship if it is of opinion that such suspension is necessary for the security of the Republic. It also mentioned in s.3 (7), No foreign warship shall pass through the territorial waters except with the previous permission of the Government.

3.1.7 Territorial Water and Maritime Zones Rules, 1977

Under S.3(1) Passage of foreign ships through the territorial waters shall be considered prejudicial to the security or interest of Bangladesh if it engages in embarking or disembarking any person or loading or unloading of any commodity or currency in violation of any laws or rules in force in Bangladesh relating to customs, fiscal matters, immigration, health or sanitation; any act of willful or serious marine pollution; fishing; carry out any search or survey activities.

3.1.8 The Ferries Act, 1885

It is mentioned in S27, every person who, after being warned by any toll-collector, lessee or assistant not to do so, goes, or takes any animals, vehicles or other things, into any ferry boat, or upon any bridge at such a ferry, which is in such a state or so loaded as to endanger human life or property, or who refuses or neglects to leave, or remove any animals, vehicles or goods from any such ferry-boat or bridge or being requested by such toll collector, lessee or assistant to do so, or who moors any boat, raft or other substance to, or in any way obstructs, any part of a public ferry, shall be punished with fine which may extend to fifty taka.

3.1.9 Ports Act, 1908

The Ports Act 1908 was adopted to consolidate the enactments relating to Ports and port charges. The administering authority is the Ministry of Shipping. Subject to this Act, a Conservator is appointed to each port. Now, the Mongla Port's Harbour Master is acting as Conservator of Mongla Port and administers the provisions of the Act for the Port.

Specific environmental management provisions of the Act are given under s.21 (1) which prohibits the discharge of ballast, rubbish and oil into any port or adjacent areas. Under s.31 of the Act, the movement of vessels of 200 tons or more cannot enter, leave or be moved within any port without having a pilot on board. In addition, no vessel of more than 100 tons is to enter, leave or be moved within any port without having a pilot, unless authority to do so has been given in writing. The lawful use of infrastructure such as piers and moorings, and ensuring navigable waters are not obstructed is detailed under s.10, whereas s.21 prohibits interference with buoys, beacons and moorings. Unless the Conservator has granted permission, any action that causes or may cause injury to the bank or shore is prohibited under s.30 (1).

3.1.10 Bangladesh Merchant Shipping Ordinance 1983

Under the Bangladesh Merchant Shipping Ordinance 1983, it is prohibited for any foreign ship to load or unload cargo within the territorial waters of Bangladesh without written permission from the Shipping Authority. This Ordinance sets standards for the construction of vessels. If the vessel has not been surveyed within Bangladesh, the Ordinance will require the ship to hold evidence of equivalent inspection such as a valid Safety Convention Certificate. A valid International Load Line Certificate (or proof of exemption) is also required under s.297 and s.339 for port clearance and to avoid undue delay in loading and unloading.

3.1.11 The Prevention of the Interference with Aids to Navigable Water Ways Ordinance, 1962

Under the Prevention of the Interference with Aids to Navigable Water Ways Ordinance, 1962; whoever commits mischief by damaging, removing, tampering with or handling any of the aids to navigation, or by doing any act which renders any of the aids to navigation less useful as such, and whoever abets such mischief, shall be punished with imprisonment which may extend to three years, or with fine, or with both.

3.1.12 Mongla Port Authority Ordinance, 1976

The Mongla Port Authority (MPA) Ordinance 1976, under the Ministry of Shipping, Government People's Republic of Bangladesh established the MPA. The Ordinance provides the MPA with the authority, function and jurisdiction over docks (wharves, warehouses, railways, piers, bridges, and other works) and vessels (including any ship, barge, boat, or raft designed or used for the transport by water of passengers or goods) within the port limits. The MPA also has authority to reclaim or excavate any part of the bank or bed of the river, to construct, maintain and operate dredgers and appliances for clearing, deepening and improving the bed of the river, and to construct, maintain and operate all means and appliances for berthing, loading and discharging vessels. The MPA's authority also extends to improvements made to the land and riverbank of its existing Port at Khulna (Roosevelt Jetty).

Under s.18 of the Act, the MPA may permit any person to make, erect or fix below high water-mark within the Port any dock, pier, erection or mooring. This provision may apply at Akram Point if moorings are established for securing barges or the floating transfer vessel (FTV).

The MPA also has the authority to issue fines for the pollution of water or environment by throwing or allowing into the water, bank or land, any goods, ballast, ashes or any other material that leads to pollution.

3.1.13 Chittagong Port Authority (CPA) Ordinance, 1976

It is mentioned in s.10(1) Subject to the provisions of this Ordinance, the Authority may take such measures and exercise such powers as may be necessary for carrying out the purposes of this Ordinance.

(2) Without prejudice to the generality of the powers conferred by sub-section (1), the Authority shall, in particular, have power-

a) To construct, maintain and operate docks, moorings, piers and bridges within the Port, with all necessary and convenient drains, arches, culverts, roads, railways, fences and approaches;
b) To undertake any work of or in connection with the loading, unloading and storing of goods in the port;
c) To construct, maintain and operate ferry vessels to carry passengers, vehicles and goods within the port;
d) To construct, maintain and operate railways, warehouses, sheds, engines, cranes, scales and other appliances for conveying, receiving, handling and storing goods to be landed or shipped or otherwise dealt with by the Authority;
e) To reclaim, excavate, enclose or raise any part of the bank or bed of the river;
f) To construct, maintain and operate dredgers and appliances for clearing, deepening and improving the bed of the river;
g) To construct, maintain and operate all means and appliances for berthing, loading and discharging vessels;
h) to construct, maintain and operate vessels, saving life and property or recovering any property lost, sunk or stranded;
i) To supply fuel or water to vessels;
j) To provide fire and security services within the port;
k) To acquire, hire, procure, construct, erect, manufacture, provide, operate, maintain or repair anything whatsoever required by the Authority for the purposes of this Ordinance.

In s.42(1) in the -case of any damage or mischief is done to any dock, pier or work of the Authority by any vessel, through the negligence of the master thereof or of any of the mariners or persons employed therein, not being in the service of the Authority, any Magistrate of the first class having jurisdiction in the port area may, on the application of the Authority and on declaration by it that payment for such damage or mischief has been refused or has not been made on demand, issue a summons to the master or owner of such vessel, requiring him to attend on a day and at an hour named in the summons to answer touching such damage or mischief.

3.1.14 The Forests Act, 1927

An Act to consolidate law related to forests, the transit of forest-produce and the levee duty on timber and other forest-produce. This Act provides power to the government to constitute any forestland, wasteland or any land suitable for afforestation which is the property of the Government, or over which the Government has proprietary rights, or to the whole or any part of the forest-produce.

The Sundarbans Reservation was established in 1875/76 and was retained after the partition between the then East Pakistan and India. The Forest Act (Act No. XVI, 1927) consolidated the previous rules relating to forests, transit timber, and levee duty on forest products and comprises the following effects:

i) Grant power to the government to reserve forests.

ii) Grant power to impose duty on timber and other forest products.

iii) Prohibit acquisition rights over land described in the notification except in accordance with rules defined by the government.

iv) Prohibit the clearing of forests.

v) Prohibit the removal of timber.

vi) Prohibit the felling of trees.

vii) Prohibit hunting, shooting, fishing, poisoning of water, snares or traps.

Allow acts done by permission in writing of the Forest Officer or under any rule made by the government.

3.1.15 Environmental Conservation Act (1995, Amended in 2000 & 2002)

The Bangladesh Environment Conservation Act of 1995 (ECA ’95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

The main objectives of ECA ’95 are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities’ discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines

Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000 or both. The Department of Environment (DOE) executes the Act under the leadership of the Director General (DG).

Bangladesh Environmental Conservation Act (Amendment 2000)

This amendment of the Act focuses on: (1) ascertaining responsibility for Compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences

Bangladesh Environmental Conservation Act (Amendment 2002)

This amendment of the Act elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like those that polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

3.1.16 The Environment Conservation Rules, 1997

These are the first set of rules, promulgated under the Environment Conservation Act of 1995 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003).

The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects.

Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE and EIA's according to categories of industrial and other development interventions.

3.1.17 The Environment Court Act, 2000

The Environmental Court Act, 2000 provide for the establishment of environment courts and matters incidental thereto. This act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.

3.1.18 The Fatal Accidents Act, 1855

An Act to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. It is mentioned in s.1, whenever the death of a person shall be caused by wrongful act, neglect or default, and the act, neglect or default is such as would (if death had not ensued) have entitled the party injured to maintain an action and recover damages in respect thereof, the party who would have been liable if death had not ensued shall be liable to an action or suit for damages, notwithstanding the death of the person injured, and although the death shall have been caused under such circumstances as amount in law to felony or other crime.

3.1.19 The Dock Labourers Act, 1934

An Act to give effect in Bangladesh to the Convention concerning the protection against accidents of workers employed in loading and unloading ships. It is stated in s.5(1), the Government may make regulations providing for the safety of working places on shore and of any regular approaches over a dock, wharf, quay or similar premises which workers have to use for going to or from a working place at which the processes are carried on, and for the lighting and fencing of such places and approaches, prescribing the measures to be taken in order to prevent dangerous methods of working in the stacking, unstacking, stowing and unstowing of cargo, or handling in connection therewith, prescribing the precautions to be observed when the workers have to work where dangerous or noxious goods are, or have bee, stowed or have to deal with or work in proximity to such goods.

It is mentioned in s.9, any person who unless duly authorized, or in case of necessity, removes any fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing required to be provided by or under the regulations made under this Act; or having in case of necessity removed any such fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing, omits to restore it at the end of the period for which its removal was necessary; shall be punishable with fine which may extend to five hundred taka.

3.1.20 The Dangerous Cargoes Act, 1953

The Dangerous Cargoes Act, 1953 was enacted to provide provisions related to the safety of ports in respect of the transit, working and storage of dangerous cargoes. Relevant provisions include s.3 (which deals with explosives and fires on vessels), s.6 (safety of vessels imports) and s.9 (enforcement). The concerned authority is the Deputy Conservator of the Port, Board of Trade or the Ministry of Communication and the Chief of Naval Staff.

3.1.21 The Fire Services Ordinance 1959

The Fire Services Ordinance 1959 also states that the owner needs to obtain a license under the Ordinance before using premises as a warehouse. In addition, under this Ordinance the Government by order no. HSLG/SVII/1R-1/60/295 dated 3rd June 1960. Declared that any stock of coal exceeding four tons shall be considered a fire risk.

3.1.22 The Railway Act, 1890

The primary legislation for the management of the Bangladesh rail network is the railway Act, 1890. This Act applies to the land, lines, administration buildings and other infrastructure, goods and rolling stock. Subject to the provisions of this Act, authority is given to the railway administration to undertake works that may have environmental impact including the ability to alter the course of any watercourse or road for the purposes of constructing and maintaining tunnels, bridges and railway lines.

Under the Act, the railway administration is required to cause as little damage as possible when undertaking its work. Provisions for the payment of compensation support this. Compensation is payable for any damage caused through the works of the railway administration.

The Act assigns an Inspector of the railway to make periodical inspections of any railway or rolling stock and to conduct an inquiry into the cause of any accident on the railway. In addition to undertaking inspections of equipment and incidents, operations are also subject to investigation. For example, maximum loads for every rail wagon and locomotive may be subject to the assessment of the railway administration under the provisions of this Act.

The Railway Act 1890 is further supported by the Railway (Transport of Goods) Ordinance of 1963, 1969 and 1976 and the Bangladesh Railways (Transport of Goods) Order 1972. Currently, the Ordinance and Order have not allowed particular provisions for the transport of coal.

In addition to reviewing the national acts, rules and policies; relevant international conventions, treaties, protocols and agreements will also be reviewed related to the coal sourcing, handling and transportation activities and will be discussed later on.

3.1.23 The Bangladesh Petroleum Act, 1974

The Bangladesh Petroleum Act is enabling legislation that allows the Government of Bangladesh to enter into all aspects of petroleum exploration, development, exploitation, production, processing, refining and marketing. In addition, the Government is authorized to enter into Petroleum Agreement(s) with any person(s) for the purpose of petroleum operations. The duties of such person(s) are:

- To ensure that petroleum operation is carried out in a proper and worker like manner and in accordance with good oil field practice.
- To carry out petroleum operation in any area in a manner that does not interfere with navigation, fishing and conservation of resources.
- To consider the factors connected with the ecology and environment.

Clause 6(2) of the Act sets out certain details related to environment and safety:

"In particular, and without prejudice to the generality of the foregoing provision, a person engaged in any petroleum operations shall, in carrying out such operations in any area:

- Control the flow and prevent the waste or escape' in the area, of petroleum or water;
- Prevent the escape in that area of any mixture of water or drilling fluid with petroleum or any other matter;
- Prevent damage to petroleum-bearing strata in any area, whether adjacent to that area or not; and
- Keep separate any petroleum pool discovered in the area."

Apart from the above, the law provides the following obligations:

(a) prescribing places where petroleum may be imported and prohibiting its import elsewhere; regulating the import of petroleum;

(b) prescribing the periods within which licenses for the import of [class I] petroleum shall be applied for, and providing for the disposal, by confiscation or otherwise, of any [class I] petroleum in respect of which a license has not been applied for within the prescribed period or has been refused and which has not been exported;

(c) regulating the transport of petroleum;

(d) specifying the nature and condition of all receptacles and pipe-lines in which petroleum may be transported;

(e) regulating the places at which and prescribing the conditions subject to which petroleum may be stored;

(f) specifying the nature, situation and condition of all receptacles in which petroleum may be stored;

(g) prescribing the form and conditions of licenses for the import of dangerous petroleum, and for the transport or storage of any petroleum, the manner in which applications for such licenses shall be made, the authorities which may grant such licenses and the fees which may be charged for such licenses; (i) determining in any class of cases whether a license for the transport of petroleum shall be obtained by the consignor. consignee or carrier;

(h) providing for the granting of combined licenses for the import, transport 18[, storage and distribution] of petroleum, or for any two of such purposes;

i. prescribing the proportion in which any specified poisonous substance may be added to petroleum, and prohibiting the import, transport or storage of petroleum in which the proportion of any specified poisonous substance exceeds the prescribed proportion;

ii. regulating the distribution of petroleum;

iii. prescribing the conditions for the appointment of, and the granting of the licenses to, agents, dealers and stockist;

iv. prescribing the form and conditions of agreement between and agent, dealer or stockist and an oil marketing company;

v. providing for cancellation or restoration of licenses of an agent or a dealer and of agreement between an oil marketing company and an agent, dealer or stockiest; and

vi. generally, providing for any matter which in its opinion, in expedient for proper control over the import, transport, storage and distribution of petroleum.”

3.2 International Maritime Conventions, Protocols and Agreements

Bangladesh is signatory of the International Maritime Organization (IMO). Therefore, all activities relating to shipment of coal through the Port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements.

The GoB-has agreed the following Conventions / Protocols of IMO

1. IMO Convention 48
2. IMO amendments 91
3. IMO amendments 93
4. SOLAS Convention 74
5. SOLAS Protocol 88
6. LOAD LINES Convention 66
7. LOAD LINES Protocol 88
8. TONNAGE Convention 69
9. COLREG Convention 72
10. STCW Convention 78
11. SAR Convention 79
12. STP Agreement 71
13. STP Protocol 73
14. IMSO Convention 76
15. INMARSAT OA 76
16. FACILITATION Convention 65
17. MARPOL 73/78 (Annex I/II)
18. MARPOL 73/78 (Annex III)

19. MARPOL 73/78 (Annex IV)
20. MARPOL 73/78 (Annex V)
21. MARPOL Protocol 97 (Annex VI)
22. INTERVENTION Convention 69
23. SUA Convention 88
24. SUA Protocol 88
25. OPRC Convention 90

Some of the Conventions/Protocols acceded by GoB are highlighted below-

Table 3.2: International maritime conventions, protocols and agreements of different issues

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
International Maritime	IMO Convention, 1948	The Convention establishing the IMO was adopted in 1948 but the Organization started life as the Inter-Governmental Maritime Consultative Organization (IMCO) until it was changed to the IMO in 1982. The Aims of the IMO include a range of objectives: - To provide machinery for co-operation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation; - To provide for the consideration by the Organization of any matters concerning shipping that may be referred to it by any organ or specialized agency of the United Nations; - To provide for the exchange of information among Governments on matters under consideration by the Organization. There have been a series of amendments to the Convention, which

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
		are 1975 amendments, 1977 amendments, 1991 amendments. This Convention came into force in Bangladesh on May 27, 1976. The amendment 1993 acceded on November 7, 2002.
Maritime safety	SOLAS Convention, 1974	The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. The Convention came into force on May 25, 1980 and acceded by GoB on February 6, 1982. The 1988 Protocol of SOLAS 1974 was acceded by Bangladesh on November 4, 2002.
Measurement of ships	Load Lines Convention, 1966	It has long been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are given in the form of freeboards, which constitute, besides external weather tight and watertight integrity, the main objective of the Convention. The Convention acceded by GoB on August 10, 1978. The Protocol of the Load Line Convention acceded by GoB on November 4, 2002.
Preventing collisions at sea	Convention on International Regulations for Preventing Collisions at Sea (COLREG), 1972	The 1972 Convention was designed to update and replace the Collision Regulations of 1960, which were adopted at the same time as the 1960 SOLAS Convention. One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes - Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
		operating in or near traffic separation schemes. The Convention was acceded by Bangladesh on May 10, 1978.
International Maritime Satellite System	Convention on International Maritime Satellite Organization (INMARSAT), 1976	IMO recognized the potential for satellite communications to assist in distress situations at sea soon after the launch of the world's first telecommunications satellite, Telstar, in 1962. In February 1966, IMO's Maritime Safety Committee (MSC) decided to study the operational requirements for a satellite communications system devoted to maritime purposes. In 1973, IMO decided to convene a conference to establish a new maritime communications system based on satellite technology. The Convention came into force by GoB on July 16, 1979.
Prevention of Pollution from Ships	International Convention for the Prevention of Pollution from Ships (MARPOL)	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and includes the Protocol of 1997 (Annex VI). It has been updated by amendments through the years. MARPOL 73/78 (Annex-I, II, III, IV, V and VI) was acceded by GoB on November 4, 2002.
	Convention on Facilitation of International Maritime Traffic (FACILITATION), London, 1965	The Convention's main objectives are to prevent unnecessary delays in maritime traffic, to aid co-operation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures. In particular, the Convention reduces the number of declarations, which can be required by public authorities. The Convention came into force in Bangladesh on October 28, 2000.
Safety of	Convention for The Suppression of	The main purpose of the convention is

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
maritime navigation	Unlawful Acts of Violence Against the Safety of Maritime Navigation (SUA convention), 1988	to ensure that appropriate action is taken against persons committing unlawful acts against ships. These include: • the seizure of ships by force; • acts of violence against persons on board ships; and • the placing of devices on board a ship which are likely to destroy or damage it. The convention obliges Contracting Governments either to extradite or prosecute alleged offenders. The Convention came into force in Bangladesh on September 7, 2005.

In addition to the aforementioned conventions, Government of Bangladesh will sign the following conventions very soon-

1. STCW- 2010
2. Bunker Convention
3. Anti-fouling Convention
4. Hong Kong Convention for Ship Recycling
5. Ballast Water Management Convention

3.3 International Environmental Conventions, Protocols and Agreements

Bangladesh is signatory to a number of Multilateral Environmental Agreements (MEAs) and to some bilateral instruments. Some of them are very important in context of environmental protection. The legal obligations and provisions of MEAs related to the proposed project activities such as; Convention on Biological Diversity; Convention on Wetlands of International Importance Especially as Waterfowl Habitat; United Nations Convention on the Law of the Sea; Convention concerning the Protection of the World Cultural and Natural Heritage will be reviewed.

Bangladesh has already had accessed to, ratified or signed a number of important MEAs related to environment protection and conservation of natural resources which shall have to be complied with during implementation of the project. The pertinent ones of these are highlighted below:

3.3.1 Rio Declaration

The 1992 United Nations Conference on Environment and Development (UNCED) adopted the global action program for sustainable development called ‘Rio Declaration’ and ‘Agenda 21’.

Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with 178 countries, states, “In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it”.

3.3.2 Convention on Biological Diversity, 1992

The Convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 5 June 1992 and entered into force on 29 December 1993. Bangladesh ratified the Convention on 20 March 1994.

The Contracting Parties of the Convention have committed to:

- Introducing appropriate procedures requiring environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimizing such effects, and where appropriate allow for public participation in such procedures; and
- Introducing appropriate arrangements to ensure that environmental consequences of its programs and policies, that are likely to have significant adverse impacts on biodiversity, are duly taken into account.

Obligation has been placed on State parties to provide for environmental impact assessments of projects that are likely to have significant adverse effects on biological diversity (art. 4).

3.3.3 Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 1971

This convention is also known as the Ramsar Convention. It was adopted 2 February 1971 and entered into force on 21 December 1975. Bangladesh has ratified the Convention 20 April 2002. This provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 127 Parties with 1085 wetland sites designated as Wetlands of International Importance'.

This is an intergovernmental treaty, which provides the framework for international co-operation for the conservation of wetlands habitats. Obligations for Contracting Parties include the designation of wetlands to the "List of Wetlands of International Importance', the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves. A part of Sundarbans Reserved Forest (Southwest of Bangladesh) is one of the Ramsar Site.

3.3.4 United Nations Convention on the Law of the Sea, Montego Bay, 1982

This Convention was adopted on 10 December 1982 at Montego Bay, Jamaica. Bangladesh has ratified this Convention.

Main objectives of the convention are:

• To set up a comprehensive new legal regime for the sea and oceans, as far as environmental provisions are concerned, to establish material rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment; and

• To establish basic environmental protection principals and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to alternate sources of marine pollution.

3.3.5 UNESCO World Heritage Convention

Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972: This convection has been ratified by 175 states. This defines and conserves the world's heritage by drawing up a list of natural and cultural sites whose outstanding values should be preserved for all humanity. Of the 730 total sites, there are currently 144 natural, 23 mixed and 563 cultural sites that have been inscribed on the World Heritage List (distributed in 125 State parties). These are the ‘Jewels in the Crown’ of conservation.

The Sundarbans is declared as the World Heritage Site. Therefore, the provision of this convention regarding protection of World Heritage Site is very much relevant for the proposed intervention.

The proposed project intervention should be carried out in such a manner that the above-mentioned provisions of the multilateral environmental agreements are not violated and many not cause adverse impact on the natural resources.

3.4 Development Agency’s Health and Safety Guidelines

Under the study health and safety guidelines of few development agencies has been reviewed. This included ADB is Social Safeguard Policy and the World Bank’s Environmental Process.

3.4.1 Social Safeguard Policy of ADB and World Bank

ADB has had environment assessment requirements for more than 20 years and own safeguard policy framework, which is currently taken to consist of three operational policies, namely the Environment Policy (2002), the Policy on Indigenous Peoples (1998), and the Policy on Involuntary Resettlement (1995), together with their respective operations manual sections and guidelines. In 1989 the World Bank adopted Operational Directive (OD) 4.00, “Annex A: Environmental Assessment”. EA became standard procedure for Bank financed investment project. In 1991 the directive was as OD 4.01, which has subsequently been changed to operational policy OP 4.01 in January 1999 and the operational policy statement has been updated in March, 2007. EA is designed to be a flexible process that part of project preparation allows environmental issues to be addressed in a timely and cost-effective way during project preparation and implementation.

ADB's safeguard policies are central to achieving sustained development impact and poverty reduction. The objective of these policies is to avoid, minimize or mitigate adverse environmental impacts, social costs to third parties or marginalization of vulnerable groups that may result from development projects. Safeguard policies prescribe; "do no harm" requirements that must be met for all ADB projects. Regarding the resettlement plan of a project ADB provides that ‘A satisfactory resettlement plan must include all eleven essential elements’. The safeguard policies are at the front line of ADB’s accountability mechanism and compliance review process, since these policies, if properly implemented, help ensure that third parties do not incur material damages, either directly or through environmental media, and thus have no basis for complaint.

All three-safeguard policies involve a structured process of impact assessment, planning and mitigation to address the adverse effects of projects and programs throughout the project cycle. The safeguard policies require that: (i) impacts are identified and assessed early in the project cycle; (ii) adverse impacts are avoided, minimized, or mitigated; and (iii) affected people are consu lted.

In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS aims to avoid, minimize, or mitigate harmful environmental impacts, social costs, and to help borrowers/clients strengthen their safeguard systems. The SPS builds upon ADB's previous safeguard policies on the environment, involuntary resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and that more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in project design and implementation.

3.4.2 *Compliance with World Bank Environmental Assessment (EA) Process*

The primary responsibility for the Environmental Assessment process lies with the borrower. The Bank's role is to advise borrower throughout the process, to confirm that practice and quality are consistent with Environmental Assessment requirements and to ensure that the process feeds effectively into project preparation and implementation.

The 2001 Environment Strategy for the World Bank emphasizes the importance of integrating–or mainstreaming–environment into country development programs, sector strategies, and investments and underpinning sustainable development. We introduced environmental policies and procedures to integrate good environmental management into our operations, and we have also developed environmental assistance programs to help client countries integrate environmental issues into their development process, to address their pressing environmental challenges.

In addition to efforts identified in the 2001 Strategy, the Bank has adopted a set of operational policies and procedures that deal with the Bank's core development objectives and goals, the instruments for pursuing them, and specific requirements for Bank financed operations.

World Bank seeks to ensure that -supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water areas where most of the native plant and animal species are still present).

Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- legally protected,
- officially proposed for protection, or
- Unprotected but of known high conservation value.

In other (non-critical) natural habitats, Bank supported projects can cause significant loss or degradation only when

i. there are no feasible alternatives to achieve the project's substantial overall net benefits; and
ii. Acceptable mitigation measures, such as compensatory protected areas, are included within the project.

(Operational Policy 4.04)

The Bank's current forests policy aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

Combating deforestation and promoting sustainable forest conservation and management have been high on the international agenda for two decades. However, little has been achieved so far and the world's forests and forest dependent people continue to experience unacceptably high rates of forest loss and degradation. The Bank is therefore currently finalizing a revised approach to forestry issues, in recognition of the fact that forests play an increasingly important role in poverty alleviation, economic development, and for providing local as well as global environmental services.

Success in establishing sustainable forest conservation and management practices depends not only on changing the behavior of all critical stakeholders, but also on a wide range of partnerships to accomplish what no country, government agency, donor, or interest group can do alone.

The new proposed forest strategy suggests three equally important and interdependent pillars to guide future Bank involvement with forests:

- Harnessing the potential of forests to reduce poverty,
- Integrating forests in sustainable economic development, and
- Protecting vital local and global environmental services and forest values

(**Operational Policy/Bank Procedure 4.36**)

Chapter 4: Approach and Methodology

4.1 Understanding of the assignment

The aim of this study is for identification of an optimal option of sourcing, transportation, and handling of coal for each of the three proposed coal based thermal power plants. The assignment as specified in the ToR might be comprehended as an interdisciplinary study that could be planned out as following schematic diagram:

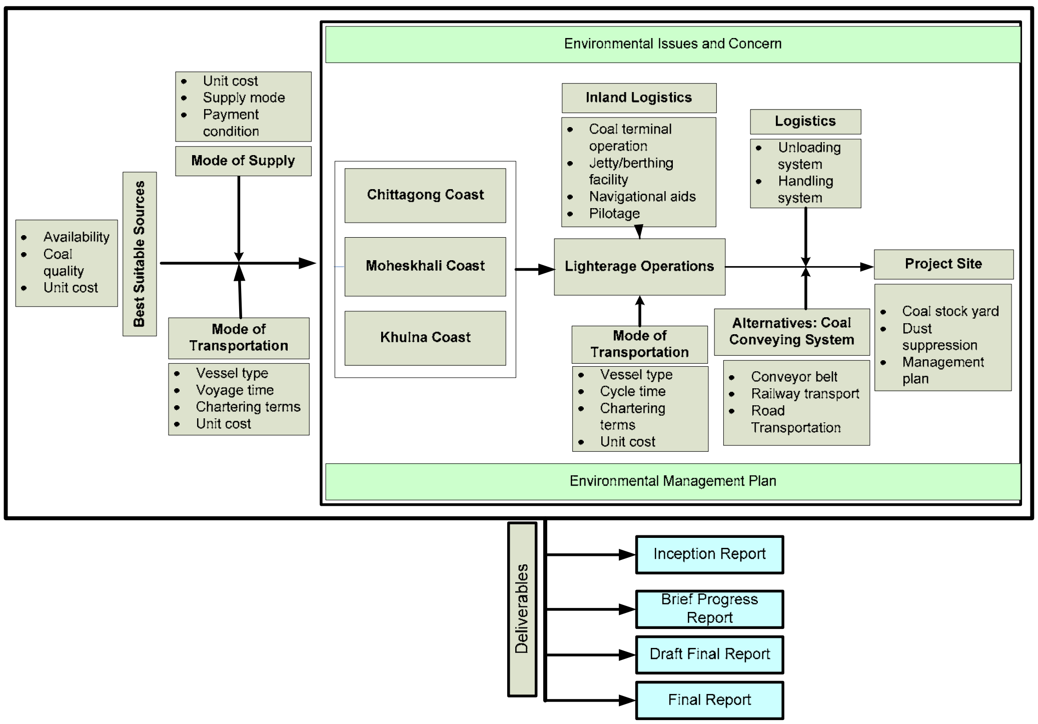


Figure 4.1: Schematic diagram of the study

4.2 Approach and Methodology

4.2.1 Overall approach and methodology

The study is executed by a team of multidisciplinary professionals of specialized field as mentioned in the ToR. The overall study is being carried out for evaluating present standard and practices in the world, expert judgment, site-specific information, and commencing specialized study on multi-criteria analysis for coal sourcing, river morphology, bathymetry, exploratory study on coal transportation, environmental investigation and financial analysis. Intensive field surveys, stakeholder meetings and international visits are carrying out the study and so on.

4.2.2 *Methodology for coal sourcing study*

The best possible coal sources evaluating national and international coal markets have been identified through multi-criteria analysis. The criterion is being considered by expert judgment, stakeholder consultation and discussion with BPDB professionals. The criteria are as follows:

i. Coal quality
ii. Coal potentiality and availability
iii. Coal policy of potential source countries
iv. Mode of agreement
v. Unit coal price, etc.

In the beginning, international coal market has been analyzed based on available data collected through reviewing literature and searching a range of international coal organizations' websites including World Coal Institute (WCI) and International Energy Agency (IEA). Accordingly, different prospective countries, namely Australia, South Africa, Indonesia, China and India were preliminary selected. Later the suggestion has been made in consideration with cost-effectiveness and sustainability of coal supply. Initiatives have also been taken to establish communication with potential coal suppliers and to collect coal export-import related information of these three countries. As part of this, a sound communication is being maintained through email with a number of coal suppliers (Annex-1) having ability of large amount of coal export. Furthermore, three international field visits have been envisaged to observe physically the coal availability, to know the coal quality and to consult with coal miners/managers about possible mode of coal purchase, coal price, transportation facilities, and market policy. In this connection, a field visit has been made in South Africa to have a meeting with SASOL Mining to discuss about world coal market, Coal Market of SA, production and export capacity of SA as well as SASOL, possible mode of agreement, etc.

4.2.3 *Maritime coal transportation*

Maritime route

Shipping routes reflect world trade flows. Sailings are most numerous and most frequent on routes where trade volumes are largest and demand is therefore greatest. In-bulk trade routes these reflect the places of origin and consumption of the commodities being carried. There will usually be a number of routes by which cargo can reach its destination. It is worth exploring that all the options available are needed to find out the best one that suites the needs in terms of price, speed, safety and contractual requisites. This can be done directly by contacting those shipping companies that advertise sailings to the destination or by engaging freight forwarders to arrange for the party.

Transport option

Attempts have been made to identify the best option in sphere of transportation on the basis of availability of vessels, maximum allowable draught and requirements of coal. The vessel types vary with deadweight tonnage (DWT). Handy, Handymax, Panamax, Capesize, Aframax, Suezmax, Chinamax, Qmax, VLCC and ULCC etc. are the vessels with different DWT available in world trade market at present. The best vessel type has been suggested considering coal requirement, maximum allowable draught in Bangladesh coast and cost effectiveness. In this line, numbers of consultation meetings were made with Mongla Port Authority, Bangladesh Navy, BIWTA, Ship Building Industries, Shipping Agent, Maritime Transportation Experts and Inland Transportation Experts.

Chartering terms and condition

Suggestions are made on most suitable mode of chartering for liner shipping, trump shipping and chartering vessel. Time charter, voyage charter, bareboat charter (demise charter) and contract of affreightment are the common mode of maritime transportation. The best mode has been suggested considering cost effectiveness, flexibility terms of agreement and transparency.

Voyage Time

Voyage time for each trip of coal transportation has been estimated considering the distance between loading port and discharge port, and vessel speed and fuel consumption. Estimations include mooring and unmooring, loading and unloading, port stay, tidal factor and berth facilities.

Vessels

Number of vessels to be required for keeping continuous flow of required coal has been estimated considering parameter of vessel, voyage time, force majeure and quantity of requirement of coal.

Freight Cost

Freight cost has been estimated taking account of draught, type and capacity of vessel, fuel price and consumption, distance, speed, voyage cost, port tariff, pilot-age charge, cargo handling cost, agency fees, custom charges, etc. The voyage cost varies due to sailing time to loading port, mooring/unmooring time at loading port, mooring/unmooring time at discharge port, loading and unloading time and extra sailing time for tidal condition. All these conditions have been taken into account to attain a possible cost and the estimated cost along with detail information.

Force Majeure

Force majeure is a common clause in contracts that essentially absolves both parties from liability or obligation when an extraordinary event or circumstances occur beyond the control of the parties. For example, war, strike, riot, crime, natural disasters such as hurricane, flooding, earthquake, volcanic eruption etc are considered as force majeure. In the overall transportation system, number of days in a year obligated due to force majeure has been estimated.

Navigational Aids

Navigational aids and facilities required for coal transshipment has been considered under this study. The existing navigational aids and facilities available in Mongla and Chittagong Port limits have been exploring and accordingly suggestions have been made to improve the facilities and aid to the world standard.

Coal terminal management

An indicative operational and management plan has been suggested for efficient management and operation of the coal terminal to be proposed. The terminal might be operated and managed either by the port authority or by the sponsor power plant company. However, a final suggestion has been made in consultation with BPDB, port authorities, shipping companies and other Government departments.

4.2.4 Inland water transportation

Identification of inland water transportation route

Waterways are operated and maintained by the BIWTA. At present BIWTA operates 3,876 km waterways in dry season and 6000 km in wet season of different classes. The inland transportation route for lighterage operation would be identified from BIWTA navigation map and considering navigability of the waterways, shortest distance, and minimum economic cost. At present attempts have been taken to analyze navigability and bathymetry of inland rivers to suggest a best suitable route.

Lighterage option

A best suitable lighterage option has been suggested evaluating lighters available in local and international market and maximum allowable draught in inland waterways. A market survey has been carried out along with consultation with local lighter owners and operators, Bangladesh Shipping Corporation, Port Authorities, BIWTA, Ship builders companies, etc. The loading equipment has been planned in similar way. Different alternative plans of Lighterage operation considering different Lighterage location, vessel options and navigability of rivers have been identified and are discussed.

Mode of operation

The operational plan also include different options for obtaining lighter and all equipment such as direct ownership of the lighterage operation or engaging outsourced party for operation through hiring. Time charter and trip charter are the two most common mode of hiring lighterage has been taken into consideration. Different alternative plans including mode of operation, Lighterage location, vessel option, navigability of rivers and force majeure have been developed and evaluated to attain a best suitable mode of operation:Estmation of cycletime and lighter quantity

The cycle time for different type of lighter has been estimated considering average speeds (considering tidal impacts), distance between lighterage location and discharge location, time for berthing and maneuvering at load and discharge port, preparation for departure, draught survey, and 10% contingency factor.

Considering this cycle time, lighter capacity, daily coal requirement, loading and unloading facilities in mother vessel and discharge points, and capacity of the water way, required numbers of lighter to be operating in the lighterage at a time has been estimated.

Freight calculation

Cost of freight has been considered to estimate for different type of lighter. In addition, freight calculation has been considered to take the draught, vessel quantity, fuel consumption, fuel price, distance, average speed of voyage, port tariff, BIWTA tariff, custom charges, etc. in account.

Identifying force majeure

Number of days in a year for which lighterage operation might not be possible will be forecasted considering yearly records of BIWTA, Port Authority and Bangladesh Meteorological Department who issue warning signals for inland navigation during cyclone and storm. In addition, experience and perception of inland masters, officer cadets, lighter owners, and deck cadets has been taken into account, commencing sufficient number of consultations and interviews.

Inland navigational aids and facilities

Navigational aids and facilities to be required for coal transshipment have been considered under this study. The existing navigational aids and facilities including channel marking, under water shoal marking, buoy, port authorities and BIWTA will provide beacon light, pilot-age services, etc. in this regard. Moreover, perception of navigation masters, maritime experts, ship owners, BIWTA, BIWTC port authorities will be taken in account. Finally, a plan for navigational aids and facilities to be required for coal transshipment through lighterage operation has been suggested.

In addition, a proposal for channel dredging works identifying tentative location of dredging has been provided.

4.2.5 River and coastal morphology, and hydrodynamic processes

Collection of data on sea state

Available data on sea state including wave, wind, tide, current, etc has been collected from available sources. Model generated sea state data including sea calm ness has been collected from tranquility analysis carried out by feasibility study team of Deep Sea Port.

4.2.6 Dredging requirement estimation

Most of the ports have an immediate problem of navigation though the channel and need their dredging, or are expecting to have to deal with that problem in the near future. In some ports, the problem is acute and a channel is reducing access to the port for larger vessels. In others, the vessels can reach the dock unloaded or partially loaded, but cannot pass through the exit channel when loaded to full capacity due to navigation problem. The other difficulty is the need for additional channels to allow vessels to pass on their way into, or out of, the port.

Dredging requirement has been estimated analyzing recent hydrographic chart and long profile of the River. Beside, location of shoals, required depth and width of the channel has been identified. Dredging cost has been estimated considering present rate of dredging cost collected from BIWTA, Chittagong Port Authority and Mongla Port Authority.

Dredging is common approach for solving navigation problem. Since the connecting channel between the Karnaphuli and Passur doesn’t have navigability in all reaches, it is crucial to identify the location of sand deposited in this channel. Time series satellite images were helpful to identify locations where sand deposition is a continuous process. Remote Sensing and GIS technology available at CEGIS would be a good approach for this component. Analysis of time series satellite images could easily determine the locations of deposition where dredging could be proposed.

4.2.7 Study on logistics for coal unloading and handling at port and project site

Exploration of existing logistics

For coal based thermal power plants, the existing facilities at the Mongla and Chittagong ports have been evaluated in consultation with concern port authorities and be based on available historical cargo handling information. Based on the above information, forward planning for the logistics has been made to handle bulk cargo in both ports.

Optimal utilization of existing facilities

In order to ensure optimal utilization of existing port facilities and required modernization (if necessary) have been planned during the study and the information have been shared with the port authorities for their concurrence. Diverse information based on overall port capacity of coal unloading and handling systems have been collected. Possible alternatives have been identified with problems and best solutions for optimization of utilization of existing facilities. The study has considered the future exporting-importing capacity of those target port sites. Historical trends of import-exports through these ports are also considered.

Exploration of scope for constructing new coal terminal

Based on huge coal requirement and analyzing the existing facilities, attempts have made to explore and to assess the needs of constructing new coal terminal(s) or the possibility of using any existing coal terminal with upgrading. This examination is fully based on the volume of coal import. Possible risks and hazards by natural and human induced disasters have considered assessing for identifying the success and failure of new terminals. A range of data such as geological, morphological, topographical, and meteorological as well as history of natural and human induced disasters (e.g. floods, cyclones, erosion, fires etc) and other necessary information has been collected and analyzed for assessing the feasibility and economical viability of constructing new coal terminals.

Identifying and describing necessary logistics and facilities

Necessary facilities such as berthing facilities, jetties, unloading system, coal stockyard, coal transfer system, stockyard management for coal unloading and handling have been assessed and then analysis has been made with respect to the actual requirements. For instance, various Jetty requirements such as operation and maintenance, provision of adequate flat deck areas, flat deck surface, designing in materials, capability and functionality of the shores have been identified and described.

Selection of optimal coal unloading facilities

A huge volume of coal will be imported from abroad for these three power plants. So, for best unloading, numbers of days for unloading, types and specification of the crane, capacity of the associated conveyors belt have been considered to estimate the required costs.

Working out the dimension and layout of marine facilities

The dimension and layout of marine facilities such as trestle, offshore berths have been determined considering future trend of load to be handled and the respective costs of construction has been estimated.

Describing coal conveying status

Identification of coal conveying arrangement from nearby Jetty at each unloading point to project site will be included but not limited to propose most convenient coal conveying corridor, identification of type and size of conveyor belt based on the daily requirement of coal for the respective power plant found out. The capacity and velocity of the belt including the operation module like electrical and mechanical mechanism have been studied and suggestions will be prescribed accordingly.

4.2.8 Evaluation of scopes of rail transportation of coal from port to project site

Proposed Power Plant Site at Chittagong

Both the proposed plant site jetty/coal terminal and power plant site are located almost at the same area. As such, transportation of coal by railway does n't need. On the other hand, there is, at present, no railway, even considering the overall aspects, it may be concluded that there is no scope to construct railway in future also. In this situation, transportation of coal from port site to plant site doesn't come in consideration.

Proposed power plant site at Maheshkhali

Maheshkhali is an isolated place from the countryside and situated nearby the proposed Deep Sea Port at Sonadia Island. This proposed port, being the Deep Sea Port, consisting of a good numbers of additional facilities for operation of coal carrying vessels throughout the year as there will not crop up any Draught problem. On the other hand, there is no existence of railway facility at present but in near future it could be available. Hence, transportation of coal by Rail does not come in any consideration.

Proposed Power Plant site at Khulna

This site is located at Rampal Upazila, Bagerhat. The location is at a distance of about 14 km from the probable coal jetty at Mongla. As it is understood, a project of Bangladesh Railway for "Construction of about 53 km long Railway starting from Mongla port to Khulna is under process scheduled to be completed by 2013. On the other hand, Installation works of proposed Thermal Power Plant at Rampal Upazila; Bagerhat is scheduled to be completed by 2015. As the project site is only at a distance of about 14 km from the Mongla port area. In the circumstances, there prevails nice scope to undertake a project for construction of railway from Mongla Port to Plant site. However, it requires cooperation and all out assistance from Railway Authority and Bangladesh Government as well. Within the scope of this study, the following aspects would be evaluated to work out the alternative plan of coal transportation by rail:

- Describing future plan of railway extension up to Mongla Port area
- Identifying facilities required for rail way transportation

4.2.9 Ash handling system for utilization

The study has explored economic way of ash handling and its utilization in development process of the country or of export. Accordingly, the study recommends appropriate ash disposal system including ash disposal facilities at site and jetty, ash-processing plants and diversified use of fly ash and bottom ash.

4.2.10 Environmental and ecological Issues

The environmental and ecological issues have been considered to evaluate with the purpose of providing feedback to the Environmental Impact Assessment (EIA) of the proposed thermal power plants. Environmental issues and concerns related to coal sourcing, coal transportation and coal handling have been identified and evaluated with expert judgment, experience and world standard. All regulatory measures related to the environmental and ecological safety are to be maintained during coal sourcing, transportation and handling have been be identified and evaluated. The coal quality has been determined considering all national and international environmental regulatory measures and possible impacts of coal firing in the power plant. Special attention has been given to Sundarbans, riverine fisheries resources and other environmental sensitive area occurring in and around the proposed location of power plant and the route of coal transportation within Bangladesh. In line with the identified potential environmental impacts, measures have been suggested to control pollution causing activities, to mitigate the impacts and to limit the consequences of the impacts. A comprehensive Environmental Management Plan shall also be developed. The studies on environmental issues are to be started after finalization of coal sources, plan of coal transportation and handling system.

Chapter 5: Stakeholder Consultation

Stakeholder consultation is being carried out to collect information on Coal Sourcing, Transportation system covering both maritime and inland transportation, ash handling and its utilization. The consultation with the stakeholders enhances in-depth understanding and eventually ensures the quality of the study. To this end, the study team of this project has conducted consultations meetings with Mongla Port Authority and Chittagong Port Authority, Bangladesh Navy, Khulna Shipyard, Mongla Cement Industry, Barapukuria Coal Mine Company Limited, etc. Moreover, attempts have been taken in conducting consultation meeting with the international stakeholders, especially with the authorities of prospective coal suppliers.

In addition to consultation with different stakeholders, attempts were made to carry out Key Informant Interviews (KIIs) to gather perception, expert opinion, and suggestions of different key informants having in-depth knowledge in Coal Sourcing, Transportation, Handling and Ash Utilization. As part of this, different KIIs have been conducted with concerned key informants and more will be carried out which listed below. Besides, in order to collect data from international coal companies, the study team held a discussion with SASOL Mining, South Africa. It has also been planned to have consultation meeting with coal suppliers in Indonesia and Australia and the summary of the consultation meeting will be appended in the Final Report.

5.1 Consultation Meeting leveling Bangladesh

In connection with the study, a wide range of consultation meeting has been conducted with relevant government and non-government department and organization. The opinion and suggestions of the relevant stakeholders are given in the following table (5.1).

Table 5.1: Opinion and suggestions of Mongla Port Authority

Person / Organization	Discussing Issues	Opinion and suggestions
Mr. Abdul Mannan, Member Finance Commander Anam Ahmed, Harbour Master Md. Helaluddin Bhuiyan, Secretary Md. Masud Ullah, Senior Security Officer Khan Altaf Hossain, Chief Engineer, Marine Md. Kaosar Ali, Chief Engineer, Civil	• Coal Transportation and Handling • Port Facilities • Coal Terminal Development	• If coal terminal constructed near the Port, dust and ash to be generated from coal stock yard will be dispersed in and around Port area; • Port facilities, vessels at jetty, goods etc will be affected for ash dispersion; • Coal transportation from Mongla port to Plant site through conveyor belt would be most sustainable and cost effective; • At present, Port does not have any facilities for handling solid bulk (like coal); • Port Authority will facilitate implementation of Proposed Power Plant Project by extending all supports and cooperation's; • Lighterage operation might be possible at outer bar only during November to March and for the rest of the year Harbaria would be a suitable location; • Outer bar allows maximum 20m draught, Harbaria allows 7.5 m to 8.5 m draught and port jetties allows only 6.5 m draught;

Person / Organization	Discussing Issues	Opinion and suggestions
		• Regular maintenance dredging will be required for keeping navigability of the channel.
Commodore M Anwarul Islam, (ND), ndc, afwc, psc, BN, Chairman Chittagong Port Authority	• Coal Transportation and Handling • Port Facilities • Coal Terminal Development	• Australia might be the best suitable coal source for Bangladesh considering present trend of Coal Export and Import of our neighboring countries- India, China, Indonesia, and coal production, export and import friendly policy of Australia; • Jetty/Coal terminal to be constructed for Chittagong Power Plant should be planned and designed in a way that would not obstruct movement of port entering and leaving vessels. In such case Jetty might be placed through construction of a Harbor by dredging. However, siltation would be a critical issue in that case. If coal terminal is constructed at sea shore then capital dredging, wave protection and break water structure would be required; • In case of Maheshkhali, Coal Terminal might be constructed in east side of Maheshkhali at shore of Maheshkhali Channel instead of Seashore side. Maheshkhali Channel would be safe for berthing, lighterage operation and coal unloading facilities considering weather, tranquility of sea and wave environment of sea. However, in that case, dredging shall be required at different location for Maheshkhali Channel. If coal terminal is to be constructed at Sea shore side, then capital dredging, wave protection, break water structure, etc. will be required; • Coal dust and ash to be generated from coal terminal of Chittagong Power Plant mayl pollute surrounding environment including Chittagong Port, International Airport located within few kilometers of the proposed Chittagong Power Plant if no Environmental Management Plant is adopted. Hence, Dust suppression system, coal terminal management, environmental management have to be planned to control possible environmental pollutions; • Port Authority will facilitate implementation of Proposed Power Plant Project by extending all supports and cooperation considering it as of national priority.
Mr. Shahazan Senior, Deputy Director (C&P) BIWTA, Khulna	• Coal Transportation and Handling • Navigational Facilities • Coal Terminal Development	• At present Passur river has restricted draught and width . • Sibsa River might be a good alternative of Coal transportation but at present complete hydrographic chart is not available. The river has also width restriction and draught limitation.

Person / Organization	Discussing Issues	Opinion and suggestions
		• Siltation rate is high in Chunkuri river, and dredging in Chunkuri river is difficult • Existing lighter available in Mongla Port area is mainly 700 – 1500 DWT and these lighters are not fuel-efficient and have draught between 2.5m to 5.5m. Purpose built lighters of shallower draught should be engaged for this project
Md. Ferdous Kabir, Proprietor, Trust Shipping, Khulna	• Coal Transportation • Lighterage operation • Lighter availability • Cost of transportation	• Lighter vessels are very limited in Mongla port area and most of the lighters are between 700 to 1500 DWT. • Availability of lighters are would be main challenges for this project, at present none of the Shipping agency has such capacity to handle such large volume of coal • Cement industries mainly import clinker by vessel of 28000 DWT that can anchor near Harbaria • The project authority should charter lighter to avoid conflict with Ship Owner Association and Stevedore Association • Basundhara group has their own lighter vessel to transport imported clinker.
Commander M G N Siddquey, (c), psc, BN, Executive Director, Mongla Cement Factory	• Ash utilization • Mode of transportation and lighterage operation for clinker import	• Yearly cement production in Bangladesh is about 14 million metric ton • Ash demand is near 1.5-2 million metric ton that mostly imported from India • Ash demand will be increasing as cement demand is increasing. In future demand of OPC will also increase especially in coastal region as in saline area OPC are more efficient than PC. • The generated ash from power plant can be transported by open truck (by using bag) or covered truck or by barge. • There is a vast scope of selling ash, as there are many cement factories are located in and around Khulna region. However, this ash can be transported to any region of the country which will be cost effective than importing ash from other country. • Clinkers for cement production as imported from Thailand and Korea mostly by vessel of 30,000 DWT that can proceed up to Joymonir Gol or Harbaria. Then further transshipment is done by lighterage operation. Lighters are mostly 800 to 1000 tons having draught of 3m to 4.5m • Purpose built lighters of shallower draught should be engaged for this power plant project
Engr. Md. Quamruzzaman Managing Director,	• Potential of Indigenous coal resources	• Agrees with the recommendation of updated Power System Master Plan to diversification of fuel for power production.

Person / Organization	Discussing Issues	Opinion and suggestions
Barapukuria Coal Mining Company Limited	• Coal Sourcing	• Coal might be a suitable alternative for boosting power generation • At present there is a plan of constructing another coal based power plant at the mouth of Barapukuria Mine • There is a proposal of Development of Northern part of the Barapukuria Coal Mine. However, government has not yet been taken any decision on the proposal. • Indigenous coal sources should be developed. Bangladesh has large reserve of thermal coal of high heating value. However, this reserve might be enough to operate the proposed Khulna and Chittagong 2x 1320 MW power plant. • Nevertheless, Government has to take decision of further mine development. The present production of coal only meets demand of Barapukuria thermal power plant. • Present infrastructure might not be suitable for transporting coal from Barapukuria to proposed projects sites • In line with the proposed imported coal based power plant, government should plan for mine mouth power plant. • Coal demand is rising in Asia and other developing country. India, China and Japan hold the major share of global coal import. Recently, Indonesia, and China sets objective of ensuring domestic energy demand and boosting coal demand for power production. • Coal market is now very competitive and buyer dominating. Hence, government level negotiation is necessary for coal sourcing. • Coal transportation for the proposed power plant project should be done by outsourcing approach. BPDB may go open tender for engaging third party for coal supply and transportation under two different agreements-Coal Supply Agreement and Coal Transportation Agreement. These processes should also be planning in line with power plant construction planning. • Some Bangladeshi People are investing mine development at Indonesia, Philippines, Australia and other countries. Local investor might be encouraged for investing mine development in Bangladesh as well as foreign country with the aim of supplying coal to the proposed power plant
Captain Imdadul Haque (H), ndc, psc, Bangladesh Navy	• Sea state data • Admiralty charts • Coal Terminal	• Sea state data of Bangladesh coast are not available. Some attempts were made to observe data during conducting feasibility study of Deep

Person / Organization	Discussing Issues	Opinion and suggestions
	Development	Sea Port • British Admiralty Charts and data might be reviewed for information • Coal terminal has to be build for this type of project • Detail study should be carried for sea state, seabed topography. Approach channel development and coal terminal development
Commodore Riazuddin, MD, Khulna Shipyard	• Navigability of Inland rivers • Type and design for purpose build coal carrier • Construction of vessels	• Sibsa River might be a good alternative but the main problems of Sibsa river is that the river has sharp bent at different location that limit length of the vessel up to 80m – 100m • Purpose built lighter vessel should be engaged for transshipping this large amount of coal. This type of vessel can be constructed in Bangladesh. • Khulna Shipyard doest not have such capacity of constructing any vessel over 2500 DWT. Other shipyard like Anando, Trust Shipyard, Western Marine, etc have such capacity • A ship can be built by 1.5-2 years.
Tofayel Kabir Khan, Managing Director Md. Ferdous Rahman Director Operation, Dr. S.M. Ikhtiar Mahmud, Senior Manager, Khan Brothers Shipbuilding Ltd., Bangladesh	• Type and design for purpose build coal carrier Construction of vessels	• Draught of the vessel can be made shallower by changing design parameter. • Construction of shallower draught vessel dedicated to coal carrying is possible in Khan Brothers Shipbuilding Ltd. As well as in Bangladesh • Khan Brothers has wide land area and facilities for construction of vessel in quicker time • Khan Brother is a fast growing industry equipped with all modern ship design, construction facilities for constructing different types of class vessels.
Capt. A B M Fazle Rabbi, Operations Director, Western Marine Shipyard Limited, Chittagong Bangladesh	• Type and design for purpose build coal carrier • Construction of vessels	• For Khulna Power Plant, purpose build coal carrier of shallower draught has to be build for ensuring sustainable coal transportation. • Construction of such vessel is possible in Western Marine as well as in Bangladesh • Generally, construction of a new design ship requires one year. But later, ships of same design might be constructed within six month • Western Marine Shipyard is one of the largest shipyards of Bangladesh that ensure quality service and product. The shipyard produces 10-12 ships in a year. It is fully equipped with all sort of hi-tech and heavy machineries for shipbuilding and fabrication.
Capt. M. Wahidur Rahman, General Manager (Insurance and	• Capacity of BSC for handling large numbers of ships and	• BSC operates vessels in the Bangladesh-Pakistan-West Asia Gulf Liner route. • It also offer sailing route of Bangladesh/Far

Person / Organization	Discussing Issues	Opinion and suggestions
Claims Department), Bangladesh Shipping Corporation	transporting coal from foreign country	East/Japan Liner Service and Bangladesh/UK-Continent/Africa Liner Service • At present it mostly provides services to Crude oil carrying and lightering, and dry bulk carrying but no services for coal carry • If BPDB expresses its interest, then government might decide to buy new coal carriers (Mother Ship and lighters) to serve the proposed project

5.2 Key Informant Interviews (KIIs)

The following table provides the details of consultation with different key informants that has been conducted so far.

Table 5.2: Key Informants Consultation Matrix

Key Informant	Perception and suggestions
Rear Admiral Md Khurshed Alam (C) ndc, psc BN (Rtd), Additional Secretary (UNCLOS), Ministry of Foreign Affairs (interviewed on 24 Oct. 2011)	• Australia might be the best suitable coal source for Bangladesh considering global coal export-import trend and maritime distance from source to Bangladesh coast; • To establish contact with coal sourcing country, communication might be proceed through Commercial Councilor of the Concern Embassy and High Commissioner of Bangladesh; • Asia Energy' Plan of exporting Phulbari Coal Through Mongla Port which is very relevant to this study might be reviewed; • Asia Energy has completed a feasibility study on dredging of Outer bar, and development of Passur Channel, and construction of floating coal terminal near Akram Point to Export coal. This report would be helpful for this study.
Mr. Wahid Salam, Chairman, Carbon Mining Company, Bangladesh And Investor, Coal Mine Development in Philippines, Indonesia and Australia (interviewed on 10 Jan. 2012)	• Appreciates BPDB's initiatives of planning coal based thermal power plants • Coal demand is rising globally also there are lots of coal suppliers/producer in global market but the market is dominated by sellers • Recently, India and China have occupied major share of global coal trades • Japanese are buying coal mine to ensure coal supply to their domestic use • Infrastructural development for transportation of coal has to be synchronized with project development • It would be wise decision, if BPDB out sources coal supply, and transportation • Both capital dredging and maintenance dredging in Passur river and Outer Bar would be required for transportation of coal from source to project site • Other previous proposal of coal yard construction in Mongla Port area should be explored and reviewed to plan present coal terminal and coal transportation system.

5.3 Discussion with JICA, NTPC and BPDB

Communication and discussion on different issues with BPDB were very common and time to time. The inception report, brief progress report were presented in meeting. BPDB also arranged a meeting with JICA team of Power System Master Plan on 14 December 2011 where CEGIS also presented the progress of the study to gain valuable comments of JICA experts. Similarly three consecutive meeting were held (on 25, 26, 27 December, 2011) with NTPC, the feasibility study team of Khulna Thermal Power Plant to gather their comments, suggestion and guidance and to exchange different ideas, knowledge and data so far generated through the study. After completion of the international visits by the study team, a meeting was held at MoPEMR on 3 May 2012 to share the experience of the international visits and the major findings of the Draft Final Report. Afterwards, on 19 June, a discussion meeting was held with BPDB to share the conclusion and recommendation of the study team and to have comments and responses of the experts of BPDB. The the meeting the foreign experts presented the details findings of the study and the recommendations of the study team for coal sourcing and transportation.

Plates 5.4: Meeting with Mongla Port Authority

Plates 5.5: Progress report meeting with BPDB and JICA, the PSMP study team

Plates 5.6: Meeting and Discussion with BPDB and NTPC-India

Meeting with Barapukuria Coal Mining Co. Ltd

Meeting in Bangladesh Shipping Corporation

Plates 5.7: Meeting and Discussion with BPDB and NTPC

Plates 5.8: Consultation Meeting with Khan Brothers Ship Building Ltd.

Plates 5.9: The team visiting Shipbuilding facilities of Khan Brothers Ship Building Ltd

Plates 5.10: Few ongoing shipbuilding projects of Khan Brothers Ship Building Ltd

Plates 5.11: Consultation Meeting with Western Marine Shipyard Ltd

Plates 5.12: The team visiting Shipbuilding facilities of Western Marine Shipyard Ltd

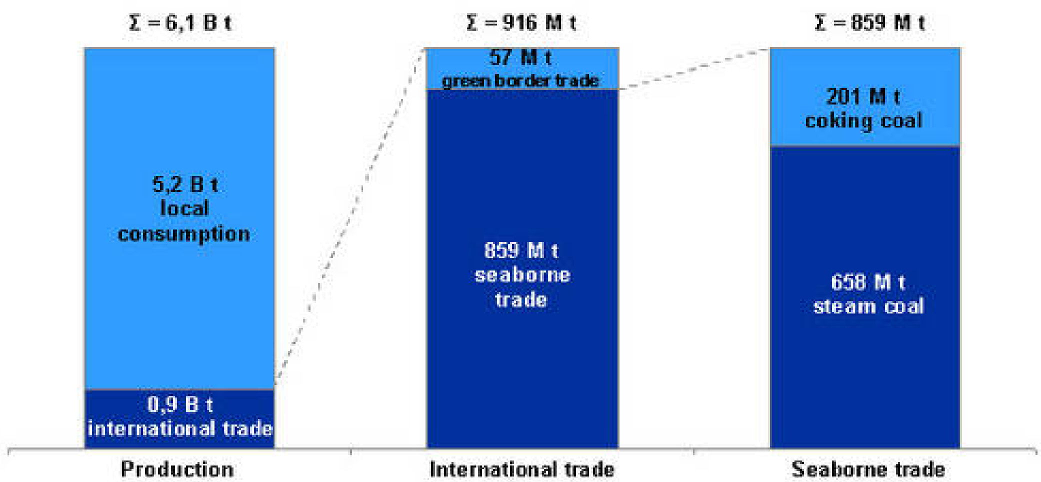
Plates 5.13: Few ongoing shipbuilding projects of Western Marine Shipyard Ltd

Plates 5.14: Meeting with Wahid Salam, Carbon Mining Company Ltd, Bangladesh

Chapter 6: Introduction to Coal Market

6.1 Coal Market

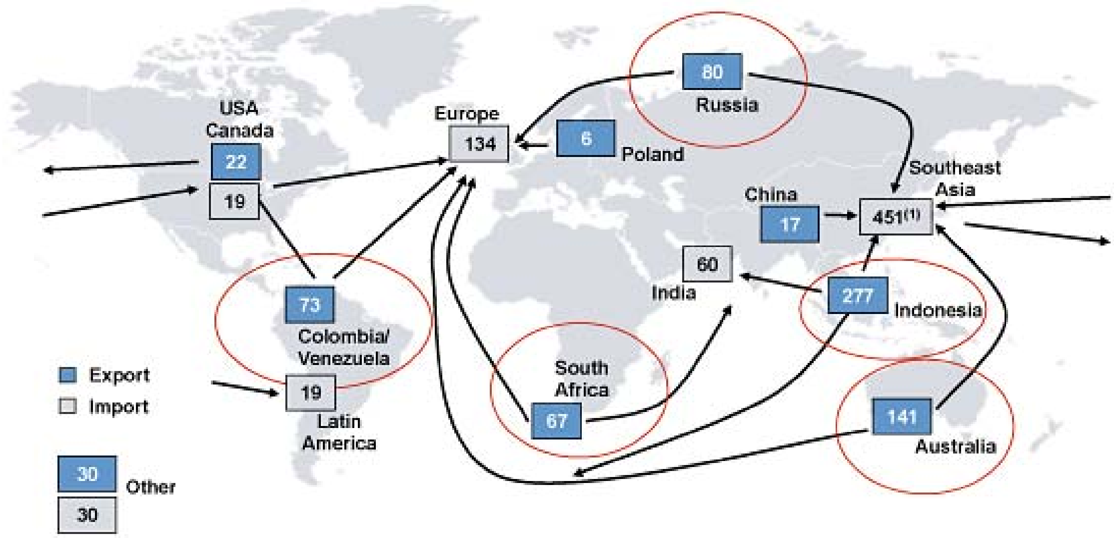
The world coal market is a global industry, with coal produced in more than 50 countries and consumed in over 70 countries. The large number of coal suppliers that are active on the coal market and the ease of transportation by rail or by sea ensure efficient and competitive functioning of the global coal market.



Source: Eurocoal, VdKI, 2010

Figure 6.1: Global World coal market, 2009

The **following numbers best portrays the dynamics of the global coal trade**: The coal market has risen from 357 million ton (Mt) in 1999 to 916 Mt traded in 2009. Seaborne trade of this volume is 94%; the remaining 6% is cross-border overland trade. In addition, of all seaborne trade over 75% is steam coal (see Figure 6.1). Due to transportation costs, the seaborne coal market is traditionally divided into two sub-markets: the Atlantic market, with the most significant import countries being Germany, Spain and the UK, and the Pacific market (see Figure 6.2), with the biggest importing countries being China, India, Southeastern Asia, e.g. Japan and Korea (Eurocoal, VdKI, 2010). The main exporting countries are Indonesia, Australia, Russia, Colombia/Venezuela and South Africa, respectively.



Source: World Coal Association, 2011

Figure 6.2: Seaborne Trade of Steam Coal in 2009

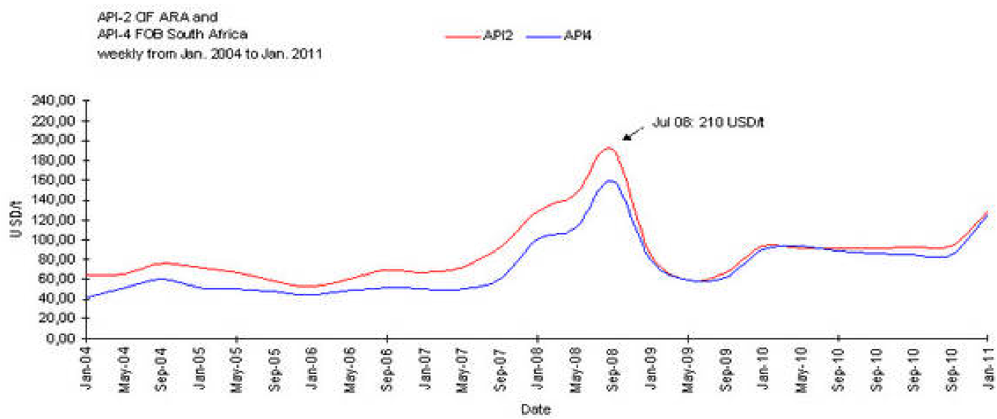
There are various reasons for this rapid development in the global coal trade:

- high growth dynamics of developing countries, especially China and India,
- decreasing coal production in Europe,
- Consumers' requirements for particular parameters, e.g. quality of coal (sulphur content, calorific value, etc.)

The coal trade market is rapidly developing into a commodity market. An increasing number of transactions are based on coal indices (especially API2 and API4) and coal derivate volumes have reached a tenfold of the physical coal trade volume in Europe.

6.2 Coal Price Development

The historical view of the **coal market** shows that coal prices have remained relatively stable and affordable than the prices of oil or gas. After the recent price hikes in summer 2008 (partly China driven and peak of world economy), coal prices have recovered and the market has returned closer to its equilibrium. Coal price projections indicate that coal will remain an affordable resource in the following decades but volatility will likely increase. These features are shown on Figure 6.3.



Reference: Schemikau, 2010

Figure 6.3: Coal Price Developments, API 2 and API4 in USD/ton

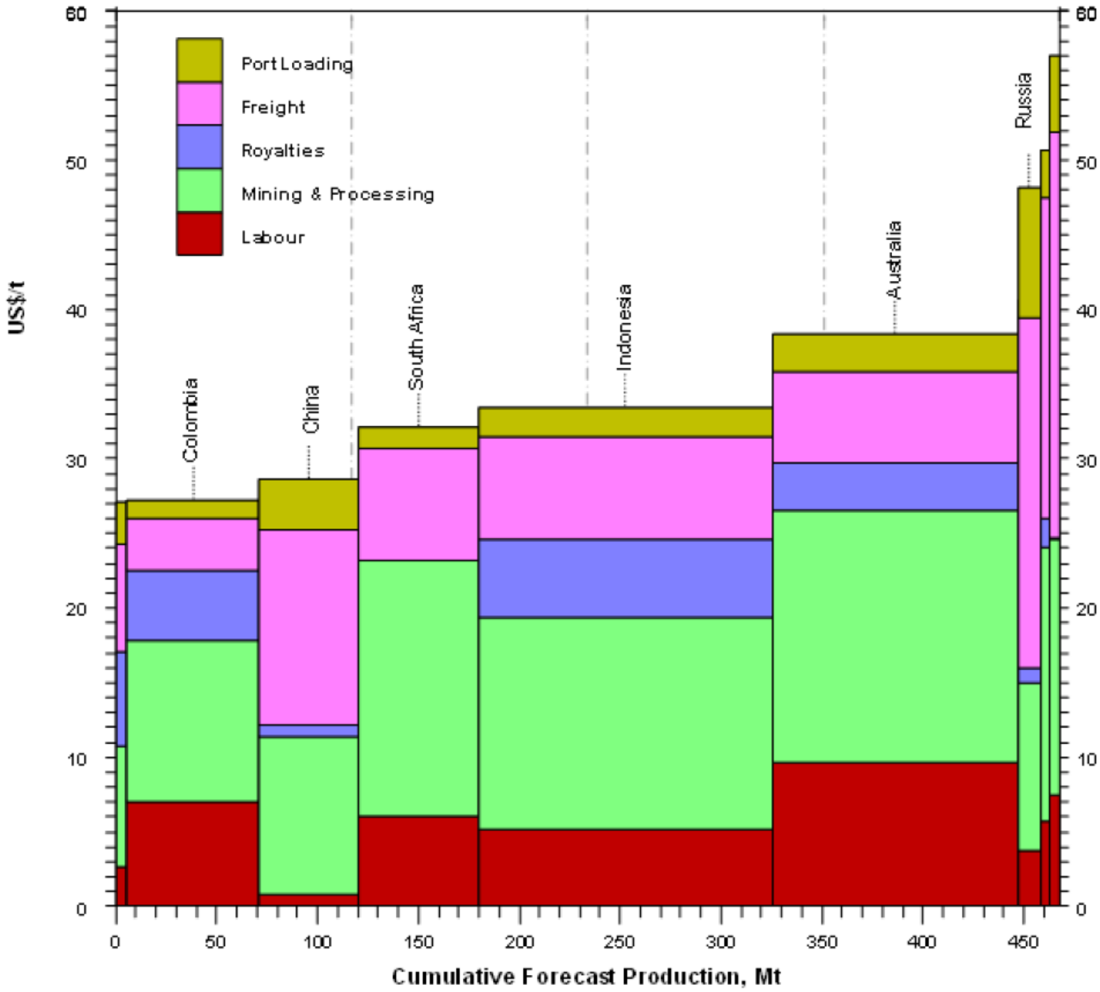
Coal can easily be transported and the mode of **coal transport** mostly depends on the distance to be covered. Over 90% of total transported coal is carried by large bulk ship.

The availability of various modes of transportation makes coal transportation simple and safe. However, the transportation costs from the coalmine to the consuming power plant can account for 80% to 90% of the final price of coal.

Coal reserves (under certain economic conditions recoverable resources) are estimated to reach 729 billion ton (2009) globally, which should last for another 120-125 years at current coal production (and consumption) levels. Reserves are part of total coal resources (part of geological or in-situ resources which are classified according to their probability of existence), which can be economically produced at the current state of technology. In comparison, estimations of oil and gas reserves are 40-45 and 60-65 years respectively. Both highly industrialized and developing countries have very large coal deposits.

6.3 Coal Cost

The supply cost has to be seen in relation to the macro-economic perspective, thus relating to each specific producing country and its free-on-board (FOB) cash cost. This comparison is provided in Figure 6.4, showing the competitiveness of producing countries in 2009, indicating the lowest level of FOB pricing (not considering different heating value).



Source: Kamandanu, 2011

Figure 6.4: International cost structure for coal (FOB basis) on lowest level, pricing base 2009[2]

The FOB costs are aggregated for export pricing and exporters on a cumulative basis. The cash costs could be related for domestic costs (ex-mine) by subtracting freight and port handling costs.

Figure 6.4 provides the FOB cost, consisting of labour, mining and processing, royalties, freight and port loading costs. Table 6.1 supplements Figure 6.4 by representing the different coal producing countries, their ranking in terms of cash cost (minimum production cost).

Table 6.1: Country ranking according to FOB cash cost

Country	Export Mt	Cash Costs US$/ton	Rank
Venezuela	5.7	27.07	1
Colombia	65.4	27.20	2
China	49.2	28.59	3
South Africa	59.5	32.15	4
Indonesia	145.7	33.37	5
Australia	121.9	38.32	6
New Zealand	0.2	40.58	7

[2] Kamandanu, B. 2011

Country	Export Mt	Cash Costs US$/ton	Rank
Russia	10.7	48.12	8
USA	5.0	50.64	9
Canada	4.7	57.03	10
Total /Average	**468.0**	**33.81**	

As Figure .4 shows the “competitiveness prices”, the lowest possible price levels, it is important to know what a wide range of negotiation surcharges has to be expected. Currently the mining costs surcharges (such as amortization, cost of capital, etc.) are approximately 20%. This adds up to coal costs at the mine of:

- approx. 40 US$/ton for South African coal,
- approx. 41 US$/ton for Indonesian coal,
- approx. 47 US$/ton for Australian coal.

This estimation is based on Figure 6.4 and does neither include any profit for the mining company and any trader, nor any insurance, surcharges for marketing, etc.

Table 6.2: Estimation of coal price (FOB)

	Units	South-Africa Richards Bay	Indonesia	Australia
Calorific value	kcal/kg	6,000	5,000	6,000
Production costs (coal statistics)	US$/ton	40	41	47
Sales price (coal statistics)	US$/ton	69	68	65
Local transportation to harbour (rail and barges)	US$/ton	8 - 11	5 - 11	7 -11
Other charges (insurance, storage)	US$/ton	3 - 4	6	8
Trading surcharge	US$/ton	15	20	20
Coal FOB (calculated)	US$/ton	99 - 107	103 - 115	108 - 113
Coal FOB (coal statistics)	US$/ton	110	108	126
Adjusted to 6,000 kcal/kg	US$/ton	110	130	126
Adjusted to 5,500 kcal/kg	US$/ton	101	119	116

Source: International Energy Agency (2012) and World Energy Council (2012)

6.4 International sources of coal

6.4.1 World coal reserves and production

Despite worldwide growing environmental concern, coal still provides 29.6 % of global primary energy needs. At present coal generates around 42 % of world electricity (World Coal Association, 2011). After recent tsunami and thereafter nuclear accident in Japan, many countries are opting coal based mega thermal power plant for future. World Coal Association estimates present world coal reserve would be 860.9 billion tons of which 35.4 % is deposited in Europe and Eurasia and 30.9% is deposited in Asia Pacific region. With individual country, US have the largest coal reserve in the world (see Figure 6.5). On the other hand, China produces highest amount of coal at present (Figure 6.6).

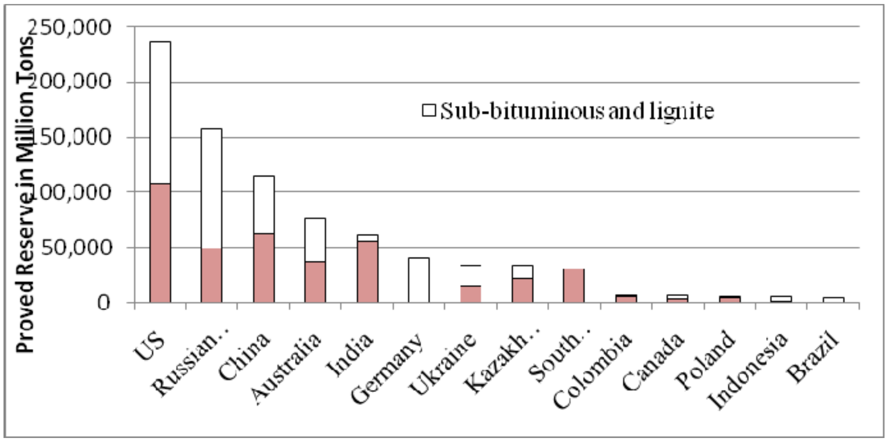


Figure 6.5: World Coal Reserve

Source: World Coal Association, 2011

Table 6.3: Global proved coal reserves at the end of 2010

Country	Reserves in Million tons				R/P ratio
	Anthracite and bituminous	Sub-bituminous and lignite	Total	Share of Total	
US	108501	128794	**237295**	27.6%	241
Canada	3474	3108	**6582**	0.8%	97
Mexico	860	351	**1211**	0.1%	130
Total North America	**112835**	**132253**	**245088**	**28.5%**	**231**
Brazil	-	4559	**4559**	0.5%	*
Colombia	6366	380	**6746**	0.8%	91
Venezuela	479	-	**479**	0.1%	120
Other S. & Cent. America	45	679	**724**	0.1%	*
Total S. & Cent. America	**6890**	**5618**	**12508**	**1.5%**	**148**
Bulgaria	2	2364	**2366**	0.3%	82
Czech Republic	192	908	**1100**	0.1%	22
Germany	99	40600	**40699**	4.7%	223
Greece	-	3020	**3020**	0.4%	44
Hungary	13	1647	**1660**	0.2%	183
Kazakhstan	21500	12100	**33600**	3.9%	303
Poland	4338	1371	**5709**	0.7%	43
Romania	10	281	**291**	#	9
Russian Federation	49088	107922	**157010**	18.2%	495
Spain	200	330	**530**	0.1%	73
Turkey	529	1814	**2343**	0.3%	27
Ukraine	15351	18522	**33873**	3.9%	462
United Kingdom	228	-	**228**	#	13
Other Europe & Eurasia	1440	20735	**22175**	2.6%	317
Total Europe & Eurasia	**92990**	**211614**	**304604**	**35.4%**	**257**
South Africa	30156	-	**30156**	3.5%	119
Zimbabwe	502	-	**502**	0.1%	301
Other Africa	860	174	**1034**	0.1%	*
Middle East	1203	-	**1203**	0.1%	*
Total Middle East & Africa	**32721**	**174**	**32895**	**3.8%**	**127**
Australia	37100	39300	**76400**	8.9%	180
China	62200	52300	**114500**	13.3%	35
India	56100	4500	**60600**	7.0%	106
Indonesia	1520	4009	**5529**	0.6%	18
Japan	340	10	**350**	#	382

Country	Reserves in Million tons				R/P ratio
	Anthracite and bituminous	Sub-bituminous and lignite	Total	Share of Total	
New Zealand	33	538	**571**	0.1%	107
North Korea	300	300	**600**	0.1%	16
Pakistan	-	2070	**2070**	0.2%	*
South Korea	-	126	**126**	#	60
Thailand	-	1239	**1239**	0.1%	69
Vietnam	150	-	**150**	#	3
Other Asia Pacific	1582	2125	**3707**	0.4%	114
Total Asia Pacific	**159326**	**106517**	**265843**	**30.9%**	**57**
Total World	**404762**	**456176**	**860938**	**100.0%**	**118**
of which: OECD	155926	222603	**378529**	44.0%	184
Non-OECD	248836	233573	**482409**	56.0%	92
European Union	5101	51047	**56148**	6.5%	105
Former Soviet Union	86725	141309	**228034**	26.5%	452
* More than 500 years. # Less than 0.05%.					
Notes: Proved reserves of coal - Generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known deposits under existing economic and operating conditions. Reserves-to-production (R/P) ratio - If the reserves remaining at the end of the year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.					

Source of reserves data: Survey of Energy Resources, World Energy Council 2010.

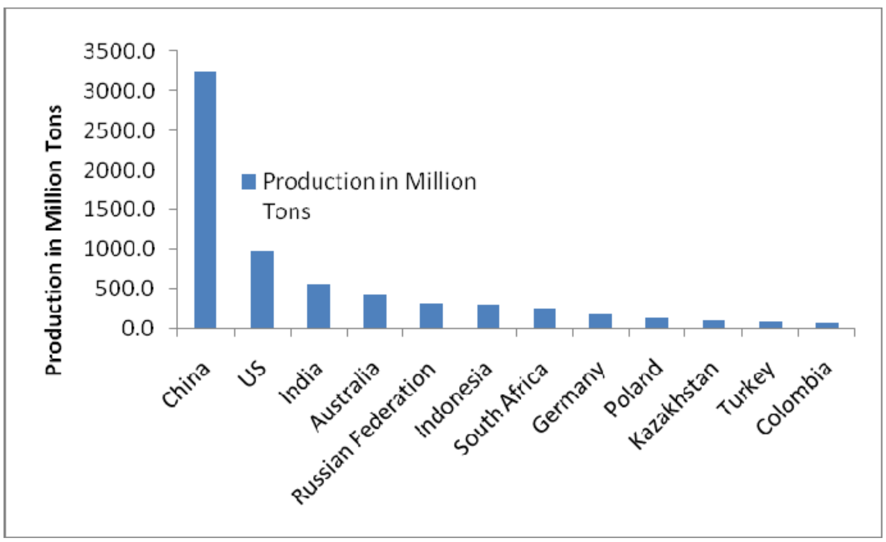


Figure 6.6: World coal production

(Source: World Coal Association, 2011)

China is the single biggest coal producing country in the world and produces almost 50% (48.3% in 2010) of global coal production. India, Australia, Indonesia and South Africa are the other major coal producing countries that are also relatively closer to Bangladesh.

6.4.2 Coal exporting and importing countries

Australia exports highest amount of coal in total including coking coal and steam coal. On the other hand, Indonesia is the largest exporter of steam coal (Figure 6.7). China and India are also producing largest amount of coal, but they are exporting little. China and India comprise largest share as coal importing countries (Figure 6.8). Japan is the highest coal importer.

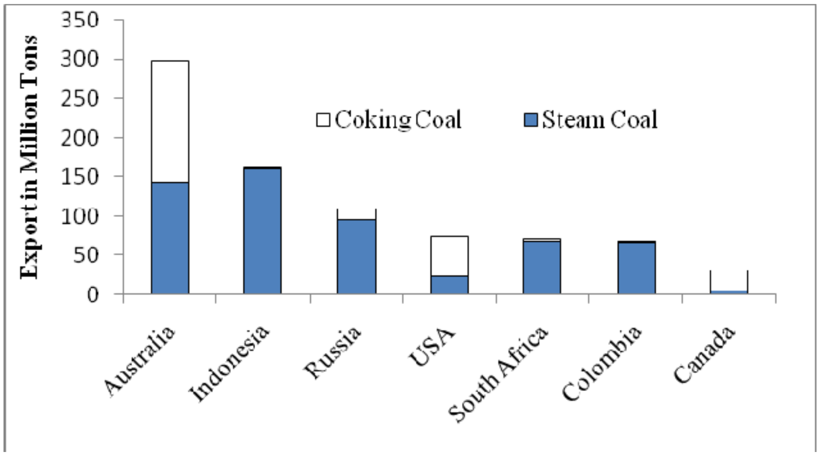


Figure 6.7: Major coal exporting countries.

(Source: World Coal Association, 2011)

On the other hand, China and India are also in the group of top most countries importing coal (Figure 6.7).

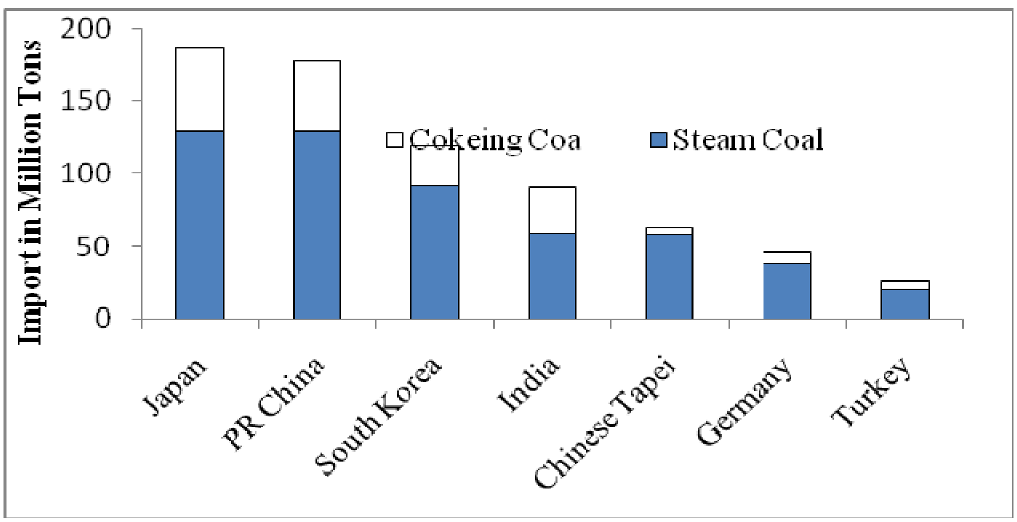


Figure 6.8: Highest coal importing countries.

(Source: World Coal Association, 2011)

This chapter has provided various sources and options of coal at national and international level. It is therefore needed to be explored the potential international coal markets for importing the required quantity and quality of coal for the proposed power plants. Some potential international coal sources including their reserves, quality, market price etc. is provided in Chapter 9.

Chapter 7: Indigenous Coal Sources

7.1 Indigenous Sources of Coal in Bangladesh

North West part of the Bangladesh is well known for deposition of good quality Gondwana coal. This coal can be the best alternate indigenous source of energy for Bangladesh. So far, five Coal (besides Kuchma and Singra, deep-seated deposits) have been discovered having in- situ Coal Deposit of about 2.5 Billion metric tons (Table 7.1). Among these, only Barapukuria coalfield has been developed. The other coal deposits await government's decision and appropriate guideline for mine development. If developed, these coal deposits have the capability to feed at least proposed Khulna and Chittagong coal fired power plants and beyond. The Coal bearing area of NW Bangladesh is very well to reasonably connect by rail and road to the proposed Khulna coal fired power plant. The above-mentioned coal deposits should be taken up for earliest development to meet the urgent need of energy for implementation of millennium development goal of Bangladesh.

7.1.1 Coal resources and reserves

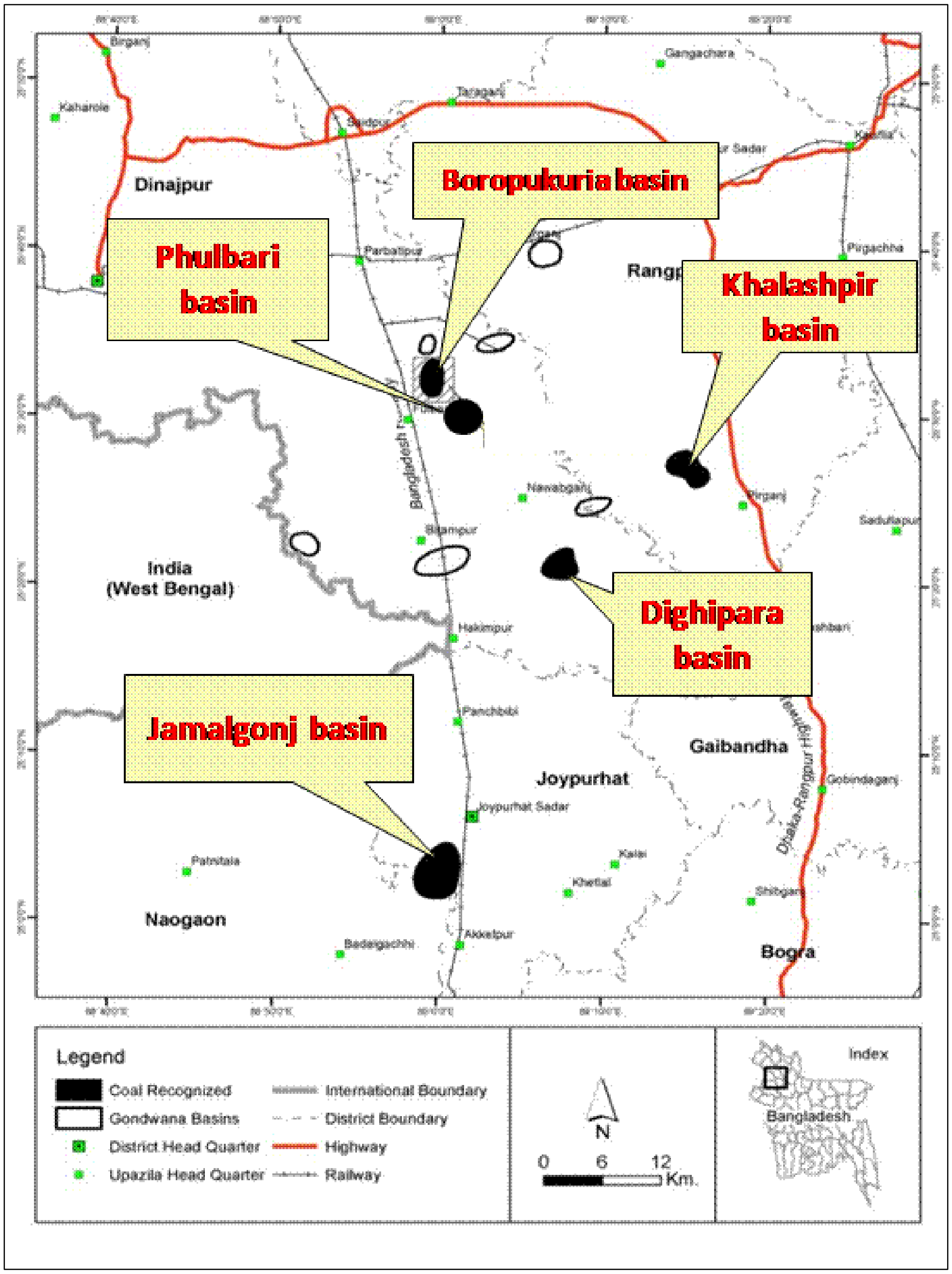
Resources and reserve

Geological Survey of Bangladesh (GSB) and BHP discovered five coal deposits with potential of about 2.5 billion metric ton in place (Table 7.1 and Map 7.1). It has been estimated that the proved in-situ reserves of four deposits (Jamalgonj coal deposits has not been considered, due to its higher depth of occurrence) amount 884 million metric ton (Table 7.1).

Table 7.1: Estimated coal resources in different coal deposits in Bangladesh.

Location/ Field	Year of Discovery	Drilled Well	Depth (Meter)	Estimated coal resources (million ton)	Total in-situ reserves (million ton)	Proved in-situ reserves (million ton)
Barapukuria Dinajpur	1985-87	31	118-509	390	390	303
Khalashpir Rangpur	1989-90	14	257-483	685	685	143
Phulbari Dinajpur	1997	108	150-240	572	572	288
Jamalgonj, Joypurhat	1962	10	640-1158	1053	-	-
Dighipara, Dinajpur	1994-95	5	328-407	600	600	150
			Total	3300	2247	884

Source: Barapukuria Coal Mine Ltd, Asia Energy Corporation, Bangladesh, and Geological Survey of Bangladesh.



Map 7.1: Coal Deposits of Bangladesh

Coal quality

Sub-Bituminous to Bituminous coal is available in our discovered coal deposits. (Bituminous coals: are dense black solids, frequently containing bands with a brilliant luster. The carbon content of these coals range from 78-91 percent and the water content from 1.5 to 7 percent; Sub-bituminous coals: usually appear dull black and waxy. These coals have carbon content of up to 48 percent and are used for electricity generation. At present Barapukuria produces coal of having average heating value of 10980 BTU/lb and very low sulfur content (less than 0.6%). Same quality coal also present in other coal deposits. Table 7.2 presents specification of coal deposited in different coalfield.

Table 7.2: Quality of coal available in different indigenous coal deposits

Parameter	Barapukuria	Khalashpir	Phulbari	Jamalgonj	Dighipara
Sp. Gravity	1.3-1.4	1.3-2.6	1.38-1.52	----	1.18-1.44
Moisture content (%)	10.0	---	2.-2.9	3.58	2.87-4.32
Ash content (%)	11 -20	17.5-27.3	6.5-19	22.4-25.7	2.53-20.05
Volatile matter (%)	29.2	17-40	33	30 -40.6	25.29-37.59
Fixed Carbon (%)	44.9-54.7	48.6-60.5	---	47	43.10-65.63
Average Sulfur cont. (% by wt)	0.52-1.33	0.51-0.96	0.8-1.0	0.6	0.49-1.29
GCV (Kcal/kg)	5800 - 7100	5900-6500	Min 6800	6600-6700	5700-8200

Source: Master Plan on Coal Power Development (JICA, 2010), Elahi, M. M., 1995

7.1.2 Status of individual coal deposits

Barapukuria Coal Mine

Barapukuria Coal Field is located at Parbatipur Upazila of Dinajpur District, was discovered by Geological Survey of Bangladesh (GSB) during 1985. It contains Sub-Bituminous to Bituminous Gondwana coal. The Proved in situ coal reserve of the field is about 300 million MT. This is the only developed coal field in Bangladesh. The coalfield has been developed to produce one million ton/year coal by underground method from the central and southern part of the field. The mine produced 0.5 to 0.8 m MT of coal from 2006/7 to 2010/11. This Coal Field has also a very good potentiality to produce coal by open cut method from the Northern part. It may be noted that the depth of coal to the north part is shallower i.e. about 100 meters below the surface. From this area, coal cannot be extracted by underground mining method due to absence of effective seal between water bearing sand and coal. To enhance production and better recovery of coal from this field, the concerned authority and GOB may like to take up a feasibility study at earliest. In case of open cut mine to the Northern part the field has a potentiality to produce two to 5 m MT of Coal per year. Most of the coal in this field would match the specification of proposed Khulna Coal fired power plant. The field is connected by Broad gauge rail line and very good road. There is a scope of improving existing railway line to transport Barapukuria coal from source to Proposed Khulna Power plant site. Asia Energy Corporation has carried out a detail study to transport Phulbari (neighboring Barapukuria) coal from mine mouth to Mongla Port. This study might be helpful for transportation of imported coal through Mongla port as well as transportation of Indigenous coal from Northern part of the country.

Khalashpir Coal Deposit

Geological Survey of Bangladesh discovered Khalashpir coal deposit located at Pirgonj Upazila under Rangpur District. It contains Sub-Bituminous to Bituminous coal. Most of the coal of the field would match quality required for Proposed Khulna Power Plant. Now the field is under exploration license to a joint venture private company of Bangladesh and China. The joint venture company has submitted a feasibility study report. The report has been reviewed by IMCL appointed by EMRD/HCU. The consultant made some suggestion to improve the feasibility study report before guaranteeing mining lease. Based on the acceptable revised feasibility report, BMD /Government may take appropriate action to expedite development of the coal deposit. The deposit has a potentiality to produce 2 to 3 million tons of coal per year. The Lessee and consultant (IMCL) has suggested for open cut mining in this deposit. This coal deposit has a potentiality to produce one to 3 million tons of coal per year.

Phulbari Coal Deposit

Phulbari Coal Field located in Phulbari, Parbatipur, Birampur Upazila of Dinajpur district, was discovered by BHP, Australia 1997 and it is now under license of Asia Energy Corp. (Bangladesh) Pty. Ltd. Asia Energy submitted a feasibility study report to BMD/GoB. Government of Bangladesh (GoB) should review the report through reputed consulting house and take appropriate decision for earliest development of the coal deposit. In case of open pit mining, it may produce 5 to 15 million tons and incase of underground method 2 to 5 m MT per year very good quality Sub-Bituminous to Bituminous coal. Most of the coal of the deposit would match the quality of coal required for proposed Khulna power plant. This coal deposit is well connected by broad gauge rail track (only 2 to 4 km away) and very well connected by road. If the field can be developed through open pit method, it would able to produce 5 to 10+ m MT coal per year. In case of underground mining method, the field may produce 2 to 5 m MT coal per year.

Dighipara Coal Deposit

Geological Survey of Bangladesh (GSB) also discovered Dighipara coal deposit located at Nawabganj Upazila during 1995. It contains Sub-Bituminous to Bituminous coal. The quality of coal of this deposit would match the quality required for proposed Khulna coal fired power plant. Government has awarded exploration lease of this Coal Deposit to Petrobangla for appraisal and development. Petrobangla is looking for a strategic partner for the appraisal and development of the deposit. They have sought permission of the Government for selecting strategic partner about 5 years back. It is still awaiting decision from the Government. Immediate decision may be made on its proposal so that Petrobangla can commence appraisal and feasibility study of the deposit. Based on the present available data the deposit has potentiality to produce very good quality 1 to 3 m MT coal per year.

Jamalgonj Coal Deposit

UNPAK Mineral Project discovered the Jamalgonj Coal deposit in 1962.. It contains the biggest known Coal resources of the country. However, due to its greater depth, present techno-economic condition it may not allow to go for mining. However, attempt may be made to explore for Coal Bed Methane (CBM) /Shale gas from this coal deposit. For exclusive extraction of CBM and Shale gas it may be dealt under Petroleum Act. Bangladesh government's immediate decision on the above-mentioned issue would help to expedite exploration and development of this resource.

Peat deposits of Madaripur/Faridpur

Besides substantial amount of good quality coal, Bangladesh is also endowed with peat deposit. These are located mostly at shallow depths between 3-7 feet below the surface at greater Faridpur, Khulna and Sylhet district. Total estimated reserve of these peat deposits is about 145 Million tons. These are under paddy field and at shallow depth ranging between 3 to 7 feet below the surface. Environmental issues hindered development of peat in Bangladesh. However if peat along with aqua culture can be developed by private sector may produce significant quantity of peat. Peat may be used for power generation and other purposes as brick burning and house hold cooking. For development of peat appropriate policy support from the government would be essential. Padma energy (a private company) is undertaking feasibility study of the area. However, the quality of Bangladesh peat may not the quality specification of Khulna coal fired power plant.

Possible discoveries

There is good probability of discovering new Coal Deposits in the surrounding area of the previously discovered Coal Deposits of Bangladesh. All out attempt may be made to encourage private parties (National/Expatriate) to invest for Coal Exploration in the area by declaring investment friendly Coal policy.

7.1.3 Coal production

Present production

At present, among the five discovered Coal Fields, only Barapukaria Coal Mine has been developed which produce around one Million MT of coal a year. The field commenced commercial production from 2005/6. Since its development, the mine has been faced various underground mining problems including spontaneous combustion, hot water and high temperature. Figure 7.1 shows coal production of the mine during 2001/2 -2010/11 collected from Barapukuria Coal Mine Company Ltd.. Most of the produced coal of the field is consumed by Barapukaria Coal fired power plant and the rest by brick fields and other industries.

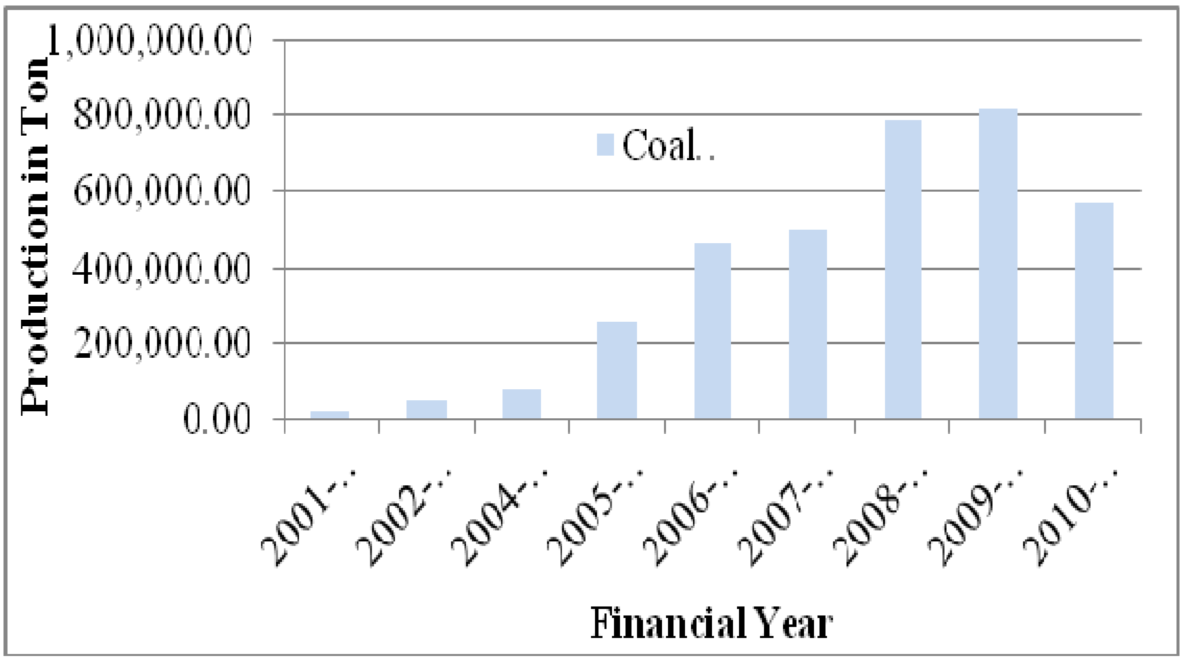


Figure 7.1: Production of Coal in Barapukuria Coal Mine

Source: Barapukuria Coal Mine Company Ltd

Indigenous Coal Production Potential

Coal resources potential in and around the discovered Coal areas in Bangladesh are good. If systematic exploration is carried out, more coal deposit may be discovered even at a shallower depth in North West Bangladesh. Coal exploration and production friendly policy of the government may accelerate coal exploration in the area at a shallower depth.

Table 7.3: Production potential of the discovered coal deposits of Bangladesh

Sl. No	Coal Deposit	Proved in-situ reserves (million tons)	Present production (million tons/ year)	Forecasted Production based on mining methods (million tons/year)		Mine development Time	Remarks
				Open	UG		
1.	Barapukuria	303	0.8 to 1.0	2.0 to 3.0	0.8 to 1.0	5to 6 years	Open Cut may be possible in Northern part. No decision has been made yet.
2	Khalashpir	143	Nil	2.0 to 3	2.0 - 3.0	4 to 5 years	Contractor has submitted application for mining lease. No decision has yet been made.
3.	Phulbari	288	Nil	5.0 to 10.0	2.0 to 5.0	4 to -6 years	Contractor has submitted application for mining lease for open cut method. No decision has yet been made. If open cut is not allowed, predicted production might also be possible from underground method.
4.	Dighipara	150	Nil	1 to 3	1.0 to 3.0	6 to 7 years	Feasibility study has not been carried out yet. As such, mining method has not yet been determined. Open cut may not be feasible. However, with underground mining, predicted production may be possible.
5.	Jamalgonj	--	Nil	Nil	Nil		Present techno-economic feasibility study does not support mining due to higher depth of occurrence of coal.
	Total	884	0.8 to1.0	10 to 19.0	5.8 to 12.0		

Source: Modified after Master Plan on Coal power Development (JICA, 2010)

Note: UG- Under Ground

7.2 Opportunity and Constraints of using domestic coal

From the above tables (Table 7.3) it may be seen that in case of field based applicable (open/ Underground) mining methods are employed the production potentiality of coal of the discovered coal deposits per year would be about 10 to 19 million tons which may be achieved in 5 to 7 years under a congenial coal exploration and development environment. One of the major barriers to exploitation and exploration of indigenous coal is the lack of public awareness. Commitment of ensuring improvement of livelihood of the locals (in and around the mining area) has not been properly addressed/disclosed by the relevant agencies. The most important water source of the area is the Dupitila formation, which is above the coal deposits. As such, the concerned and stakeholders apprehend significant impacts on water management of the area in case of open cut mine development.

For proposed Khulna and Chittagong coal fired power plants, total requirement of coal would be maximum 9.44 million metric tons (4.72 x 2) in a year. The deposits have the potentiality to supply this amount of coal up to the considered plant life time. However, at present, it is not possible to feed these proposed power plants from these indigenous sources. To ensure energy security and economy of the country all out effort should be made to develop the discovered coal deposit to supply coal from the indigenous source. Even further exploration and development of coal in Bangladesh may even allow indigenous sources to feed Maheshkhali proposed power plant.

However, the proposed power plants may come up before the development of the potential indigenous coal sources. Considering this fact, BPDB has to look for external reliable, sustainable and economic sources to feed the plants for a considerable time. The same has also been realized in power system master plan (PSMP, 2010).

7.3 Recommendation for Development of Coal Mines in Bangladesh

- The Government should consider the exploitation and exploration of the coal in the Northern part of the country as a prime issue for the energy policy.
- In parallel, an open public awareness campaign has to be elaborated under the participation of all parties representing the different interests. The interests of the different stakeholders should be considered on equal base.
- For the Northern portion of the Barapukuria deposit an open-pit mining concept should be elaborated under consideration of:
    - the utilization of the overburden volumes of the first mining period - until in-pit disposal can be applied.
    - establishing a detailed channel system supplying the agricultural area in the surrounding of the open-pit with adequate water to satisfy the agricultural community.
- For the underground mines, the backfilling of the mined out sections should be considered in order to optimize the extraction of the available coal resources.
- In a long run a coal strategy integrating all coal occurrences qualifying for mining should be prepared and transferred into a time schedule.

7.4 Summary of the Indigenous Coal Resources

In Bangladesh Geological Coal Resources of approximately 884 million metric tons are known to occur. Not all the prospective ground (mainly in the Gondwana basin) has been explored yet. Further exploration work certainly will discover additional Resources.

Of the known occurrences only a smaller portion can be extracted by open-pit mining. This applies for approximately 135 million ton of coal in the Northern part of the Barapukuria deposit, the only active coal mine of Bangladesh producing coal by underground technology in the Southern portion of the deposit.

Since the coal, deposits in water-saturated younger sedimentary units the water management becomes a major activity in preparation of the property for the mining activity overlie Bangladesh. This is a technical issue and a challenge in terms of public acceptance since most of the population in the flat farming districts depend on ground water for irrigation.

This conflict of interest can only be avoided or solved by an intensive communication and public relation campaigning. Nevertheless, this will be a tedious process lasting for some years. The mining industry in other parts of the world had to face similar problems – mainly when the public involvement activities started not early enough. All involved companies realized that it is rather difficult to regain public confidence and support after the social consensus has been violated.

For the proposed power plants, coal from the indigenous sources may not be available at the initially. Nevertheless, at least for the Khulna Power Plant, considering the cost of coal, transportation, etc of the imported coal, all out effort may be made to develop the indigenous coal.

Chapter 8: International Visits

8.1 Introduction

Two teams consisting members from the Ministry of Power, Energy and Mineral Resources (MoPEMR), Power Cell of MoPEMR, BPDB and CEGIS (Consulting organization involved in Coal sourcing, transportation and handling study) visited South Africa, Australia, Singapore and Indonesia to have meeting with different coal producers, coal suppliers, coal traders, coal terminal operators, shippers, shipping agents, ship brokers, ship survey and inspection agents and solicitors in connection with the study. The team-visited coalmines, coal terminal, barge loading points and coal crushing, washing and processing plant in Australia and Indonesia.

A wide range of consultation meeting was carried out with different stakeholders playing important role in coal sourcing, transportation and handling in South Africa, Australia, Singapore and Indonesia. The opinions, suggestions and concerns of the stakeholders are briefly discussed in the following sections.

8.2 Objective of the visits

- To gather necessary data and information on Coal reserve, Coal quality, Coal mining activities, Coal productions, Coal supply, Coal transportation facilities, etc
- To have a detail knowledge on coal business
- To identify stakeholders playing important role in coal business
- To explore the scope of coal procurement
- To visit coal mine and coal terminals for
    - understanding mining activities, coal terminal facilities
    - understanding coal handling and management system at mine and terminal site
- To have meetings with coal producers, coal suppliers, coal traders, coal terminal operators, shippers, ship brokers, and solicitors

8.3 Tour Program

Day	Local Time	Activities	Remarks
30 November, 2011 to 9 December 2011		Visit South Africa and Meeting with SASOL mining Company, Johannesburg	
26 March, 2012, Monday	0120 hr	Depart from Shah Jalal International Airport, Dhaka	Flight MH 197
	0705hr	Arrive in Kuala Lumpur	
	0900hr	Depart from Kuala Lumpur	Flight MH141
	1950 hr	Arrive in Sydney	
		Night stay in Sydney	Shangri-La Hotel
27 March, 2012 Tuesday	0700 to 1200 hr	Visit Coal Terminal of Newcastle Coal Infrastructure Group (NCIG)	
	1400 hr	Visit Coal Terminal of Port Waratah Coal Services Limited (PWCS)	
		Night stay in Sydney	Shangri-La Hotel
28 March 2012 Wednesday	1045 hr	Visit to Moolarben mine	
		Night Stay in Sydney	Shangri-La Hotel
29 March 2012 Thursday	1000 hr	Meeting with SOJITZ	
		Night Stay Sydney	Shangri-La Hotel
30 March 2012 Friday	1500hr	Depart Sydney	Flight MH 122
	2030hr	Arrive in Kuala Lumpur	
	2245hr	Depart from Kuala Lumpur	Flight MH 609
	2340 hr	Arrive in Singapore	
		Night Stay in Singapore	
31 March 2012 Saturday	0900 hr to 1700 hr	Meeting with Coal Brokers and Shipping Agents	Assisted by Sapphire Pacific Pte ltd
		Night Stay in Singapore	
01 April 2012 Sunday	1105hr	Depart from Singapore	Flight MH 614
	1205 hr	Arrive in Kuala Lumpur	
	1355 hr	Depart Kuala Lumpur	Flight MH 721
	1455 hr	Arrive in Jakarta	
		Night stay in Jakarta	
02 April 2012 Monday	0900 hr to 1700 hr	Travel to Jambi	Assisted by Sapphire Pacific Pte ltd
		Visit Coal Mine at Jambi	
		Night stay at Jambi	
03 April 2012 Tuesday	0900 hr to 1300 hr	Meeting with Mine owner	
		Visit coal stockpile	
	1500 hr	Travel to Jakarta from Jambi	

Day	Local Time	Activities	Remarks
	1800 hr	Meeting with Coal and Shipping agent	
		Night stay in Jakarta	
04 April 2012 Wednesday	0900hr - 1100 hr	Meeting with Mine owners, Coal Traders, Shippers	
	1545 hr	Depart from Jakarta	Flight MH 720
	1845 hr	Transit in Kuala Lumpur	
	2220 hr	Depart Kuala Lumpur	Flight MH 196
05 April 2012 Thursday	0010 hr	Arrive in Dhaka	

8.4 Visit to South Africa

Meeting with SASOL, South Africa

As part of the study on coal sourcing, transportation and handling for a sustainable coal supply to three coal-based thermal power plant, GEGIS study team comprising of Team Leader and two members of the study team conducted a meeting with SASOL Mining (Pty) Limited on 6 December, 2011. GEGIS team accompanying with the honorable secretary of Power Division, Ministry of Power, Energy and Mineral Resources, and three representative from the Embassy of Bangladesh, South Africa met with three high level officials of SASOL Mining (Pty) Limited at their Johannesburg office. The participants of the meeting as below:

Table 8.1: Meeting details on Coal sourcing with SASOL, South Africa

Organization	Participants	Meeting Place
SASOL Mining (Pty) Limited	Mr. Nasir Sheik Hassan Global Sales Manager	SASOL Mining (Pty) Limited Johannesburg South Africa
	Mr. Gerome Marrian General Manager Marketing	
	Mr. Peter Digby Manager marketing Services	
Ministry of Power, Energy and Natural Resources	Mr. Abul Kalam Azad Secretary, Power Division	
Center for Environmental and Geographical Information Services (CEGIS)	Mr. Giasuddin Ahmed Choudhury Team Leader of the Study & Executive Director of CEGIS	
	Mr. Waji Ullah Team Member of the Study & Deputy Executive Director (operations) of CEGIS	
	Mr. Md. Sarfaraz Wahed Team Member of the Study & Director, Water Resources, CEGIS	

With the aim of assessing the possibility of coal sourcing from SASOL, South Africa an intensive and informative discussion was held which largely served the aim of the tour. The discussion not only limited to the probability of coal import, transportation and handling facilities from SASOL and other South African companies but also share the experiences of international coal market situation too. The following issues were discussed:

Illustration: Discussed issues with SASOL, South Africa

SASOL as Tentative Coal Supplier	**Coal Transportation from South Africa**
• SASOL as coal supplier • Capacity, quality of coal, • Etc	• Mine mouth to Port • Port facilities • Port locations, distances

South Africa as Coal Source

South African's Coal has been exporting to different continents including Europe (including Belgium, Denmark, France, Germany, Italy, Netherlands, Portugal, Spain, Switzerland and the United Kingdom), the Asia (mainly India but also to China, South Korea, Malaysia, Pakistan and Taiwan), Africa (mainly Morocco but also Kenya, Mauritius, Reunion and Senegal) and small amounts to Latin America (Argentina, Brazil, Chile and Mexico). Several studies indicate that demand for coal imports in Europe will slowly decline but that import demand in India and China and the Pacific basin will increase substantially. This swing to the east is already evident in South Africa's coal exports: sales of coal to India have increased in recent years while sales to Europe have fallen, from about three-quarters of South African exports in 2005 to less than a half in 2009. In this context, Bangladesh has the huge opportunity of importing coal from South Africa. Furthermore, although coal mining productivity in South Africa is comparatively poor compared with other world exporters (6500 tons/ man-year on average), the costs per ton are relatively low, mainly due to low wages.

SASOL Mining (Pty) Limited

SASOL, South Africa is one of the companies which deal in mining, energy, synthetic fuels and chemicals around the world. Basically SASOL is the producer of gas, petrol and diesel from coal. In 1950, SASOL Company was set up by the South African Apartheid government. SASOL Mining operates as a subsidiary of SASOL Limited. SASOL Mining (Pty) Limited (hereafter SASOL Mining) is Africa's third largest coal produces, after Anglo coal and Exxaro, with production capacity of 43-46 Mtpa.

The company is headquartered at Secunda, South Africa. It is an integrated energy and Chemicals Company engaged in the provision of coal mining and exploration services. The company operates through three coal-mining operations, namely, Secunda Mining Complex, Export Complex and Sigma Mooikraal Complex. The company mines about 37.3 million tons (Mt) of saleable coal per year for its South African plants and exports approximately 2.8 Mt of coal annually. During the fiscal year ended June 30, 2011, the company's total production was 38.6 Mt of coal, as compared to 42.6 Mt in the previous year. It operates six mines for the supply of coal to the group's SASOL Synfuels and SASOL Infrachem (utility coal only), as well as external market. The company export about 40Mtpa, which is 4.5 percent of its total production of coal. The mines of SASOL Mining are located 130 km away from Johannesburg and 600 km away from the Richards Bay Coal Terminal. The company is in 16 years in production and export good quality of coal (with typical sulfur content 0.8-1%) consistently. SASOL now can have export only 4 Mt. In the discussion, they also mentioned some other sources of coal of South Africa who are involved in coal export. Commercial banks of South Africa, inter alia, export coal and so it is imperative to have a consultation with them about the possibility of coal import.

Mode of contract and pricing

Discussion was also held on the mode of possible contract between Bangladesh and SASOL Mining. Generally they make contact with the importer for 3-4 years, but it is also possible to reach a contract for a longer period through negotiation with the SASOL Mining following the African Price Index (API). SASOL contract system is ‘fixed price based’. At present, FOB price of coal is $103/ton (What type of coal) with an adjustment of ± 50 cent. FOB index published every day price, which determines the market price of coal. They suggest the study team that South Africa will be more suitable country to import coal for Bangladesh compared to other two tentative coal suppliers namely Indonesia and Australia. They also suggest that it is easy to import coal directly from company instead of leasing mines as it is complicated due to socio-economic situation of South Africa, although many traders go for lease out the mines. In this regard, SASOL praised the initiative of installing thermal power plan based on coal as it is a cheaper than any other fuel.

Coal transport from South Africa

This section described the coal transportation system for South Africa based on the meeting with SASOL and information found on several websites. According to SASOL, nearly all South Africa’s export is transported via rail from central coal basin to The Richards Bay Coal Terminal (RBCT) on the East Coast.

Plate 8.1: Richards Bay Coal Terminal

The Richards Bay Coal Terminal (RBCT), the single largest export coal terminal in the world, was opened in 1976, with an export capacity of 12 million tons per annum (Mtpa). At present, it has the capacity to handle of 91Mtpa. Situated at deep sea port, RBCT is able to handle large ships and subsequent large volumes. As such, it has gained a reputation for operating efficiently and reliably. The 276-hectare site currently boasts a quay 2, 2 kilometers long with six berths and four ship loaders, with stockyard capacity of 8.2 million tons. RBCT shares a strong co-operative relationship with South Africa’s national utility, Transnet, which provides the railway services linking the coalmines to the port, and the shipping coordination of more than 700 ships per annum.

The terminal currently boasts a quay 2.2 kilometers long with 6 berths and four ship-loaders, the two largest of which load at 10,000 and 11,000 tons per hour. RBCT provides a valued link in South Africa’s coal export chain to the benefit of all stakeholders.

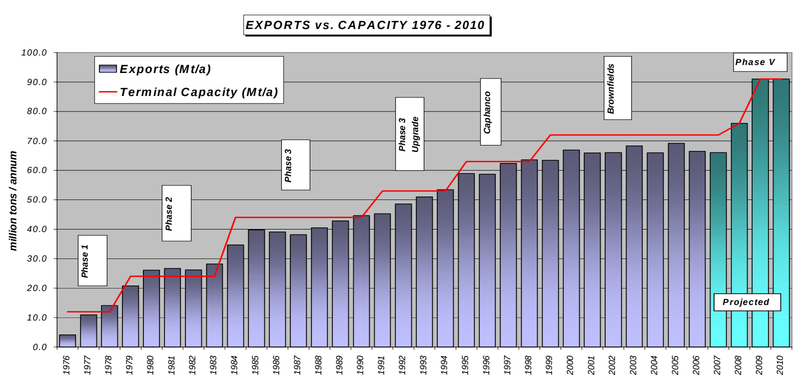


Figure 8.1: Export capacity of RBCT

Richards Bay Coal Terminal is a hub of strategic economic importance in the South African coal industry. It is the primary source of export coal leaving South Africa, accounting for 69.2 million tons in 2005, or 97.5 % of the coal exported from SA. The terminal has a bulk handling facility which, together with its strategic business partners provides a reliable and uninterrupted flow of coal from the mines through to its clients' customers, making South Africa a preferred source of coal for the international markets.

Focal point in SASOL

As mentioned, the meeting with SASOL representatives was very informative and fruitful. Mr. Nasir Sheik Hassan, Global Sales Manager of SASOL Mining, will be the key contact person to developing further communication in order to make a deal with SASOL for coal importing. He expressed cordial interest to visit Bangladesh for a detail discussion with regard to coal supply for the proposed thermal power plant, if needed. It is therefore required to develop a close communication with Mr. Nasir to import coal from SASOL Mining

8.5 Visit to Australia

The Joint team visited Australia from 25 March 2012 to 30 March 2012. Additional Secretary of the Power Division, MoPEMR was the Team Leader of the Joint Team. The composition of the team is given below:

Ministry of Power, Energy and Mineral Resources, Bangladesh

1. Mr. Tapos Kumar Roy, Additional Secretary, Power Division
2. Mr. Mohammad Hossain, Director (Management), Power Cell, Ministry of Power, Energy and Mineral Resources

Bangladesh Power Development Board

3. Mr. Minhaj Uddin Ahmed, Director (Civil), Bangladesh Power Development Board
4. Mr. Mohammad Ilyeas Rahman, Executive Engineer, Coal Project, BPDB

Consultants from Center for Environmental and Geographic Information Services (CEGIS)

5. Mr. Giasuddin Ahmed Choudhury, Executive Director, CEGIS and Team Leader of the Study
6. Mr. Md. Waji Ullah, Deputy Executive Director, CEGIS and team member of the study
7. Mr. Md. Sarfaraz Wahed, Director, CEGIS and team member of the study
8. Mr. Md. Shibly Sadik, Water Resources Professional, CEGIS, Jr. Environmental Expert of the Study

In Australia the team visited a coal mine, two coal terminals and meetings with coal mine operator, coal terminal operator, and a coal trading companies. A detail list of the agencies consulted during the international visits has been attached in Annex IX.

8.5.1 Consultation Meeting in Australia

An eight (08) member team four each from MoPEMR and CEGIS visited Australia from 26.3.12 to 30.04.12. The team carried out wide ranges of consultation meeting during their visit in Australia. The objectives of the consultation meeting were to have detail knowledge on coal business (coal mining activities, coal procurement, and transportation of system) in Australia with the target of sourcing coal from Australia. The attached Table 8.2 is briefs on the opinions and suggestions of the stakeholders/agencies consulted during the visits are narrated below:

Table 8.2: Opinion and suggestions of different stakeholders in Australia

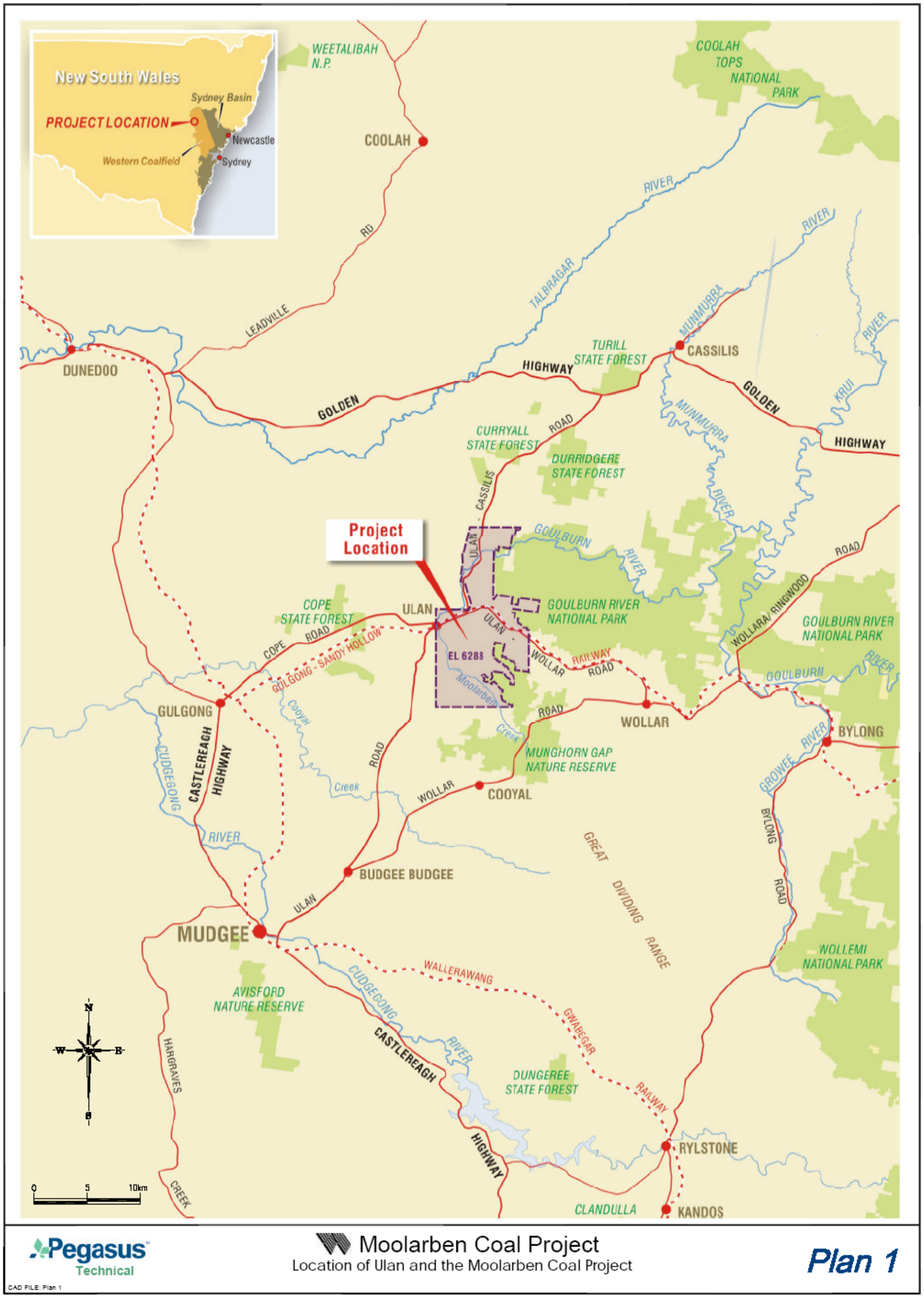
Category	Organization	Representatives discussed	discussed Issues	Information, Opinion and Suggestions obtained
Coal Trader	Sojitz Australia Limited	1. Tadahiro (Tad) Kinoshita, Managing Director 2. Taru (Terry) Shindo, General Manager, Coal & Energy Dept.	• Coal Business in Australia • Coal Trading system of Australia • Coal Resources and Reserve in Australia • Role of Sojitz in coal business • Process of coal procurement from Australia	• Sojitz Corporation is an innovative, function oriented trading company. • Sojitz operates business through its four divisions- Machinery, Energy and Metal, Chemical and Functional Materials, and Consumer Lifestyle Business. • Sojitz runs its coal business through coal department aegis under Energy and Metal Division. • Activities of Coal Dept. of Sojitz : o Investment in Coal Mine, Coal Center, IPP, Coal processing Plant, etc o Sojitz Australia has investment in 11 coal mines in Australia and performs exploration, development and operation o Sources coal for JCOAL and provides technical support to JCOAL o Flexible coal supply, and o Coal trading around the globe • Sojitz has more than 30years of experience in international coal trading • At present from these 11 mines in Australia, 6.77 Mtpa coal is attributable to Sojitz. It also sources coal from non invested mines around the world. • Globally, Sojitz traded 12.33 Mt coal in 2010 where 17% was from invested mines (equity share) and the rest 83% was from non-invested mines. • Sojitz supplies this coal to its buyers contracted under long term agreement. As per new demand, they will further invest in mine to source required quantity of coal. • Sojitz shows interest to involve with BPDB in coal sourcing, transportation and handling • Coal price is always changing. In common practice, only the index

Category	Organization	Representatives discussed	discussed Issues	Information, Opinion and Suggestions obtained
				/ benchmark price is mentioned in the contract agreement. The contractual price is calculated from this index price during procurement. • FOB of thermal coal at Newcastle Port wasUS $105.00 per ton in the date of the discussion (29 March 2012). • Recently, a huge exploration and development activities on coal mine and transportation infrastructure is going on in Mozambique. Large importers like China, India and Japan are looking for sourcing coal from Mozambique that is a new comer with enourmous potentiality in world coal trade. Bangladesh may also look into the coal market of Mozambique.
Coal Producers	Moolarben Coal Operations Pty Ltd (MCOPL)	Frank Fulham, General manager	• Overview of the Moolarben coal mine • Coal Mining Activities, Coal Reserve, Productions, Sell. • Scope of Coal Procurement • Future Development Plan	• The Moolarben Coal Mine is located within the western Coalfields of NSW near the village Ulan, approximately 45 kilometers north-east of Mudgee and 25 kilometers east of Gulgong (Map 7.1) • A presentation showed by the MCOPL is appended in Annex VII • The mine area covers 11,000 ha • Coal Reserve in the Mine: 350 million Ton • MCOPL Production Forecasted for 2012: 15 Mt (17.2 Mt ROM) • Specification of dominating coal: GCV 6200, Ash 12-14% • Infrastructures: o Open Cut Mine: 03 nos. o Under Cut Mine: 01 no. o Coal Handling and Processing Plant (coal crusher, washing plant, handling facilities, etc o Stockyard (raw and product coal) and stacking facilities o Rail loop and loader, etc o Office building • Moolarben Coal Operations Pty Ltd is the operator on • behalf of the JV of: o YanCoal Australia Pty Ltd (80%), o Kores Australia Moolarben Coal Pty Ltd (10%), and o Sojitz Moolarben Resources Pty Ltd (10%). • Interested buyers should contact with the shareholder for coal

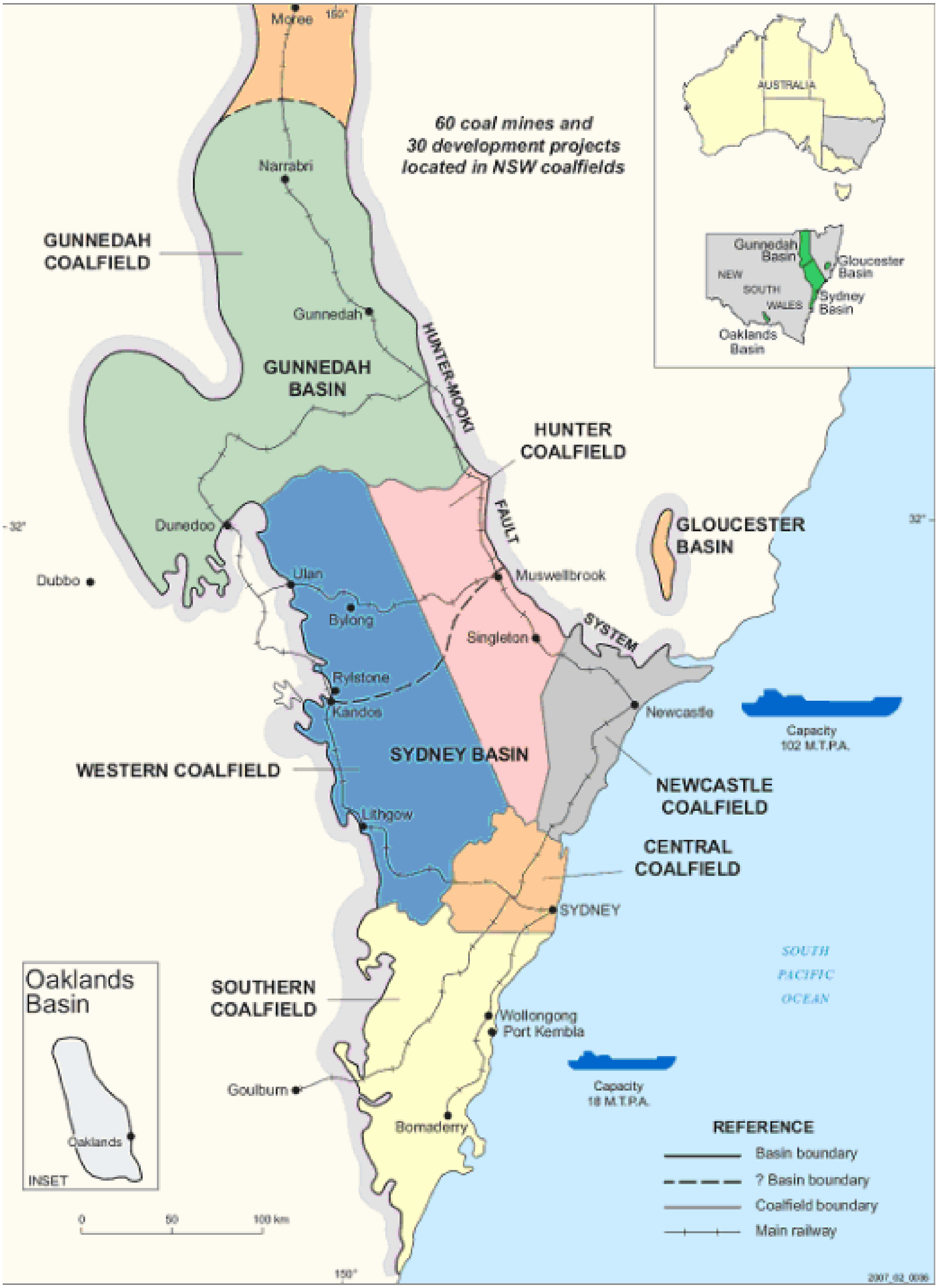
Category	Organization	Representatives discussed	discussed Issues	Information, Opinion and Suggestions obtained
				procurement. Coal price as well as Energy is very much unpredictable. Price of the coal will be defined during agreement. In common practice, index linked price is defined in the agreement. • Production capacity would be increased based on demand of coal.
Coal Terminal Operator	Newcastle Coal Infrastructure Group (NCIG)	Tour Officer	• Coal Terminal Facilities • Coal Handling System • Coal Loading System • Stacking and Stockyard Management (the presentation showed by the NCIG is appended in the Annex VIII	• Port of Newcastle is the world's largest coal export port of the world. • There are three coal terminals in Newcastle Port. • NCIG Coal Export Terminal is located in Kooragang Island (Map 7.3) • Coal supply: Hunter Valley Coal Chain Coordinator. • Exporting Capacity: 30 Mtpa • Plan: Facilities development in their process with the target export of 66 Mtpa of coal. • Infrastructures: ✓ Inbound system of coal receiver rated at 8,500tph ✓ Rail system consists of: o Two turnouts off main line (in and out) o Three rail sidings. o One balloon loop ✓ Inbound Plant Components: o Rail Dump Station o Single dump hopper with belt feeder o Three conveyors o Sampling station ✓ Future Plan: o Maximize the number of trains that operate on a regular basis o Provide an even program for train loading at mine sites ✓ Stockyard system: Rated at 8,500tph ✓ Stockyard components: o Three stockyards o Two combined stacker / reclaimers

Category	Organization	Representatives discussed	discussed Issues	Information, Opinion and Suggestions obtained
				o Two yard conveyors ✓ Stockyard Management: o Mixture of dedicated stockpiles and cargo assembled stockpiles o Regular high volume shippers will have dedicated areas o Other shippers will have cargo assembled areas o Blending by combining stack out patterns with reclaim patterns ✓ Outbound system rated at: o Reclaim capacity 8,500tph o Ship loading capacity 10,500tph ✓ Ship loading system consists of: o Four conveyor belts o One buffer bin o Sample station o One ship loader o Two wharves ✓ Future Plan: o Minimize the effect of deballasting and tidal departures o Keep reclaiming during hatch changes ✓ Channel Depth: 15.2m ✓ Berth Position: 16.5m ✓ Tidal range: 1-2 m ✓ Strong Environmental Management and Occupational health and Safety System ✓ Transportation loss: less than 1%
Coal Terminal Operator	Port Waratah Coal Services (PWCS) Limited	Rod Dove, Tour Officer	• Coal Terminal Facilities • Coal Handling System	• PWCS operates two coal terminals in Newcastle (Map 7.3) ✓ Kooragang Island and ✓ Carrigton Island or Carrinton • Coal Supply: Hunter Valley Coal Chain Coordinator • Infrastructures in Kooragang Island Coal Receiver

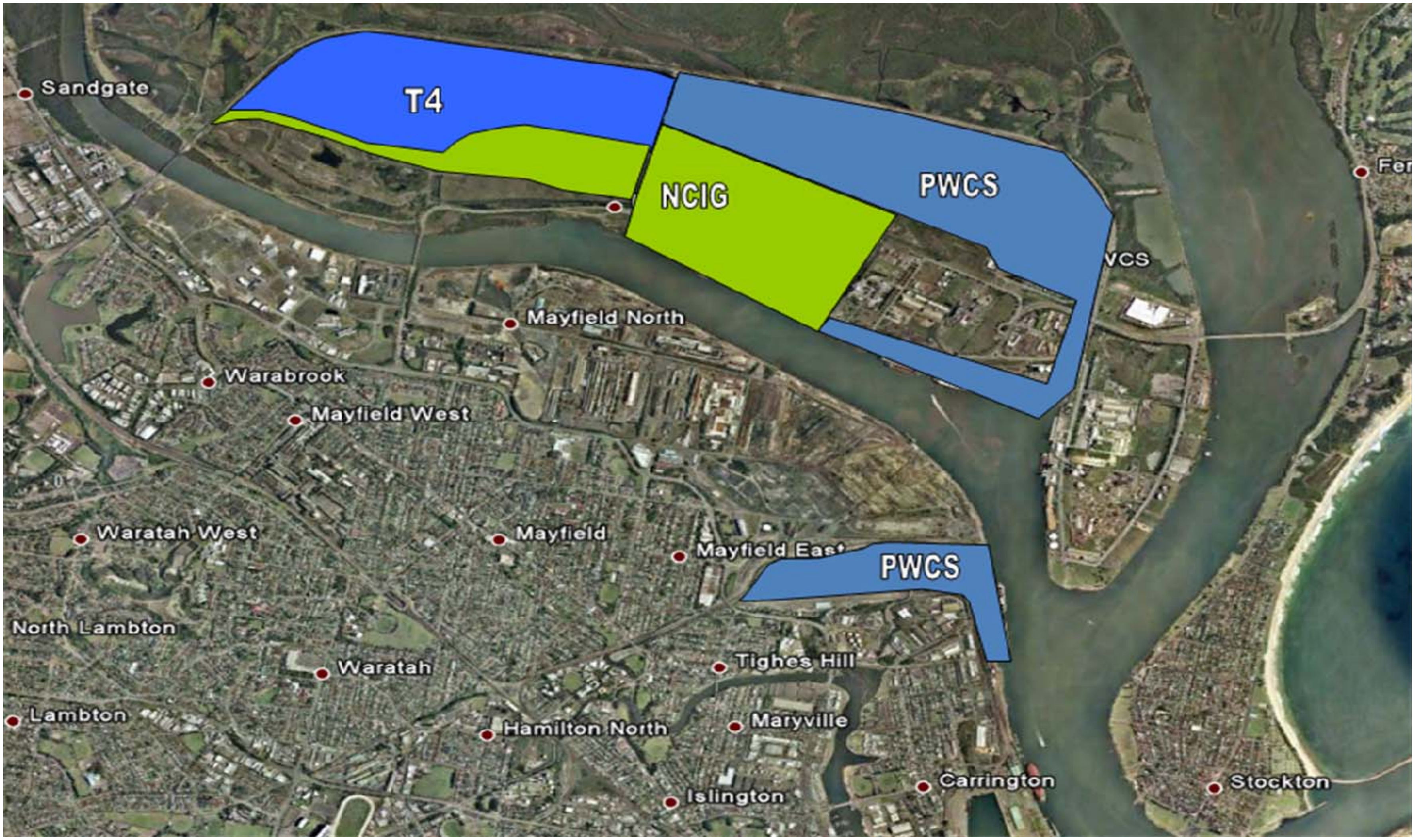
Category	Organization	Representatives discussed	discussed Issues	Information, Opinion and Suggestions obtained
			• Coal Loading System • Stacking and Stockyard Management (the presentation showed by the PWCS is appended in the Annex VIII	✓ 3 x 8,500 tph rail capacity Coal Stockpiles ✓ 4 x 2.5 kilometers x 56 meters ✓ 4,200,000 tons max capacity ✓ 2,700,000 tons working capacity Coal Stacking ✓ 6 x 8,500 tph stacking capacity Coal Loading ✓ 4 x 8,000 tph reclaiming capacity ✓ 3 x 10,500 tph ship loading capacity ✓ 2.0 – 3.2 meters wide, ✓ conveyor belts Berths ✓ Berth space for 4 vessels ✓ 16.5 meters depth at berth ✓ 15.2 meters approach to channel Vessel Capacity ✓ 210,000 dwt max 300 meters max length 50 meters max beam 70,000 dwt min capacity • Existing facilities are dedicated to shareholders and fixed users contracted under long term agreement. As per new demand, shareholder might invest in development of new facilities • The terminal has strong Environmental Management to control environmental impacts. • EMP includes Covered conveyor belt, automated dust suppression system, reuse and recycling of water, waste water treatment plant • Treatment Plant and Disposal pit for surplus water from stockyard have been constructed for environmental safety



Map 8.1: Location of the visited coal mine- Moolarben Coal Mine



Map 8.2: Coal deposits of New South Wales



Map 8.3a: Location of PWCS and NCIG coal terminals in Newcastle

Map 8.3 b: Location and Facilities of NCIG Coal Export Terminal

8.5.2 *Learning from Australia visit*

Coal resources, reserve and price

Australia has considerable reserves of metallurgical and thermal coals. It has more than 76 billion metric tons of efficiently recoverable reserves of black coal (BP, 2011). Significant resources occur throughout the country, but production for export markets are currently based on deposits in the eastern states of Queensland and New South Wales. The Australian coal industry has over more than100 numbers of privately owned coal mines located mainly in the coal exporting states of New South Wales and Queensland and employs over 21,000 people through Australia. About 60 of these mines have open cut operations while 50 have underground operations. These include around 10 mines with both open cut and underground operations.

In Australia, most of the coal miners explores, develops and operates mine with financial investment of shareholders. As such, the shareholders market the product coal. The productions are attributed to shareholders on equity basis.

Coal suppliers source coal from their invested mines as well as from non-invested mines (from shareholders). Potential buyers have to contact with coal traders, coal suppliers on directly with the shareholders of the mines for coal procurement. Long-term supply agreements with index linked price of benchmark price are the common practice of coal procurement contract with coal traders/suppliers/mine shareholders.

Australia generally exports coal of higher GCV value (above 6000 kcal/kg). Among its 76 billion tons of proved reserve, 51 percent coal is Anthracite and Bituminous, and rest 49% is sub-bituminous (BP, 2011). General specification of the exported coal is given below:

Table 8.3: General specification of Australian coal

GCV (Kcal/kg)		TM (% Max)	IM (% Max)	Ash (% Max)	VM (%)	FC (%)	TS (% Max)	HGI	Sizing (mm)	AFT Deg. C (Max)
AR	AD	AR	AD	AD	AD		AD			
5732 - 6900	6100 - 7250	6.0 - 18.5	1.0- 13.5	8.7 - 21.0	19.0- 50.0	by diff.	0.2 - 1.0	37 - 82	50	1300 - 1600

Source: Resource Development Branch, Australia, 2005

Note: AD: Air Dried; AR: As received; GCV: Gross Calorific Value; TM: Total Moisture; IM: Inherent Moisture; VM: Volatile Matter; FC: Fixed Carbon; TS: Total Sulfur; HGI: Hardgrove Grindability Index; AFT: Ash fusion temperature (flow temp. in a reducing atmosphere), By Difference: 100- (IM +Ash + VM).

Price of the coal is always fluctuating. During the day of visit (29 March 2012), FOB price of thermal coal (GCV above 6000 kcal/kg) at Newcastle Coal Terminal was US$ 105.00/ton where as the average price (FOB) of the same coal (6300 kcal/kg) at Newcastle Coal Terminal was US$ 122 /ton in 2011.

Coal supply chain, and coal terminal facilities

There are around two hundred ports in Australia Port of Townsville, Abbote point, Dalrymple Bay, Hay point, Gladstone, Port of Brisbane, Port Stephens, Newcastle, Port Botany, Port Kembla, Melbourne, Geelong, Portland, Victoria, Adelaide, Port Bonython, Whyalla, Ship Hill, Port of Lincoln, Fremantle etc. are the major port. Among these, Abbote point, Dalrymple Bay, Hay point, Gladstone, Port of Brisbane, New Castle, and Port Kembla handle major share of the exported coal.

Newcastle Port Corporation is the largest coal terminal. There are three coal terminals at Newcastle Port Corporations. Two terminal are at Kooragang Island operated by NCIG and PWCS and while the other is in Carrigton Island operated by PWCS.

The coal transportation system from mine mouth to export port is very efficient and sustainable. Hunter Valley Coal Chain Coordinator (HVCCC) is one of the largest Coal Supply Chain in New South Wales. About 90% of coal from this supply chain is exported through Newcastle coal terminals. The HVCC includes 40 mines operated by 14 producers, three train haulage operators, two track infrastructure operators and three export coal terminals. Annually the three export terminals handle 1200 vessels. The supply chain is operated with the target of 365 operation days (24hr a days, and 365 days a year). The entire system is monitored and controlled through an automatic monitoring system.

8.6 Visit to Singapore

After successful completion of the activities in Australia the above mentioned team visited Singapore from 30 to 31 March 2012. Mr. Md. Maqbul-E-Elahi, Coal Expert, CEGIS and Deputy Team leader of this Study Project also joined the team.

Though Singapore is not a coal or other mineral producer but it plays an important role in coal and other mineral business in Asia

To understand the Coal business, its modality etc. in Singapore the team had meeting with a numbers of coal traders, shippers, ship brokers, solicitor, etc. A detail list of the agencies consulted during the international visit has been attached in Annex IX.

The points of discussions of the meetings along with the opinions and suggestions obtained may be seen in details in Table 8.4:

Table 8.4: Information, opinions and suggestions of the stakeholders consulted in Singapore

Category	Organization	Representative (s)	Issues of Discussion	Information, Opinion and suggestions
Coal Trader and Shipping Agent	Sapphire Pacific Pte Ltd	Capt. Arun Dua	• Role of the Coal Traders and Shipping agents. • Coal trading system • Options of coal procurement in Indonesia • Coal transportation system	• Coal traders and Shipping Agents have very important role in overall Coal business. Coal traders source coal for the buyers. The Shipping Agents would take delivery of coal ensuring contracted quality and quantity on behalf of the buyer and discharge coal at desired location of the buyer on time, • Finding a reliable coal supplier is a major challenge in case of Indonesia. It would prudent to contact a Supplier having a long proven track. • Before investing in coal mine in Indonesia following issues have to be cleared: o Ownership document has to be checked very carefully o The Resources and Reserve of the Coal deposit to be carried out based on standard code like JORC, UNFC, etc. • Options of coal sourcing from Indonesia: o Mine leasing and operation under joint

Category	Organization	Representative (s)	Issues of Discussion	Information, Opinion and suggestions
				venture o Offtake agreement with mine owner (offtake from stockpile, offtake from Barge, offtake from mother vessel) o Short-term agreement, price fixed. o Long term agreement with quarterly price negotiation (not common) o Long-term agreement, price adjustment linked to index price (common). o Shareholding of mine. o Spot market. o Agreement with Coal Traders/Coal Suppliers • If BPDB lease mine/tie with mine owner, BPDB has to look after: o Mine operation o Coal handling system at mine site, barge, loading point, intermediate stock pile and mother vessel o Continuous supply of coal from mine to mother vessel, o Control quality and quantity of coal. • In case of JV for investing in mining coal GOB/PDB should consider the following: o Title of the deed should be clear and based on measured reserve basis o Prior to forming JV, Report on Mineral Resources Classification Systems, Suitability and Selection (e.g. JORC, UNFC, etc) should be prepared o Finding a reliable local partner • Options for coal transportation o Buying/hiring ships and operating by a dedicated shipping department of the power plant project, BPDB need to take care of: stevedoring, barge feeding system, etc o Joint Venture with established Transportation Company/Shippers o Outsource the coal transportation under long term agreement • For exploring the scope of mine leasing BPDB should engage JV of Indonesian consultant and Bangladeshi Consultant for detail investigations • Finding a reliable coal supplier, shipping agent and contact agency is a major challenges that has to be overcome before sourcing coal from Indonesia • GOB should engage responsible person in Singapore and Indonesia for initiating and processing coal sourcing and transportation

Category	Organization	Representative (s)	Issues of Discussion	Information, Opinion and suggestions
Lawyer/ Solicitor	Joseph Lopez and Co	Joseph Lopez	• Coal sourcing process • Coal Sourcing/Supplying, and Transportation Agreement	• Joint venture in operating mine in Indonesia preferable than sole-operation of a mine • Local people and elite play an important role in obtaining mining licenses/approval. • As such reliable local partner might play an important role in obtaining mining approval and handling local issues. • For preparing agreement GOB should engage consultant (local and Indonesians including lawyers, solicitors, coal trading experts, etc) • In case of long-term contract, index price should be preferable instead of a fixed price. • Off take agreement with coal producers might be made for short term (2-3years) with a fixed price. • Considering competitive market, business nature in Indonesia, and issue of reliability, long term agreement with established coal trader/suppliers, shipping agent would be the best option for GOB for coal procurement from Indonesia. • GOB should source coal from multiple sources (multiple traders/suppliers, and multiple country) for ensuring sustainable supply chain • Similarly for maritime transportation multiple agents/shippers should be engaged
Shipper	Vivek Datar	TATA NYK	•	• For coal transportation, COA might be made for 15 years. • The agreement should be based on benchmark price of ship hire, fuel, operation cost, etc that would be revised following the index • Established shipping agent should be engaged in that case. GOB should prefer private shipping agent instead of any state owned agent. As private agents are more flexible and capable of taking quick decision • Coal unloading facilities at unloading port are most important factor in coal transportation. Freight cost largely depends on discharging rate of coal at loading port. • Ship brokers play an important role in ship hire as well as in maritime transportation • Ship brokers sources, controls and concludes the business • Inspection of the transportation system (barge feeding system, ship to ship transfer, loading, unloading, etc) is very importation for maintain sustainable supply chain and for ensuring required quality of coal
Ship Brokers	ADITYA NUGRAHA	PCN (PT.PROLIDO CIPTR NUSANTARA)		

Category	Organization	Representative (s)	Issues of Discussion	Information, Opinion and suggestions
				• As such, an inspection, testing and certifying agency has to be engaged. • It would be better if GOB establish an office with the responsibility of coal sourcing and transportation at Jakarta and Singapore. On the other hand,

8.7 Visit to Indonesia

8.7.1 Consultation Meeting in Indonesia

The same team visited Singapore also visited Indonesia after completion of activities in Singapore. During visit in Indonesia, the team had a wide range of meetings with coal producers, suppliers, shippers, inspection, testing, survey and certifying company. The team also visited an open cut coalmine and barge loading point in Jambi Province. A detail list of the agencies consulted during the international visit has been attached in Annex IX. The important findings of the meeting are briefed in following table:

Table 8.5: Information, opinions and suggestions of the stakeholders consulted in Indonesia

Category	Organization	Representative Persons	Discussing Issues	Information, Opinion and suggestions
Coal Suppliers	P.T BORNEO RESOURCES INTERNATIONAL	Capt. Masood Farooque, (Former student of Bangladesh Marine Academy).	• Coal export Policy of Indonesian Government. • Potential suppliers of Coal for Bangladesh • Coal management	PT. Boneo Resources is a trading company dedicated to supply coal from Indonesia to the end users. Currently it is buying coal for a Pakistani Cement factory form Nippon Oil and Energy Corporation. Indonesian government in coming days may impose some restriction on the export of Coal. The present Indonesian Govt. priority is to supply energy to the domestic sector and has imposed regulation on the export of unprocessed minerals including coal. Business communities are not happy with the present policy. To have an over view on the debate 'The Jakarta Globe, Tuesday, March 6, 2012 and Indonesian Coal web pages may be seen. As such Indonesia may not be considered as lone source of coal for a plant life. Buy coal from the producer, those have good logistic for handling and transportation of coal from the mine to the mother vessel. Among other may be Middle East Coal Mining Company who is going to start production from 2015 at the rate of 10 Million M tons of coal years. Second option to buy coal may be from major coal traders those have good track record to supply large quantity of coal for reasonable time like Nippon Oil Company in Indonesia. There are also very good German Coal Traders in Indonesia carrying out business with reputation in Indonesia. Considering transportation cost and quality of coal it would better to buy coal from Sumatra for Bangladesh. Stressed the need to learn 'Coal Stockpile Management' for the people engaged in coal business and at plant site coal handling system.
Coal Producer	Batang Hare Coal Field (110 km East of Jambi Airport), owned by Pt. Nan Riang Company.	Mr. Anthony	•	Open pit Mining, depth – Max. 20m, number of seams 2 (1m and 4-5m), stripping ratio 1:4. Age of coal: Tertiary (Plio-Pleistocene). Reserve (Indicated); 7 million tons. Production : 60-80 Thousands tons /months Coal quality : Sub-bituminous, GCV 5300 Kcl/Kg (Air dried), Moisture 45%, Sulfur 0.2%, Ash content 5-8% Volatile matter 43-46%, HGI 60-70 Transported by truck to the nearby river site to load into 1000 tons to 3000 tons (depending on water depth) barge to ship it to mother vessels. Coal from this mine is being exported to India.

Category	Organization	Representative Persons	Discussing Issues	Information, Opinion and suggestions
				Cost up to barge US $33/ton and & US $ 44 up to mother vessel.
Testing and certifying	Sucofindo, a state owned mineral including coal quality testing/inspection and quantity certifying agency. It has about 63 laboratory throughout Indonesia.	Mr. Diding Sudira, Sr. Manager. E-mail: diding@sucofindo.co.jd	• Place of inspection • Standard • Fees for test and certificates	This type of organization is engaged by the buyer to ensure quality and quantity as stipulated in the contract. Sucofindo carries out 60% of testing and certifying business in Indonesia. Testing of coal to maintain contracted quality is made throughout the system of transportations i.e. from mine mouth/ crushing plant, stock pile, barge and finally at mother vessel. Before loading goods to ship cleanliness of the hatch is also made. On receipt of certificate on cleanliness loading of goods commences. After loading the goods in to the mother vessel draught survey (for determining quantity) is carried out. ISO and other standard are maintained for testing coal as desired by the client. Suggested a) Don't delay for loading coal to Mother vessel after testing coal at Barge b) Engage a supplier having good and long track record. c) Preserve umpire sample as reference in case of dispute arise. Cost of such survey is about $0.25/ton. Testing and reporting time for 60,000 tons ship load 2/3 days.
Transport and Shipping Agent	Indo Dharma Transport and Shipping Agent	Mr. Dadang Sonda	• Shipping document • Stevedoring • Equipment	Shipping document should be filled up clearly. Coal supplier should be responsible for stevedoring. Must have heavy equipment including grabber up to 12m3 and loading crane up to 20 thousand tons /day capacity. They must have barge and tug. Shippers are responsible for transportation of coal from mine to Jetty (/??).
Mining	PCN, South Kalimantan	Aditya Nugraha, Director, Email: aditya@lcp-coal.com Tele: +62-21-23586068-69 and +62-21-23586070	• Coal quality • Buyer • Stripping ratio • Max. thickness of coal	Sub-bituminous, CGV 5300 Kcl/Kg, Sulfur 0.5%, Moisture 38-40%,Ash content 6% Stripping ratio: 1:2; Max thickness of coal seam 30m. Present production 3 lacs ton per month. Buyer : Agarwal and other Indian Long term Contract with quarterly price adjustment. FOB Sales price: $45.00 Metric ton. Tonnage contract is preferred. Long term contract with quarterly price adjustment is also acceptable.

Category	Organization	Representative Persons	Discussing Issues	Information, Opinion and suggestions
			• Type of contract • Present production capacity • Type of sale /purchase contract	
Coal Producer	PT. Baratama International, Jl. Danau Sunter, Ruku Terrace, Block A, No. 16, Jakarta Utara	Mohammad Veroniko, Director Utama	• Place of Mining • Mining lease area • Present production and scope to increase • Quality of coal. • Mode of transportation	Jambi and Kalimantan 5000 Hector, partially developed. Present production 100000-200000 tons /month. Capable of increasing production in case of firm demand. Coal quality ranges from 5000 to 6000 Kcl/Kg, sulfur content <1%, total moisture content 46% Normally by truck to barge loading point, from there by barge to the mother vessel. However, during the lean period of the river intermediate stockpiles are maintained.
Coal Producer	PT. Lestari Cipta Persada	Henry Soetio	• Place of mine • No. mine in operation • Quality of coal • Availability of Heavy Equipment	Jambi and Kalimantan 02 mines are in operation. Coal quality more less same as PCN owned mines. The company owns heavy equipment for transportation and handling coal from mine mouth to mother vessel.

8.7.2 Coal resources, reserve and price

Over the past two decades, Indonesia's coal industry has transformed itself from being an unknown, minor player in Asia's coal markets to the world's largest exporter of steam coal. When compared to the coal industries of Australia, the United States, the UK, South Africa, China, and India, Indonesia's coal industry is very young. Except for government-owned PT Bukit Asam (PTBA), Indonesia's major coal producers only started serious exploration work from the early 1980, with commercial production at their mines commencing after 1988.

Estimation of the Indonesian Government shows that at the end of 2009 the Indonesian Coal Resources has been increased to 104.94 billion tons while the proven reserves are 5.5 billion and probable reserves are around 13.5 billion (Indonesian Coal Book, 2010/2011).

Nearly 80% of the Indonesian coal production is ranked as sub bituminous coal with the calorific values of between 5,100 and 6,100 kcal/kg. In general, Indonesian coals have lower Sulfur (0.1% to 0.8%) and ash content (2% to 12%) but the moisture contents are relatively high (10% to 40%).

Due to low GCV, value and high moisture content Indonesian coals are sold at apparently lower price. During the field visit, coal quality and related price of a particular coal producer (Redox Coal) were collected from their office (Table 8.6).

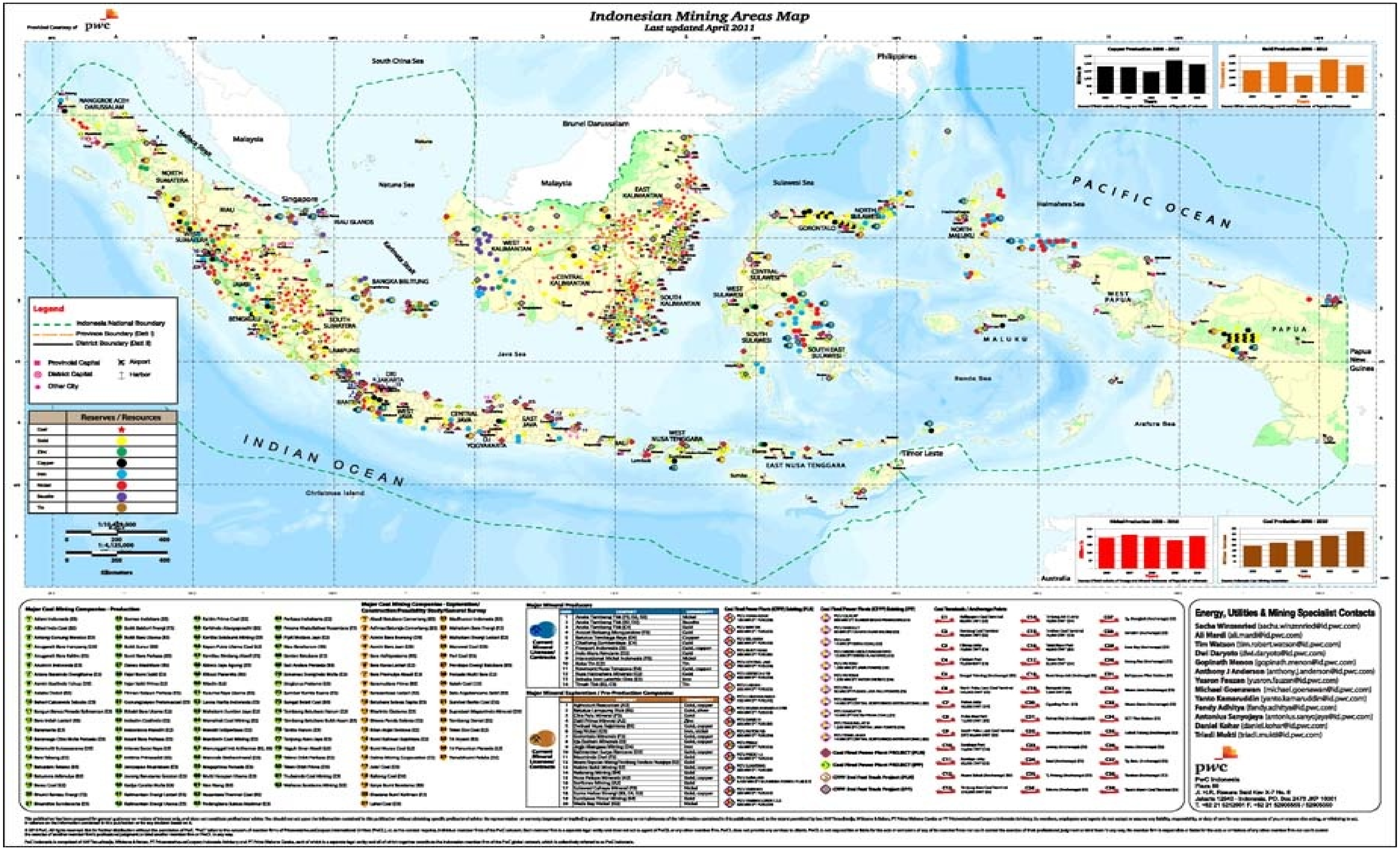
Table 8.6: Coal quality and price of the product of Redox Coal

Analysis	Basis	Specifications or REDOX Coal (collected during visit)						
Energy (Kcal/Kg)	ADB	6800-6900	6500-6300	6300-6100	6000-5800	5800-5500	5500-5300	5300-5100
TM (%)	AR	9-10%	10-12%	34%	21%	21%	35%	38%
IM (%)	ADB	8-12%	8-12%	14%	13%	13%	15%	16%
ASH (%)	ADB	9-14%	10-12%	12-14%	10-12%	10-14%	10-14%	12-15%
VM (%)	ADB	40-45%	40-45%	40-45%	40%Apprx	36-40%	36-40%	35-40%
FC (%)	ADB	By Diff	By Diff	By Diff.	By Diff.	By Diff.	By Diff.	By Diff
S (%)	ADB	0.8-1%	0.8-1%	0.8-1%	0.8-1%	0.8-1%	0.8-1%	0.8-1%
HGI	ADB	43-45	45-50	40-45	45-50	45-55	50-55	50-60
Price (USD/Ton) of REDOX coal as of March, 2012								
FOB	Barge	-	107	95	81	73	44	42
FOB	MV	-	122	110	96	88	59	57

Source: Redox Coal, Indonesia

Note: The mentioned coal prices are the price of the products of Redox Coal as of March 2012. This is only for reference, may not be applicable for estimation general coal price of Indonesia.

Note: AD: Air Dried; AR: As received; GCV: Gross Calorific Value; TM: Total Moisture; IM: Inherent Moisture; VM: Volatile Matter; FC: Fixed Carbon; TS: Total Sulfur; HGI: Hardgrove Grindability Index



Map 8. 4: Indonesian mining area map

8.7.3 *Learning from Indonesia visit*

- With relatively lower GCV Value (5,100 to 6,100 Kcal/kg) with low Sulfur and Ash but high moisture content Coal with relatively lower price are available in Indonesia. PDB 7and NTPC may look in the issue closely. If acceptable, the Bangladesh entities may save a huge amount of money for importing of Coal.

- Infrastructures for coal transportation are not well developed in Indonesia. Still greatly dependent on nature i.e. wait for the rain to improve river navigability.

- Indonesia has different business risk including failure in supply commitment (time, quality, price, etc).

- In case of joint venture operation local (Indonesian) participation is very important especially in Kalimantan area where the lands are owned by few land lords.

- Quality and quantity certifying agencies should be engaged.

- It would be advisable to go for long-term contract with coal producer who has long record of accomplishment to supply coal with reputation and would be responsible to supply coal on FOB (mother vessel) basis.

- Alternately, to contract coal traders who has long record of accomplishment to supply coal with reputation on FOB basis (mother vessel).

- Price of coal may be adjusted with an acceptable benchmark to both the parties.

- Considering sustainability of the coal supply, it is advisable to contract more than one supplier.

- FOB mother vessel price of coal varies in different locations of Indonesia. Coals from Sumarta origins are cheaper in terms of FOB mother vessel than central and eastern Kalimantan origins. Similarly, maritime transportation cost may also vary.

8.7.4 *Challenges to be faced in sourcing coal from Indonesia*

- Reliable information on coal reserve, coal quality and ownership of mine in case of mine leasing/JV operation

- Influence of local elites in obtaining mining licenses and on mining activities

- Reliability of coal supplier in supplying agreed coal quality and quantity

- In case of offtake agreement, finding a reliable coal producers, suppliers and/traders is a challenge

- Continuous supply of coal despite of stevedoring problem, interruption in coal barge feeding system, problems in mining activities

8.7.5 Way to overcome the challenges

- In case of Mine Lease under JV
  - Title of the deed should be clear and based on measured reserve
  - Prior to forming JV, Report on Mineral Resources Classification Systems, Suitability and Selection (e.g. JORC, UNFC, etc) should be prepared
  - Finding a reliable local partner
- In case of offtake agreement and long term agreement with coal traders/suppliers
  - BPDB should tie with reliable coal producer/suppliers having strong investment in multiple coal mine
  - Agreement might be made with multiple sources and multiple suppliers
  - agreement with reliable coal transportation agent and ship brokers
  - Engagement of independent surveyor/inspector for quality control and monitoring at
    - Mining operation
    - barge feeding system and Mother vessel

8.8 Summary

As per requirement of the study on coal sourcing, transportation and handling, the international visits and open discussion with stakeholders playing important roles in coal business were necessary. Accordingly, the visits were successful in gathering relevant information, understanding global coal trading system, process of coal procurement, identifying important stakeholders and establishing communication with established coal suppliers.

In general, South Africa and Australia are sustainable source for coal having GCV of above 6000 kcal/kg. On the other hand, coal having GCV 5000 to 5800 are easily available in Indonesia but there are some challenges that have to be overcome before sourcing coal from Indonesia. To ensure sustainability of the coal supply, GOB should source coal from multiple countries, multiple suppliers and engaging multiple shipping agents. In terms of cost, sourcing from Indonesia would be cheaper due to low transportation cost and low cost of coal (GCV 5000-5800). Besides, transportation cost would be higher in case of South Africa and Australia. However, actual cost of the coal completely depend on size of the vessel to be used, and loading and unloading facilities at loading and unloading port.

On the other hand, Mozambique is a new entrant in the world coal trade. A huge investment in exploration, exploitation of coal, as well as development of infrastructure (roads, railway, ports, etc) is going on there in Mozambique. It is expected that, in next five to seven years time it would be one of the major coal exporting country in world. It would be prudent for Bangladesh to contract the relevant stakeholders of Mozambique coal business at this stage for sourcing coal.

Considering the competitive market, it would be convenient for BPDB to make necessary arrangement for coal sourcing (e.g. offtake agreement with producers) from these countries under the active support of the government.

8.9 Recommendation

From the experience of the visit in South Africa, Australia, Indonesia, and Singapore the following suggestions may be made:

- Coal should be procured from multiple sources (multiple suppliers and multiple countries) for ensuring continuous and sustainable supply
- Australia would be a sustainable source for coal of higher GCV value (above 6000 kcal/kg)
- Indonesia would be suitable source for coal of 5000 to 5800 GCV subject to above mentioned challenges are successfully handled
- Long term agreement with coal trader/suppliers would be suitable mode of coal sourcing (considering present knowledge of mine operation and investment)
- Offtake agreement (FOB Mother Vessel basis) with coal producer may be the suitable mode of coal sourcing. However, investment in mine under JV agreement may be the future option after earning enough experience and knowledge in coal business including mine operation.
- If government opts to lease mine in Indonesia, a JV consultant group (local and Indonesian) should be engaged for estimation of resource and reserve of potential mine
- Long term agreement needs to be made with multiple coal transportation agents/shippers for continuous supply of coal
- BPDB will need to engage a survey and inspection agent for proper inspection and monitoring of coal supply system, coal quality and coal quantity
- The establishment of the contract with the mining companies proved to be very difficult. We experienced that this contract should be prepared via companies with established relationship to the mining companies or via governmental agencies.
- Govt. should form a dedicated team comprising Ministry, BPDB, and other stakeholders at the earliest possible time with the responsibility of initiating coal sourcing and transportation
- Government should also assign responsible officers in the Embassy of Bangladesh at Jakarta, Indonesia and High Commission of Bangladesh at Canberra, Sydney and South Africa for coordinating the coal supply to Bangladesh.

Photo Album: South Africa Visit

Meeting with SASOL Mining, South Africa

Photo album: Australia Visit

Meeting with Newcastle Coal Infrastructure Group   Meeting with Port Waratah Coal Services Ltd

Visiting NCIG Coal Terminal

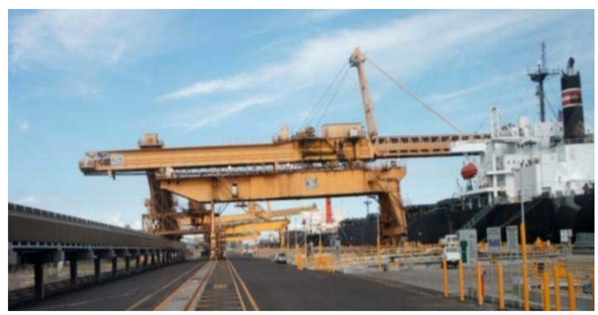
Meeting with Moolarben Coal Operations Pty Ltd

Team visiting Moolarben Coal Mine Infrastructures and Mining Activities

Photo Album: Newcastle Coal Terminal (NCIG and PWCS)


Inbound facilities: Train haulage and coal unloading


Coal Stockyard: Stacking and reclaiming facilities

Outbound Facilities: Ship Loaders

Photo Album: Moolarben Coal Operations Pty Ltd


Stock yard of Product Coal


Mining activities in Open Pit

Coal Processing and Handling Plant at Mine Mouth

Photo Album: Meeting with Sojitz Australia Ltd

Meeting with Sojitz Australia at Sydney

Photo Album: Singapore Visits

Meeting with Sapphire Pacific Ltd.

Meeting with TATA-NYK

Meeting with Solicitor

Meeting with Ship Broker

Photo Album: Indonesia Visit

Meeting with IDT

Coal Mining activities in an open pit coal mine of Jambi

Coal stacking activities at mine mouth

Barge Loading Point

Chapter 9: Suitable International Coal Sources

9.1 International Coal Market

The potential coal sources for the supply of the Client can be divided into three different categories: past coal exporters, current and future.

9.1.1 Current producers

Under this category, only countries with an accredited coal export history will be considered. These enclose South Africa, Australia and Indonesia.

The resource situation in **South Africa** can be summarized as followed:

- Country with traditional coal mining.
- The coal quality suits well the demand of the Client.
- The logistics (railway and harbor) fulfill the requirements.

The resource situation in **Australia** can be summarized as followed:

- Coal of sufficient quality and required quantity is available.
- The concentration of the coal producers on the "Big Four, (BHP-Billiton and Mitsubishi, Rio Tinto, Xstrata and Rio Tinto)" creates an obscure market.
- The "Big Four" concentrate strongly on the Asian market (India, China, Korea, Japan, etc.). This is a fundamental keystone to take into consideration.

The resource situation in **Indonesia** can be summarized as followed:

- Indonesia has huge coal resources but mostly of lignite quality.
- The quality might be suitable but lower calorific values and higher moisture content increases the absolute supply and transportation costs.
- The proximity to Bangladesh might establish the development of a new market strategy.

9.1.2 Future producers

The current development of new markets represents an issue to be observed, especially under consideration of long-term coal supply scenarios. Mozambique is considered to fulfill these requirements.

The resource situation in **Mozambique** can be summarized as followed:

- Appropriate coal resources are known in Mozambique. The quality is suitable as well.
- The development of the coal resources started and is making good progress.
- Mozambique is for the time being not a partner to be considered (only few mines are currently under development, harbor facilities require upgrading) but this may change over the next years.

New Zealand is a small coal producing country with only a limited export potential. Nevertheless, coalmines in New Zealand will be contacted in order to evaluate the additional export potential.

9.1.3 Past Exporters

India and China are former coal exporting countries. Due to their industrial development and corresponding increase in coal demand, these nations became presently the biggest importing countries in the Asian region. For this reason, these countries do not represent an attractive alternative for the Client's requirements.

Even the logistic situation is not designed for coal exports anymore.

9.2 Factors Considered for Identifying Suitable Coal Sources

To select one or more countries for importing coal for proposed coal fired power plants of Bangladesh. The following factor are been considered;

- Export policy of potential coal exporting countries.
- Reserve, yearly production and export
- Coal quality matching to NTPC standard set for Proposed plants
- Price of coal in different countries (potential importing)
- Transportation cost/ ton up to nearest Bangladesh port/ project site
- Landing Cost of coal

9.3 Australia

9.3.1 Coal export policy

Australia is one of the major coals exporting country of the world and it has long history of smooth and uninterrupted supply. The Australian government has a very open policy towards the export of coal. The present policy of the government is as follows:

Australia has a three-tiered federal system of government-Commonwealth, State/Territory and Local. Local governments have significant responsibility for planning matters (including buildings on mine sites), zoning and local environmental issues. Conditions for mineral exploration and development in Australia are generally set out in State/Territory Mining Acts and related regulations, which specify the procedures to be followed for, coal exploration and exploitation. Other State/Territory legislation covers a broad range of issues including safety, employment, environment protection, royalties, and transport within Australia. State governments also put levy taxes and charges for rail transport and in some cases for coal loading.

Areas of Commonwealth Government responsibility relevant to the coal industry include the economy, international trade, commerce, and industrial relations. In recent years, the Commonwealth Government has relaxed or abolished many regulations affecting the coal industry. It has de-regulated financial and foreign exchange markets, reduced taxes and charges, relaxed foreign investment guidelines and removed export control powers on coal.

From the point of export policy of the Government, Australia may be chosen as one of the best country to import of uninterrupted supply of coal to Bangladesh.

9.3.2 Coal reserve, yearly production and export

The Australian government's official estimates of coal resources and reserves are published annually by Geoscience Australia. It provides estimates of demonstrated resources (both economic and sub-economic) as well as JORC reserves for all mineral resources, including black and brown coal.

These resources are considered recoverable resources. Other figures include the huge basins of Surat, Galilee and others where exploration just started.

Australia has considerable reserves of metallurgical and thermal coals. It has more than 76 billion metric tons of efficiently recoverable reserves of black coal (BP, 2011). Significant resources occur throughout the country, but production for export markets is currently based on deposits in the eastern states of Queensland and New South Wales. The Australian coal industry has over the100 privately owned coal mines located mainly in the coal exporting states of New South Wales and Queensland and employs over 21,000 people through Australia. Around 60 of these mines have open cut operations and around 50 have underground operations. These include around 10 mines with both open cut and underground operations. Figure 9.1, 9.2 and 9.3 show the coal resources in Australia.

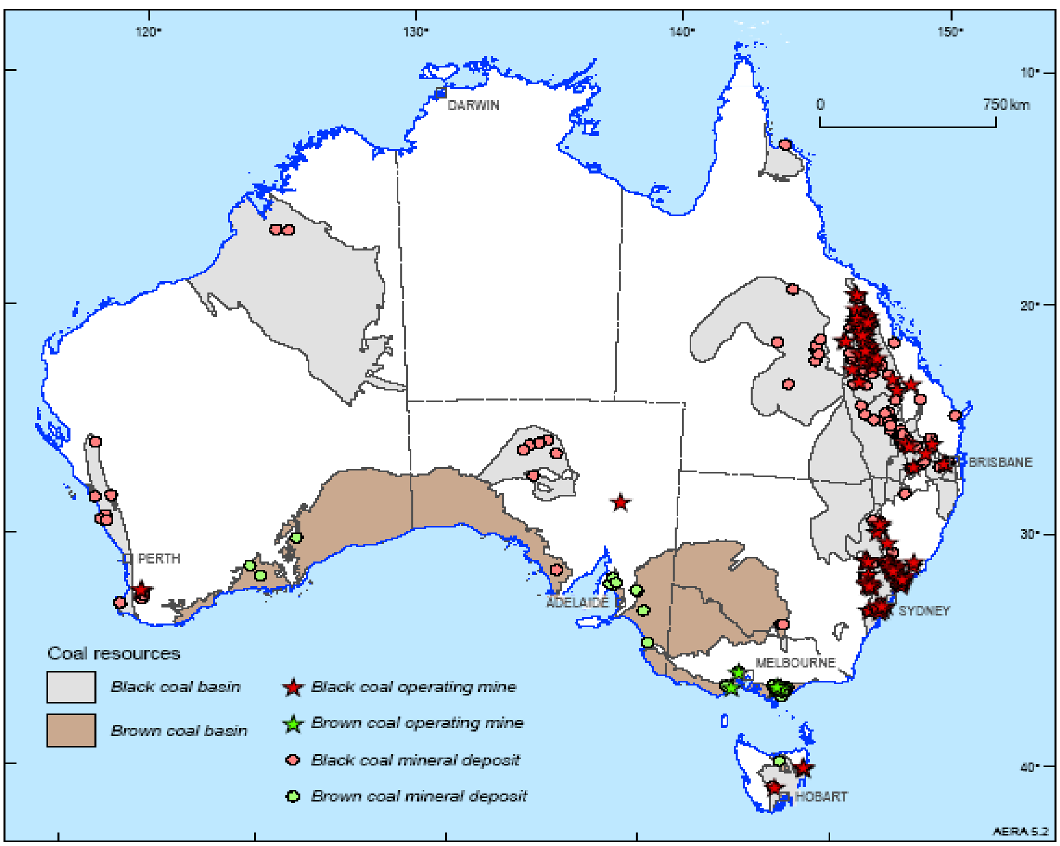


Figure 9.1: Black and brown coal operating mine in Australia

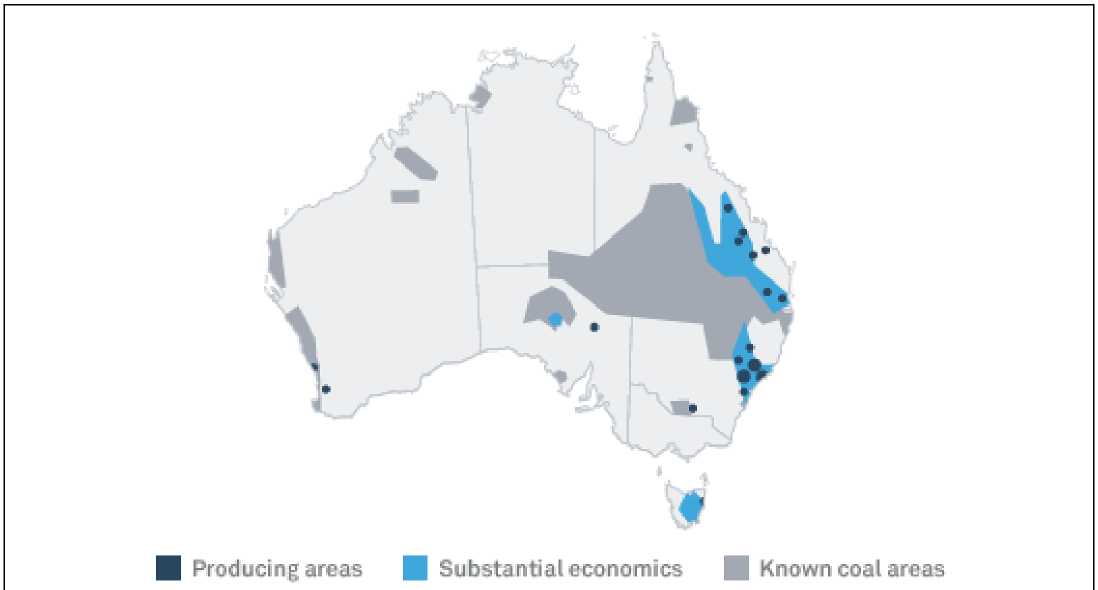


Figure 9.2: Australian black coal resources

Source: Geosciences Australia and ABARES, 2010. Australian Coal Association, 2011

Figure 9.3: Coal basins of eastern Australia

The industry has the capacity to expand to meet increasing world demand. New mines, covering a range of thermal and metallurgical coals, are currently under development. In 2009, there were 123 operating black coalmines in Australia, which included 78 open-cut mines and 45 underground mines. Table 9.1 shows the number of black coalmines in Australia.

Table 9.1: Number of black coalmines in Australia.

State	NSW	QLD	SA	WA	Tas	Australia
Underground	29	15	0	0	1	45
Open-cut	31	43	1	2	1	78
Total	60	58	1	2	2	123

(Source: Australian Coal Association, 2011)

Note: NSW: New South Wales, QLD: Queens Land, SA: South Australia, WA: West Australia, Tas: Tasmania

Australia is a good source of thermal coal. Among its 76 billion tons of proved reserve, 51 percent coal is Anthracite and Bituminous, and rest 49% is sub-bituminous (BP, 2011). Their Reserve-to-Production ratio is 180 (BP, 2011), which is also very high in compare to other coal exporting countries. Presently the country exports about 134 million tons of thermal coal and 157 million ton of metallurgical coal (Australian Commodity Statistics, ABREAS, 2011). Among the Australian States, New South Wales and Queens Land produce thermal and metallurgical coal for export. However, the producers have their fixed buyer under long term agreements. But there is also scope of future development. A projection of Australian Government (Geosciences Australia and ABARE, 2010) shows that coal production in Australia will be increasing with an annual rate of 1.8% to about 2029-30. At the same time, export will also be increasing at an annual rate of 2.4%. However, it is very likely that export of thermal coal will increase by 6.7% each year between 2011 to 2020 (Australian Coal Association, 2011). Recently, private investment in mineral exploration has been increased that indicates opportunity of future coalmine development. Future development depends on global economic growth, carbon reduction policies, coal prices, adequacy of coal handling infrastructure, and local water and environmental issues. Government level negotiation with mine owner, investors and regulatory bodies may open the door of importing coal from Australia.

9.3.3 Coal quality

Australia produces both black and brown coal while they export the high quality coal of metallurgical and thermal, and consume medium to low grade coal. Australian thermal coal is typically high in calorific value (energy content), has moderate ash level and is low in sulfur and heavy metal contents. Typical characteristics of different major coal brands of Australia are given in the Table 9.2.

Table 9.2: General specification of Australian exportable thermal coal

GCV (Kcal/kg)		TM (% Max)	IM (% Max)	Ash (% Max)	VM (%)	FC (%)	TS (% Max)	HGI	Sizing (mm)	AFT Deg. C (Max)
AR	AD	AR	AD	AD	AD		AD			
5732 - 6900	6100 - 7250	6.0 - 18.5	1.0-13.5	8.7 - 21.0	19.0-50.0	by diff.	0.2 - 1.0	37 - 82	50	1300 - 1600

Source: Resource Development Branch, Australia, 2005

Note: AD: Air Dried; AR: As received; GCV: Gross Calorific Value; TM: Total Moisture; IM: Inherent Moisture; VM: Volatile Matter; FC: Fixed Carbon; TS: Total Sulfur; HGI: Hardgrove Grindability Index; AFT: Ash fusion temperature (flow temp. in a reducing atmosphere), By Difference: 100- (IM+Ash + VM).

9.3.4 Coal price

Energy price is most unreliable. Coal price is also fluctuating over the last decade. Strong demand for coal over the past five years has resulted in substantial increases in coal prices. Moreover, presently, coals are extracted from deeper seams that results higher production cost. In response to price fluctuation, long term contract with yearly pricing negotiation based on benchmark price is most common in world coal trade of coal. Table 8.3 gives changes of FOB coal price at New Caste for last five year.

Table 9.3: FOB price of thermal coal at Newcastle from December 2010 to May 2011

Month	Price (USD/Ton)	Change	Month	Price (USD/Ton)	Change
Dec-06	53.3	-	Jun-09	76.48	10.66%
Jan-07	54.95	3.10%	Jul-09	79.07	3.39%
Feb-07	56.68	3.15%	Aug-09	77.68	-1.76%
Mar-07	59.34	4.69%	Sep-09	72.47	-6.71%
Apr-07	60.13	1.33%	Oct-09	76.15	5.08%
May-07	60	-0.22%	Nov-09	84.43	10.87%
Jun-07	66	10.00%	Dec-09	89.04	5.46%
Jul-07	72.12	9.27%	Jan-10	103.93	16.72%
Aug-07	74.3	3.02%	Feb-10	100.92	-2.90%
Sep-07	73.33	-1.31%	Mar-10	101.12	0.20%
Oct-07	80.15	9.30%	Apr-10	107.3	6.11%
Nov-07	90.64	13.09%	May-10	107.28	-0.02%
Dec-07	97.5	7.57%	Jun-10	105.2	-1.94%
Jan-08	98.3	0.82%	Jul-10	102.84	-2.24%
Feb-08	141.43	43.88%	Aug-10	96.19	-6.47%
Mar-08	126.7	-10.42%	Sep-10	101.66	5.69%
Apr-08	131.79	4.02%	Oct-10	104.41	2.71%
May-08	142.71	8.29%	Nov-10	114.81	9.96%
Jun-08	171.16	19.94%	Dec-10	126.74	10.39%
Jul-08	192.86	12.68%	Jan-11	141.94	11.99%
Aug-08	169.71	-12.00%	Feb-11	137.53	-3.11%
Sep-08	160.71	-5.30%	Mar-11	135.14	-1.74%
Oct-08	115.71	-28.00%	Apr-11	131.25	-2.88%
Nov-08	98.84	-14.58%	May-11	126.84	-3.36%
Dec-08	84.27	-14.74%	Jun-11	127.8	0.76%
Jan-09	85.71	1.71%	Jul-11	128.57	0.60%
Feb-09	80.76	-5.78%	Aug-11	127.79	-0.61%
Mar-09	65.36	-19.07%	Sep-11	131.3	2.75%
Apr-09	68.1	4.19%	Oct-11	127.49	-2.90%
May-09	69.11	1.48%	Nov-11	121.93	-4.36%

Note: Coal Specification: GCV: 6667 Kcal/kg (GAR), Sulfur: less than 1% sulfur, Ash: 14% ash, FOB price at Port Kembla, New Castle. Prices are in US$ per metric tonne
Source: Index Mundi and Global Coal

The present market price of coal is much higher that the price forecasted by the JICA team under in Power System Master Plan (PSMP, 2010). The average FOB price of 2011 at Newcastle and Gladstone, are about 122 USD/ton (GCV 6300 Kcal/kg, GAR basis) and 126 USD/ton (GCV 6500 Kcal/kg, GAR Basis) respectively (Platts 2011). Coal price is volatile. Section 6.3 and Table 6.2 discuss details of the cost of coal and indicative market price that may be followed for feasibility study purpose. The coal price (FOB) of Australia provided in Table 6.2 is 116 USD/ton (adjusted to 5,500 kcal/kg). This figure includes trading surcharge and other additional cost as mentioned in the table.

9.3.5 Transportation from the port of Australia to Bangladesh sea port

The approximate distance between the Australian and Bangladesh is 5600 Nautical Mile (New Castle Coal Terminal to Mongla Port Fairway buoy. The time of sailing and cost of transportation would be higher for Australia compare to Indonesia, South Africa and India. However, internal transportation facilities between Australian Coal mines and ports are good and seaport facilities for export of coal is very well developed and handling facilities are very efficient. Coal ports are capable to handle any capacity of ships presently carrying.

Details of transportation mode, transportation cost and landing cost coal from different source countries to Bangladesh have been discussed in Chapter 11 of this report. However, considering long-term reliable supply, Australia may be considered as a Potential source of coal for proposed thermal power plants of Bangladesh.

Figure 11.1 shows the sea route from the coal terminals in New Castle to the port of Mongla. The total distance amounts to approx. 5,523 nautical miles. It would take 17 days and 17 hours for a vessel with an average speed of 13 nm to cover the distance between the two ports.

9.3.6 Risks

Risk: The “Big Four” (Rio Tinto, Xstrata, BHP Billiton – Mitsubishi and Anglo) companies control the Australian mining scene, the logistic chain and the port facilities.
Comment: There are only restricted possibilities to avoid the “Big Four”. FOB prices for hard coal reflect the business plans of the “Big Four”.

Risk: Dependency on weather conditions of railway and port facilities in Australia.
Comment: Severe flooding events are known to occur.

9.3.7 Summary

Australian Government has very open policy for coal export with long history of smooth and sustainable supply. On the world coal market Australia is firstly an exporter of coking coal and secondly of steam coal. The majority of coal is produced by only four mining houses in Queensland

and New South Wales. All coal is washed and the ash content reduced to marketable values and of constant quality. There are four efficient ports accessible for any vessel size and rail connection from the mines are well established, though at their capacity limits.

The general situation in **Australia** can be summarized as followed:

- Open policy for coal export
- Coal of sufficient quality and required quality is available.
- The concentration of the coal producers on the "Big Four" creates an intransparent market.
- The "Big Four" concentrate strongly on the Asian market, less on Europe and not at all on the Africa market.
- The Australian coal market focuses in South Eastern Asia. The possible offtake volumes of the Bangladesh and the geographical location would be very favourable for Bangladesh.

9.4 Indonesia

9.4.1 Coal export policy

Indonesia's history of coal export is also very good. Present energy policy of Indonesia is as follows:

Vision: Guaranteeing the sustainable energy supply to support national interest.

Mission: To guarantee a domestic energy supply.

To increase the added values of energy sources

To manage energy sources in an ethical and sustainable manner

To provide an affordable energy for low income people and develop domestic capacities in the field of energy management.

Considering Indonesian coal and mineral resources as an essential for national development, and to guarantee sufficient supplies to fulfill national needs, the Government considers, it is important to limit national coal production where necessary.

However, considering the present Indonesian Energy policy and recent embargo on further LNG export from Indonesia made the long-term coal traders apprehensive that similar policy may also be adopted for coal export by Indonesia. As such, Indonesia may not be considered as a long-term coal supply source for coal for Bangladesh. Since Indonesia is a trusted friend of Bangladesh and has a long friendly relation, small requirement of coal compare to the export quantity of Indonesia, there is a good opportunity to import coal from Indonesia.

Coal reserve, yearly production and export

As per the recent estimation (2009) of the Ministry of Energy and Mineral Resources, Indonesia, the coal resources has increased to 104.94 billion tons from the previous estimation of 90 billion ton (Figure 8.4). According to the government agency, 75.62 billion tons of the coal resources are suitable for exploitation using open pit mining method and the rest 29.14 billion tons require underground mining method. The agency also estimates the probable reserves as 13.48 billion tons. Figure 9.4

shows the previous estimated resources and reserves of coal of the different region of Indonesia (estimation of 2007 and the Table 9.4 provides the recent estimations.

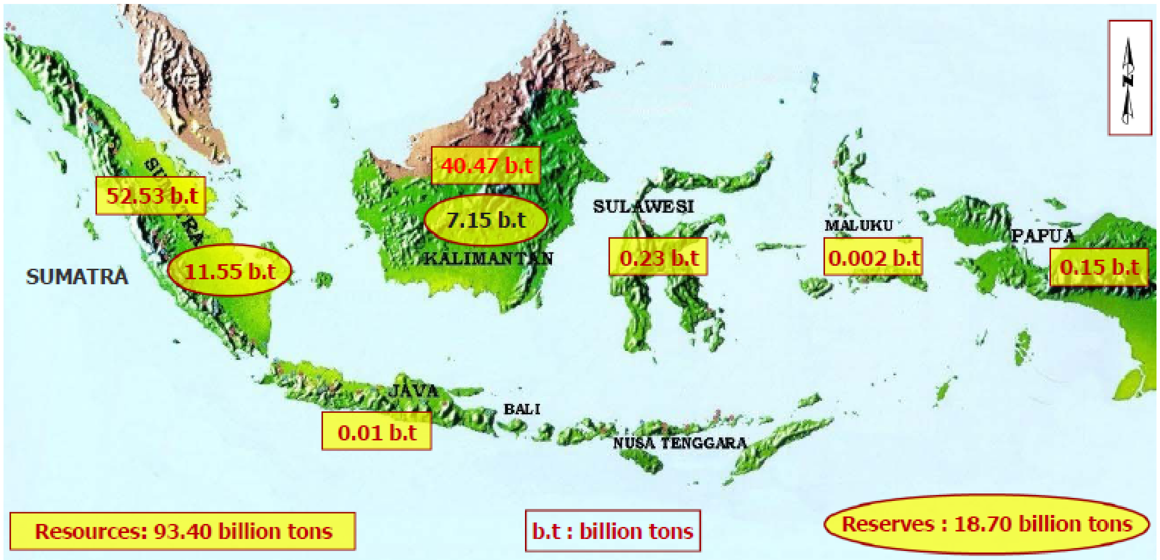


Figure 9.4: Indonesian coal map, resources and reserves as estimated in 2007

(Source: Jeffrey Mulyono, 2009 based on estimation of 2007)

Table 9.4: Distribution of Coal Resources and reserves as per estimation of 2009

Distribution	Resources					Reserves	
	Hypothetic	Inferred	Indicated	Measured	Total	Probable	Proven
Sumatra	20,153.72	13949.29	10634.37	7699.18	52,436.57	10644.45	904.8
Java	5.47	6.65	0	2.09	14.21	0	0
Kalimantan	14,377.51	18050.72	5136.66	14535.9	52,100.79	2833.14	4624.57
Suleswari	0	146.92	33.09	53.09	233.10	0.06	0.06
Maluku	2.13	0	0	0	2.13	0	0
Papua	89.4	64.02	0	0	153.42	0	0
Total	34,628.23	32217.6	15804.12	22290.26	104,940.22	13477.65	5529.43

Source: Indonesian Coal Mining Association, 2011

Among this coal resource around 66% is sub-bituminous, 20% is Lignite, 12 percent is Bituminous and 1% is Metallurgical coal. Table 9.5 shows coal reserves by rank. Major portion of this Bituminous coal is exported mostly under long-term selling agreement.

Table 9.5: Indonesia coal reserves by coal rank

	GCV (Kcal/kg)	Resources (billion tons)		Reserves (billion ton)			
Coal Rank	**AD**	**Total**	**% of total**	**Probable**	**Proven**	**Total**	**% of total**
Lignite	<5,100	21.18	20.18	6.7	1.36	8.06	42.41
Sub-bituminous	5,100 -6,100	69.74	66.45	5.87	2.71	8.59	45.19
Bituminous	6,100– 7,000	12.97	12.36	0.83	1.33	2.16	11.34

	GCV (Kcal/kg)	Resources (billion tons)		Reserves (billion ton)			
Metallurgical	> 7,100	1.05	1.00	0.073	0.125	0.2	1.05
	Total	104.94	100	13.477	5,461	19.01	100

Source: Indonesian Coal Mining Association, 2011

The historical trends of Indonesia's coal production shows that the production has been increased in 2008 almost five times than the production in 1996. Although they are increasing amount of coal exporting, but the exportable amount will be stabled in future due to its current policy for increasing the amount of domestic use. Figure 8.3 and 8.4 show the production, export and domestic sales from 1996 to 2025 with future estimation. There is a projection based on Indonesian Government's target that shows the production will continue to rise and the domestic consumption will be booming, on the other hand export will be stable at present rate due to policy implication (ICMA, 2011).

9.4.2 Coal quality

Indonesia mostly exports coal of medium to high calorific value and having widely varying ash, moisture, Sulfur and volatile matter characteristics. Table 9.6 shows general specification of Indonesian coal.

Table 9.6: General specification of Indonesian exportable thermal coal

GCV (Kcal/kg	TM (% Max)	IM (% Max)	Ash (% Max)	VM (%)	FC (%)	TS (% Max)	HGI	Sizing (mm)	AFT Deg. C (Max)
AD	AR	AD	AD	AD		AD			
5000 - 5800	26-42	15-20	5-10	38-44	By Difference	0.5 - <1	42-60	50	1100-1250
6000-6500	12-28	7-15	12-15	38-45	By Difference	<1 - <1.5	45-55	50	1280-1300
6700-7000	3-10	2-3	10-15	40-45	By Difference	<1.5	38-58	50-100	1400-150

Source: collected from different major coal sellers of Indonesia
Note: ADB: Air Dried; AR: As Received; GCV: General Calorific Value; TM: Total Moisture; IM: Inherent Moisture; VM: Volatile Matter; FC: Fixed Carbon; TS: Total Sulfur; HGI: Hardgrove Grindability Index; AFT: Ash fusion temperature (flow temp. in a reducing atmosphere), By Difference: 100- (IM +Ash + VM).

9.4.3 Price of coal

Indonesia's advantages in coal quality, transportation distance and cost structure continue to be attractive to the producers and consumers alike. Table 9.7 shows the coal indices incorporating assessments by Argus Media and PT Coalindo.

Table 9.7: Indonesian coal indices incorporating assessments by Argus Media and PT Coalindo.

Grade (kcal)	Price (US$/Ton)
6500 GAR (6200 NAR)	126.70
5800 GAR (5500 NAR)	99.74
5000 GAR (4700 NAR)	80.59
4200 GAR (3900 NAR)	50.89

(Source: Indonesian Coal Index Report, February 2011,)

The prices mentioned above are index price. But the actual market price may be different. Section 6.3 and Table 6.2 discuss details of the cost of coal and indicative market price, which, may be followed for feasibility study purpose. The coal price (FOB) of Indonesia provided in Table 6.2 is 119 USD/ton (adjusted to 5,500 kcal/kg). This figure includes trading surcharge and other additional cost as mentioned in the table.

9.4.4 Coal export

Over the past decade, coal producers located on Kalimantan have accounted for more than 90% of Indonesia's coal production and exports. The concentration of coal production capacity on Kalimantan is also due to its proximity to the large power markets of Japan, Korea, Taiwan, China and India (Ewart, D, and ET. Al, 2009). These countries have been the fastest-growing coal markets in Asia for the past 30 years. Kalimantan's coal reserves have higher typical calorific values (CVs) and are located closer to either the coast or navigable rivers.

Indonesia's coal industry, in addition to being geographically concentrated on the island of Kalimantan, is also concentrated by producer. Indonesia's top six producers, which are all located on Kalimantan, accounted for more than 75% of Indonesia's coal production between 2002 and 2009.

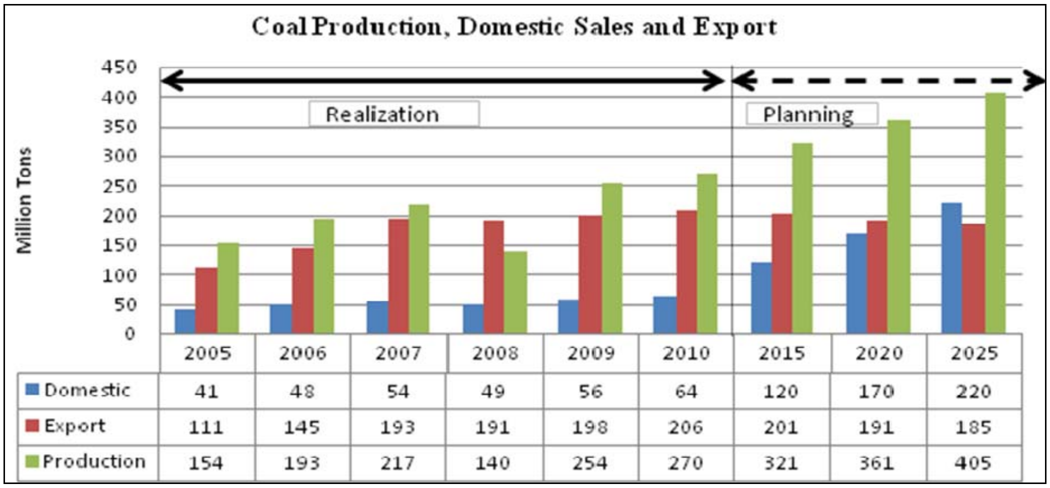
The share of production accounted for by the "Big Six" (Bumi, Adaro, Kideco, Berau, Banpu, and PTBA) is expected to increase over the next decade (see Table 9.8)

Table 9.8: Production Share of the Big Six producers of Indonesia

Name of the Producers	Production				
	2005	2006	2007	2008	2009
Bhumi (Kaltim Prima Coal, PT and Arutmin Indonesia, PT)	44.6	51.6	54.9	52	57.5
Adaro Indonesia, PT	27	33.5	36	38.5	40.6
kideco Jaya Agung, PT	18.1	18.9	20.6	21.9	24.7
Berau Coal, PT	9.2	10.8	11.8	12.9	14.3
Banpu (Indo Tambangraya Megah Tbk): Indominco Mandiri PT, Jorong, Trubaindo Coal Mining PT and Kitadind	12.2	18.2	18	18.8	21.5
Tambang Batubara Bukit Asam, PT (PTBA)	8.7	8.7	8.6	10.1	10.8
Sub-total	119.8	141.7	149.9	154.2	169.4
All others	31.1	38.4	40.7	48.6	45.2
Total	150.9	180.1	190.6	202.8	214.6
Big 6 as % of Total	79%	79%	79%	76%	79%

Source: Indonesian Coal and Power Report, July 2010 for 2009 estimates, February 2004 through February 2009 for 2002 through 2008 estimates (Lucarelli, B., 2010a).

Indonesia increased its exports of steam coal by 13% per year over the localization period from 58.30 Mt in 2000 to 176.39 Mt in 2009 (Lucarelli, B. 2010b).



Source: Indonesian Coal Book, 2011

Figure 9.5: Present and forecasted coal production, domestic sales and export of Indonesia

Coal exports over the period 2000–2009 went mostly to other Asian countries with limited quantities being exported to Europe and the United States. The main Indonesian's coal customers (Lucarelli, B. 2010b) are listed on Table 9.9.

Table 9.9: Indonesia's coal exports 2007 vs 2009 by destination

Country of Destination	2007 Coal Exports (million ton)	% of Total	2009 Coal Exports (in million tons)	% of Total
Japan	30.3	19 %	21.0	12%
India	22.6	14 %	25.9	15%
China	22.0	14%	32.2	18%
Taiwan	21.6	13%	19.1	11%
South Korea	21.2	12%	19.7	11%
Hong Kong	12.9	8%	10.2	6%
Malaysia	7.0	4%	7.5	4%
Thailand	6.6	4%	6.3	4%
Philippines	2.5	2%	2.1	1%
Europe	14.5	9%	10.7	6%
USA	3.9	2%	0.6	<1%
Statistical Discrepancy and Others	- 5.5	n/a	+21.4	12%
Total	163.5	100%	176.4	100%

Source: Lucarelli, B. 2010b

The outlook for the next decade is for significant growth in steam coal demand coming from China, Korea, and India with moderate growth coming from the Philippines, Malaysia, and Thailand (Sjoholm and Tongzon, 2005). The volumes the Asian market is requiring and the transportation distances speak in favor of the Asian clients.

9.4.5 Transportation of coal from the port of Indonesia to Bangladesh sea port

Indonesia is the nearest coal exporting country. Distances between Bangladesh to Indonesian ports are approximately 2521 Nautical miles (North Pulau Laut Coal Terminal to Mongla Port Fair Way Buoy). It has also a good history of coal export. Coal handling facilities are fair to good. Transportation time and cost would be reasonable. Detail study on coal transportation to project site may be seen in Chapter 11. Figure 11.2 shows the port-to-port distance between Indonesia and Bangladesh.

Indonesia's coal suppliers rely heavily on floating transshipment facilities, instead of fixed land ports, for the following reasons:

- Shorter construction and installation periods: Transshippers and floating cranes take around one to one and a half years to bring into operation, from date of order to start of operation, while a land-based port can take 7 to 10 years to bring into operation due to the long lead times needed for acquiring land, obtaining necessary permits, and carrying out the construction

- Low initial costs: Transshipment facilities cost between US$7m and US$20m per facility to purchase and move into position, ranging from US$7m for a 3 Mtpa (10 k ton/d) floating crane facility to US$20m for a 10 Mtpa floating loading facility (35 k ton /d) with storage capacity. A fixed port facility with a capacity of 30 to 40 Mtpa would cost US$100m plus. Although the fixed port will be of larger total capacity and have substantial coal storage capacity and a longer operating life, the capital costs per ton of capacity for transshippers and floating cranes are so much lower than those of a fixed port that they are the preferred transshipment technology in Indonesia.

Modular additions to ship loading capacity: Transshippers and floating cranes offer the ability to add small increments of new ship loading capacity (as low as 3 Mtpa per facility) and to more closely match growth in coal demand with new transport infrastructure. The reliance on floating transshipment facilities also allows coal suppliers to locate ship-loading facilities closer to the sources of supply.

The Kalimantan floating facilities are located at 10 offshore anchorages while Sumatran coal producers have access to two offshore anchorage areas. The floating crane and transshipment facilities have maximum throughput capacities that range from 4 - 15 Mtpa. Most can load up to Cape size vessels. More transshippers and floating cranes are being added as required each year, which enables Indonesian coal suppliers to meet their coal demands without the infrastructure-related shipping delays being experienced in Australia.

9.4.6 Risks

Risk: Political Risk in Indonesia to access coal after nationalization and indigenization of the coal suppliers.
Comment: A privatization and nationalization process of the big coal producing companies is ongoing. The international companies will retreat or have to retreat from Indonesia – fully or partly.

Risk: Weather dependency of barging in Indonesia.
Comments: The influence of extreme weather conditions can interfere with on-time delivery schedules.

Risk: In-sufficient infrastructure related to coal transportation and handling as well as to power supply.
Comment: Most of the mines sites had to develop with multiphase logistic chain (barging, conveyor belt system, truck transport, etc) between mine and loading facilities to mother vessel.

The transportation from the mine to the port facilities does not bear unaccountable risks since there are a number of mines and a number of competing barging enterprises.

9.4.7 Summary

Indonesia has emerged as major factor in the world coal market in the past decade and has grown to the leading coal exporter. Currently export coal is nearly exclusively from the Kalimantan Island and produced by a few mines (The "Big Six"), which were developed by foreign capital and engineers and have now been transferred to domestic ownership and management.

The coal from Kalimantan is a sub-bituminous coal of low heat value and high moisture, but of low ash and extremely low sulfur content ("envirocoal"). In Asia, it is marketed based on Australian prices with discount for the lower heat value.

In future, the coal reserves of South Sumatra will come to the market. This coal is comparable with the coal of Wyoming/USA. This "lignite" coal is of lower heat value and higher moisture than the Kalimantan coal, but large reserves, mining conditions and proximity to the ports are favourable enough to compete on the world market.

Problematic is only the political environment with regard to mining right and taxation, which is hardly foreseeable. This refers to both existing operations, new mines projects and the development of transport means and ports.

The general situation in Indonesia can be summarized as followed:

- Coal resources are available, and in a developed situation.
- The reorganization of the coal producers following a nationalization of the foreign companies could create supply problems.
- The quality of coal is below the coal quality of the coal producers of the other countries discussed in this study. But the quality still fulfils the expectation.
- The supply companies strongly direct their interest to clients in Asia (China, India, Japan, Korea, etc.). This client orientation will dominate the Indonesian sales strategy in the future.

9.5 South Africa

9.5.1 Policy

South Africa is one of the major coals exporting country of the world. It is exporting coal since decades with reputation. Its policy is to respond more purposefully and successfully to coal export opportunities in the East. For coal exports, it is looking for number of interventions for more efficient allocation of prospecting and mineral resource rights and mobilization of capital and public-private partnerships that would support major expansion of coal mining and rail infrastructure. South Africa does have a default coal policy; it could be summarized crudely as ―export the best and burn the rest.

From the Government policy point of view towards export of coal South Africa can be considered as one of the best country for coal source of Bangladesh.

9.5.2 Coal reserve, yearly production and export

South Africa is one of the top ten countries having significant coal reserve. As of 2010, South Africa has 30.15 billion tons of proved reserved and the Reserve to Production (RP) ratio is 119 (BP, 2011. There is also a vast scope of coalmine development as well as export growth. Economically recoverable coal reserves in South Africa are estimated between 15 and 55 billion tons (Eberhard, 2011). In terms of production, the country ranks sixth in world coal producing countries. According to Statistical Review of World Energy (BP, 2011), during 2010, total coal production of South Africa was 253.8 million tons. A large portion of this coal is produced by only eight mega-mines and seven of them are in central basin. The others are in Waterberg. Only five companies- Anglo-American, Exxaro, SASOL, BHP Billiton and Xstrata produce 80% of total production.

Figure 9.6: South African coal deposits and ports

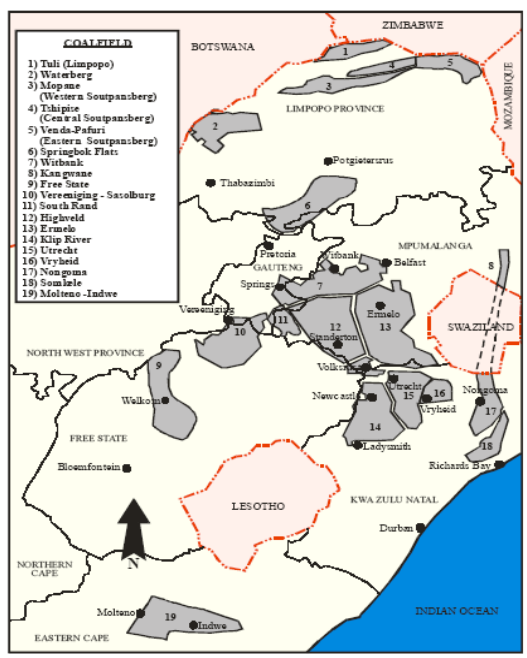


Figure 9.7: South African coal field and mines

South Africa is exporting coal to Europe, Asia, Middle East, Africa and South America. South Africa mostly export coal of higher calorific value while the coals of medium heating value are mostly used in domestic purpose. Export coal of having heating value of 6400-6500 Kcal/kg (Gross as Received basis) were very common. Recently, the demand of lower calorific value coal (6100 – 6200 Kcal/kg) is increasing.

In overall, there is an enormous opportunity of future development in mining industry. Infrastructural constraints hinder export growth. However, government is focusing on infrastructural development and mining development.

9.5.3 Coal quality

South African producers have seen a permutation, of what has always been known as standard export specification. About 96% of reserves are bituminous coal; metallurgic coal is approx. 2% and anthracite 2%. Table 9.10 shows the typical export specification for South African thermal coal.

Table 9.10: General specification of South African exportable thermal coal

GCV (Kcal/kg)	TM (% Max)	IM (% Max)	Ash (% Max)	VM (%)	FC (%)	TS (% Max)	HGI	Sizing (mm)	AFT Deg. C (Max)
AD	AR	AD	AD	AD		AD			
6100-6500	8 -12	3-5	15	20 – 22	By diff.	0-1.0	45-70	50	1200-1300

Source: collected from different major coal sellers of South Africa

Note: AD: Air Dried ; AR: As received; GCV: General Calorific Value; TM: Total Moisture; IM: Inherent Moisture; VM: Volatile Matter; FC: Fixed Carbon; TS: Total Sulfur; HGI: Hardgrove Grindability Index; AFT: Ash fusion temperature (flow temp. in a reducing atmosphere), By Difference: 100- (IM+Ash + VM)

9.5.4 Price of Coal

Although coal mining productivity in South Africa is comparatively poor compare with other world exporters, the cost per MT are relatively low, mainly due to low wages. Table 8.8 shows the South African coal production and local and export sales 2009.

Table 9.11: Average FOB price of South African coal

Year	Average price (FOB), USD			
	Bituminous		Anthracite	
	Nominal Price	Real Price	Nominal Price	Real Price
1/1/2001	30.3	45.8	36.3	54.9
1/1/2002	34.6	47.9	46.9	65.0
1/1/2003	23.3	30.5	36.6	47.9
1/1/2004	25.1	32.4	32.4	41.8
1/1/2005	36.7	45.8	39.5	49.4
1/1/2006	38.5	46.0	51.5	61.6
1/1/2007	44.5	49.6	55.2	61.5
1/1/2008	91.2	91.2	74.7	74.7
1/1/2009	64.2	58.8	110.3	101.0

Note: Prices are exclusive of vat;   Source Eberhard, 2011

The average FOB price of 2011 at Richard Bay Coal terminal, are about 124.3 USD/ton (GCV 6300 Kcal/kg, GAR basis) (Platts 2011). The prices mentioned above are index price. However, the actual market price may be different. Section 6.3 and Table 6.2 discuss details of the cost of coal and indicative market price which, may be followed for feasibility study purpose. The coal price (FOB) provided in Table 6.2 has been adjusted to 5,500 kcal/kg. This figure includes trading surcharge and other additional cost as mentioned in the table.

9.5.5 Transportation of coal from port of South Africa to Bangladesh sea port

The distances between South Africa and Bangladesh ports are approximately 4620 Nautical Miles. Figure 11.3 shows transportation route with distance from Richard Bay Port of South Africa to the Project site. However, actual distance would depend on the selection of mine for importing coal for the proposed power plants of Bangladesh. Internal transportation facilities between the mines and port are reasonable to good. Seaport and coal handling facilities are good. However, coal transportation time and cost from South African to Bangladesh ports would be highest among the possible source countries. From the transportation cost and time, consideration South Africa would be competitive with Australia. The details of the coal transportation have been discussed in Chapter 11.

9.5.6 Risks

Risk: Rail transport efficiency of Transnet, South Africa is bottleneck for coal export
Comments: The general situation improved in the last years due to decreasing freight volumes from the coalmines. However, this is expected to increase again.

Risk: Additional slots for high volume (like coal) rail transport in South Africa are difficult to get
Comments: The railway network of South Africa is quite busy and new slots are difficult to get.

9.5.7 Summary

Coal exports have huge macro-economic benefits in terms of South Africa’s balance of payments and current account. The potential for substantial expansion of coal exports (especially to India) is constrained by the absence of an integrated coal development policy, more distant and more difficult to mine coal fields, water shortages and insufficient infrastructure, especially rail capacity to the ports.

The need for strong coordination between coal producers, Transnet, and RBCT, to strengthen SA’s reputation as a well-organized and reliable coal supplier, would seem obvious.

Growth in exports could come from both the Central Basin and the Waterberg field. There will have to be consolidation and optimization of mines in the Central Basin, while in the Waterberg field, the requirements of opencast mining and multiple washing processes imply large-scale development and investment, and adequate access to technology, favoring the involvement of coal majors (Eberhard, A. 2011).

The general situation in **South Africa** can be summarized as followed:

- Country with traditional coal mining.
- The coal quality suits well the demand of the Client.
- The logistics (railway and harbor) fulfill the requirements.

9.6 Mozambique

9.6.1 Introduction

Mozambique is home to one of the world's largest known and nearly untapped coal resources. Mining companies from Brazil, Australia, Kazakhstan and India try to get a good initial position on the coal market in Mozambique.

Coal bearing strata in Mozambique are mainly concentrated in an east-west trending graben-controlled basin, the Zambezi Basin, which is further divided into a number of sub-basins. The Zambezi Energy Corporation (ZEC) licenses are located in the most eastern part of this Minjova Sub-Basin, adjacent to the Malawi border. Three main stratigraphic units are recognized, from top to bottom (youngest to oldest) being – Post-Karoo formations (Cretaceous to Quaternary), Karoo Super group (Carboniferous-Cretaceous) and Pre-Karoo formations (Precambrian basement).

Most of coal-bearing strata are located within erosion remnants of the Ecca Group of rocks, of the Karoo Super group, in the Zambezi Graben of the Tete Province of Mozambique.

The Karoo Super group (Karoo) overlies the basement rocks with a significant unconformity and comprises a series of detrital sedimentary lithologies and coal bearing horizons, intruded at a late stage by dolerite dykes and sills. Coal seams are present throughout the Karoo, but the main productive series are found in the middle or intermediate unit of the Ecca group towards the base of the Karoo. It seems likely that tectonic activity during the deposition of the coal bearing strata has resulted in the complex sedimentological history and this has typically resulted in seam structures with cumulative thicknesses of inter-banded coals and mudstone partings, collectively designated as “coal zones”. These zones are recognizable over wide areas within an individual coal basin

9.6.2 Coal Reserves

In the following the most important coal projects in Mozambique are presented. Some of these coal projects are under early production but the most of them are still in the development phase.

Moatize Mine (Vale S.A.)

Vale S.A. of Brazil planned to produce 8.5 Mtpa of coking coal and 2.5 Mtpa of thermal coal at the Moatize Mine in Tete Province started in 2011 finally resulting in an 11.0 Mtpa production (USGS 2009). The coking coal was likely to be consumed by steel plants in Brazil; a new coal-fired power plant built by Vale at Moatize with a capacity of more than 1,500 Megawatts (MW) would consume thermal coal. Reserves at Moatize were estimated to be 1.4 Bt in May 2011 (Mozambi Coal Ltd, 2011). Development of the Moatize Mine depended upon the reopening of the railway from Moatize to Beria, which had been severely damaged during the civil war of the 1980ies. The railway was expected to be reopened in January 2010 (USGS 2009) but is still under repair. The first coal was to be shipped from Vale’s new US$1.66-billion Moatize coal operation, in Tete province (Campbell, K., 2011).

After a drilling programme of **Beacon Hill,** a large number of cores were extensively tested. The results enabled the gross resource at Minas Moatize to be increased to around 80 million metric tons (from 50 million metric ton) and the minable resource to be increased to around 57 million metric tons (from 25 million tons). This increased the former estimated mine life of 12-14 years (Green, M.,2011). Table 9.12 gives an overview of the reserves and analysis at Minas Moatize Mine (Green, M.,2011).

Table 9.12: Reserves and analysis at Minas Moatize Mine

	Gross ton in situ million ton	Total ton in situ million ton
Measured	35.92	32.33
Indicated	30.50	24.40
Unclassified	13.55	-
Total	79.77	56.73

Source: Green, M.,2011

Coking test results have confirmed that Minas Moatize Coking Coal will be classified as a Hard Coking Coal. The Coke Strength after Reaction (CSR) range of 68 to 71% is similar to the hard coking coal produced from Queensland, Australia. Hard Coking Coal trades at a premium to other coking coals due to its limited resources and its importance in the production of steel (Beacon Hill Resources, 2011).

Table 9.13 gives an overview about the quality parameters for coking coal and thermal coal for export from Minas Moatize Mine (Green, M.,2011).

Table 9.13: Quality parameters for coking coal and thermal coal for export from Minas Moatize Mine

Likely Coking Coal	Minas Moatize	Likely Export Thermal	Minas Moatize
Moisture (wt. %)	1.3	Total moisture (wt. %)	6 – 8
Ash (wt. %)	10.5	Ash (wt. %)	26
Volatiles (wt. %)	17.1	Volatile Material (wt. %)	15
Fixed Carbon (wt. %)	71.9	Fixed Carbon (wt. %)	58
Sulfur (wt. %)	0.9	Sulfur (wt. %)	0.9
Calorific Value (CV) Kcal/kg (MJ/kg)	7,689 (32.2)	CV Kcal/Kg	6,200
		Hardgrove grindability Index (HDI)	80-100

Source: Green, M.,2011

Beacon Hill has commenced production of export grade thermal coal from the initial open pit mine, Trial Pit 1. The Group is currently mining approximately 20,000 tons Run of Mine (ROM) coal per month. The coal mined is being washed at the Group's first wash plant which has been built, installed and that has a capacity of 120 tons per hour (Beacon Hill Resources, 2011).

The development plan calls for current production to be increased from current levels up to a production rate of 4Mtpa. ROM, which is calculated to yield 2.36Mtpa of saleable coal there of 0.56Mtpa domestic thermal coal, 0.88Mtpa export thermal coal and 0.92Mtpa coking coal (Green, M.,2011).

Beacon Hill said it continues to make progress at Minas Moatize, with production of thermal coal building from the initial open pit mine and the production of coking coal on target to start in the first quarter of 2012. Coal is being processed at Minas Moatize's washing plant and is then transported to the Port of Beira by truck in readiness for the group's first export shipment, which is targeted to take place before the end of 2011 (Lazenby, H., and Beacon Hill, 2011).

Benga Mine (Rio Tinto)

The Benga Coal Mine in Mozambique is a metallurgical coalmine which was initially commenced by Riverdale Mining prior to the company being taken over in June 2011 by Rio Tinto. The Benga Coal Mine is in production. Tata Steel is a 35% joint venture partner in the project. The mine received government approval in January 2010. Resources at Benga were estimated to be about 1.23Bt (Ncondezi Coal Company Limited 2010).

Rio Tinto – which took over Riversdale Mining Ltd. – and its joint-venture partner Tata Steel Ltd. of India opened up the new Benga Mine in Tete Province in the fourth quarter of 2010. Production in the first stage of the project was expected to be 5.3 Mtpa and would increase to 10.6 Mtpa after about 5 years. Subsequent increases to 20 Mtpa depended on the availability of transportation infrastructure. Riversdale planned to use coal from Benga in its new power plant, which would have an initial capacity of 500 MW. Resources at Benga were estimated to be 4 billion tons, of which 273 Mt were reserves. Capital costs of the project were estimated to be more than US$800 million (USGS, 2009 and Beacon Hill Resources, 2011).

Now Benga Mine is in construction and first exports were scheduled for the end of 2011. Products will be hard coking coal and export thermal coal (Ref. 23). It consists of four seams - named B, C, D, and E. Its resources and reserves are listed in Table 9.14 (Riversdale Mining Ltd 2009).

Zambezi Project (Rio Tinto)

In October 2009, Rio Tinto (as the successor of Riversdale Mining Ltd.) completed its first resource assessment at the Zambeze Project, which was located adjacent to Benga. This Mine is under development. Indicated resources were estimated to be 1.7 Billion tons. In March 2010, the Government awarded state-owned Coal India Ltd. the A1 and A2 licenses in Tete Province, which had estimated resources of 1 Bt of coal. In April 2010, Central African Mining and Exploration Company plc of the United Kingdom announced that resources at its 871L property in Tete Province amounted to 1.03 Bt (USGS, 2009).

Based on company information 9.0 BT of hard coal were identified for the Zambeze Project (Campbell, K., and First Moatize, 2011, and Mozambique Coal Development Association 2011).

With **Benga** and **Zambezi** are two first class hard coking coal and thermal mines under development. A potential for a large-scale operation and for first exports in 2015 is given (Mozambican Coal Development Association, 2011).

Ncondezi Coal Project (Ncondezi Coal Company)

The Ncondezi Group’s licenses are located in the Zambesi Basin in the Tete Province, which is situated in the northwest of Mozambique (Mozambican Coal Development Association, 2011).

The AIM-listed coal exploration and development company holds 4 licenses in the Tete province. The company is due to complete a bankable feasibility study on the project in the second half of 2012. The aim is to construct an open pit mine, which will initially produce 2.6 Mt of export thermal coal a year, ramping up to 10 Mt. Production start is expected in late 2014 or 2015. The potential to produce coking coal at the site has also been identified (Mozambican Coal Development Association, 2011).

JORC (an international methodology for the resource/reserve classification) resources of 1.8 billion ton at less than 200m depth have been classified. A bankable feasibility study completion is targeted for the second half of 2012 (Business Standard, 2011). The JORC classification and tonnages of the South, North and West Blocks are listed in Table 9.14 below. With a geological loss factor the in situ resource tonnages have been adjusted by 30% (Ncondezi Coal Company Limited 2010)

Table 9.14: JORC classification and tonnages of the South, North and West Blocks

Block	Measured (million ton)	Indicated (million ton)	Measured and Indicated (million ton)	Inferred (million ton)	Total (million ton)
South	24	447	471	127	597
North	0	174	174	503	677
West	0	0	0	534	534
Total	24	620	644	1,164	1,809*

Note; * number is rounded

From the drilling work 1.81Bt, with 1.16 billion tons of this being in the Inferred category, 0.62 billion tons in the Indicated category and 0.02Bt in the measured category were identified (Ncondezi Coal Company Limited, 2011).

Songo Project (Mozambi Coal)

The Songo Project (2738L) is located 115 km west of the city of Tete and extends over 224 km². Tenement lies 40km to the south of the Jindal Steel and Power (Jindal) tenement 1218L where a 700 million tons coal reserve has been identified. The Songo Project is under development.

The Company has the rights to earn an 80% interest in this tenement, with the remainder held with local partner Xiluva Minerals Resources Lda. Geological mapping and ground verification indicates the potential for coal-bearing Lower Karoo sediments in the south east of the license area.

The Company recently completed a capital rising that has ensured sufficient funding to undertake the initial exploration programme. The planned drilling programme will involve an estimated 3,000 m of core drilling. Initially, the programme will centre on five wide-spaced deep drill holes. Systematic wide spaced drilling to determine the extent of the coal-bearing stratigraphy will follow this. All drill holes will be logged. The programme will be followed by resource definition drilling in areas of mineralisation (Mozambican Coal Development Association, 2011).

Tete West Project (Mozambique Coal)

Tete West is located 12 km west of the city of Tete and extends over 182 km². The tenement lies immediately to the southwest of the Riversdale Mining Limited tenement 946L where an indicated and inferred coal resource of 9.0 Bt was recently reported to occur. Some 20km to the east is the 4.0 Bt Benga coal deposits where Riversdale has commenced mining. A geologic mapping and ground verification is being done (Mozambican Coal Development Association, 2011). This project is still under development.

Other significant projects with given JORC resources are the **Ncondezi Coal Project**, the **ENRC Coal Project** and the **Jindal Coal Project**.

ENRC Mozambique

The Kazakh miner holds several exploration licenses for areas in the Tete province. The company initiated a feasibility study for one of the assets, which is expected to be completed in the first half of 2012 (Business Report: Mozambique's major coal projects 2011).

ENRC Mozambique has 12 prospecting licenses in Tete province, three of which are located in the district of Cahora Bassa, two in the Zumbo district, another two in Mutarara district, one in Marávia district and another in Magoé district (ENRC 2011)

Coal India

The state-owned company and the world's biggest coal producer secured exploration rights at two blocks in Mozambique's Moatize region and hope to start mining coal at the site within five years. The miner plans to export 10 Mt of coal from the two blocks to India in the next 10 years. The blocks are estimated to hold reserves of a billion tons of coking and thermal coal. It will invest US$400m in the project (Business Report: Mozambique's major coal projects 2011)

Jindal Steel & Power

The Indian company holds a 25-year license to explore and mine for coal in the Tete province, home to some of the world's largest untapped coal reserves (Business Report: Mozambique's major coal projects 2011).

Mozambique gave the green light in the beginning of October 2011 to Jindal Steel & Power to build a 2,640 MW coal-fired power plant in the northern province of Tete. The energy ministry said the plant, estimated to cost US$3 billion, would start operating in 2015. The power will be sold domestically and to the rest of southern Africa. Mozambique already exports power to neighbours Zimbabwe and South Africa, which are struggling to meet fast-rising demand. Tete is attracting vast amounts of foreign investment, with miners such as Vale and Rio Tinto developing coalfields left untouched during the 1977-92 Civil War. Mozambique is also developing a 1,500 MW hydropower project involving a consortium consisting of Brazilian conglomerate Camargo Correa, Mozambican Investment Company Insitec Group and state electricity firm EDM (Business Standard 2011).

9.6.3 Coal Export Policy

Mozambique currently produces only a minor amount of coal. However, major global mining companies such as Vale and Rio Tinto are developing major coking coal export projects which would make Mozambique one of the world's major coal exporters. Some of the proposed new coalmines would have mine-mouth power stations at their primary markets. In May 2011 the Brazilian company, Vale began coal production at Moatize, and Rio Tinto completed its takeover of Riversdale Mining, which commenced the development of the Benga Coal Mine and has the title for the Zambezi Project (Source Watch, 2011).

9.6.4 Coal Transportation

The existing Sena rail line from Moatize to the port of Beira (570 km) is expected to have a capacity of 6 Mtpa by the end of 2012 (Taylor, J. 2011), although the allocation of this capacity has not yet been finalized. Vale and Riversdale are also believed to be aiming to secure capacity on the line to match the capacity of their refurbished Quay 8 facilities at Beira. There is considerable uncertainty regarding the timing and level of rail capacity that will be available on the Sena line. The company believes that under a worst-case scenario, it could export a minimum of 0.5 Mtpa on the Sena line and a further 0.5 Mtpa by trucking to the port at Beira. Assuming a unit cost of 0.10 to 0.12 US$/tom-km, road transport to Beira could cost in the range of 57 to 68 USD/ton (Taylor, J. 2011). Although not an ideal solution, this would provide access to the market for all of the planned coking coal production and a small proportion of the planned export thermal coal. In addition, an expanded route from Tete to Beira along an upgraded Sena line may provide transport for a further 20 Mtpa of coal (Fred, J., 2011).

Rail and port capacity is a constraint on not only Beacon Hill's production plans but also those of Vale and Riversdale (now controlled by Rio Tinto), which have significant mine developments under way. Now there is an assumed rail capacity limited to one Mtpa between 2012 and 2014 (Taylor, J. 2011). Plans under consideration include developing a new coal terminal at Beira with a capacity of 18 – 24 Mtpa and associated rail upgrading, which could be in place from 2015 (Taylor, J. 2011) onwards.

Due to the shallowness of the Port of Beira, there exist also plans for the development of an expanded rail link from Moatize to the natural deepwater port of Nacala in northern Mozambique. This rail line would amount to 1,000 km (Ref. 31) crossing through Malawi, which could handle 25 Mtpa, with a subsequent potential expansion to 50 Mtpa (Taylor, J. 2011).

Maputo

Maputo's Matola port (Figure 9.8) is currently able to handle up to 4 Mtpa (Eberhard, A. 2011). Grindrod Freight Services operating the Maputo Port concession as well as the coal terminal sub-concession is exploring plans to expand capacity to between 16 and 25 Mtpa by 2013. A part of this capacity may be used by Mozambique coalmines, which are in the early stage of development. Export of South African coal through the port of Maputo will only be meaningful if rail capacity is expanded in parallel.

The railway connection allows as of 2012 up to 42 trains per week (actually only 27 trains per week). By now, 50 wagons with max. 2300 t/train are in use. The crossing of the border is uncomplicated, only driver changes could generate a problem. Transnet is serving up to the border port of Komatipoort. The harbour facilities at Maputo were improved and seem to be very competent. The loading facilities allow loading 25,000 ton of coal per day.

Figure 9.8: Maputo dry bulk terminal

The port is limited to serve Handymax and Panamax vessels up to 65,000 tons loaded.

Figure 9.9 shows the sea route from Maputo to the ports of Bangladesh. The total distance amounts to approx. 4,500 nautical miles. It would take 13 days and 10 hours for a Handymax vessel with an average speed of 14 nm to cover the distance between the two ports.

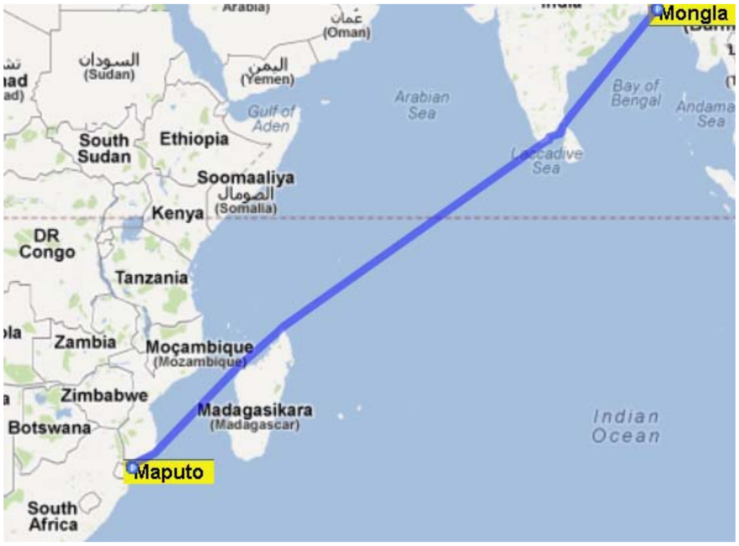


Figure 9.9: Sea route from Maputo to Mongla

Beira

The port of Beira is situated at the mouth of the Pungue River. Beira port has 11 berths; the coal terminal is situated on berth 8. Access to the port is obtained via the dredged Mancuti Channel with a mean height range between 6.2 and 7.4 m (Ports & Ships 2011). The approach to the River Pungue is obstructed by numerous banks and shoals, which are constantly changing. Vessels with a draught of 4.88 m or less may enter the port at any state of the tide. Those (incl. Handysize vessels with more than 35,000 tons) drawing more than 4.88 m are required to wait for a suitable height of tide before entry.

Vale and Riversdale are in the latter stages of an US$80 million (Fred, J., 2011) investment in the refurbishment of Berth 8 at Beira to provide capacity of 6 Mtpa (Vale 4 Mtpa; Riversdale 2 Mtpa) by end of 2011. Dredging is also under way, which would allow the loading of barges or Handimax vessels in the port for offshore transshipment to Panamax or Capesize vessels. The current draught does not allow docking of these vessels.

Further investments co-founded by World Bank (Fred, J, 2011) are being considered by the government to build a new terminal with capacity for 18 to 24 Mtpa, although funding for this is likely to require take-or-pay (ToP) contracts with producers for capacity to underpin the estimated US$ 400 million of investment required. It is estimated that this capacity could potentially be in place by 2015 (Fred, J., 2011).

Other projects currently under consideration by companies in the Tete district of Mozambique, including Riversdale, Vale, Ncondezi Coal, Jindal and Beacon Hill, have the potential to produce somewhere in the region of 85 Mtpa (Fred, J., 2011) of export coking and thermal coal. In the medium term, there are a number of infrastructure routes that we expect to be developed that have the potential to support production on this scale. Routes being considered include the northern rail route to the natural deepwater port at Nacala.

The port of Beira could qualify as an alternative for the shipment of coal from South Africa. Since the international mining companies active in Mozambique have a preferred access to the port of Beira, it seems to be unrealistic to believe that South African coal will get medium term access to the port facilities.

Nacala

As shown on Figure 9.10 (Fred, J., 2011), Riversdale considers that this route could provide a route to the market for 25 to 50 Mtpa. Currently there exists a rail line of 800 km with a capacity of one Mtpa. In November 2009 an investment of the rail and port capacities amounting to US$1.6 billion (Mozambi Coal Ltd, 2011) was announced by Vale and the Government. This would increase the coal capacity to 20 Mtpa with an upgrade potential up to +40 Mtpa. Another benefit of this port is the possibility to handle Panamax vessels.

Chinde

Riversdale has an own plan to barge material down the Zambezi River to Chinde, which could provide 20 Mtpa (Mozambi Coal Ltd, 2011) or more of capacity. This comes up to a distance of 525 km from Tete area to Chinde. Considering the construction of transshipment facilities at sea, an upgrade potential amounting +20 Mtpa would be feasible (Mozambi Coal Ltd, 2011).

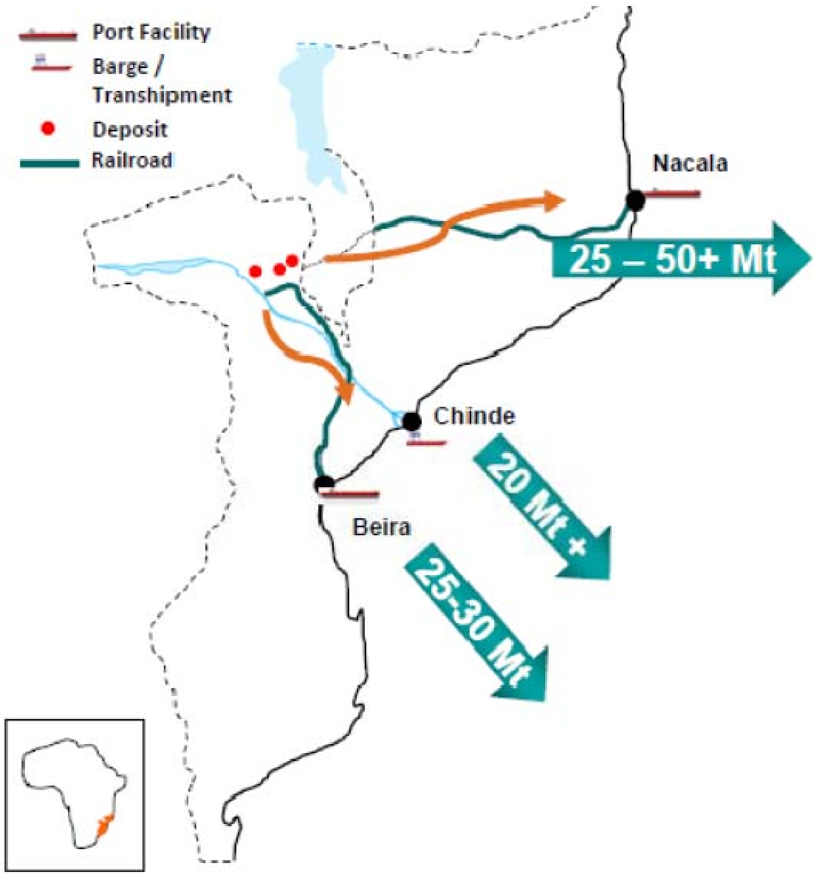


Figure 9.10: Long-term coal transport options from Tete province

The port situation in Mozambique could be summarized as followed:

- Planning of shipping coal from a mine in Mozambique via a port in Mozambique is in the moment still too risky. This could be re-evaluated in 3 to 5 years.

9.6.5 Coal Price

Beacon Hill announced on April 2011 the signing of a Heads of Agreement (HoA) with Basil Read (Pty) (Southern Africa's fifth largest construction firm) to appoint its subsidiary, TWP Australia, to complete a DFS for mine design and a CHPP with a capacity of four Mtpa of RoM coal, with a view of beginning expanded operations in January 2011.

At the planned expanded capacity and with the coal yields indicated, the project is expected to be capable of producing 0.92 Mtpa of hard coking coal, 0.85 Mtpa of thermal coal for export markets and 0.58 Mtpa of thermal coal for domestic markets. Assuming a waste/coal ratio of 1.5, and unit costs of 2.50 US$/t (Ref. 29) of material moved and coal washing costs of 5.00 US$/t of material processed, onsite operating costs are forecast to be US$45m per annum – the equivalent of 11 US$/t RoM coal, or 25 US$/t of expected coking and export thermal coal production.

9.6.6 Risks

Risk: Coal delivery limitation (for the next 5 to 8 years)
Comment: Since most of the coal projects are in the late development or early production stage, a larger delivery risk exists over the next 5 to 8 years.

Risk: The Mozambican rail lines represent a constraint for the planning of new producing coal fields.
Comments: Coal producers and Government are willing to develop new infrastructure over the next few years, but there is no certainty for planning at present.

9.6.7 Summary

International mining companies are developing the coal export market with great financial power, mainly because of the coking coal quality but also high thermal coal quality. The development embraces mining and infrastructure at mining sites, but also railway transport and ports. Thus, Mozambique will emerge shortly as a major coal export country and will become an interesting coal supplier for future years. During the development phase, the risks are too high for a single project to become dependent on such a supply situation.

The general situation in **Mozambique** can be summarized as followed:

- Appropriate coal resources are known in Mozambique. The quality is suitable as well.
- The development of the coal resources started and is making good progress.
- Mozambique is for the time being not a partner to be considered (only few mines under development, harbor facilities require upgrading) but this may change over the next years.

9.7 India

India is the third largest producer of coal in the world. As of April 2010, the geological resource of Indian coal was 276.81 billion tons (Source: Geological Survey of India, GoI (GSI, GoI). At the end of 2010, the proved reserve of coal was around 60 billion tons in India. Among this reserve, 92.57% is

Anthracite and Bituminous, and 7.43% is Sub-Bituminous and lignite. During 2010 their production was around 7% of the total world production of coal. The Reserve to Production (RP) ratio is 106, which is very high. There is a scope of further coalfield development.

India is the nearest major coal producing country of the world but export a very little low-grade coal to its neighbor Bangladesh, Bhutan, and Nepal. On the other hand, it is noticed that India is importing coal in an increasing rate to meet its internal demand. Last year it imported about 35 m MT coal. Its internal demand is growing day by day. Most of its coalmines are operated by public sector. Only very recently, private sector has been allowed to mine on captive basis. No firm export policy of coal by the Indian Government could be found yet. So under free economic business, India cannot be considered as a potential source of coal for Bangladesh. However, India is the nearest neighboring and good friendly country of Bangladesh, inter governmental dialogue may be made to arrive a special coal supply contract with India before concluding decision on import of coal for Proposed Khulna power plant.

9.7.1 Risks

Risk: Long-term supply.
Comments: Due to the increasing domestic consumption, India is not a reliable partner for a long-term supply of coal.

9.7.2 Summary

- The Indian coalfields represent an optimized location for shipment to Bangladesh.
- The economy of India requires coal in steadily increasing volumes. India became over the last years a coal importing country.
- India is in a long term not a reliable coal supplier since the internal demand is rapidly growing.

9.8 China

All the coalmines and coal business in China is controlled by the Government. In general the Chinese policy is to make them self sufficient in respect of primary energy. No policy outline on coal policy of the Chinese govt. could be found /collected yet. However, fact remains that China is the biggest coal producer in the world at the same time the second largest importer (about 135 million MT/ year) of the world. It does not show in the list of major coal exporting countries in the world.

At the end of 2010, the proved reserve of coal was around 115 billion tons in China. Among this reserve, 54.32% is Anthracite and Bituminous, and 45.68% is Sub-Bituminous and lignite (BP 2011). According to the report of BP, during 2010 their production was around 13% of the total world production of coal. The Reserve to Production (RP) ratio is 35which is very low. Recently the production has been decreased due to imposing of new environmental and safety regulation. On the other hand, domestic demand has been rising very rapidly. Accordingly, Chine increases their export of coal. Under the above circumstances and from the free market economic point of view, China cannot be chosen as the potential source for Bangladesh. However, China has a strong business relation with Bangladesh. So an attempt may be made to explore to import coal from China under special arrangement. A bilateral dialogue may be made in Government level on the issue.

9.8.1 Risks

Risk: Long-term supply.
Comments: Due to the increasing domestic consumption, China is not a reliable partner for a long-term supply of coal.

Risk: Efficiency of transportation lines in China.
Comments: The transportation of coal from the Chinese deposits to the Chinese export harbours can interfere with on-time delivery schedules.

9.8.2 Summary

- The Chinese coal deposits could well qualify as a source of coal for Bangladesh.
- Since the Chinese are one of the biggest importing nations, it cannot be expected that China is interested to sign any long-term delivery contract.

9.9 Comments on Coal Quality

The tendency of the coal quality for long-term international contracts moves worldwide downwards to coal with a range in calorific values from 5,200 to 5,800 kcal/kg. This is due to

- the depletion of deposits with high calorific coal at the surface,
- decreasing shipment rates and
- improved efficiency of the TPPs.

Taking consideration of these facts in mind, for the proposed three projects calorific value of the coal may be considered from 5,200 to 5,800 kcal/kg. The Power System Master Plan of Bangladesh (PSMP 2012) also recommends the same. Coal in between this range with low Sulfur content (< 0.6%) is available in international coal market. In case of high Sulfur content, Flue-gas desulfurization should be installed with plant for satisfying international standards of emissions (e.g. World Bank group's standard) With the calorific values between 5200 to 5800 k cal/kg, the buyers might get discounts in coal price. The negotiation strategy should consider this from the beginning. Thence, the negotiations of any long-term contract should target at:

- discounts for coal qualities below RB standards (6,000 kcal/kg) long term delivery commitments
- discounts on shipping rates for high volatile contents of the coal and processing costs.
- hedging and swapping should not be excluded but additional risk due to the contracting should be avoided.
- optimal use of options should be considered.

9.10 Comments on Potential Coal Sources

Considering competitive market condition and rising domestic demand of coal in Indonesia, China and India, a single source might not be suitable for sustainable coal supply chain to the proposed power plants in Bangladesh.

Scope to import of Bituminous coal from Indonesia is limited as the country exports mostly of its bituminous coal (11% of its total reserve) having high GCV value (plus 5800 kcal/kg, GAR basis) to fixed buyers under long term agreement. Very limited Bituminous coal may be available in spot market, which might not serve the projects' demand. On the other hand sub-bituminous coal (60 % of total Indonesian reserve) having medium GCV (4500 to 5800 kcal/kg, GAR basis) might be available under long term agreement of coal supply. To ensure availability of high-grade sub-bituminous coal, agreement may be made at the earliest. The domestic demand of coal at Indonesia is growing very fast and the priority of the government is to ensure national energy security. Recently, the government of Indonesia has set regulation to control coal export to ensure coal supply to domestic sectors. Reliability of coal producers, traders, suppliers and shippers is the main limiting factor that has to be properly considered during sourcing coal from Indonesia. Besides, poor infrastructural development for coal transportation from mine mouth to mother vessel may hinder continuous supply of coal.

South Africa would be a reliable coal source for medium to high heating value coal. South Africa mostly exports coal of heating value more than 6400 kcal/kg (GAR basis). Recently, as per market demand they are also exporting coal of 5800 to 6300 kcal/kg (GAR basis) heating value. Low and medium graded coals are mostly used for their domestic purpose. South Africa would be most reliable coal source for the proposed power plant where coals of the required quality are easily available.

Considering reserve, quality and reliability to supply coal Australia is undoubtedly a good country to import coal. Coal of medium GCV (5600 to 6100 kcal/kg, GAR basis) is readily available in Australia, those would mostly require for Bangladesh thermal power plants. For coal of required quantity, government level negotiation with coal producer, investor and regulatory bodies of Australia will be required.

Considering availability, cost of coal, and cost of transportation to supply coal it would be judicious to import coal from South Africa, Indonesia, and Australia. However, preference might be given to South Africa considering reserves, and recent improvement of coal infrastructure. Second preference might be given to Australia as the coal market of the country is controlled by the "Big Four" and is oriented towards China, India, Japan and South Korea. Considering all the cost components and the lower calorific value, Indonesia is similar in costs as others but reliability of coal producers/suppliers is the major risk. For future, Mozambique would also be a suitable source as a huge investment has been made in its coal infrastructure and mine development. In summary, the following recommendations might be made:

- Currently: South Africa (most probably together with Indonesia).
- Australia receives second priority due to their strong commitment with India and China. (The Big Four dominates the market)
- in the future: additionally Mozambique (and probably New Zealand)

In determining coal quality, environmental concerns should be considered as different environmental issues and concerns (discussed in Chapter 15) are involved with each of the three power plants due to geographical location of the sites, and environmental and socioeconomic condition of the surrounding. In accordance with the environmental issues discussed in Chapter 15, Sulfur content of the coal should be below 0.6% to satisfy national and international emission standard. However, in case of high Sulfur content coal, provision of FGD should be kept in the main plant for ensuring minimum environmental pollution.

Table 9.15: Probable quality of coal and required quantity

	Power Plants		
	Khulna 1320 MW TPP	Chittagong 1320 MW TPP	Maheshkhali 8320 MW (5320 MW Coal Based) TPP
Electrical Output	1320.0	1320	5320
GCV of Coal (kcal/kg)	5,500	5,500	5,500
Annual Coal Requirement In million tons			
Coal Req. (million Tons/ year) at 85% Plant Load Factor and 290 days operation time	3.1	3.1	12.3
Coal Req. (million Tons/ year) at 100% Plant Load Factor and 365 days operation time*	4.5	4.5	18.2

Note: Coal requirement has been estimated considering 40 % efficiency of the power plant

9.11 Comments on Coal Price

In reference to sub-section 6.3 (coal cost), following baseline coal prices (FOB) might be considered for feasibility purposes of the three power plants

Table 9.16: Estimation of Coal Price (FOB)

	Units	**South-Africa Richards Bay**	**Indonesia**	**Australia**
Calorific value	kcal/kg	6,000	5,000	6,000
Production costs (coal statistics)	US$/t	40	41	47
Average sales price (coal statistics)	US$/t	69	68	65
Local transportation to harbour (rail and barges)	US$/t	8 - 11	5 - 11	7 -11
Other charges (insurance, storage)	US$/t	3 - 4	6	8
Trading surcharge	US$/t	15	20	20
Coal FOB (calculated)	US$/t	99 - 107	103 - 115	108 - 113
Coal FOB (coal statistics)	US$/t	110	108	126
Adjusted to 6,000 kcal/kg	US$/t	110	130	126
Adjusted to 5,500 Kcal/kg	**US$/t**	**101**	**119**	**116**

Source: International Energy Agency (2012) and World Energy Council (2012)

9.12 Road Map for Coal Sourcing

A road map indicating all necessary engineering and preparatory works for the coal supply of the TPPs has been attached in Annex IV. It has to be noted that the figures used are adjusted according to the knowledge of the consultant and practicality. They are little dissimilar to the figures provided by the BPDB earlier. The table has to be adjusted as soon as the precise figures are available.

The road maps shows future coal based generation, future coal demand, present and indigenous coal production, planning for coal sourcing, planning for institutional development for coal sourcing, etc.

For the organization of the BPDB internal professional engineering team managing the coal supply chain (The Core Team) and for conceptual mine development work technical specification have been prepared (Annex V and VI).

9.13 Summary

- There are enough coal resources in reachable distance to Bangladesh. Price per kcal, reliability of the source and the convenience of the transportation chain will be the criteria influencing the decision making process.
- BPDB should thoroughly define their advantages in this process. The long-term demand and the support of the Government are major assist in these negotiations.
- Generally, the mining companies prefer this long-term thinking as well, traders like the "quick money".
- The development of the domestic resources should become a part of this strategy. It well might be that the mining companies providing the import coal are of assistance to develop the domestic resources.

Chapter 10: River and Costal Bathymetry

10.1 Bathymetry of Passur and Sibsa System, and Khulna Sundarbans Coast

Bathymetric map and cross sections are prepared based on latest hydrographic charts, which are collected from Bangladesh Navy, BIWTA and Mongla Port Authority. A surface is generated with the help of ArcMap 9.3 to observe the bed profile and to find out the suitable paths for navigation of coal carrying vessel as well as project sites. Hydrographic chart of two rivers Passur and Sibsa are collected from BIWTA and Mongla Port Authority to analyze two alternative routes for project site of Khulna 1320 MW coal based thermal power plant.

In Passur River, Mongla Port Authority conducted survey from 2007 to 2009. BIWTA conducted bathymetric survey up to 1 km downstream of Nalian Hat (village market) in Sibsa River in 2010. Hydrographic chart of rest portion (red marked line in map 10.1 and 10.2) of Sibsa River is not available. For better understanding of the bathymetry of two rivers cross-section of different location are given in map 10.2 as section 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8 and 9-9.

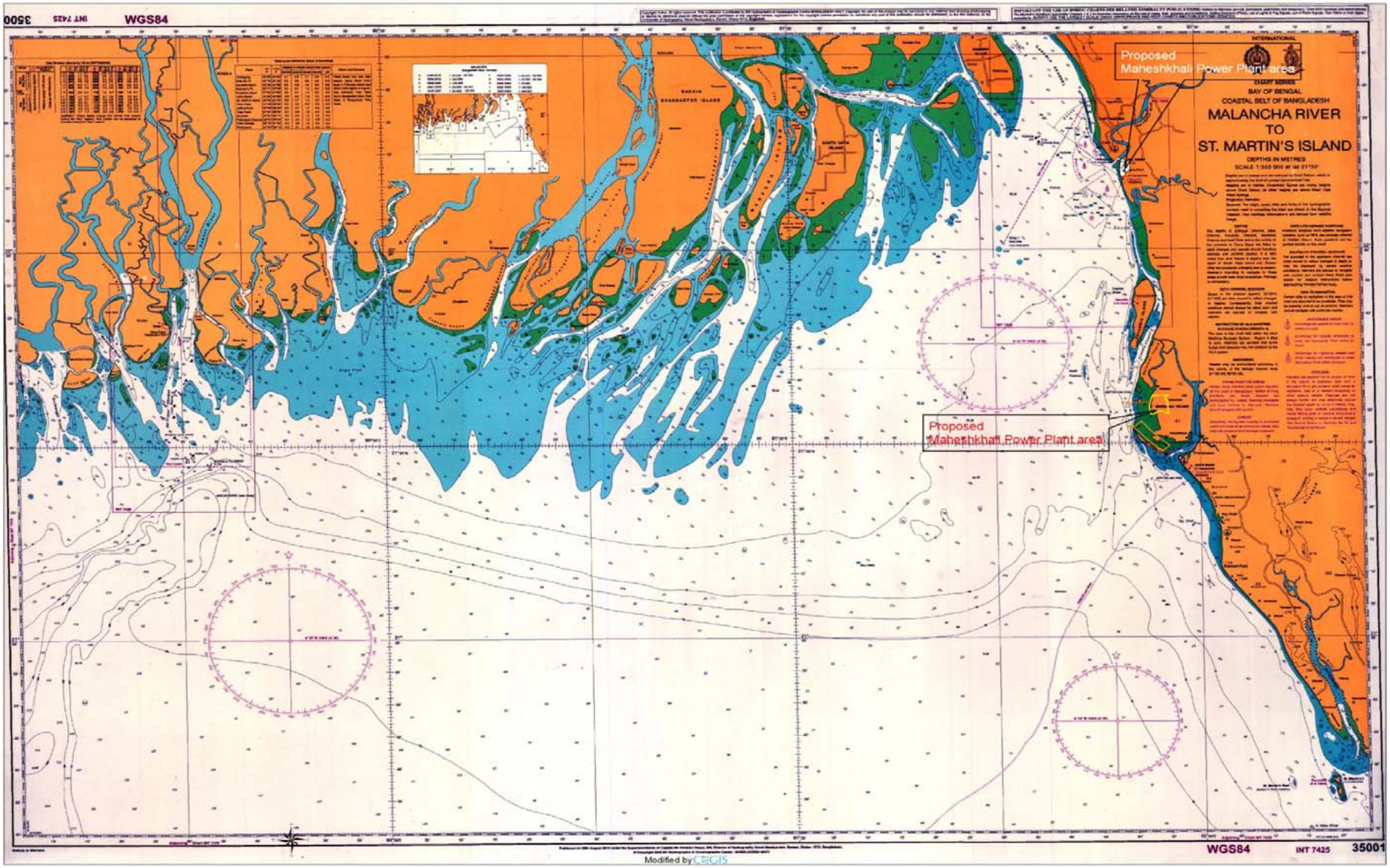
In existing condition, Akram point shows depth of 15 m to 20 m but there are some shoals in outer bar that limit approaching of vessel having draught over 8m. The same vessel can proceed up to near Harbaria (12 nautical miles downstream of Mongla Port Jetty). Presently, vessel of maximum 5 m – 6 m draught can proceed up to port jetty with taking tidal advantage. Further upstream of Mongla port the draught is improving. Up to south end to the project, area draught varies 4 m to 7 m. But in some places, shoals restrict draught. Further upstream of the south end of the project the draught decreases due to some shoals and submergible sandbars.

About 35 km of the Sibsa River (North of Akram Point) and 25 km of the Chunkuri River's bathymetric maps are not available. This bathymetric information is very important in respect of studying alternative route the project site from Akram Point. BPDB may request Bangladesh Navy to carry out the survey at the earliest.

10.2 Bathymetry of Chittagong coast and Maheshkhali Coast

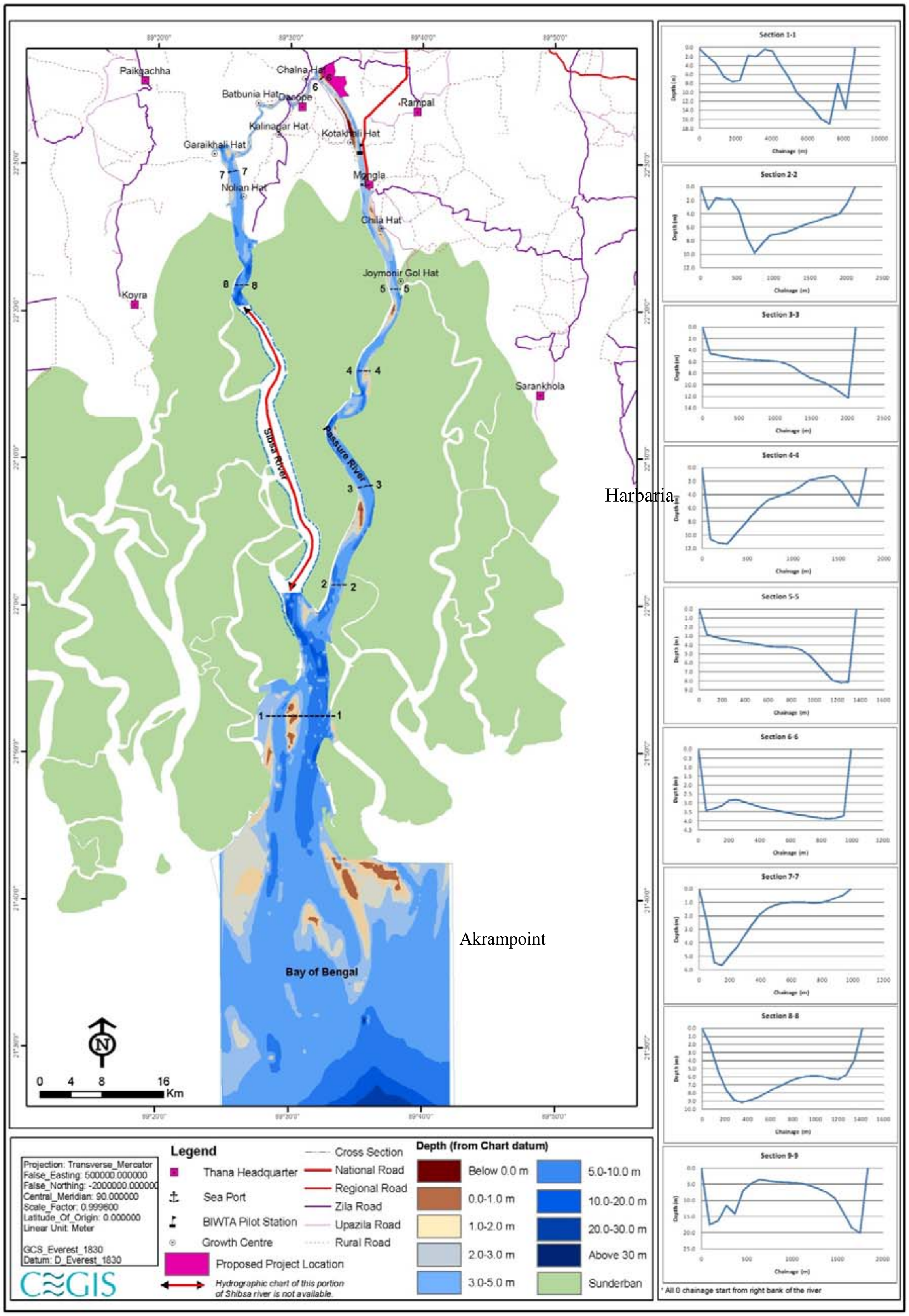
Proposed site for Chittagong 2x (500-600) MW Coal Based Thermal Power Plant will be Anwara Upazila. The bathymetry of Karnaphuli River, its confluence and adjacent sea are analyzed with the data of bathymetric survey of January 2010 (Map 10.4). Depths are in meters and are reduced to Chart Datum (CD), which is approximately the level of lowest astronomical tide. In Karnaphuli River and confluence, average depth is around 6 meter. For better understanding of the bathymetry of Karnaphuli channel and the Seashore cross-sections of different locations are given in map 10.2 as section 1-1, 2-2, 3-3, 4-4, 5-5 and 6-6.

In Maheshkhali channel confluence and Adjacent Sea Bangladesh Navy conducted bathymetric survey on January 2010. Depths are in meters and are reduced to CD, which is approximately the level of lowest Astronomical Tide. Map 10.3 shows the bed profile of Maheshkhali channel confluence and adjacent Sea. The minimum available depth is around zero in the area of Kobatar char, Motir char and Sonadia Island. For better understanding of the bathymetry of Maheshkhali channel and the Seashore cross-sections of different locations are given in map 10.3 as section 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8.

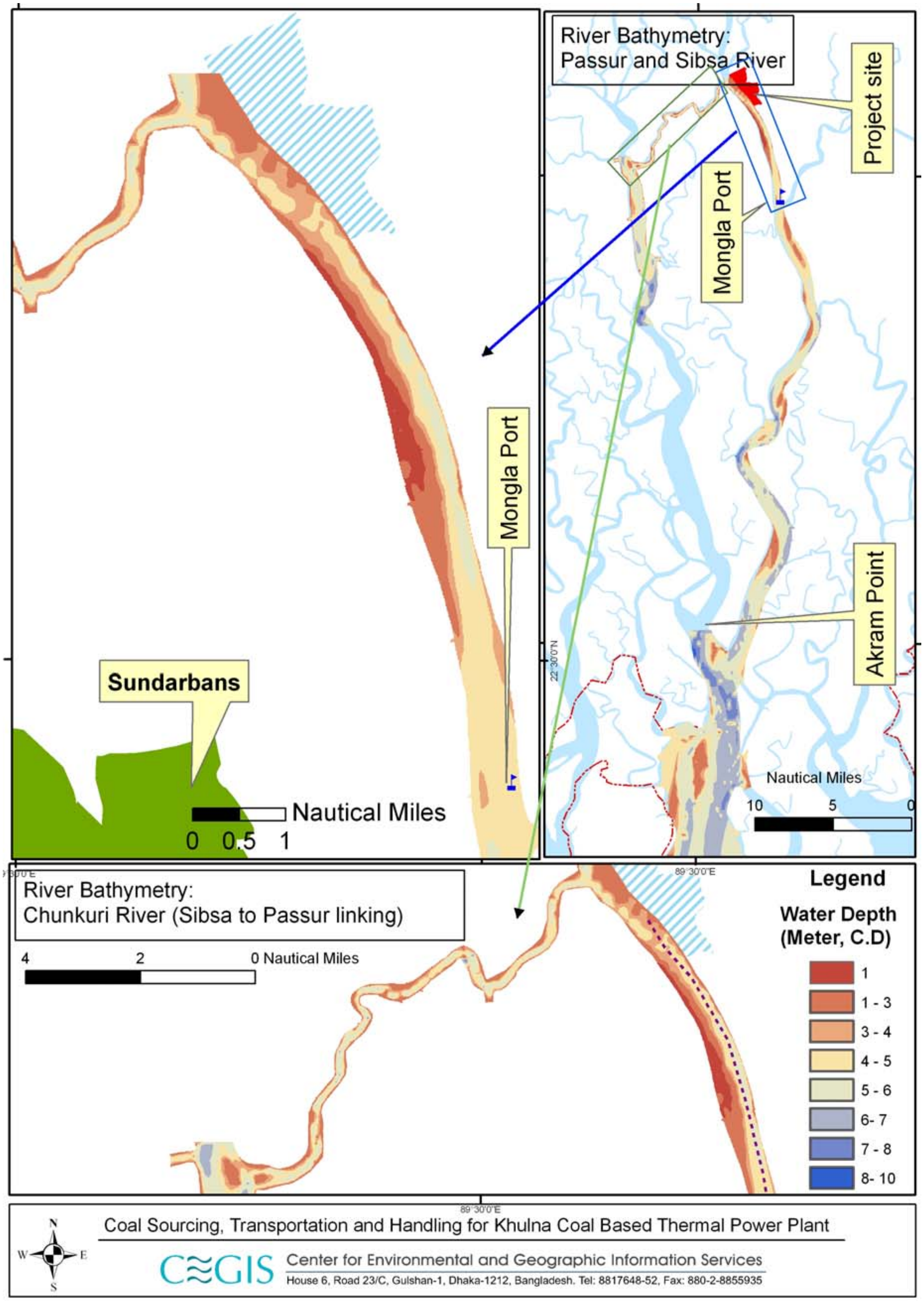


Source: Bangladesh Navy Hydrographic and Oceanographic Center (BNHOC)

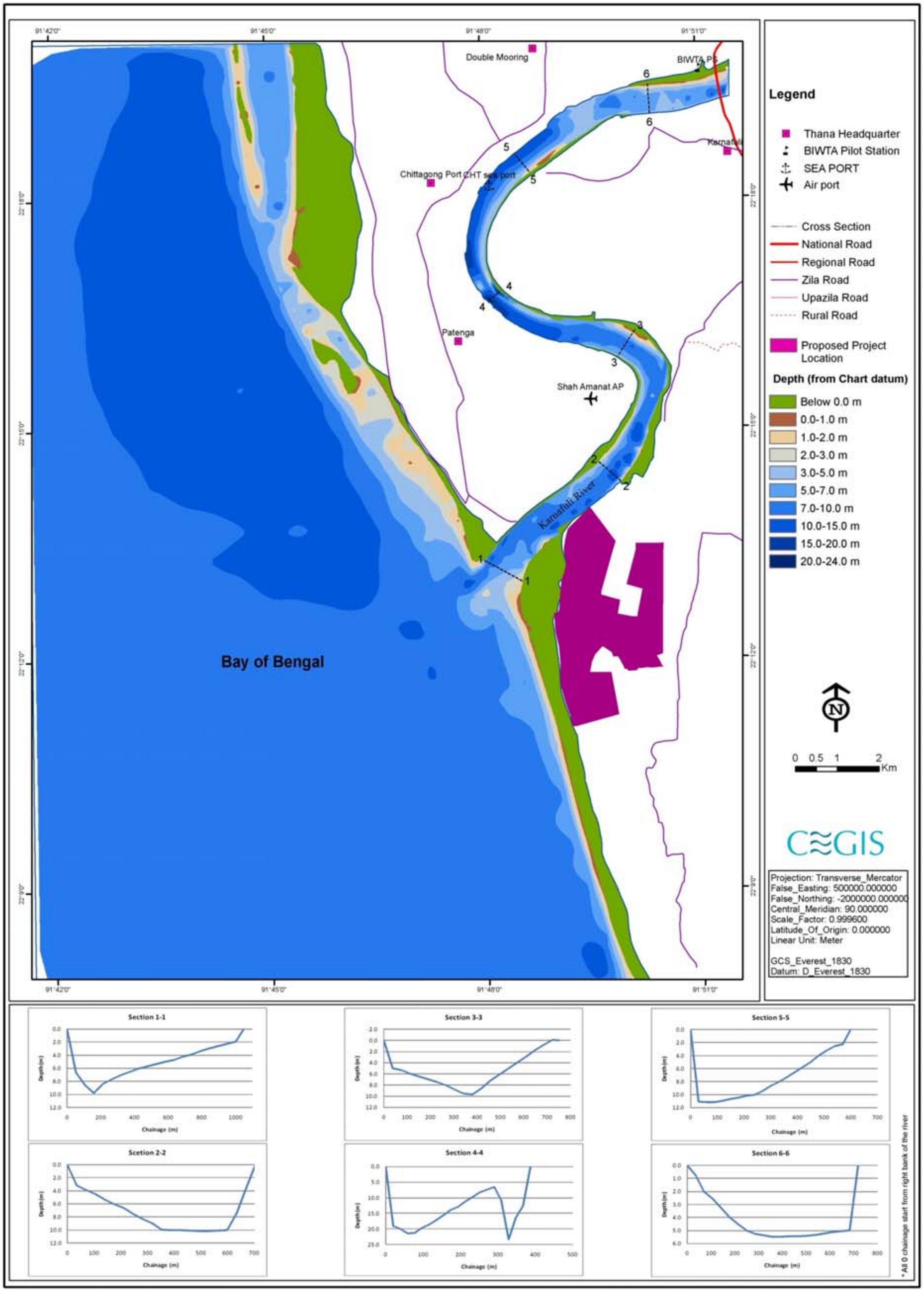
Map 10.1: Bathymetric map of Bangladesh Coast



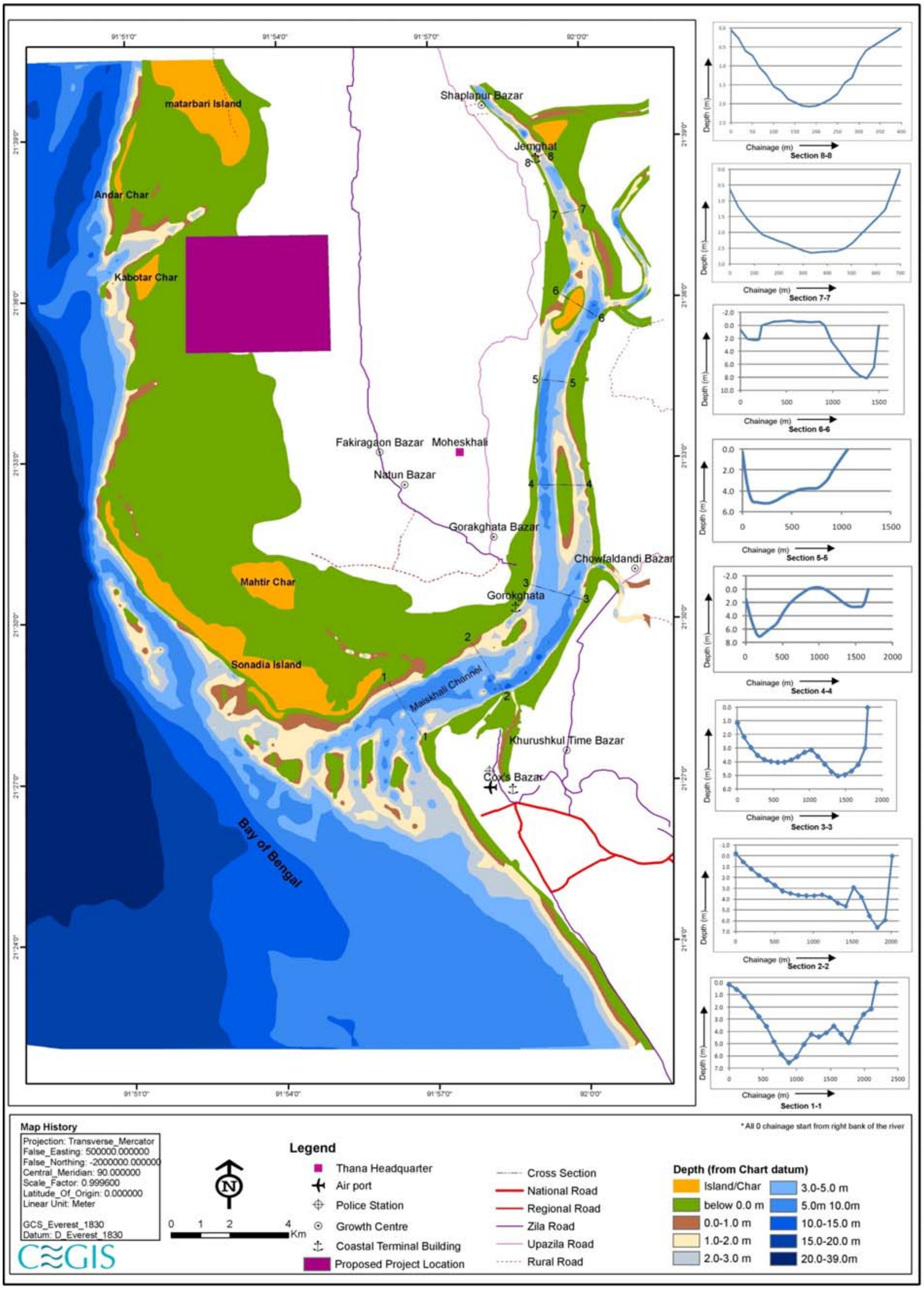
Map 10.2: Bathymetric map of Sibsa-Passur River System



Map 10.3: Bathymetric map of Passur and Chunkuri



Map 10.4: Bathymetric map of Chittagong Cost



Map 10.5: Bathymetric map of Maheshkhali Coast

10.3 Dredging requirement assessment

Dredging requirement has been assessed for different alternative plans described in Chapter 11 for coal transportation from source to project site. The assessment has been made analyzing bathymetry of the river.

10.3.1 Dredging at Outer Bar for proceeding 80,000 DWT mother vessel up to Akram point

The Alternative II- Anchorage at Akram Point would require dredging at outer bar (Map 10.2). The distance between Akram Point anchorage areas to Outer Bar of the Bay of Bengal is approximately 60 km of which 20 km has a draught restriction of 12 m. considering a single lane channel; 160 m channel width is required to enable a safe ship movement. Based on analysis of long profile (Fig 10.1a) which is generated from hydrographic chart of Mongla Port Authority, the volumes to be dredged at the initial stage to create the preferred channel is approximately **30 million m^3**. A similar study (DEMAS 2005) was carried by the Asia Energy to export Phulbari coal through Mongla Port by similar type of vessels. The dredging requirement of that study also matches with this assessment.

The yearly volumes to be dredged to maintain an artificial channel in river outlet varies greatly. The volumes of maintenance dredging are 6.0, 5.5, 5.0, 4.0, and 3.5 million m^3 for the 1st, 2nd, 3rd, 4th, 5th and 6th year respectively. Considering the remoteness of the dredging section, the distance of the disposal site and the prevailing wave conditions, a “Trailing Suction Hopper Dredger (TSHD)” is the most suitable type of dredge to carry out the work.

The unit price for TSHD type dredger to dredge is **3.5 USD** per cubic meter. So the total cost for capital dredging is estimated at **105 million USD.**

Table 10.1a: dredging requirement and cost for Khulna Power Plant

Sl. No.	Dredging location	Dredging Vol.	Dredging Cost.
Capital Dredging			
1	Outer Bar	30 Million m^3	105 million USD
Maintenance Dredging			
1st year	Outer Bar and the channel	6 Million m^3	21 million USD
2nd year	Outer Bar and the channel	5.5 Million m^3	19.2 million USD
3rd year	Outer Bar and the channel	5 Million m^3	17.5 million USD
4th year	Outer Bar and the channel	4 Million m^3	14 million USD
5th year	Outer Bar and the channel	3.5 Million m^3	12.25 million USD

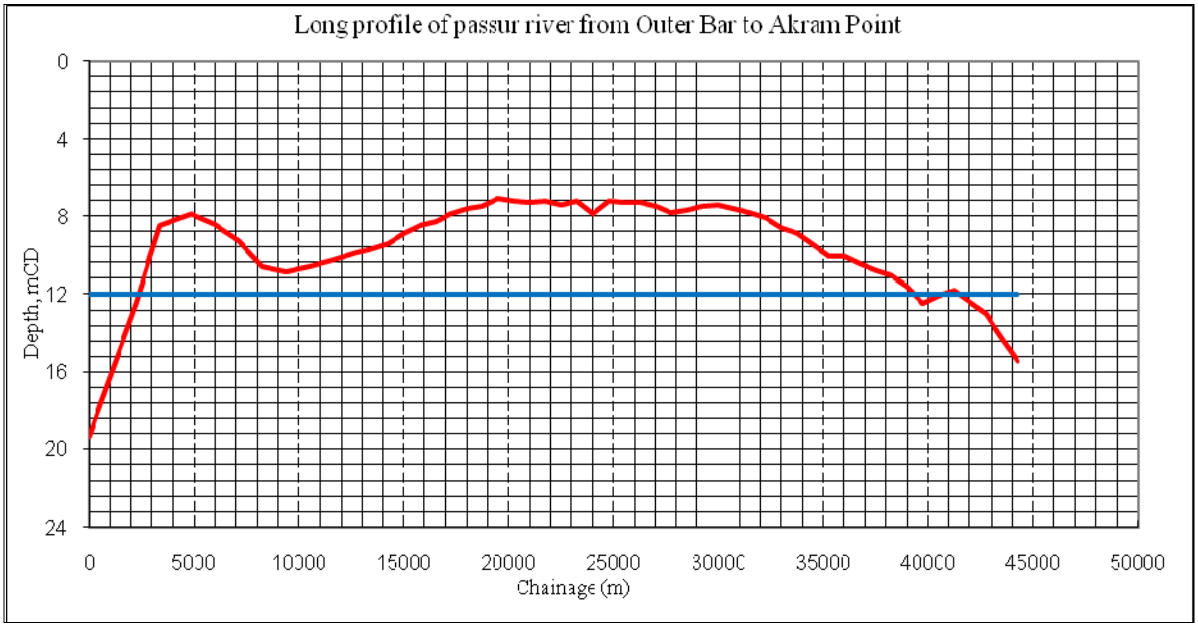


Figure 10.1a Long profile of Passur River from Outer Bar to Akram Point 2011

10.3.2 Dredging from Base Creek to Mongla Port for accommodating lighter vessel of 10,000 DWT

If coal terminal is constructed near Mongla Port jetty, dredging from Base Creek to Jetty area would be required to enable shallow draught lighter vessel of 10,000 m DWT. However, a draught of less than 5.5 meter is perhaps not feasible. The distance between Mongla Port and Base Creek is approximately 12.5 km of which 10 km has a draught restriction of 5.5 m. considering a single lane channel; 100 m channel width is required to ensure safe movement of ships. Based on analysis of long profile (Fig 10.1b) which is generated from hydrographic chart of Mongla Port Authority, the volumes to be dredged at the initial stage to create the preferred channel is approximately **1.3 million m^3.**

According dredging will be required every year for maintaining the channel. The estimated volumes to be dredged annually to maintain an artificial channel in river outlet varies greatly. However, an estimate of **1.2 million m^3** per year may be considered as prudent.

Considering the remoteness of the dredging section, the distance of the disposal site and prevailing the wave conditions, a “Cutter Suction Dredger" might be suitable type of dredge to carry out the work. However, dredging method should be determined after detail investigation and analysis that has to be carried out during detail design.

The unit price for CSD type dredger to dredge is **4.5 USD/m^3** for capital dredging and **5 USD/m^3** for maintenance dredging. Maintenance dredging cost will be higher due to problem of disposal of dredged materials for which additional land might be required. So the total cost for capital dredging is **5.85 million** USD (6 million USD can be assumed as LS including the cost of disposal of dredged material). The yearly maintenance dredging cost will be of 6 million USD.

10.3.3 Dredging from Mongla Port to Project site for proceeding lighter vessel of 10,000 DWT

If coal terminal is built at project site as it is proposed by this study in chapter 11 and 12 then in addition to dredging from Base Creek to Mongla Port site, dredging will be required from Port Jetty to project site as well.

The distance between Mongla Port and middle of the project site is approximately 12.5 km, of which only 6 km has a draught restriction of 5.5 m considering a single lane channel of 100 m width is required to ensure safe movement of ships. Based on analysis of long profile (Fig 10.1b) which is generated from hydrographic chart of Mongla Port Authority, the volumes to be dredged at the initial stage to create the preferred channel is approximately **0.8 Million m3**. This estimation also match with the dredging feasibility study (DEMAS 2005) carried out by Asia Energy to export Phulbari coal through Passur River.

For estimates for maintenance dredging, the yearly volume to be dredged to maintain the channel in river outlet varies significantly. However, an estimate of **0.6 Million m^3** per year may be considered as prudent.

Considering the remoteness of the dredging section, the distance of the disposal site and prevailing the wave conditions, a "**Cutter Suction Dredger (CSD)"** might be suitable type of dredge to carry out the work.

The unit price for dredging by cutter suction dredger is **4.5 USD/m^3** for capital dredging and **5 USD/m^3** for maintenance dredging. Maintenance dredging cost will be higher due to problem of disposal of dredged materials for which additional land might be required. Hence, the total cost for capital dredging is **3.6 million** USD (it can be assumed as 4 million USD as LS including cost of disposal) will be required to dredge from Mongla Port to Project site. Similarly, the yearly maintenance dredging would be of about **3 million USD.**

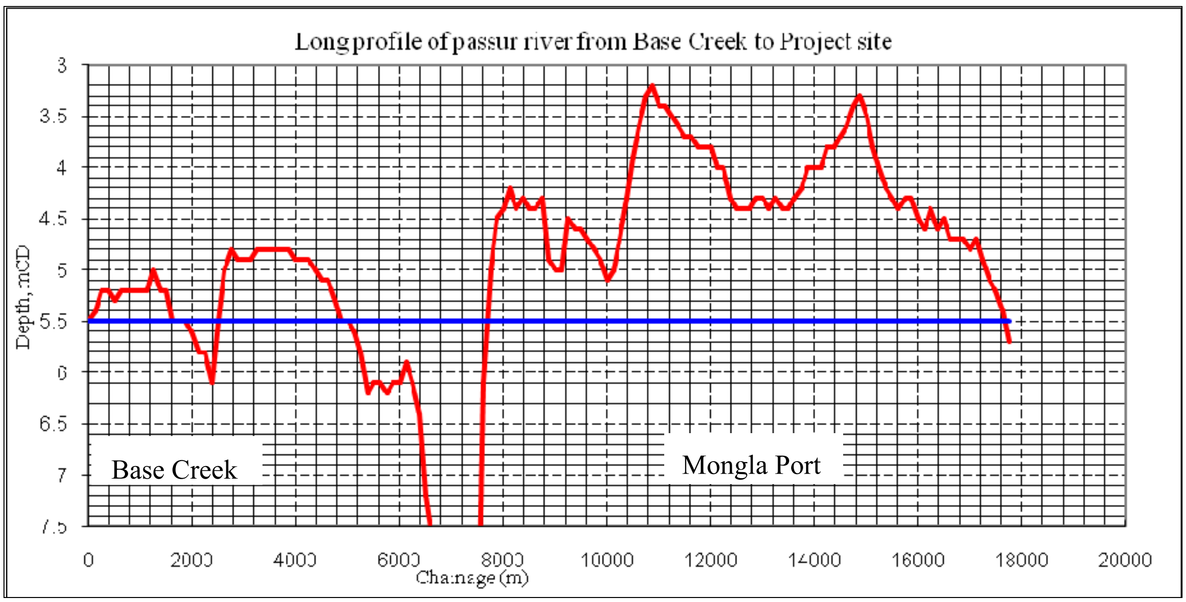


Figure 10.1b Long profile of Passur River from Base Creek to Project site 2011

10.3.4 Dredging from Base Creek to Mongla Port for allowing navigation of mother vessel of 25,000 DWT

Under, alternative IV, if the mother vessel of 25,000 DWT were to proceed for the project, dredging would be required to maintain water depth of 8.0 m for a channel of 100m width. In this case, the distance between Mongla Port and Base Creek is approximately 12.5 km of which 12 km has a draught restriction of 8 meter. This is a typical draught for a ship of 25000 DWT. The length and breadth of the vessel are also to be taken into account for examining navigability. Considering a single lane channel, 100 m channel width is required to maintain safe movement of ships.. Based on analysis of long profile (Fig 10.2) which is generated from hydrographic chart of Mongla Port Authority, the volumes to be dredged at the initial stage to create the preferred channel is approximately **4.3 Million m^3.** Dredging of this volume might not be feasible on a long term. The yearly maintenance dredging would be also very large. Considering present rate of siltation, it is very hard to maintain the existing draught of 4.5 -5.5. Hence, it would not be feasible to maintain a draught of 8.0 m to the Port area. However, a detailed feasibility study should be carried out for taking the most prudent decision.

Considering the remoteness of the dredging section, the distance of the disposal site and prevailing the wave conditions, a “Cutter Suction Dredger" is the most suitable type of dredge to carry out the work.

The unit price for dredging with CSD dredger is **4.5 USD/m3** for capital dredging and **5 USD/m^3** for maintenance dredging. Maintenance dredging cost will be higher due to problem of disposal of dredged materials for which additional land might be required. Hence, the total cost for capital dredging is **19.3 million** USD. Yearly maintenance dredging would be approximately 4 million m^3 for which the cost will be approximately 20 million USD.

10.3.5 Dredging from Mongla Port to project site for allowing navigation by mother vessel of 25,000 DWT

If coal terminal is constructed at project site as it is proposed by this study in Chapter 11 and 12 then in addition to dredging from Base Creek to Mongla Port site, dredging will be required from Port Jetty to project site.

The distance between Mongla Port and middle of the project site is approximately 12.5 km, of which around 10 km has a draught restriction of 8 m. considering a single lane channel; a width of 100 m is required to ensure safe movement of ships. Based on analysis of long profile, which is generated from hydrographic chart of Mongla Port Authority, the volumes, to be dredged at the initial stage to create the preferred channel is approximately 3.6 **million m^3**.

For maintenance dredging, the yearly estimated dredging to maintain the channel in river outlet varies greatly. A prudent figure would be **3.3 million m^3** per year.

Considering the remoteness of the dredging section, the distance of the disposal site and prevailing the wave conditions, a “**Cutter Suction Dredger (CSD)"** is the most suitable type of dredge to carry out the work.

The unit price for dredging with CSD is estimated at **4.5 USD/m^3** for capital dredging and **5 USD/m^3** for maintenance dredging. Maintenance dredging cost will be higher due to problem of disposal of dredged materials for which additional land might be required. Hence, the total cost for capital dredging is **16.2 million** USD will be required to dredge from Mongla Port to project site. Similarly, the yearly maintenance dredging cost will be 16.5 million USD. The maintenance coast rises, as an extra cost will be required for management of dredged material.

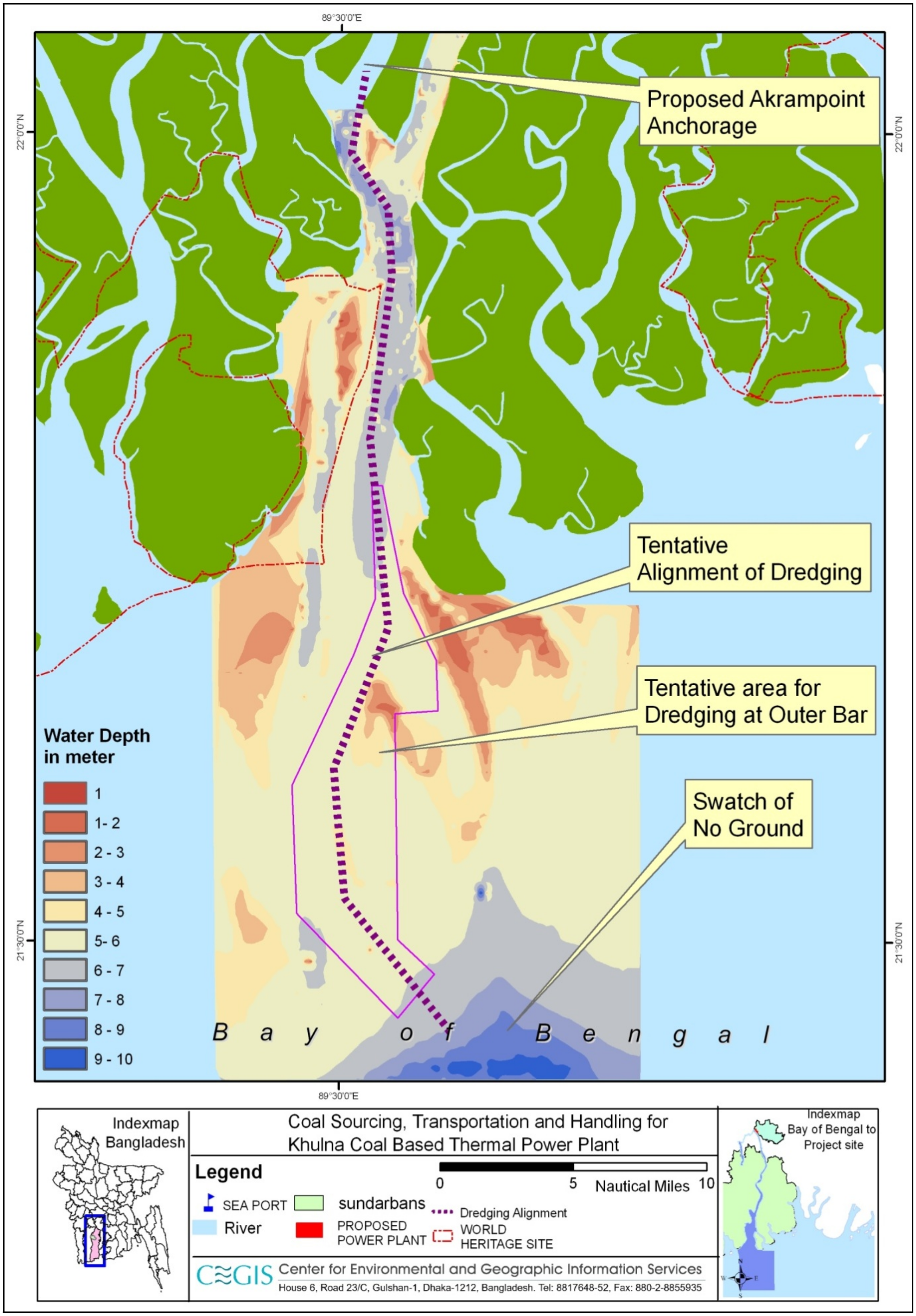
10.4 Suggested Dredging plan for Khulna Thermal Power Plant

Considering cost of dredging, and suggested coal transportation plan (in Chapter 11) it is suggested to dredge at Outer bar to enable navigation of vessel of 80,000 DWT to anchor at Akram Point (Map 10.3) and in channel between Base Creek to project site (Map 10.4). Transshipment up to the project site would be with lighter vessel. The final dredging plan is given in the following table:

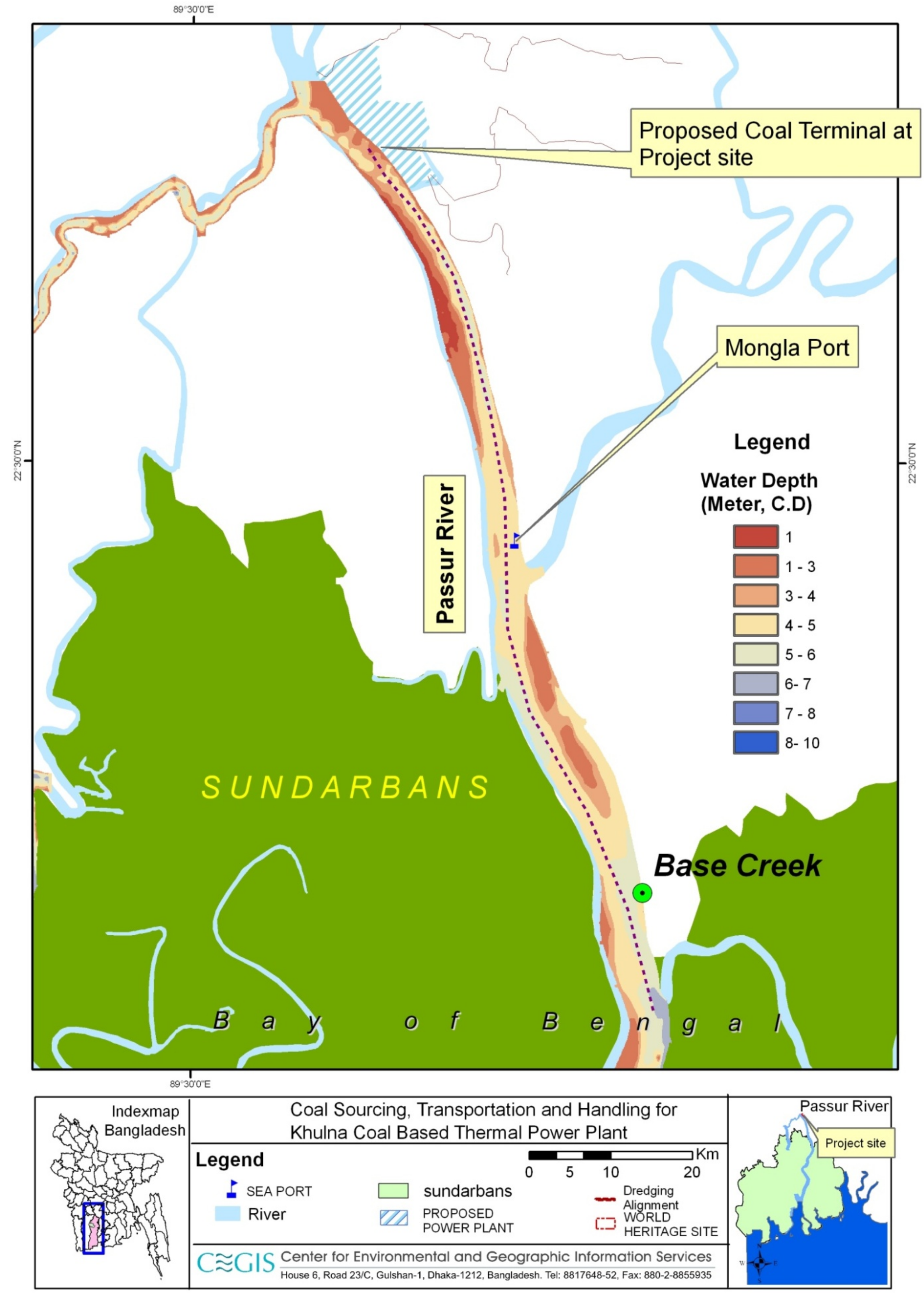
Table 10.1b: Suggested dredging plan for Khulna Power Plant

Sl.No	Dredging location	Dredging Vol.	Dredging Cost.
Capital Dredging			
1	Outer Bar (Length 20km, Channel width-160m, depth 12 m CD)	30 million m^3	105 million USD
2	Base Creek to Mongla Port (Length-10 km, Channel width-100m, Depth-5.5m CD)	1.3 million m^3	6 million USD
3	Mongla Port to Project site (Length-6 km, Channel width-100m, Depth-5.5m CD)	0.8 million m^3	4 million USD
		Total	**114.45 million USD**
Maintenance Dredging for Outer Bar			
1st year	Outer Bar and the channel	6 million m^3	21 million USD
2nd year	Outer Bar and the channel	5.5 million m^3	19.2 million USD
3rd year	Outer Bar and the channel	5 million m^3	17.5 million USD
4th year	Outer Bar and the channel	4 million m^3	14 million USD
5th year	Outer Bar and the channel	3.5 million m^3	12.25 million USD
Yearly Maintenance Dredging for Channel (Base Creek to Project site)			
1	Base Creek to Mongla Port (Length-10 km, Channel width-100m, Depth-5.5m CD)	1.2 million m^3	6 million USD
2	Mongla Port to Project site (Length-6 km, Channel width-100m, Depth-5.5m CD)	0.6 million m^3	3 million USD
		Total cost of maintenance dredging for first year	**30 million USD**

Note: Either the GOB or the BPDB may bear this cost of the dredging. Cost of the coal transportation as described in Chapter 12 does not include this dredging cost.



Map 10.6: Tentative dredging plan at Outer bar



Map 10.7: Tentative dredging plan from Base Creek to Project

10.5 Dredging of approach channel for Maheshkhali coal terminal

10.5.1 Conceptual planning for approach channel

A channel has to be developed from deep sea to the project site coal terminal by dredging. The width of the approach channel was considered as 400 m following the PIANC guideline for 80,000 DWT vessel and design of Sonadia deep sea port. However, maintaining such wide channel would be challenging and cost intensive. In such, 200 m width might be adopted considering single lane channel, which will reduce 50% of dredging cost. However, wide should be determined considering traffic volume, scope of future extension of the project, purpose of using the coal terminal (whether it would be for project based or would be a coal center for national interest). The design depth of the channel has been considered as 15 m CD targeting vessel of 80,000 DWT. The slope of the channel should be designed after getting information of subsoil condition. The length of the channel from the entrance to berth stands 7 km. The channel starts from the area of sea having over 15 m draught (Map-10.5-a and b). Sea state condition considered for Sonadia Deep Sea Port has also been conceptualized for planning of this approach channel. Accordingly, the direction of approach has been fixed 90 degree (east direction from the sea) considering wave, wind, current and tide condition of sea as assumed in the feasibility study of the Sonadia Deep Sea Port. However, during detail design, the direction, angel and slope of the approach channel should be fixed as per detail investigation and analysis.

10.5.2 Dredging requirement

Dredging requirement has been assessed for two options- approach channel of 400m and of 200m. The requirements have been estimated analyzing the bathymetry of the coast (Map 10.8 and 10.9), long profile of the coast (Figure 10.2) and conceptual plan of the approach channel.

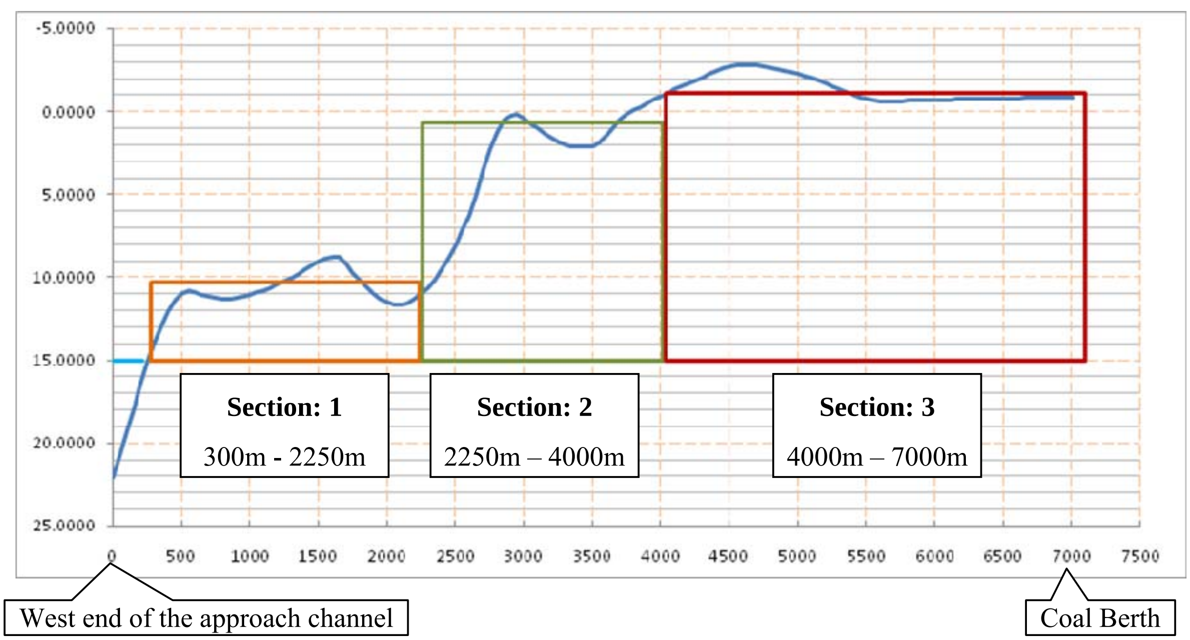


Figure 10.2: Long profile of the Maheshkhali Coast along the proposed approach channel

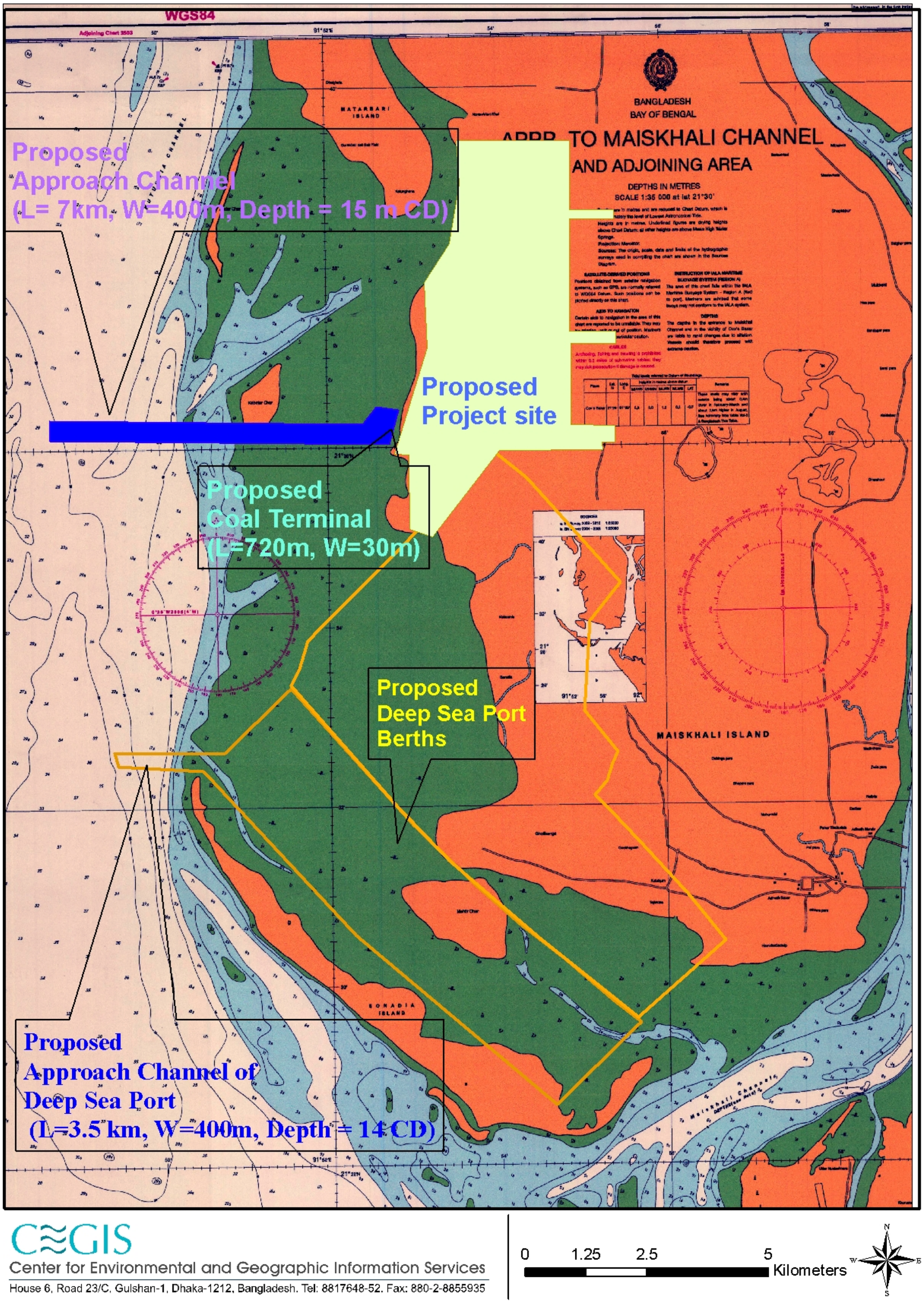
Considering, 7 km length, and 15m CD design depth, the total volume of the dredging comes at around 37.8 million m^3 for 400m wide channel and million 20 million m^3 for 200m wide channel. Accordingly, costs come at around 132 million USD and 69 million USD. Table 10.2 gives details of the indicative cost of the dredging for different sections of the channel. The dredging work might be done under capital dredging program. Dredging method might be varied at different section of the channel. Near deep-sea port, Trailing Suction Hopper (TSH) type Dredger might be used. In the area nearer to shore, Cutter Suction Dredger (CSD) might be useful considering utilization of dredged material in land filling.

The unit price for TSHD type dredger to dredge is **3.5 USD** per cubic meter and **4.5 USD** per cubic meter for CSD type. However, further study should be carried out for investigating long shore sediment transport, sea state and environment to determine breakwater structure and training work for sediment management and for achieving harbor calmness.

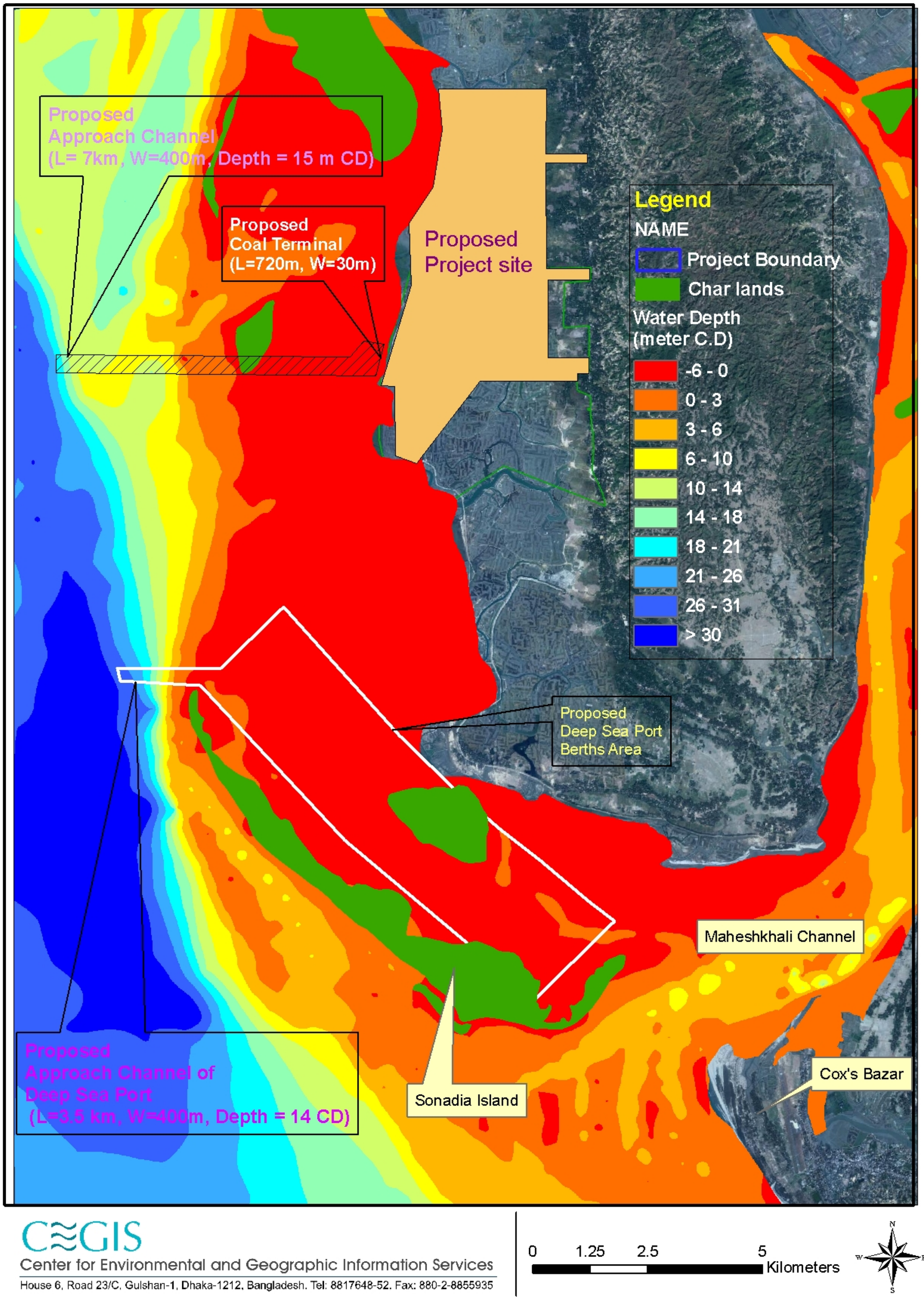
Table 10.2: Dredging requirement and cost estimation

Dredging Section	Required Dredging (Million m3)	Type of Dredger	Cost of Dredging (Million USD)
Dredging requirement for Option-1: approach channel of 400m			
Section 1 (Chainage 300m to 2250m)	14.5	TSHD	50.75
Section 2 (Chainage 2250m to 4000m)	21.5	CSD	75.25
Section 3 (Chainage 4000m to 7000m)	1.75	CSD	6.13
Total	37.75		**132.13**
Dredging requirement for Option-2: approach channel of 200m			
Section 1 (Chainage 300m to 2250m)	7.25	TSHD	25.38
Section 2 (Chainage 2250m to 4000m)	10.75	CSD	37.62
Section 3 (Chainage 4000m to 7000m)	1.75	CSD	6.12
Total	**19.75**		**69.12**

Note: 1USD = 80 BDT assumed; TSHD: Trailing Suction Hopper Dredger; CSD: Cutter Suction Dredger



Map 10.8: Location of the Approach Channel to be dredged



Map 10.9: Dredging Plan and Bathymetry of Maheshkhali Coast

10.6 Wind environment of Bangladesh coast

Bangladesh has a small footprint in the global map. The coastline is 500 km in the East-West direction. As a result, phenomenon like wind, tides do not vary significantly between places. Some representative parameters are presented in the following. This is expected to give a broad indication of the sea state so as to understand the complexities that will be encountered in navigation as well as harbor operations.

Table 10.3: Mean monthly wind speed and direction

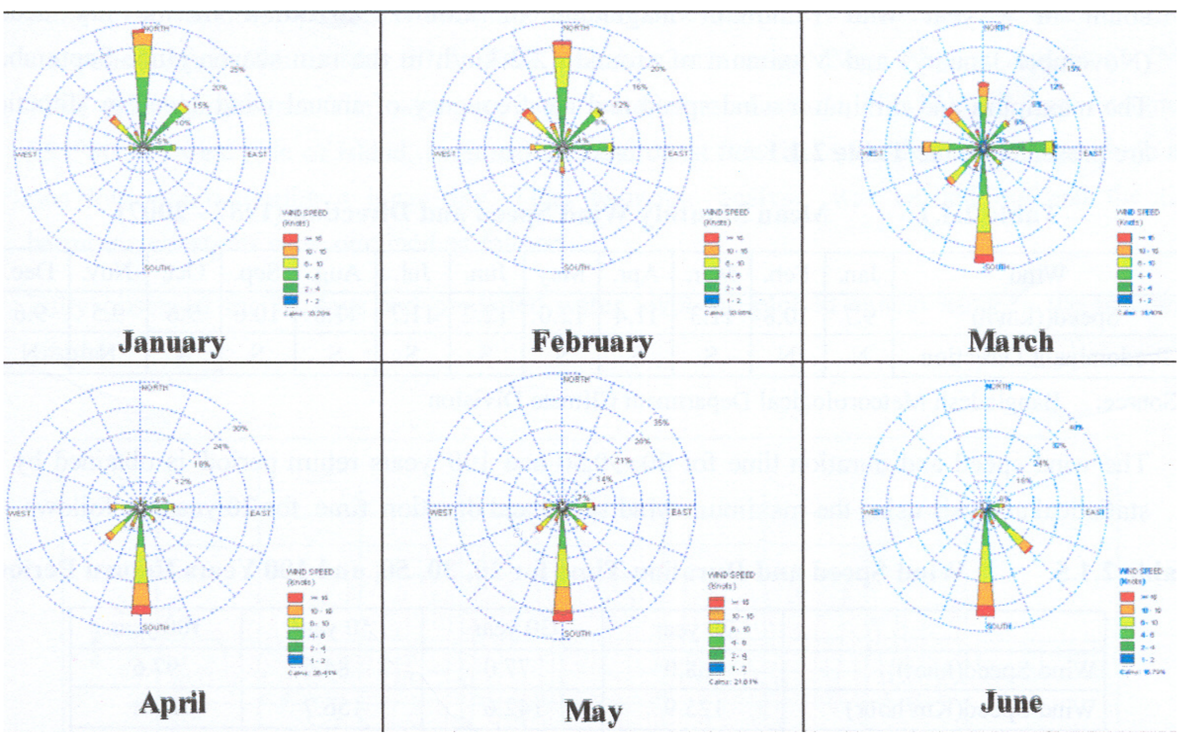
Wind	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Speed (Km/h)	9.7	10.8	11.3	11.4	12.0	12.2	11.7	11.6	10.6	9.6	9.5	9.6
Predominant Direction	N	N	S	S	S	S	S	S	S	N	N	N

Source: Bangladesh Meteorological Department (BMD)

Table 10.4: Wind speed and duration time for 20, 30, 50 and 100 years return period

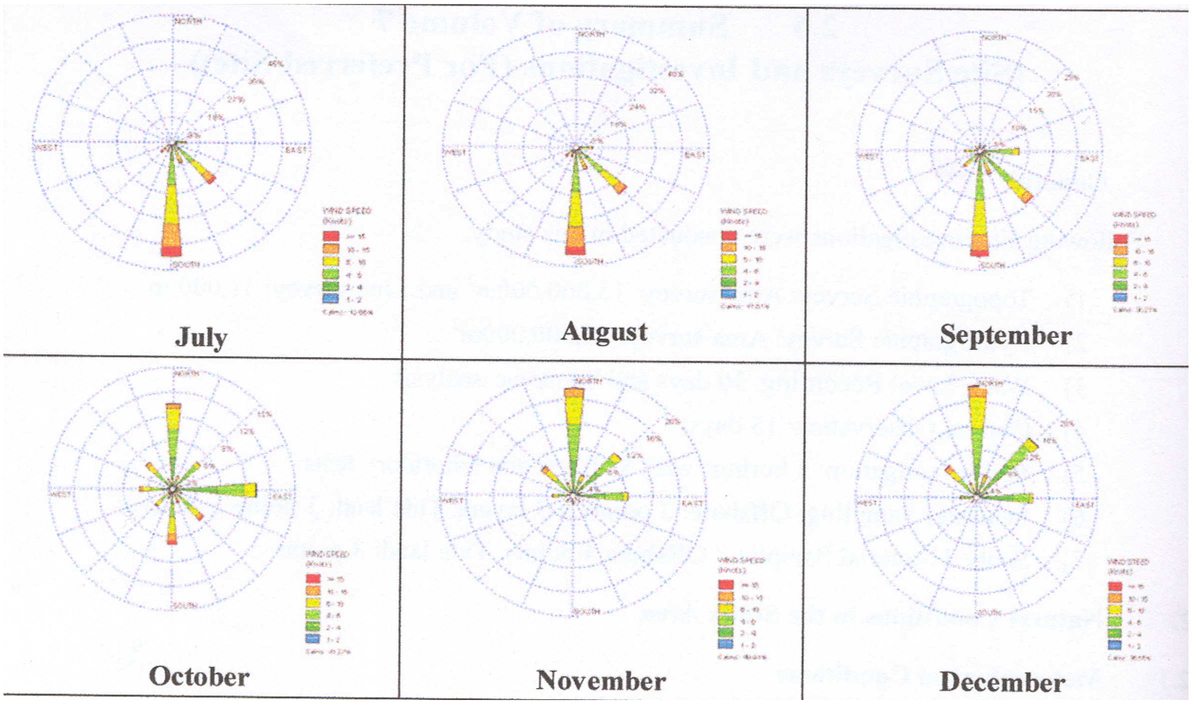
	20 Years	30 Years	50 Years	100 Years
Wind Speed (knots)	68.0	77.0	84.6	97.6
Wind Speed (km/hr)	125.9	142.6	156.7	180.8
Duration Time (hours)	15.5	17.5	21.1	25.5

Source: BMD and Feasibility Study Report on Deep Sea Port (PCI, 2009)



Source: Feasibility Study of Deep Sea Port (PCI, 2009) based on data of BMD

Figure 10.3a: Average windrose diagram of Cox's Bazar coast (January to June)



Source: Feasibility Study of Deep Sea Port (PCI, 2009) based on data of BMD

Figure 10.3b: Windrose diagram of Cox's Bazar coast (July to December)

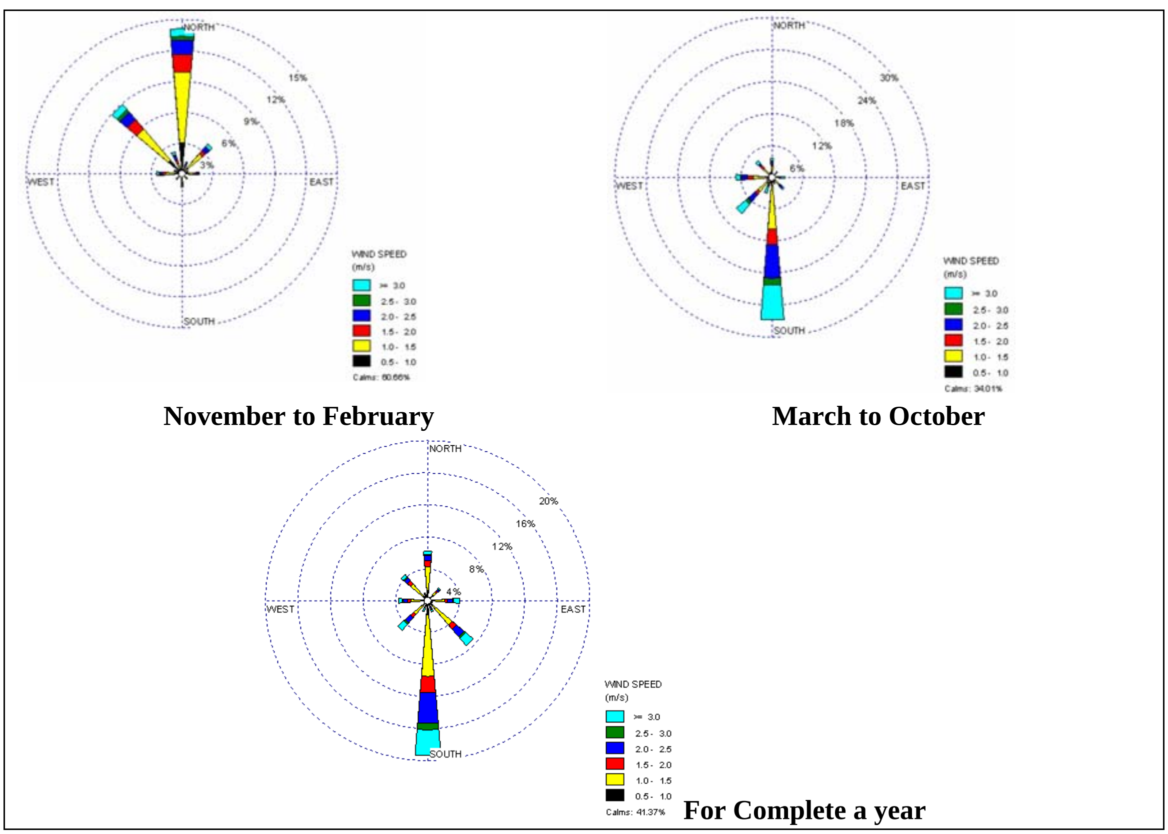


Figure 10.4: Windrose diagram of Khulna

10.7 Tidal Level

Tides in Bangladesh coast originate in the Indian Ocean. It enters the Bay of Bengal through the two submarine canyons, the ‘Swatch of No Ground’ and the ‘Burma Trench’. Tide arrives with semi diurnal features all over the coastal zone of Bangladesh. The periods of oscillations are 12 hours 25 minutes or 12 hours respectively.

The coastal area of Bangladesh has three tidal zones. These are:

Macro Tidal Zone: isotidal fluctuation > 4 m

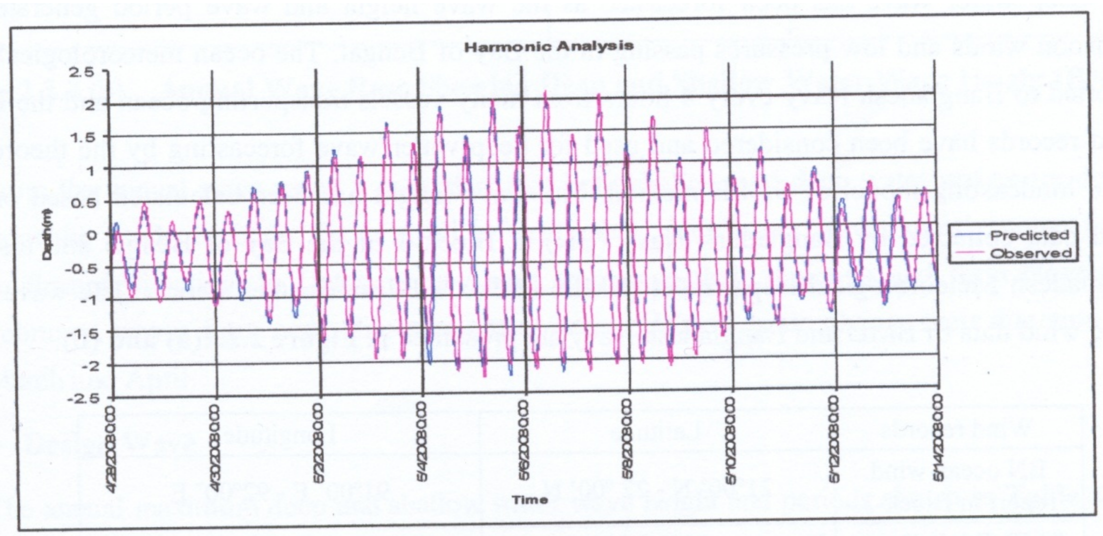
Meso Tidan Zone: isotidal fluctuation 2 – 4 m

Micro Tidal Zone: isotidal fluctuation < 2 m

Each of the proposed power plants falls under the meso tidal zone.

10.7.1 Tidal Behaviour in Chittagong-Maheshkhali Coast

Chittagong and-Maheshkhali cost falls under Meso tidal zone where yearly average tidal fluctuation. The yearly average tidal fluctuation is around 2 m. The Figure 10.5 shows observes and predicted tidal level of Chittagong –Maheshkhali Coast. The tide level is routinely predicted published by BIWTA.



Source: BIWTA

Figure 10.5a: Comparison between predicted and observed tide level of Bangladesh coast

For investigation of waves in a proposed or existing port area, it is recommended that the Lowest Data of Sounding be considered. For specific site, it is important to set to a specified LAT.

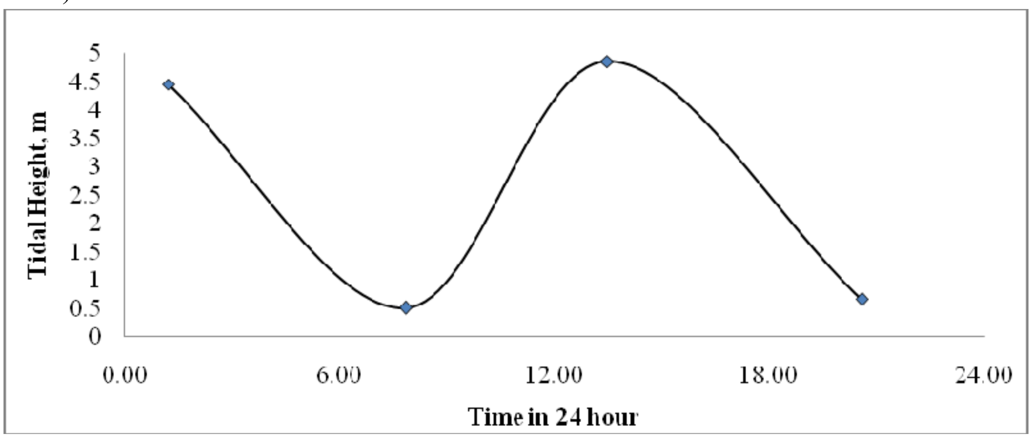
It has been worked out that with the theoretically predicted annual lowest level under any average meteorological conditions and under any combination of astronomical conditions, the Lowest Water Level (LAT is around 2.4 meter. The exact calculations for the selected site will have to be assessed for the exact location, which may be performed in due course of time.

Table 10.5: A Typical Tide level of Chittagong-Maheshkhali cost

Tidal level	Ref MSL	Ref CD
H.W.L. (H.W.S.)	+4.94	+4.63
M.S.L.	+0.0	+2.69
L.W.L. (L.W.S.)	-2.08	+0.61
L.A.T. Chart Datum	-2.69	±0.0

Source: Feasibility study report of Deep Sea Port (PCI, 2009)

Chittagong Port Authority regularly anticipates, observes and published tidal data for Khal No 10 (Karnaphuli River). Annex XIV contains the anticipated tide table of Khal No 10 (Karnaphuli River) published by CPA. The Figure 10.5b shows 24hour anticipated tidal cycle of Khal No 10 (Karnaphuli River).



Source: Chittagong Port Authority

Figure 10.6: 24hr anticipated tidal cycle of Karnaphuli River for 3 July 2012.

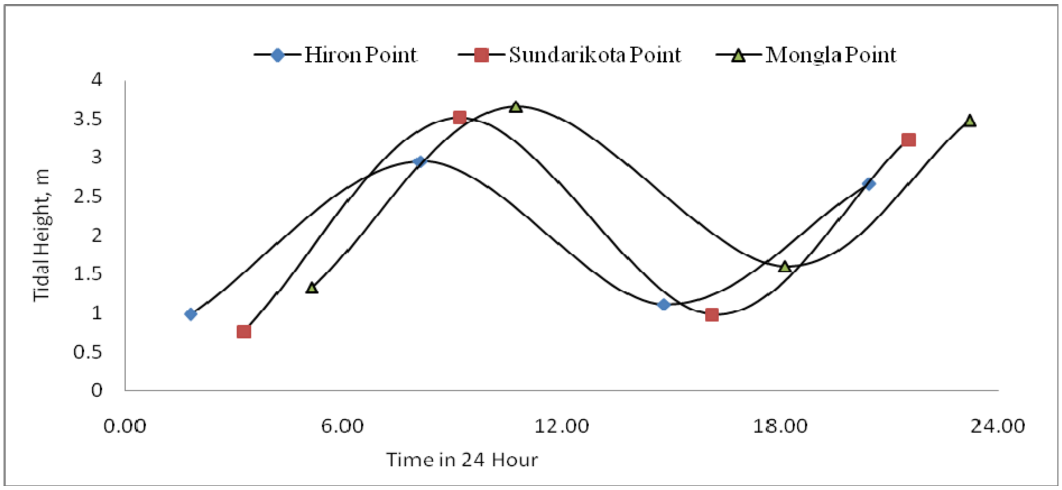
10.7.2 Tidal behavior in Khulna TPP project area

The tides of the Passur River are important for navigation as determines the possibility of crossing the shallow outer bar at the entrance. The approximate range of the tide observed at Mongla station is between 1.2 m to 3.5 m and the tidal amplitude is around 3.25m (Observation of Mongla Port Authority). The tide is semi-diurnal in nature.

In the Passur River System, the tidal range varies between 1.2 and 3.1 meters. The mean water level (CD) is about 0.87 meters (PWD=CD –1.17 meters). The mean high water level varies due to spring-neap tide conditions between +1.60 m and +2.6m PWD. The Highest High Water Level (HHW) is about +3.1m PWD and the Lowest Low Water Level (LLW) is about –1.4m PWD.

Tidal amplitude also varies with location. The tidal amplitudes increase when going upstream from Hiron Point to Mongla Port and then reduce again when continuing to Khulna. As per observation and estimation of Institute of Water Modeling (IWM) the aptitude, approximately 2.5 m up to 3.5 m from Hiron point to Mongla and upto Khulna it downs 1.5 m (IWM, 2006).

The Figure 10.6 shows 24hour anticipated tidal cycle for the Passur River at Hiron point, Sundurukota Tidal Station and Port Jetty.



Source: Mongla Port Authority, 2012

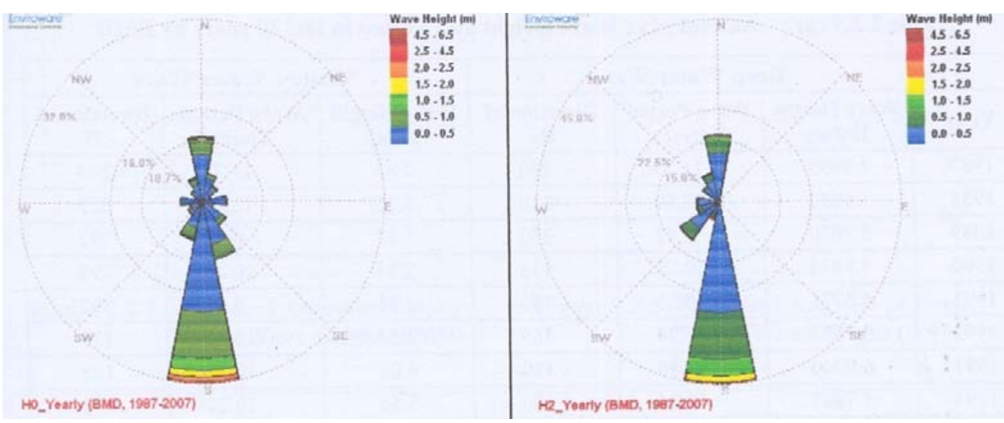
Figure 10.6: 24hr anticipated tidal cycle of Passur River for 1 July 2012

The time difference for the tides at Hiron Point to Mongla is 2 hours 30 minutes. From Mongla to Chalna the time lapse is 30 minutes, from Chalna to Jalma 30 minutes, and from Jalma to Khulna 30 minutes.

Mongla Port Authority and BIWTA regularly publish anticipated permissible draught from MPFWB to Port Jetty. Annex XIV contains anticipated permissible draught for January to June 2012 for MPFWB to Port Jetty.

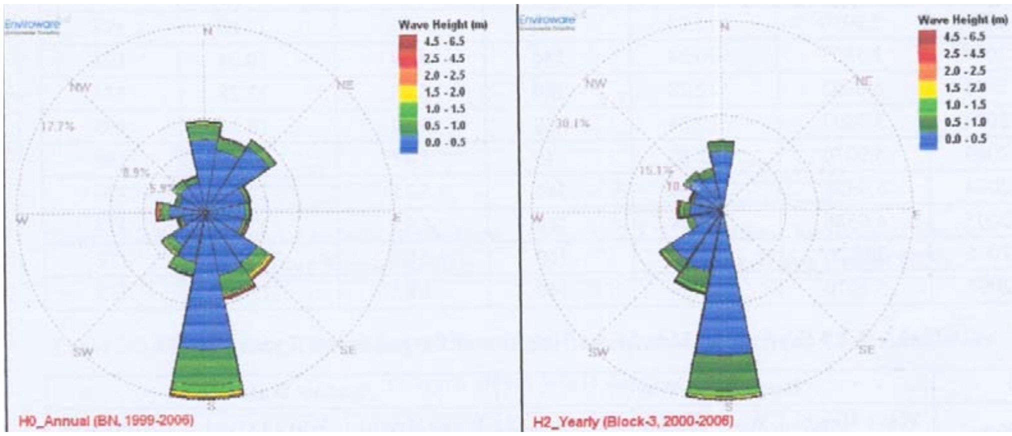
10.8 Wave Conditions

In the Bangladesh waters, the deep-water waves are forecasted as the wave height and wave period generated by monsoon wind and low pressure passing in the Bay of Bengal. The ships of Bangladesh Navy navigating different parts of the coastline record data. Wind data are available from the observatories of the Bangladesh Meteorological Department. The following is a typical Wave Rose is the forecasted for a typical location. Once the site for the port is finally selected, a forecasting may be performed for the specific site.



Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) prepared based on BMD data

Figure 10.7a: Annual wave rose showing deep and shallow water wave height



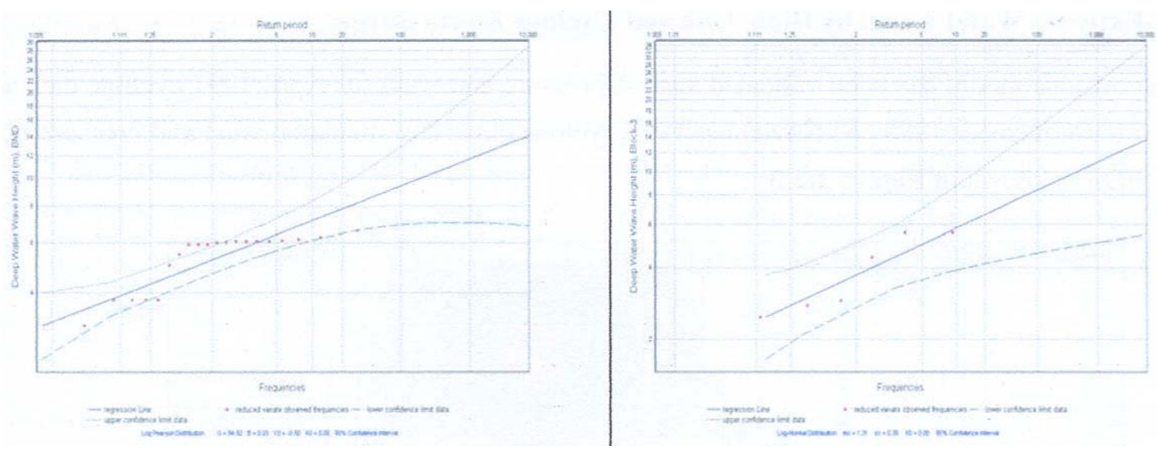
Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) prepared based on BN data

Figure 10.7.b: Annual wave rose showing deep and shallow water wave height

From the annual wave roses, it is evident that both shallow and deep-water waves are dominant from the south direction. From April to September, deep-water waves mostly come from the southward direction. In October, they start to change their direction and from November to February, waves from north direction are dominant.

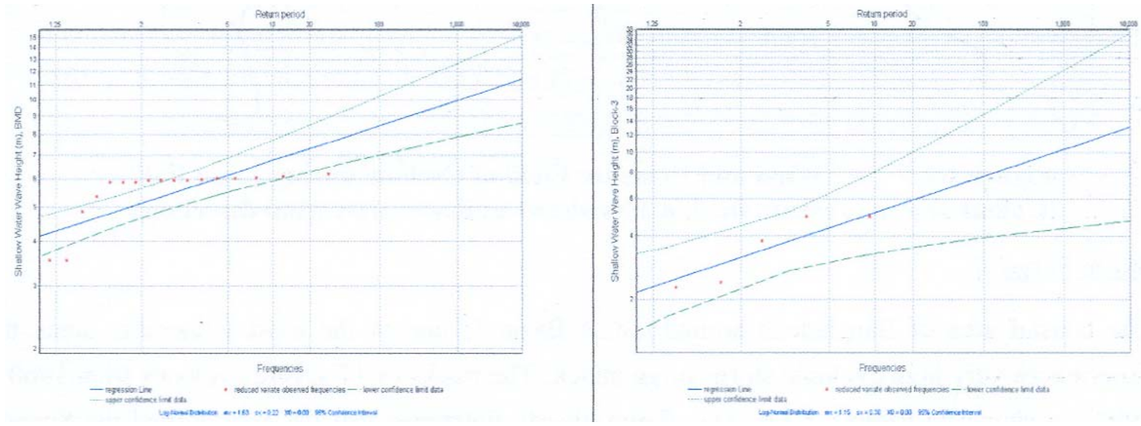
10.9 Design deep water wave for Maheshkhali

A brief study was carried out by deep-sea port project authority for design deep-water wave. The feasibility study report of the Deep Sea Port mentioned the following prediction of the annual maximum deep and shallow water wave heights and periods presented as lognormal distribution curves of 25, 50 and 100 year return periods. However, for determining the design deep-water wave a detail study with at least one year observed data should be carried out.



Source: Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) prepared based on BMD data (left figure) and BN data (right figure)

Figure 10.8.a: Statistical analysis of deep-water wave height



Source: Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) prepared based on BMD data (left figure) and BN data (right figure)

Figure 10.8.b: Statistical analysis of shallow water wave height

Table 10.6: Annual maximum wave height and period for last 20 years

	Deep Water Wave			Shallow Water Wave		
Year	Wave Height Ho (m)	Wave Period To (Sec)	Direction of Ho	Wave Height Ho (m)	Wave Period To (Sec)	Direction of Ho
1987	4.999	11.77	230	4.83	11.77	244
1988	5.9853	12.8	310	5.95	12.80	325
1989	5.9070	9.72	150	5.87	9.72	192
1990	5.9873	10.75	130	5.95	10.75	193
1991	6.5771	9.21	180	6.03	9.21	192
1992	3.7807	10.24	360	3.54	10.24	272
1993	6.0640	12.80	180	6.03	12.80	195
1994	3.7807	10.24	180	3.54	10.24	193
1995	6.0438	12.80	180	6.01	12.80	195
1996	6.0586	12.28	360	5.95	12.28	374
1997	6.2349	11.26	130	6.20	11.26	223
1998	6.1343	12.80	180	6.10	12.80	195
1999	5.9070	12.80	180	5.87	12.80	195
2000	3.7807	10.24	180	3.54	10.24	193
2001	6.0892	12.28	160	5.98	12.28	174
2002	3.7807	10.24	30	3.54	10.24	193
2003	5.9070	12.80	40	5.87	12.79	195
2004	5.4438	12.28	360	3.53	12.28	374
2005	6.0586	12.28	360	5.95	12.28	374
2006	3.0620	9.21	160	2.82	9.21	172
2007	5.9079	12,80	360	5.87	12.80	375

Source: Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) and BN

Table 10.7 Summary of the statistical distribution of the annual maximum wave height

	Deep Water Wave		Shallow Water Wave	
Return Period	**Wave Height Ho (m)**	**Wave Period To (Sec)**	**Wave Height Ho (m)**	**Wave Period To (Sec)**
25 years	7.48	12.4	7.48	12.4
50 years	7.95	13.1	7.98	13.1
100 years	8.38	13.7	8.46	13.7

Source: Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) and BN

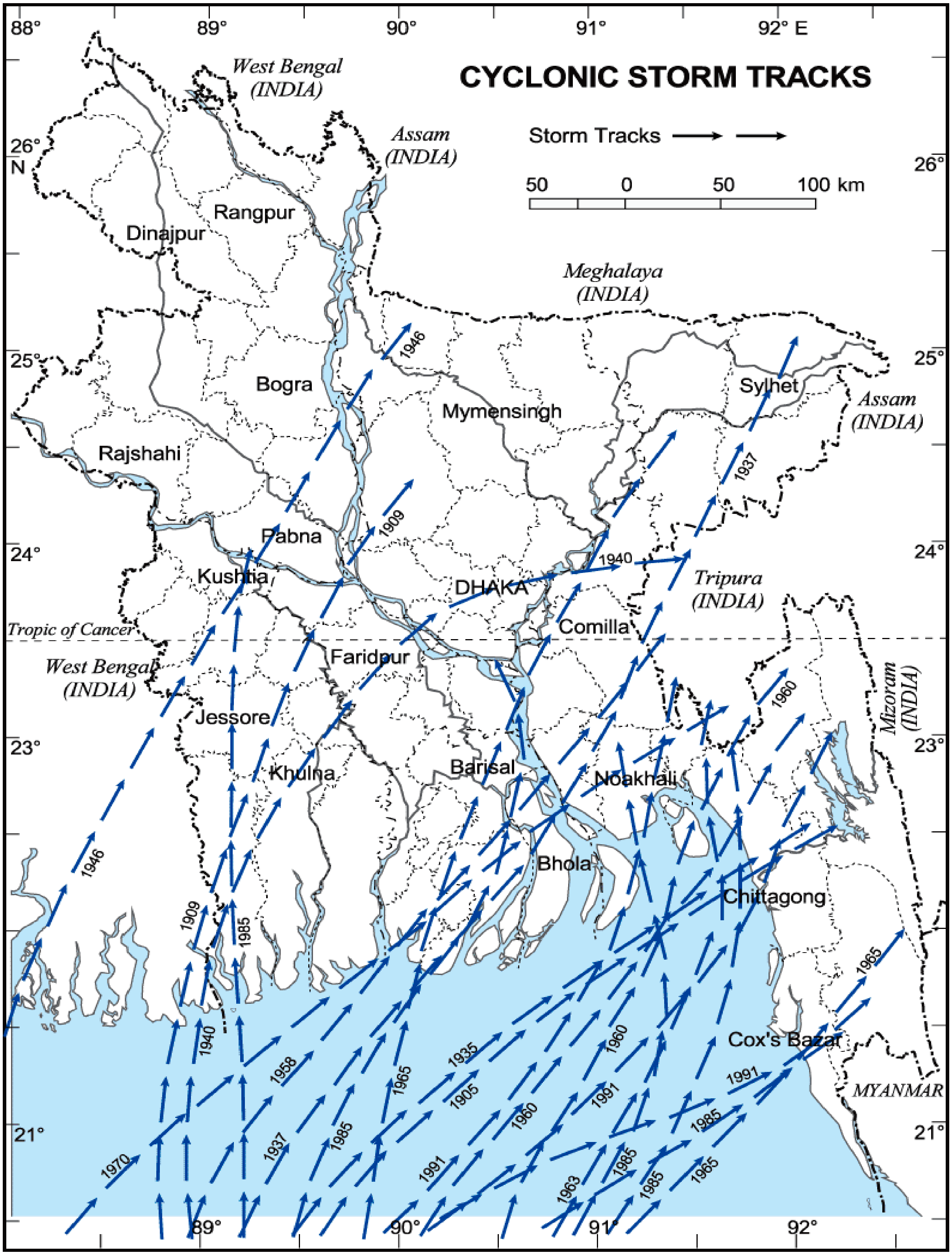
10.10 Extreme Water Level by High Tide and Cyclone Storm Surge

Cyclone is a natural phenomenon which in unpredictable in terms of timing, intensity and the actual track. Obviously, no measure of design consideration can influence any of the three factors. The only option is to try to predict, as early as possible, the track and intensity of the cyclone storm. During the last 125 years more than 42 cyclones have hit the coastal areas (Map 10.10) and 16 cyclones (Table 10.) have occurred in the last 25 years.

Table 10.8: Major cyclones hitting the Bangladesh coast

Date		Maximum Wind speed (km/hr)	Storm Surge height (Meter)
30 October	1960	211	4.6-6.1
30 May	1961	160	6.1-8.8
28 May	1963	203	4.2-5.2
11 May	1965	160	6.1-7.6
15 December	1965	211	4.6-6.1
1 November	1966	146	4.6-9.1
23 October	1970	163	3.0-4.9
12 November	1970	224	6.1-9.1
25 May	1985	154	3.0-4.9
29 November	1988	160	3.0-4.0
29 April	1991	225	6.0-7.5
2 May	1994	210	2.0-3.0
25 November	1995	140	2.0-3.0
19 May	1997	220	3.1-4.2
15 November (Sidr)	2007	240	up to 10
25 May (Aila)	2009	120	3.0

Source: MCSP, 1993 and Bangladesh Meteorological Department



Source: Source: MCSP, 1993

Map 10.10: Tract of Major cyclones struck Bangladesh cost

As such, there is no prediction method available, which can rather accurately predict any of the factors. The intricacies in the prediction vary widely with the geographical location. Thus, until now, no single model can claim to be equally efficient in all seas. In context of the intended coal fired power plant, a strategy is to be adopted for predicting not only the intensity but also track of a cyclones storm as soon as the depression initiates, or perhaps even earlier.

Incomplete atmospheric data makes it difficult for regional forecasters to forecast track and intensity of a tropical cyclonic storm. The usual approach in wave and wind hind casting is data integration and mathematical modeling. Cyclones in the Bay of Bengal – stretching from the southern tip of India to Thailand – are particularly difficult to analyze because of "blind spots" in available atmospheric data for individual storms, as well as the small dimensions of the Bay, which ensure that storms do not have much time to develop or circulate. In most instances, regionally strong wind shear suppresses cyclone development.

But when tropical cyclones do form in the Bay of Bengal area, flooding waves and storm surges can quickly reach the narrow basin's shores. And that unusual wind shear, which is fueled by large temperature contrasts between sea and land, can lead to erratic storm tracks. Forecasting is also made particularly difficult by the "blind spots". Land-based weather stations monitor the edges of the bay, but they cannot see much when a storm is brewing several hundred miles from the coastline.

Accurate forecasting requires access to the fleet of "hurricane hunting" airplanes that fly through Atlantic storms. However in most places including the Bay of Bengal, the forecasters have to rely on remote satellite measurements that can only assess atmospheric and ocean temperatures under "clear-sky," or cloudless, conditions - not exactly common in the midst of a cyclone.

An effective alternative would be to employ 3-dimensional satellite imagery and atmospheric profiles from the Atmospheric Infrared Sounder (AIRS) from satellite to see into the heart of the storm. AIRS has become increasingly important to weather forecasting because of its ability to show changes in atmospheric temperature and moisture at varying altitudes. Until recently, many weather modelers were only using AIRS data from cloud-free skies. Accurate atmospheric temperatures can be obtained using real AIRS partly cloudy data.

AIRS cloudy-sky data can now be integrated into what are called shared data assimilation systems, which combine millions of data points from Earth-observing satellites, instrumented ocean buoys, ground-based sensors, aircraft-based instruments, and man-on-the-scene observations. Data assimilation transforms the data into digital local maps that models can read to produce either hind casts or advance projections of future weather conditions.

Regional forecasting agencies can now readily access AIRS' data daily and optimize forecasts for cyclones in the Indian Ocean. The same technique can be useful to forecasts of hurricanes in the other parts of the world when the storm is formed over open oceans out of flight range of hurricane-hunting airplanes. With this approach, it is now possible to more efficiently define cyclones at the early stages and track them and thus can assist maritime operations.

Wind observations from the Comprehensive Ocean Atmosphere Data Set (COADS) can also be used for hind casting of ocean waves, particularly in severe storms. However, such data sets for the Bay of Bengal is not available.

The wave hind casting may also be performed using the SWAN Model. The SWAN model is a third generation spectral model, suitable for the simulation of wind generated waves from the near shore to the surf-zone. The spectrum that is considered in SWAN is the action density spectrum rather than the energy density spectrum. The action density is equal to the energy density divided by the relative frequency. The independent variables are the relative frequency and the wave direction. In the SWAN wave model the evolution of the wave spectrum is described by the spectral action balance equation.

The parameters in the model are the local rate of change of action, propagation of action in geographical space, shifting of the relative frequency due to variations in depths and currents and the depth-induced and current-induced refraction, energy density representing the effects of generation, dissipation and nonlinear wave-wave interactions, linear and exponential growth by wind, dissipation due to white capping, bottom friction and depth-induced wave breaking and energy transfer due to quadruplet and triad wave-wave interaction.

Data Assimilation and Forecasting System known as GEOS-5 developed by NASA and its NASA/NOAA- is now able to create analysis technique using data from the days leading up to a cyclonic storm in the Bay of Bengal area. The method was developed by after the severe cyclonic storm that hot Nargis in 2008. The track of the storm was erratic when compared with the traditional prediction approaches. The path of the cyclonic storm was quite different from what was predicted using the conventional approaches. This model was later developed and was applied to records available from Nargis. It appeared that the prediction of the available data at any stage was very close to the actual track and intensity.

The current version of the model is Goddard Earth Observing System Model, Version 5 (GEOS-5). This is a system of models integrated using the Earth System Modeling Framework (ESMF). The GEOS-5 DAS integrates the GEOS-5 AGCM with the Grid point Statistical Interpolation (GSI) atmospheric analysis developed jointly with NOAA/NCEP/EMC. The GEOS-5 systems are being developed in the GMAO to support NASA's earth science research in data analysis, observing system modeling and design, climate and weather prediction, and basic research.

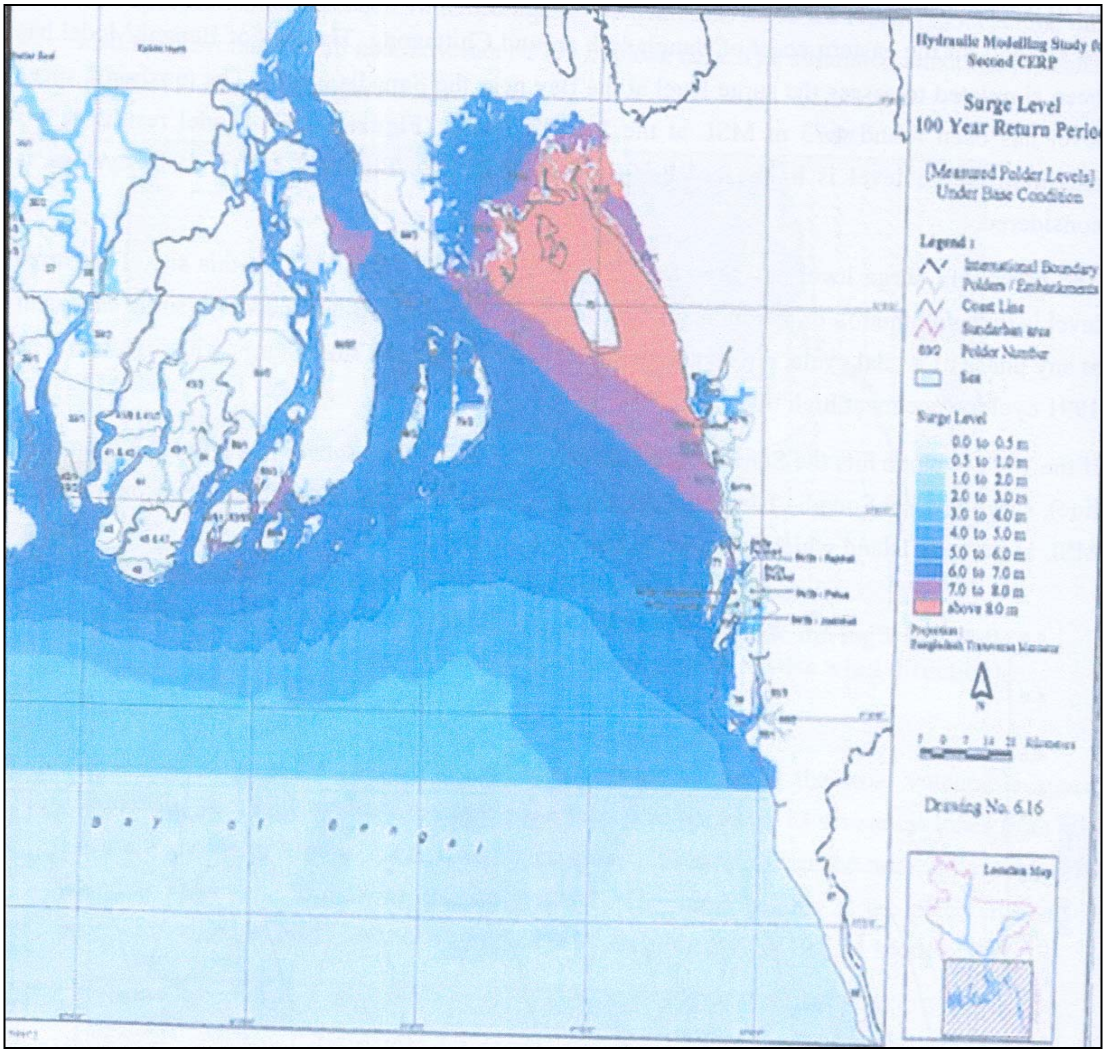
Plan for operation of the port may adopt the method for prediction of any cyclonic storm once a depression is identified.

10.11 Storm Surges

The coastal areas of Bangladesh are one of the most vulnerable areas that experience very high cyclonic storm surge attack. The tracks of different cyclonic storm have been shown in the figures above. The figures clearly illustrates that the areas in the intended port for coal handling is vulnerable to cyclone and surge attack.

The intensity of the coastal surge largely depends upon the pressure fall in the sea level. The most severe pressure fall was recorded in the cyclone of 1991, which was 74 mb with a radius strength of 74 km. The cyclone hit the eastern coast of the Bay of Bengal around Chittagong. The consequent maximum surge was 4.73 m MSL that was a result of combination of astronomical tide and the storm surge. It is advisable to assume a similar figure in design of the coat transportation port under the project. Some safety margin should also be added. However, a more precise calculation should be performed in the process of design of the port. The worst condition is the combination of the astronomical tide and the storm surge.

Under a coastal embankment rehabilitation project, highest simulated water levels of 17 cyclones were fitted to an exponential frequency distribution. Considering the frequency distribution, a map of 100-year return period of surge level was developed as shown in the Figure (10.9) below.



(Source: Water Resources Planning Organization, WARPO)

Figure 10.9: Predicted storm surge level at 100-year return period

10.12 Current conditions

No data is available for the current condition in the intended port areas. However, in other places of the Bay, the highest recorded depth average velocity is around 145 m/sec with the predominant direction NNE, SSW, flood, and Ebb tide. Attempts were made by the Feasibility Study Team of Proposed Deep Sea Port to investigate current condition of the Maheshkhali coast. The Table 10.9 presents some observed current data

Table 10.9: Maximum current velocity at the Sonadia Island in the Chittagong area

5/25/2008 (spring tide condition)			5/24/2008 (spring tide condition)		
Time	Direction	Speed (m/sec)	Time	Direction	Speed (m/sec)
L.W.L. (6 am)	SSW	0.8	L.W.L. (6 am)	SSW	0.5
+1.0 hour	SSW	0.2	+1.0 hour	SSW	0.2
+2.0 hour	NNE	0.6	+2.0 hour	NNE	0.5
+3.0 hour	NNE	1.3	+3.0 hour	NNE	1.1
+3.5 hour	NNE	1.45	+3.5 hour	NNE	1.1
+4.0 hour	NNE	1.2	+4.0 hour	NNE	1.1
+5.0 hour	NNE	1.0	+5.0 hour	NNE	0.8
H.W.L. (+6 hour)	NNE	0.6	H.W.L. (+6 hour)	NNE	0.55
+7.0 hour	NNE	0.2	+7.0 hour	NNE	0.2

Source: Feasibility Study Report of Deep Sea Port (PCI, 2009) and BN

Chapter 11: Coal Transportation

11.1 Introduction

Coal is a global industry, with coal mined commercially in over 50 countries and used in over 70 countries. Coal is readily available from a wide variety of sources in a well-supplied worldwide market. From the discussion of the previous chapter, it may be assumed that the required coal for operation of the proposed thermal power plant will be imported. Coal can be transported to demand centers quickly, safely and easily by ship or by rail from source country to end user. A large number of suppliers are active in the international coal market, ensuring a competitive and efficient market. In case of proposed thermal power plants of Bangladesh, maritime transportation would be the best and may be the only way to transport coal from the source country. In the proposed thermal power plant, coal transportation will involve maritime transportation from source to Bangladesh coast then inland water or rail or road transshipment up to plant sites. The aim of this chapter is to suggest a suitable and coal transportation system for the proposed power plant evaluating different alternatives plans, their merits, demerits, cost and effectiveness in supplying required amount of coal up to the project sites.

11.2 Maritime Transport

11.2.1 International sea born trade

Coal is traded all over the world with coal shipped huge distances by sea to reach markets and end users. Over the last twenty years seaborne trade in steam coal has increased on average by about 7% each year (UNCTAD, 2011). Overall international trade in coal reached to1083 million tons in 2010, while this is a significant amount of coal, it still only accounts for about 16% of total coal consumed (Table 11.1). Most coal is used in the country at which it is produced. Australia is the world's largest coal exporter. Transportation cost accounts for a large share of the total delivered price of coal, therefore international trade of steam coal is effectively divided into two regional markets

- The Atlantic market, made up of importing countries in Western Europe, notably the UK, Germany and Spain.
- The Pacific market, which consists of developing and OECD (Organization of Economic Cooperation and Development) Asian importers, notably Japan, Korea and Chinese Taipei. The Pacific market currently accounts for about 57% of world seaborne steam coal trade.

Table 11.1: World seaborne trade in 2006-2009, by type of cargo and country group

Country group	Year	Goods loaded				Goods unloaded			
		Total	Crude	Products	Dry cargo	Total	Crude	Products	Dry cargo
Millions of tons									
World	2006	7682.3	1783.4	914.8	4984.1	7885.9	1931.0	894.2	5060.8
	2007	7983.5	1813.4	933.5	5236.6	8136.1	1995.5	904.3	5236.3
	2008	8210.1	1785.2	946.9	5478.0	8272.7	1942.1	964.1	5366.5
	2009	7842.8	1724.5	924.6	5193.6	7908.4	1877.8	957.3	5073.3
Asia	2006	3073.1	921.2	357.0	1794.8	2906.8	552.7	248.8	2105.3
	2007	3187.1	938.1	358.1	1890.8	3263.6	620.7	260.8	2382.1
	2008	3211.8	902.7	339.3	1969.9	3361.9	565.6	318.3	2477.9
	2009	3061.7	898.7	355.5	1807.5	3582.4	604.1	313.1	2665.2

Source: Review of Maritime Transport, 2010, UNCTAD, 2011

11.2.2 Vessels type by Category of Cargo

In World Sea borne trade, wide range of variety of vessels is being used in transportation. Different types of vessels transport different goods. The type of cargo they carry classifies Ocean–going vessels and their size expressed as DWT or dead weight tonnage.

- General Cargo Ships- designed to carry break bulk cargo.
- Bulk carriers- designed to carry bulk solids such as grains, coal, fertilizer and ores or bulk liquids such as refined petroleum products, chemicals and orange juice.
- Oil Tankers - designed for transporting crude oil.
- Containerships- Designed to transport standard-sized ocean freight containers.
- Other Types of Ships.

11.2.3 Different types of bulk carrier

A bulk carrier, bulk freighter, or bulker is a merchant ship specially designed to transport unpackaged bulk cargo, such as grains, coal, ore, and cement in its cargo holds. Since the first specialized bulk carrier was built in 1852, economic forces have fueled the development of these ships, causing them to grow in size and sophistication. Today's bulkers are specially designed to maximize capacity, safety, and efficiency and to be able to withstand the rigors of their work.

Mini-bulker carriers (Plate 11.1) are prevalent in the category of small vessels with a capacity of under 10,000 DWT. Mini-bulkers carry from 500 to 2,500 tons, have a single/two hold, and are designed for river transport. They are often built to be able to pass under bridges and have small crews of three to eight people.

Plate 11.1: A typical mini bulk carrier

Plate 11.2: A typical modern Handymax bulk carrier

Handysize and Handymax (Plate 11.2) ships are general purpose in nature. These two segments represent 71% of all bulk carriers over 10,000 DWT and have the highest rate of growth. This is partly due to new regulations coming into effect, which put greater constraints on the building of larger vessels. Handymax ships are typically 150-200 m in length and 52,000-58,000 DWT with five cargo holds and four cranes. The Handy and more recent Handymax types remain popular ships with less than 60,000 DWT. The Handymax sector operates in a large number of geographically dispersed global trades, mainly carrying grains, coal and minor bulks including steel products, forest products and fertilizers. The vessels are well suited for small ports with length and draught restrictions and also lacking transshipment infrastructure.

Panamax carrier: Represents the largest acceptable size to transit the Panama Canal, which can be applied to both bulker and tankers; lengths are restricted to a maximum of 275 meters, and widths to slightly more than 32 meter. The average size of such a ship is about 65,000 DWT. They mainly carry coal, grain and to a lesser extent, minor bulks, including steel products, forest products and fertilizers.

Plate 11.3: A typical Panamax bulk carrier

Capesize: Refers to a rather ill defined standard, which have the common characteristic of being incapable of using the Panama or Suez canals, not necessarily because of their tonnage, but because of their size. These ships serve deepwater terminals handling raw materials, such as iron ore and coal. As a result, “Capesize” vessels transit via Cape Horne (South America) or the Cape of Good Hope (South Africa). Their size ranges between 80,000 and 175,000 DWT. Due to their size there are only a comparatively small number of ports around the world with the infrastructure to accommodate such vessel size.

Aframax: A tanker of standard size between 75,000 and 115,000 DWT. The largest tanker size in the AFRA (Average Freight Rate Assessment) is tanker rate system.

Suezmax: This standard, which represents the limitations of the Suez Canal, has evolved. Before 1967, the Suez Canal could only accommodate tanker ships with a maximum of 80,000 DWT. The canal was closed between 1967 and 1975 because of the Israel - Arab conflict. Once it reopened in 1975, the Suezmax capacity went to 150,000 DWT. An enlargement to enable the canal to accommodate 200,000 DWT tankers is being considered.

VLCC: Very Large Crude Carriers, 150,000 to 320,000 DWT in size. They offer a good flexibility for using terminals since many can accommodate their draught. They are used in ports that have depth limitations, mainly around the Mediterranean, West Africa and the North Sea. They can be ballasted through the Suez Canal.

ULCC: Ultra Large Crude Carriers, 320,000 to 550,000 DWT in size. Used for carrying crude oil on long haul routes from the Persian Gulf to Europe, America and East Asia, via the Cape of Good Hope or the Strait of Malacca. The enormous size of these vessels requires custom-built terminals.

Chinamax is a standard of ship measurement that allows confirming ships to the multiple harbours at maximum capacity with the 380,000DWT tons. Inversely, harbours and other infrastructure that are Chinamax-compatible can receive such ship economically, i.e. all harbours accept the same maximum measurement: Length overall 360m/1180ft, beam 65m/213ft and max draught 24m/79ft.

Gearless carriers (Plate 11.4) are bulkers without cranes or conveyors. These ships depend on shore-based equipment at their ports of call for loading and discharging. They range across all sizes, the larger bulk carriers (VLOCs) can only dock at the largest ports; some of these are designed with a single port-to-port trade in mind. The use of gearless bulkers avoids the costs of installing, operating, and maintaining cranes.

Geared bulk carriers (Plate 11.5) are typically in the handysize to handymax size range although there are a small number of geared panama vessels, like all bulkers they feature a series of holds covered by prominent hatch covers. They have cranes, derricks or conveyors that allow them to load or discharge cargo in ports without shore-based equipment. This gives geared bulkers flexibility in the cargoes they can carry and the routes they can travel.

Plate 11.4: A typical gearless carrier

Plate 11.5: A typical geared bulk carrier

Table 11.2: Ship parameter of different bulk carrier

Vessel's Name	**Dead weight (Tons)**	**Length**	**Beam**	**Draught ballast**	**Draught loaded**	**Holds**
Handy size	10,000 to 35,000	180 m	26 m	5.5m	10.6 m	4-5
Handy max	35,000 to 59,000	200 m	30 m	5.5m	11.5 m	5
Pana max	60,000 to 80,000	275 m	32 m	6-7m	13.5 m	7
Cape size	80,000 to over	290m	32.3m	9-10m	18-20m	9
China max	3,80,000 tons	360m	65m	Not specified	24m	Not specified

Availability of vessel is also an important issue that governs decision making of transport option. At present Handysize and Handymax are very common in world market that covers around 70% of world fleet. Table 11.3 shows percentage distribution of different vessel available in world fleet.

Table 11.3: Percentage of bulk cargo vessel in world fleet

Sl. no	**Types of vessel**	**Percentage of the world fleet**
1	Handysize	34% of the world fleet
2	Handymax	37% ” ”
3	Panamax	19% ” ”
4	Cape size	10% ” ”

Source: Review of Maritime Transport, 2010 (UNCTAD, 2011)

11.3 Maritime Routes

Shipping routes reflect world coal trade flows. Sailings are most numerous and most frequent on routes where trade volumes are largest and demand is therefore greatest. In-bulk trade routes reflect the places of origin and consumption of the commodities carried. The way that coal is transported to where it will be used depends on the distance to be covered. Port that handles coal has to have special arrangement and logistic to handle the bulk and as well as the carrier. Coal exporting and importing countries have coal terminal provided with coal handling facilities.

11.3.1 Major sea ports and coal terminal in Australia

Australia is number one country in coal export. The country has well developed logistics and facilities for coal export at their ports. In general, they load/ discharge most of the bulk cargos of Handymax, Panamax, and Capesize vessels. There are around two hundred ports in Australia of which Port of Townsville, Abbote point, Dalrymple Bay, Hay point, Gladstone, Port of Brisbane, Port Stephens, Newcastle, Port Botany, Port Kembla, Melbourne, Geelong, Portland, Victoria, Adelaide, Port Bonython, Whyalla, Ship Hill, Port of Lincoln, Fremantle etc. are major. Among these ports, Abbote point, Dalrymple Bay, Hay point, Gladstone, Port of Brisbane, New Castle, and Port Kembla handle coal. Table 11.4 shows annual handling capacity of major ports of Australia having coal terminal facility.

Table 11.4: Annual handling capacity of major coal handling ports of Australia

State/Port	Annual Capacity 2009-2010 (million Ton)	Export loadings (million ton)	
		2008-09	2009-10
Queensland			
Abbot Point	25	14	17
Brisbane	07	06	7
Dalrymple Bay	68	47	63
Gladstone	75	56	60
Hay Point	44	35	36
Total Qld	**219**	**158**	**183**
New South Wales			
New Castle	113	84	96
Port Kembla	16	13	14
Total NSW	**129**	**97**	**110**
Australia			
metallurgical coal	Na	125	157
thermal coal	Na	136	135
Total AUS	**348**	**262**	**292**

Source: www.australiancoal.com.au

11.3.2 Major sea ports and coal terminal in Indonesia

Indonesian coal production has increased in recent years, currently making the country the world's largest exporter of thermal coal and the third largest exporter of steaming coal. Worldwide demand for power is growing several countries whose power consumption is expected to grow rapidly. Ports of Indonesia's like Tanjung priok (Jakarta), Cirebon(west java),Sunda kelapa(Jakarta), Tnjung Intan,cilacap(central java), Belawan(sumatra), Teluk Byur(west sumatra), Panjang (south Sumatra), palembang(soth Sumatra), Banjarmasin(south Kalimantan), Pontianak(West Kalimantan), Balikpapan(east Kalimantan), pare (sulawesi),Bitung (north sulawsi) etc. plays a vital role in it. Most of them are coal-handling ports but the majors are Banjarmasin (south Kalimantan), Pontianak (West Kalimantan), Balikpapan (east Kalimantan) & North Pulau laut (Kalimantan).

Table 11.5: Location and Handling capacity of major coal handling ports in Indonesia

SI no.	Name of Port	Location	Loading Rate (metric ton per day)	Loading Facility
1	Apar Bay	Kalimantan Island	about 8,000-10,000 metric ton per day by ship's gear	Ship's gear / Floating Crane on subject
2	Adang Bay	Kalimantan Island	about 8,000-10,000 metric ton per day by ship's gear	Ship's gear
			about 10,000-15,000 metric ton per day per Floating Crane*on subject	
3	Banjar masin, Taboneo	Kalimantan Island	about 10,000-15,000 metric ton per day by ship's gear	Ship's gear / available one unit Floating Crane (various shippers)

SI no.	Name of Port	Location	Loading Rate (metric ton per day)	Loading Facility
			about 15,000-20,000 metric ton per day per Floating Crane	available 4 units floating crane (PT. Adaro Indonesia)
4	Jorong	Kalimantan Island	about 8,000-10,000 metric ton per day by ship's gear	Ship's gear
5	Satui	Kalimantan Island	about 8,000-10,000 metric ton per day by ship's gear	Ship's gear / Floating Crane on subject)
6	Samarinda	Kalimantan Island	about 8,000-10,000 metric ton per day by ship's gear	Ship's gear / Floating Crane
			about 15,000-20,000 metric ton per day per Floating Crane	
7	Muara, Pantai, Berau		about 8,000-12,000 metric ton per day by ship's gear	
			about 15,000-20,000 metric ton per day by SST (Semi Submersible Transshipper)	
			about 15,000 MT per day per Floating Crane, available 2 units	
8	North Pulau Laut (Kalimantan).	Kalimantan	Loading rate: about 35,000-40,000 metric ton per day	Loading facility: Traveling loader

11.3.3 Major sea ports and coal terminal in South Africa

The ports of southern Africa play a most important role, approximately 95 percent of all trade to the region passes through these ports. The ports that located in South Africa are Cape Town, Durban, Saldanha, Elizabeth, and Richard Bay etc. Among them, Richard Bay is one of the biggest coal terminal. The Richards Bay Coal Terminal (RBCT), located in the Richards Bay harbour, is the largest coal export facility in Africa. The Richard Bay handles 91 Million tons in a year.

11.3.4 Maritime distance from loading port to Bangladesh Coast

Maritime routes and sea distance from major coal ports to Bangladesh ports around the world has been calculated using web based sea route calculation application (Figure 11.1 to 11.3). The distances were calculated for Chittagong and Mongla port considering average vessel speed of 13 nautical miles.

Table 11.6: Sea route distance from different major coal ports to Bangladesh ports

Sl No.	Coal Loading port	Discharging port	Distance (nm)	Duration of time
Indonesia				
1	Samarinda Kalimantan	Chittagong	2747	08 days 19 hrs
		Mongla	2825	09 days 01hrs
2	Merak java	Chittagong	1964	06 days 07 hrs
		Mongla	2041	06 days 13 hrs
3	Bitung	Chittagong	3042	09 days 18 hrs
		Mongla	3119	10 days 00 hrs
4	North Pulau laut (Kalimantan).	Chittagong	2460	07 days 21 hrs
		Mongla	2521	08 days 19 hrs
South Africa				
4	Richard bay	Chittagong	4681	15 days 00 hrs
		Mongla	4620	14 days 19 hrs
5	Durban	Chittagong	4765	15 days 07 hrs
		Mongla	4705	15 days 02 hrs
6	Cape Town	Chittagong	5529	17 days 17 hrs
		Mongla	5469	17 days 13 hrs
Australia				
7	Brisbane	Chittagong	5240	16 days19 hrs
		Mongla	4906	15 days17 hrs
8	Gladstone	Chittagong	4963	15 days 23 hrs
		Mongla	5656	18 days 03 hrs
9	Kembla	Chittagong	5710	18 days 07 hrs
		Mongla	5240	16 days19 hrs
10	New Castle	Chittagong	5523	17 days 17 hrs
		Mongla	5599	17 days 23 hrs

Figure 11.1: Maritime sea route From New Castle CT, Australia to Mongla port, Bangladesh

Figure 11.2: Maritime sea route From North Pulau Laut (NPLCT), Indonesia to chittagong port, Bangladesh

Figure 11.3: Maritime sea route From Richard Bay, South Africa to Mongla port, Bangladesh

11.3.5 Seaports in Bangladesh

There are two seaports in Bangladesh, one is the Chittagong port Authority and another is the Mongla port authority. In addition, there are two proposed seaport one is deep-sea port in Sonadia Island in Chittagong and another is third sea port in Patuakhali.

Chittagong Port

It is the major port of Bangladesh. It is situated on the bank of Karnaphuli River; nine miles upstream from the Bay of Bengal and connected with the hinterland by Rail, Road, River, Air and Sea. Normally, ocean going vessel having deep draught dropped anchor in outer anchorage area and then after literage come inside the port with the assistance of CP pilot and discharge rest of the cargo in the jetty. The Port usually handles containers and bulk materials other than coal. The Port has well developed facilities for cargo and ship handling but at present no facilities for coal handling. However, for coal handling, a coal terminal shall have to be developed at plant site.

Mongla Port

Mongla is the second seaport in Bangladesh. It is situated at the confluence of the river Passur and Mongla Nullah at a distance of 47 nm (85.5km) of Bay of Bengal and connected with the hinterland with the river, road and sea. It is anchorage port. To approach in Mongla port, ocean going vessel drops anchor near fairway buoy marked by MP and then with the high tide and guidance by the Hiran Point Pilot Station crosses the outer bar area along with about 22 nm (40km) up to the pilot station. Then MP pilot brings the vessel inside the port about 47n.mile (85.5km) as per the instruction by the concern authority. The Port does not have facilities for coal handling at present. However, a new coal terminal shall have to be developed at suitable location for handling the coal and coal carriers.

Proposed Deep Sea Port of Maheshkhali

Government of Bangladesh has a plan of developing a new deep-sea port in Maheshkhali near Sonadia Island. The proposed deep-sea port is located in Kutubjhom and Hoanok Union of Maheshkhali Upazila. The Maheshkhali power plant project falls under the proposed port limit of the proposed deep-sea port. The proposed berth area is only 10 km south from the power plant project area (center-to-center distance). As per feasibility study report (PCI, 2009), the first phase of the project (i.e. short term) will come up with 5 berths (300m each) for container cargo and 4 berths (250m each) for general cargo in 2020. Full scale of the deep sea port project will be completed by 2055. It has been planned targeting vessel of 50,000 DWT with 13.0m load draught. However, the project is still in planning process.

11.4 Ownership of vessel

Either BPDB may own vessel by buying or chartering for coal transportation, or may engage outsource agency under a Coal Transportation Agreement for coal transportation. As BPDB does not have any experience of shipping business, it is recommended engage third party under Contract of Affreightment to handle coal transportation from source country to project site. However, there are different alternatives to own ship and the recommended (Contract of Affreightment) option has been made evaluating all of these options. The following sections briefly discuss different options of owning vessels.

11.4.1 Chartering of vessel

There will also be scope of chartering vessel for transportation. The contract between shipper (and charterer) and the ship-owner called the charter party. Chartering is an activity within the shipping industry. In some cases, a charterer may own cargo and employ a shipbroker to find a ship to deliver the cargo for a certain price, called freight rate. Freight rates may be on a per-ton basis over a certain route (e.g. for coal between Australia and Bangladesh) or alternatively may be expressed in terms of a total sum - normally in U.S. dollars - per day for the agreed duration of the charter. There are three basic types of vessel charters: voyage charter, time charter and bareboat charter.

Voyage charter

A voyage charter is the hiring of a vessel and crew for a voyage between a load port and a discharge port. The charterer pays the vessel owner on a per-ton or lump sum basis. The owner pays the port costs (excluding stevedoring), fuel costs and crew costs. The payment for the use of the vessel is known as freight. A voyage charter specifies a period, known as lay time, for unloading the cargo. If lay time is exceeded, the charterer must pay demurrage. If lay time is saved, the charter party may require the ship-owner to pay dispatch to the charterer.

Time charter

Time charter is the hiring of a vessel for a specific period; the owner still manages the vessel but the charterer selects the ports and directs the vessel where to go. The charterer pays for all fuel the vessel consumes, port charges, and a daily hire to the owner of the vessel.

Bareboat charter

A bareboat charter or demise charter is an arrangement for the hiring of a vessel whereby no administration or technical maintenance is included as part of the agreement. The charterer obtains possession and full control of the vessel along with the legal and financial responsibility for it. The charterer pays for all operating expenses, including fuel, crew, port expenses, PI and hull insurance. In commercial demise chartering, the charter period may last for many years; and may end with the charterer acquiring title (ownership) of the ship. In this case, a demise charter is a form of hire purchase from the owners, who may well have been the shipbuilders. Demise chartering is common for tankers and bulk-carriers.

11.4.2 Contract of Affreightment

Contract of Affreightment (from freight) is a legal term used in shipping. Contract of Affreightment is the expression usually employed to describe the contract between a ship-owner and another person called the charterer, by which the ship-owner agrees to carry goods of the charterer in his ship, or to give to the charterer the use of the whole or part of the cargo-carrying space of the ship for the carriage of his goods on a specified voyage or voyages or for a specified time. The charterer on his part agrees to pay a specified price, called freight, for the carriage of the goods or the use of the ship.

11.5 Coal Transportation Plans for Khulna Thermal Power Plant

Different alternatives have been developed for coal transportation considering different vessel type, inland waterways and mode of transshipment. The alternatives are discussed below

11.5.1 Alternative I: Mongla Port Fairway Buoy anchorage

Vessel up to 3,80,000 tons DWT so called Chinamax type with the draught of 24m (78.7feet) can arrive near Mongla Port Fairway Buoy (MPFWB) and discharge cargo safely. In this anchorage, lighterage operation of cargo may be carried out safely from November to February subject to clearance of customs authority. About 15 nos of different size ships may be anchored in the anchorage area. At anchorage coal discharge operation may be done by own gear of the mother vessel. In case of gearless vessel, gear vessel or floating crane might be used. After discharging from mother vessel at MPFWB coal may be transshipped to the coal terminal (either at project site or Mongla Port area), through Mongla Port’s exciting channel i.e. through Passur River directly with the 5.0m-5.5m (16.4feet-18feet) draught vessel of 10,000DWT. At present, minimum draught of 4.0 m during LLW exists. With tidal advantage vessel having 5.5 m draught can easily proceed to the south end of the project site. However, capital dredging and maintenance dredging would be required to ensure continuous supply of coal up to the project site considering no waiting time for tide. If coal discharged at Mongla Port Jetty area, then it would be further transshipped up to Project site through either coal conveyor corridor or rail way. In this case both capital and maintenance dredging also will be required.

Merits

a) Huge quantity of coal may be carried at a time and maritime transportation will be cheaper.

Demerits

a) Discharging of coal is possible only for four months. Rest of the months of the year, discharging is not possible due to rough weather and sea condition.

b) Due deep draught and length restriction vessel cannot proceed to Akram point.

c) At present Chinamax type vessel is not always available in the world trade volume.

d) This type of vessel may not have own gear for discharging of coal.

e) Distance from project site to MPFWB is also too long (78 nm) for lighterage.

f) Coal transshipment from this type of mother vessel to small type lighterage vessel will be difficult.

11.5.2 Alternative II: Akram point anchorage

It is the area of the adjoining of the Sibsa and Passur River which is 34 nautical mile (approx. 61km) upstream of MPFWB. Vessel up to 80,000tons DWT with the draught of 13.5m (44.3feet) can proceed to Akram point to the adjoining of Sibsa and Passur River if dredging at outer bar and in channel is carried out. Discharge of cargo operation can be done safely to the mouth of Sibasha River, subject to the clearance of the custom authority. With this alternative plan, dredging at outer bar might be required to maintain 13.5m draught. An indicative estimation of dredging requirement has been provided in Chapter 10. Under this plan, there are two options of further coal transshipment up to project site or coal terminal:

Option IIA: Transshipment of coal may be done by the shallow water draught vessel up to the project area through Passur river channel from Akram point anchorage. The shallow water draught vessel would discharge coal at coal terminal to be constructed at plant site or near Mongla Port. If coal discharged at Mongla Port Jetty area, then it would be further transshipped up to Project site through either coal conveyor corridor or rail way. In both case capital dredging and maintenance, dredging will be required to carry coal using innovative lighters of 5.5 m draught.

Option IIB: Transshipment of coal may be done by shallow water draught vessel from Akram point through Sibsa River-Chunkuri River system to the project site. This route is not completely covered by the existing BIWTA's inland waterways at present. With this option, dredging would be required in Chunkuri River at different sections. Finally, the shallow water draught vessel would discharge coal at coal terminal to be constructed at plant site. This option requires further investigation and evaluation.

In both case option IIA and IIB, innovative lighters of 3000 DWT – 10000 DWT having draught of 3.5 m to 5.5 m should be engaged.

Merits

a) Handymax/Panamax type of vessel may proceed to Akram point with coal having 13.5m draught

b) Water depth in Akram point are in available (20m-25m) and suitable for anchorage of Handymax/Panamax type vessel.

c) Coal discharging operation is possible for whole year.

d) Width of the Passur River and Sibsha River (width about 2 km) at Akram point is sufficient for maneuvering of maritime vessel and anchoring of lighterage vessels. Wave condition of the river also favors lightering operation.

e) Distance from project site to Akram point is about 43 nm, which is 35n.mile less than MPFWB.

f) In future, Passur River may be a busy route. In such case, Sibsha River under Alternative –IIB plan might be adopted.

g) Maritime transportation cost will be cheaper than small handy size vessel.

h) Handymax/Panamax types of vessel are available in world trade volume.

Demerits

a) Capital dredging will be required at outer bar channel up to Hiron point. Large investment will require.

b) In case of Passur River: high traffic may disrupt continuous supply of coal.

c) With Sibsha River (under Alternative-II plan), vessel will have to face draught and length limitation. Sharp bents existing in several places of Chunkuri river (need to be used for approaching up to the project site) permits vessels of having maximum 80 m length. At present survey data are also limited. Dredging will be required with proper survey for increasing depth and width of the channel and land cutting for removing the sharp bents. Permission from DoE and Forest Department might also be required for using this route.

11.5.3 Alternative III: Harbaria Anchorage

Vessel up to 25,000 tons DWT with the draught 8.0m (26.3feet) (subject to wide beam and length of the vessel) can enter into the port and discharge cargo at Harbaria anchorage safely for the whole year. The distance from MPFWB to Harbaria is about 59 nm (107.4km). Mother vessels might discharge coal to Lighter for transshipment up to coal terminal at project site or Port site Coal Terminal. If coal discharged at Mongla Port Jetty area, then it would be further transshipped up to Project site through either coal conveyor corridor or rail way. For transshipment from Harbaria to project site or Mongla Port Jetty, innovative lighters of shallower draught should be engaged.

Merits

a) Small Handy type of 25000DWT Ocean going vessel may proceed with 8 m draught (subject to wide beam and length of the vessel) to Harbaria, which is only18 nm downstream from the project site. These types of vessel with own cargo gears are easily available in world trade market.

b) Lightering operation is easier with this type of vessel.

c) No capital dredging will be required, only maintenance dredging might be required for maintaining the channel of 8 m depth from outer bar to Harbaria.

d) Transshipment of coal from Harbaria to project site is easier, cheaper and shorter.

e) Innovative lighters of 10000 DWT can easily proceed to Mongla Port Jetty with 5.5 m draught if the channel is maintained by capital and maintenance dredging

f) Same lighter vessel can also proceed to the project site if the channel is maintained with 5.5 m draught.

Demerits

a) At present, activities of Mongla port are being operated at Harbaria Anchorage. In most time available anchorage areas remain occupied. Sometime, vessels have to wait for a long times.

b) For lighterage operation dredging will be required from Base creek to Mongla Port Jetty and also up to the project site to maintain depth of 5.5 m CD (for innovative lighter of 10,000 DWT).

11.5.4 Alternative IV: Berthing at Coal Terminal at Mongla Port Jetty no-11

Ocean going vessel of 25,000 DWT with the draught 8.0m (26.3feet) subject to the wide beam and length of the vessel may arrive to the port jetty (Jetty no 10 and 11), and discharge cargo. After discharging cargo in the jetty coal may transport to the project site by conveyor belt. In this respect also require dredging from southern anchorage to the jetty side up to 8.0 m (26.3 feet) CD. If coal discharged at Mongla Port Jetty area, then it would be further transshipped up to Project site through either coal conveyor corridor or rail way.

Merits

a) Coal terminal might be constructed at proposed jetty of Mongla Port. In that case, coal can be easily transferred to the project site through conveyor belt.

b) Bangladesh railway has a development project of constructing new rail line from Khulna to Mongla port. In future, this rail way can also be used for coal transportation from port to project site.

Demerits

a) Huge capital dredging and as well as yearly maintenance dredging will be required from Base creek to port site for maintaining the channel depth up to 8 m CD. Main obstruction is at port jetty mouth.

b) A new coal terminal has to be constructed since; the Port has no bulk cargo handling facilities.

c) Regular port operation might be disturbed due to coal unloading and handling activities.

d) There is a risk of environmental damage in Port area and in nearby Sundarbans if dust suppression system is not properly operated. Leached water from coal stockyard might cause environmental damage if no treatment process is adopted.

e) Construction of conveyor belt (around 15 km long and 20m wide) will require land acquisition, canal crossing and road crossing which involves huge expenditure.

11.5.5 Alternative V: Berthing at Coal Terminal at plant site

Ocean going vessel of 25,000 DWT with the draught of 8.0m subject to the wide beams and length of the vessel may arrive to the project site directly to discharge cargo. But, dredging would be required from port jetty to the project area for this plan. An already developed channel with shoaling and shallower area at some location exists from port to project site.

Merits

a) Vessel that can proceed up to Mongla port Jetty-11, which can also easily proceed up to project site.
b) Small Handy type vessel having 8 m draught (subject to beam wide and length) may proceed up to project site.
c) No transshipment/lighterage operation will be required.
d) Cost will be cheaper than the alternative IV.
e) Future expansion will be possible as sufficient land is available in project site.

Demerits

a) Huge capital dredging and maintenance dredging will be required (similar to alternative IV) from base creek to Mongla port Jetty and up to project site.
b) Maintaining depth of 8 m CD in the channel will be the major difficult. Yearly maintenance dredging cost will be very high. However, a detail study has to be carried out for feasibility of dredging activities.

11.5.6 Screening of alternative plans

Through analyzing merits and demerits of each alternative plans, the study screens out alternative I – anchorage at MPFWB. To arrive at a feasible plan further analysis including voyage planning, cost estimation will be required. The following sections describe coal terminal locations, voyage plans and cost estimations.

11.6 Coal transportation plan for Chittagong Power Plant

11.6.1 Alternative- I: Coal discharge at Chittagong port outer anchorage and transported by lighterage

Vessel up to 50,000 tons DWT with the draught of 11.5m (37.7feet) can discharge coal in Chittagong port outer anchorage and transport by lighterage to project site. Under this plan a coal terminal has to be constructed at project site at left Bank of Karnaphuli River. Dredging might be required to develop navigability of the Karnaphuli River and a maneuvering area at coal terminal.

Merits:

a) Handymax/Panamax type mother vessel may proceed to outer anchorage (A-anchorage, ctg. with about 50000 tons of coal having 11.5m draught.
b) Coal discharging operation is possible for whole year.
c) Water depths at Alfa Anchorage are available about 15m and suitable for Anchorage of mother vessels.
d) Distance from Alfa Anchorage to project site only 10 n.m.
e) Lighterage transportation cost will be cheaper
f) Handymax and Panamax type of vessels are available in world trade volume.

Demerits:

1. Most of the deep draught vessels anchorage position for unloading of cargo and for which this area is found always busy.

2. Extra cost for lighterage is involved.
3. During monsoon sometimes, coal discharging may be hampered due to bad weather.

11.6.2 Alternative-II: Direct discharge of coal at Project site

Vessel up to 25000 ton with the draught of 9.1m can discharge coal at plant site. Under this plan a coal terminal has to be constructed at project site at left Bank of Karnaphuli River. At present, no dredging might be required to develop navigability of the Karnaphuli River. However, dredging may require constructing coal terminal inside the Karnaphuli channel provided with a maneuvering area at project site.

Merits:

a) Handymax type vessels having 9.1m draught may precede upto project site.
b) No Transshipment/lighterage operation will be required.
c) Cost will be required for vessels of 25000DWT having 9.1m draught.

Demerits:

1) Maximum 186m length of vessels may enter into the port (Project site) as per ports circulars.
2) Maintenance dredging may require at project site.

11.6.3 Alternative-III: Coal discharge at Kutubdia anchorage

Coal might be transported by 80,000DWT vessel up to Kutubdia anchorage then transshipped up to the project site by lighter vessels.

Merits:

a) Large amount of coal might be possible to transport at a time from source country
b) Maritime transportation cost might be less in compare to other two alternatives
c) As the anchorage area is located outside the Chittagong Port Limit, pilotage cost, tug cost, and other port tariff might not be applicable for the vessel.

Demerits:

a) Lighterage operation might not be possible round the year due to unfavorable weather and sea state condition
b) Lighterage cost will be higher.

11.6.4 Screening of alternative plans

Through analyzing merits and demerits of each alternative plans, the study screens out alternative III – anchorage at Kutubdia. To arrive at a feasible plan further analysis including voyage planning, cost estimation will be required. The following sections describe coal terminal locations, voyage plans and cost estimations.

11.7 Coal Transportation plan for Maheshkhali thermal Power Plant

A deep draught coal terminal might be constructed at project site provided with safe berthing and maneuvering area. Vessel up to 80,000 tons with the draught of 13.5 m may berth at the deep draught coal terminal to be constructed on green shore at project site. The distance from proposed Deep Sea Port to the project is about 5.5 nm.

11.8 Lighterage option

At present lighterage, vessels are available in Bangladesh having carrying capacity 1000-1200 tons only which are not suitable/ feasible for lightering/carrying of this huge coal for the Power Plant. Purpose build coal carrier should be build for lighterage operation. Shallow draught special type of lighterage Barge (Self Propelled) suitable for coal carrying can be constructed in Bangladesh. Some innovative approach might be followed in designing new lighterage vessel with shallower draught. Innovative design approach allows lighterage to carry more goods with shallower draught. Under different alternative plans discussed above, lighterage vessel of 8.000 -10,000 tons DWT with the draught of 5m-5.5m (16.4feet-18feet) may be innovated and engaged for transshipment of coal from mother vessel to the project area. Shallow draught type barges may be engaged for coal transportation in waterways. This type of shallower Barge (Plate 11.6) is already available in international market. Table 11.7 gives some parameters of this available purpose built coal carrier of shallower draught. The following type of barges may carry from 8,000 to 10,000 tons of coal throughout the year, from the mother vessel to the project site directly.

Plate 11.6: Self propelled purpose built shallower draught barge

Plate 11.7: Purpose built flexi float shallower draught barge

Table 11.7: Purpose built barge design specifications

Parameter	Specification
Dimensions	96.0m x 24.5m
Max.DWT	8,000 ton DWT
Loaded Draught	4.5 m
Engines	2 x 1,200 BHP diesel engines
Approx. Max. speed	9 knots (maximum operational speed of 7 knots)
Crew accommodation	15

Source: Kimtrans, Singapore

Presently, Bashundhara Shipping Company has ordered for two vessels of the following specification. These vessels are plying in Mongla port during good weather for carrying clinker from MPFWB to its own cement factory. (Meghna cement factory.)

Table 11.8: Barge Design Specifications of Basundhara Shipping Company

Parameter	Specifications
Dimensions	101.08mx26m
Max.DWT	10,187 mt DWT
Draught	5.5m
Engines	2 x 1,195 bhp diesel engines
Approx. Max. speed	8.5 knots (maximum operational speed of 7 knots)
Crew accommodation	12-13

Source: Basundhara shipping company

At present, Western Marine Shipyard, Khan Brothers Shipyard, Ananda Ship Yards, etc are capable of building such ships. Initially, one year is required to build such purpose build coal carrier.

11.8.1 Ship to Ship transfer

Coal may be unloaded from mother vessel to lighterage vessel by own gear of mother vessel at every anchorage point. If mother vessel is "Handy" type with 4 hatches than at a time four numbers lighterage vessels may be placed and coal may be discharged about 1000 to 1200 Tons per day per hook. If mother vessel is "Handymax" type than at a time six numbers lighterage may be placed and coal may be discharged about 1000-1200 tons per day per hook. If mother vessel is "Panamax" type than eight numbers lighterage may be placed at a time and coal may be discharged about 1200 -1500 tons per day per hook. If vessel having own gears is not available, floating crane might be used. The floating transfer vessel would be anchored/positioned at anchorage area. For Khulna Thermal Power Plant floating transfer vessel would be more suitable. As such, a twin-hull transshipper equipped with three grab cranes combined with two loader conveyor systems into barges might be an option.

Plate 11.8: Pictures of typical floating transfer vessel

11.9 Location of Coal Terminal

11.9.1 Coal terminal location for Khulna

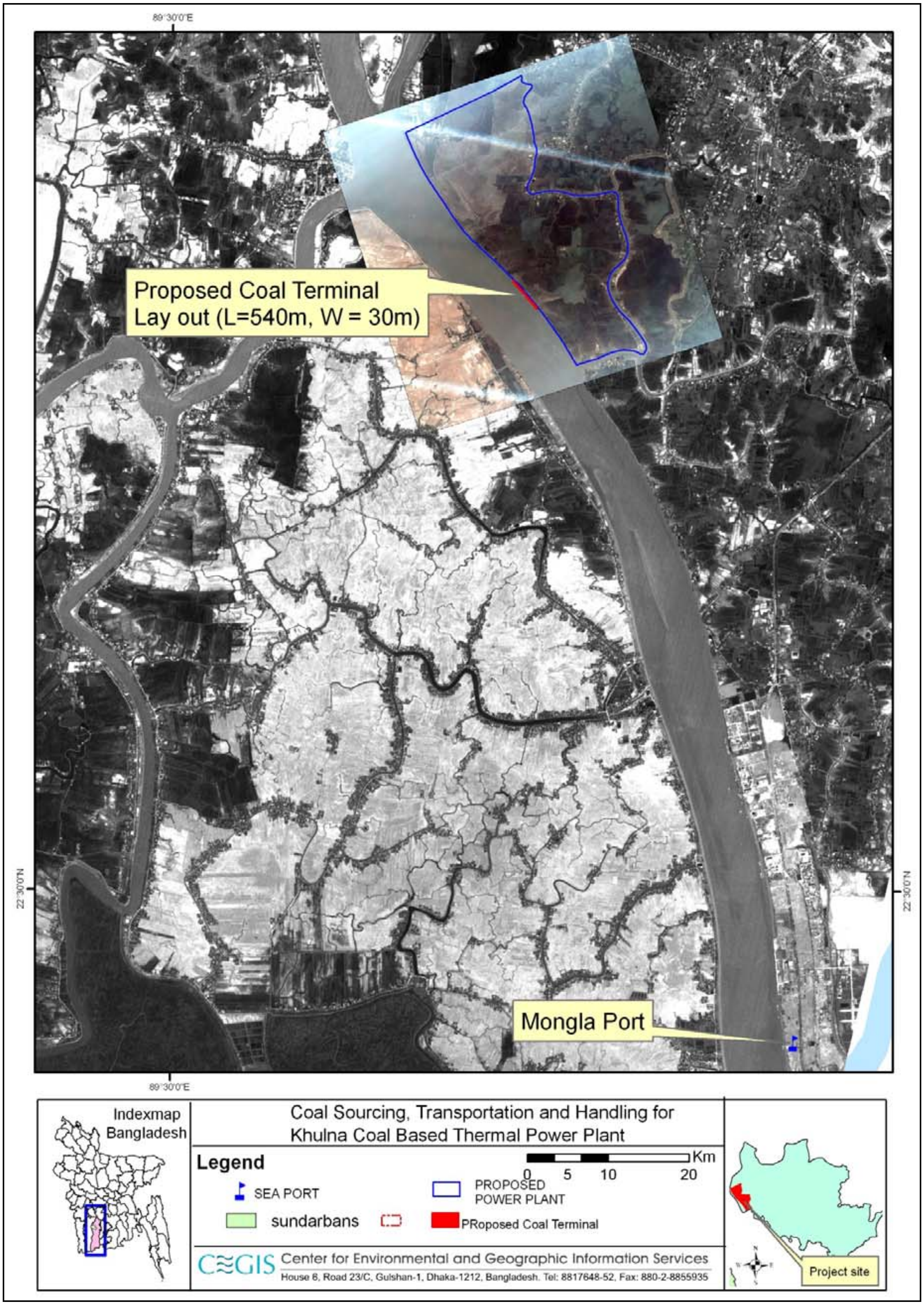
A coal terminal might be constructed either at Mongla Port Jetty-11 or at project site. If coal terminal is constructed at Mongla Port Jetty, further coal transshipment will be through coal conveyor belt. In this case, a capital dredging will be required from Base Creek to Port Jetty. On the other hand, the channel between Mongla Port Jetty to the south end of the project site is in favorable condition and shows an improving trend. If maintenance dredging is carried out vessel coming to the Mongla Port Jetty can also proceed to the Project site. Distance between Project site to Port Jetty is only eight nautical mile (nm). Hence, direct discharge of coal from lighters at project site would be more feasible rather than discharge at Port Jetty that would require further transshipment. In both case of coal terminal location dredging will be required. However, dredging to be required in case of coal terminal at project site would be little higher than the case of coal terminal at Mongla Port Jetty. However, decision should be made comparing the cost of coal transshipment directly up to the project site with transshipment through Mongla Port Jetty and Coal conveyor belt. In addition, comparison should be made between cost of dredging and cost of conveyor belt construction and maintenance.

11.9.2 Coal terminal location for Chittagong Thermal Power Plant

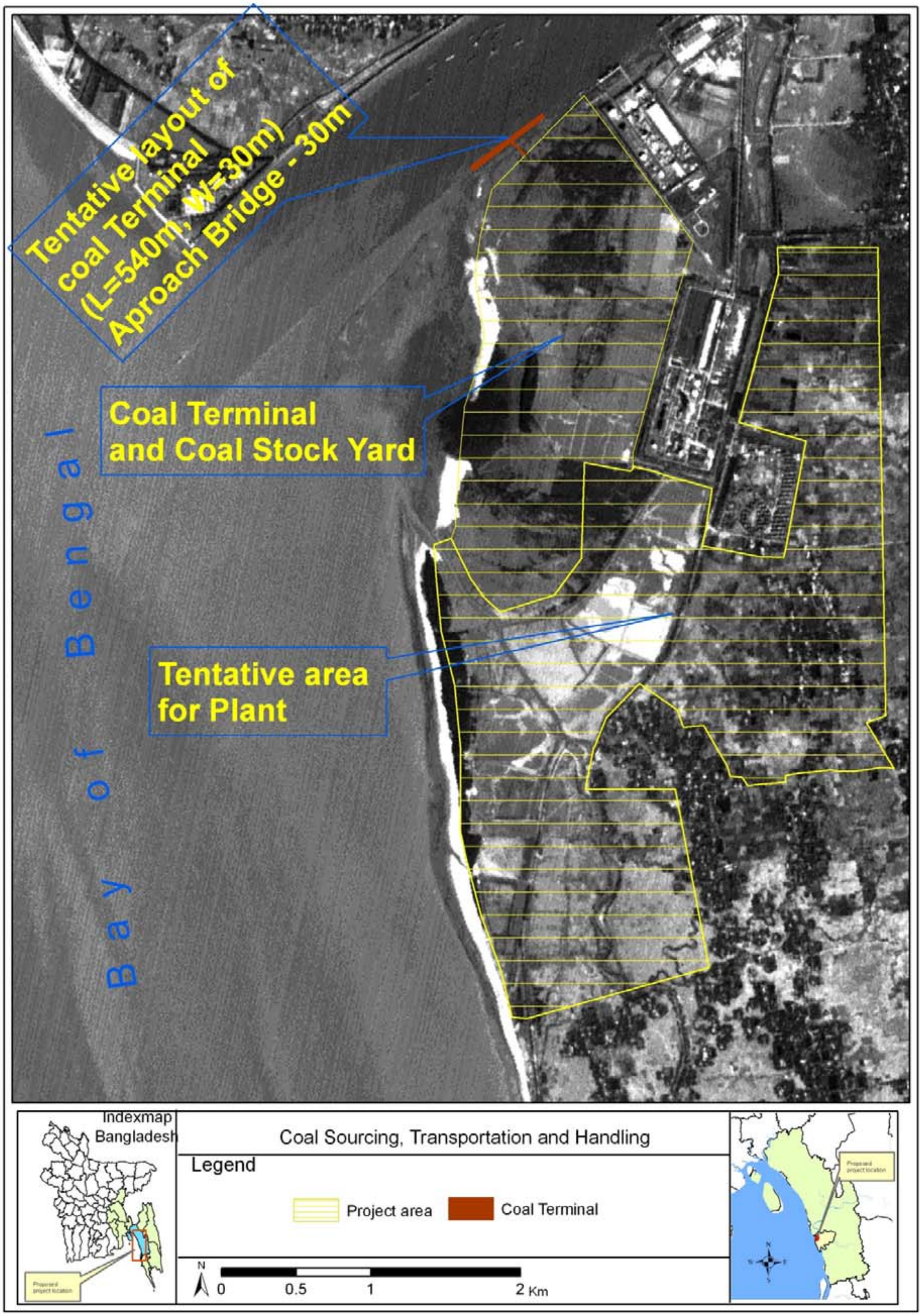
A coal thermal might be constructed at project site, at left bank of Karnaphuli River. At present, no dredging might be required to develop navigability of the Karnaphuli River. However, dredging may require constructing coal thermal, inside the Karnaphuli channel provided with a maneuvering area at project site. The approach to the coal terminal would be thorough Karnaphuli river.

11.9.3 Coal terminal location for Maheshkhali Thermal Power Plant

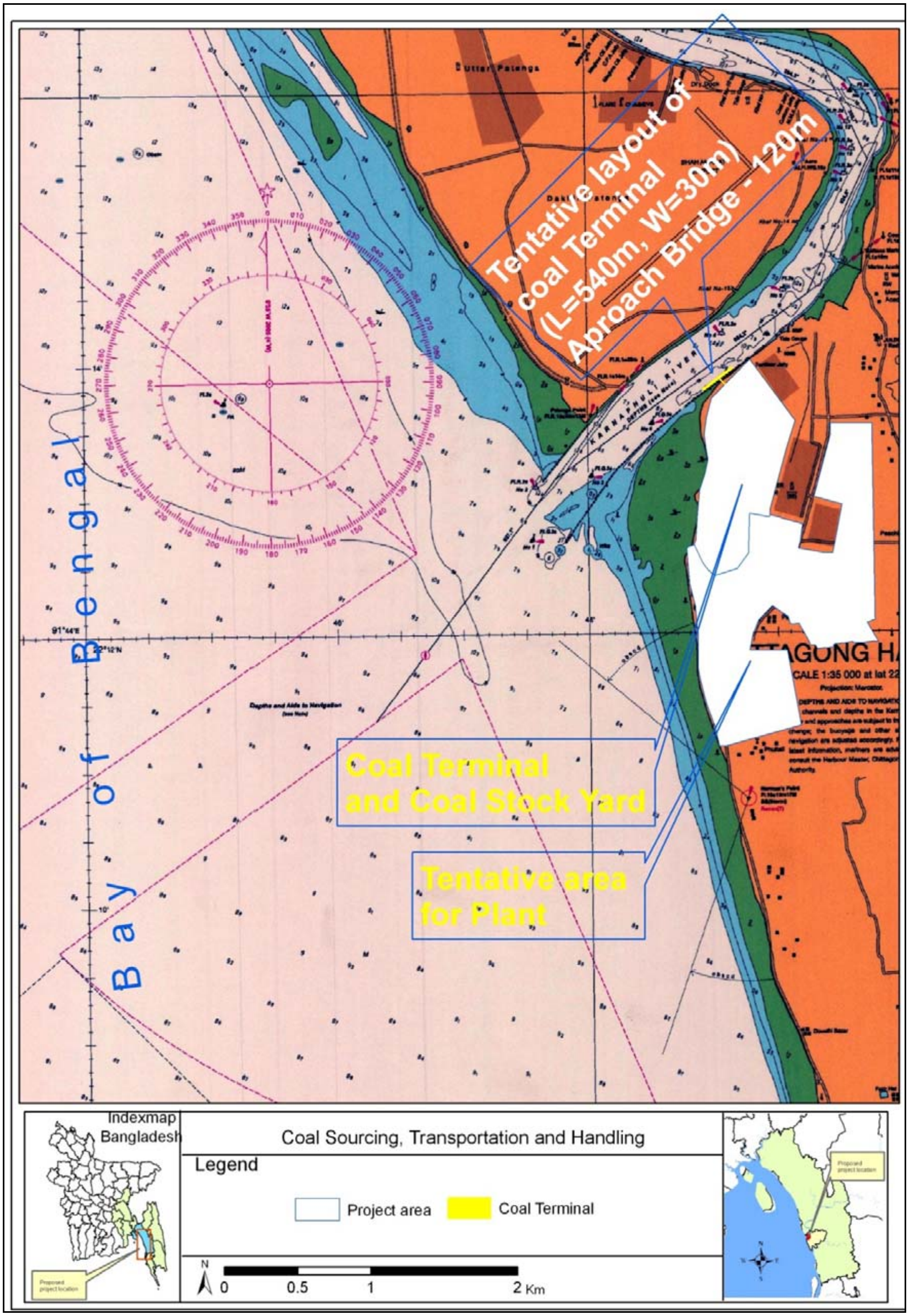
In case of Maheshkhali a coal terminal might be constructed at sea shore side of the project area. The site falls under port limits of the proposed deep-sea port to be constructed in Sonadia. For navigability an approach channel need to be developed by dredging from deep sea to project site (Map-11.5 and 11.6). The approach channel for the Maheshkhali coal terminal has been planned in line with approach channel planned for proposed Sonadia Deep Sea Port. It has been assumed that sea state (wave, tide, wind and current) considered for Sonadia Deep Sea Port would be similar in case of this coal terminal. On this basis, alignment of the approach channel has been considered as same as deep sea port. Channel length would be 7 km, wide would be 400m and design depth would be 15 m CD. At jetty front, channel width would be 650m considering berthing, de-berthing and maneuvering of the vessel with tug facilities.



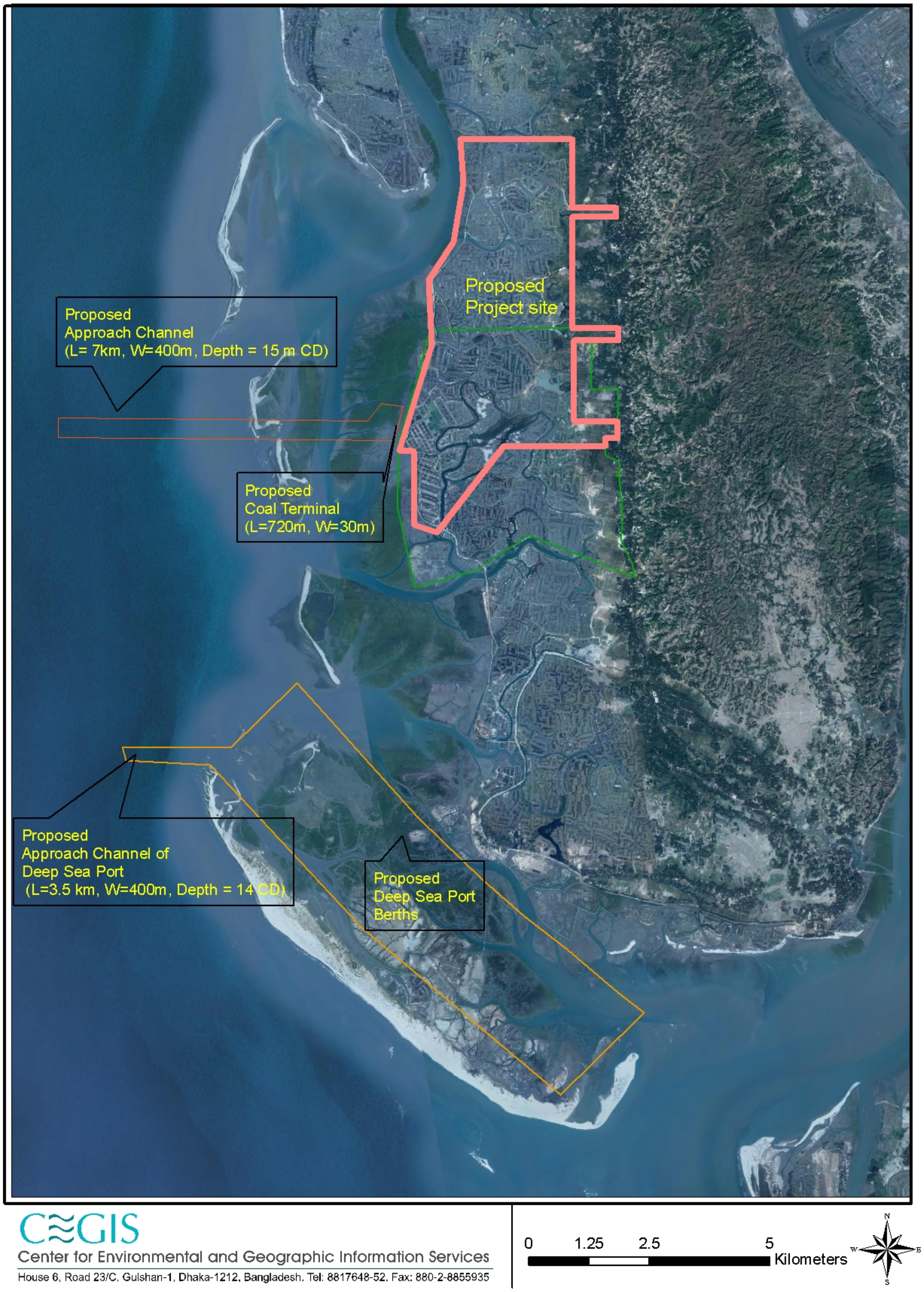
Map 11.1: Coal terminal location of Khulna thermal power plant



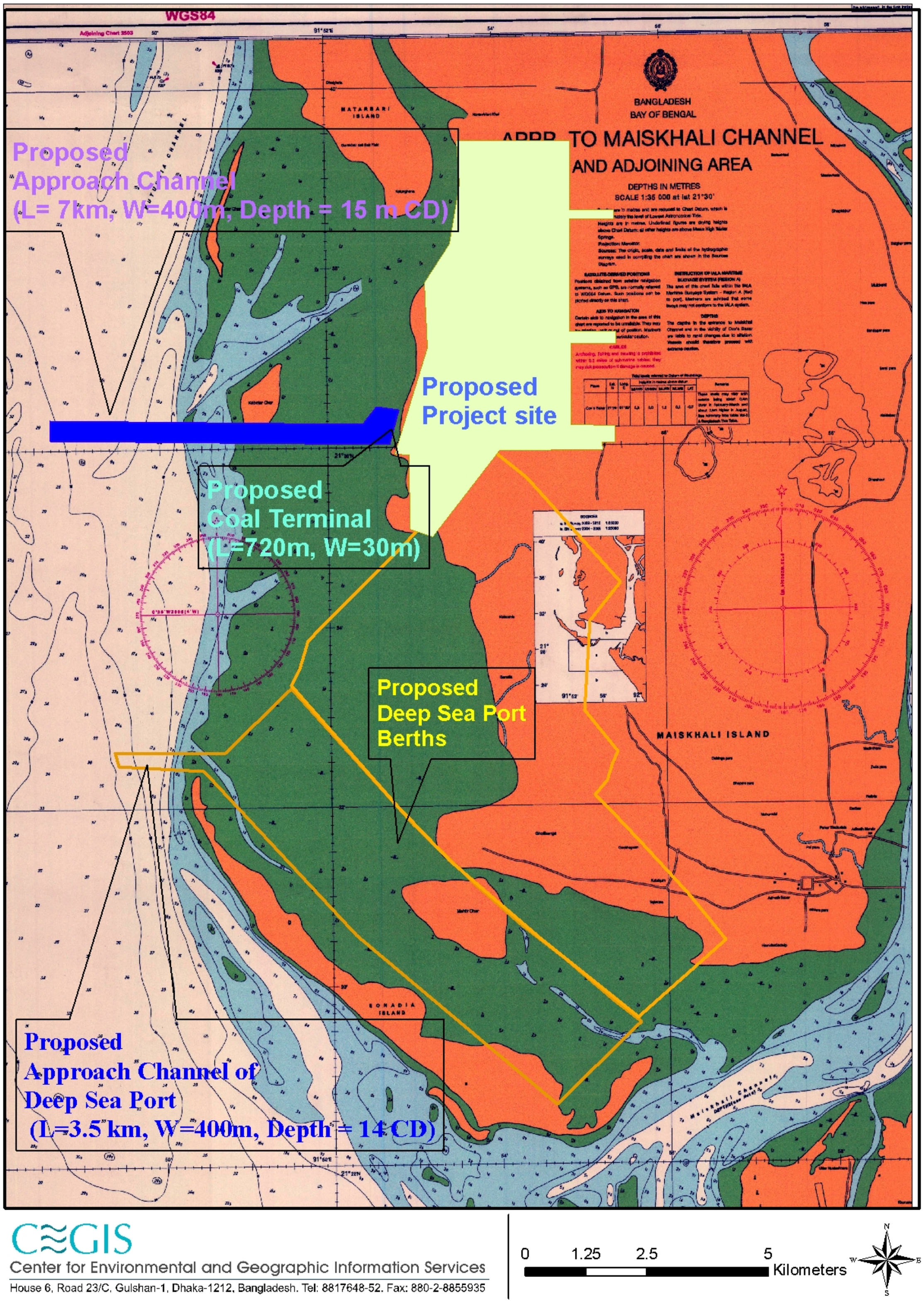
Map 11.2: Location of coal terminal and approach area for Chittagong Thermal Power Plant



Map 11.3: Location of coal terminal and associated navigational information Chittagong thermal power plant



Map 11.4: Coal terminal location and approach channel proposed for Maheshkhali Power Plant



Map 11.5: Proposed Approach channel and associated navigational information for Maheshkhali Power Plant

11.10 Voyage planning for maritime transportation

For planning purpose, three countries- Indonesia, South Africa and Australia have been considered as the source countries as per the assumptions and considerations made in Chapter 9. Major coal handling port of each country has been selected as loading port. In Indonesia, major portion of coal are exported through Kalimantan where numbers of coal terminal with different capacities exist. North Pulau Laut Coal Terminal, which is for this planning. Richard Bay Coal Terminal, which is also one of the major coal handling ports in the world, has been considered as loading port in case of import from South Africa. With Australia, New Castle Coal Terminal which is one of the major coals handling port has been selected. Vessel parameters have been considered taking account of world standards. Berthing, un-berthing, loading and unloading time, ship-to-ship transfer time vary with capacity of port and capacity of vessel (cargo capacity and unloading capacity). It is assumed, vessel might be delayed due to bad weather condition for a day in a round trip.

11.10.1 For Khulna 1320MW Coal Based Thermal Power Plant

From the Table 11.9 and Table 11.10 it is seen that numbers of vessel increases with decrease of capacity of vessel. Minimum numbers of vessel will be required for vessel of 80,000 DWT considered under Alternative Plan-II (Akram Point Anchorage and Further transshipment thorough lighters). Indonesia would be the nearest source that requires 20 to 25 days (varies with vessel capacity due to loading unloading time) for each round trip. On the other hand, round trip from Australia requires 39 to 44 days (varies with vessel capacity due to loading unloading time). Number of vessel to be engaged in a year depends on number of voyage, vessel capacity and time for a round trip. With 80000DWT, only 5 (five) vessels will be required to carry coal from Indonesia while each vessel will make 13 round trips. On the other hand, 12 vessels will need to be engaged for carrying coal with 25000 DWT vessels. Number of the vessels is higher in case of carrying coal from South Africa and Australia. From this comparative analysis of voyage planning it is clear, that vessel of 80,000DWT is most feasible to carry coal for this power plant. However, final suggestion might be made after detail cost estimation including lighterage operation planning and cost that has been described in the following sections.

Table 11.9: Voyage Time Talculation for Mother Vessel for Khulna TPP

Alternative Plans	Port to Port Distance, nm	Averag e speed, knot/hr	Berthing/De-berthing and Loading time, days	Bad weather	Unloadin g time, days	Round Trip Sea time in days	Round Trip in days
North Pulau Laut Coal Terminal (NPLCT), Indonesia							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	2,600	13	1	1	1	16.7	20
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	2,496	13	1	1	2	16.0	20
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	2,521	13	2	1	3.8	16.2	23
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	2,521	13	2	1	6	16.2	25
Richard Bay, SA							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	4,700	13	1	1	1	30.1	33
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	4,595	13	1	1	2	29.5	34
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	4,620	13	1	1	3.8	29.6	36
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	4,620	13	1	1	6	29.6	38
New Castle, Australia							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	5,680	13	1	1	1	36.4	39
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	5,574	13	1	1	2	35.7	40
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	5,599	13	1	1	3.8	35.9	42
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	5,599	13	1	1	6	35.9	44

Note:
Vessel will use jetty facilities (two grab unloaders of 1000 TPH rated and 750 TPH average capacity each) for unloading coal at coal terminal
Ship-to-Ship transfer shall be carried out by Floating Transfer Vessel

Table 11.10: Voyage planning for mother vessel For Khulna TPP

Alternatives	Size of a cargo (DWT)	Time for a round trip	No of available days in an year (excluding 10% contingency)	No of Round trips *	Coal Requirement in a year	Nos of vessels in a year	Nos of voyage in a year*
North Pulau Laut Coal Terminal (NPLCT), Indonesia							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	25,000	20	328	16	4,745,000	12	190
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	25,000	20	328	16	4,745,000	12	190
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	50,000	23	328	14	4,745,000	7	95
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	80,000	25	328	13	4,745,000	5	59
Richard Bay, SA							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	25,000	33	328	10	4,745,000	19	190
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	25,000	34	328	10	4,745,000	19	190
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	50,000	36	328	9	4,745,000	11	95
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	80,000	38	328	9	4,745,000	7	59
New Castle, Australia							
Alt V: Berthing at Project Site by 25,000 DWT Vessel	25,000	39	328	8	4,745,000	23	190
Alt III: Harbaria Anchorage by 25,000 DWT Vessel	25,000	40	328	8	4,745,000	23	190
Alt II: Akram Point Anchorage by 50,000 DWT Vessel	50,000	42	328	8	4,745,000	12	95
Alt II: Akram Point Anchorage by 80,000 DWT Vessel	80,000	44	328	7	4,745,000	8	59

Note:
Coal requirement has been estimated considering extreme case scenario (100 % load factor, 365days operation time, 6000 kcal/kg GCV of coal and 30% plant efficiency as provided by NTPC India). Voyage numbers and numbers of Vessel to be engaged will be varied as per requirement of coal.
*adjusted rounding off the estimated figure

11.10.2 For Chittagong 1320MW Coal Based Thermal Power Plant

From the Tables 11.11 and 11.12, it is found that numbers of vessel increases with decrease of capacity of vessel. Minimum numbers of vessel will be required for vessel of 80,000 DWT. Indonesia would be the nearest source that requires 19 to 21 days (varies with vessel capacity due to loading unloading time) for each round trip. On the other hand, round trip from Australia requires 39 to 40 days (varies with vessel capacity due to loading unloading time). Number of vessels to be engaged in a year depends on number of voyages, vessel capacity and time for a round trip. With 50,000DWT, at least 6 (six) vessels will be required to carry coal from Indonesia while each vessel will make 16 round trip. On the other hand, 11 vessels will need to be engaged for carrying coal with 25000 DWT vessels. Number of the vessels is higher in case of carrying coal from South Africa and Australia. From this comparative analysis of voyage, planning it is clear, that vessel of 50,000DWT is most feasible to carry coal for this power plant.

Table 11.11: Calculation of Voyage Time of Chittagong Thermal Power Plant

Alternative Plans	Port to Anchorage/CT Distance, nm	Average speed, knot/hr	Berthing/ De-berthing and Loading time, days	Bad weather	Berthing, Unloading, Un-berthing, days	Round Trip Sea time in days	Round Trip time in days *
North Pulau Laut Coal Terminal (NPLCT), Indonesia							
Alternative III (80000 DWT)	2,420	13	2	1	2	15.5	20.5
Alternative II (25000 DWT)	2,470	13	1	1	1	15.83	19.0
Alternative I (50000 DWT)	2,460	13	2	1	2.5	15.8	21.0
Richard Bay, SA							
Alternative III (80000 DWT)	4,721	13	1	1	2	30.3	34.3
Alternative II (25000 DWT)	4,691	13	1	1	1	30.1	33.0
Alternative I (50000 DWT)	4,681	13	1	1	2.5	30.1	35.0
New Castle, Australia							
Alternative III (80000 DWT)	5,483	13	1	1	2	35.1	39.1
Alternative II (25000 DWT)	5,533	13	1	1	1	35.5	39.0
Alternative I (50000 DWT)	5,523	13	1	1	2.5	35.5	40.00

Notes:

a. Alternative III: Discharge of coal at Kutubdia by 80,000 DWT and transshipment to the project site by lighterage
b. Alternative II: Direct Discharge of Coal at Project Site by 25,000 DWT Vessel
c. Alternative I: Discharge of coal at Alfa Anchorage by 50,000 DWT Vessel and transshipment to the project site by lighterage.

* adjusted rounding off the estimated figure

Table 11.12: Voyage planning for Chittagong thermal power plant

Alternative Plans	Volume of Coal in a MV (ton)	Time for a round trip (days)	Available days in a year *	No of Round trips	Coal Requirement in an year (ton)	No. of vessels in an year	No. of voyage in a year
North Pulau Laut Coal Terminal (NPLCT), Indonesia							
Alternative III (80000 DWT)	80,000	20.51	328	15	4,745,000	4	59
Alternative II (25000 DWT)	25,000	19.0	328	17	4,745,000	11	190
Alternative I (50000 DWT)	50,000	21.0	328	15	4,745,000	6	95
Richard Bay, SA							
Alternative III (80000 DWT)	80,000	34.3	328	9	4,745,000	6	59
Alternative II (25000 DWT)	25,000	33.0	328	10	4,745,000	19	190
Alternative I (50000 DWT)	50,000	35.0	328	9	4,745,000	10	95
New Castle, Australia							
Alternative III (80000 DWT)	80,000	39.15	328	8	4,745,000	7	59
Alternative II (25000 DWT)	25,000	39.0	328	9	4,745,000	22	190
Alternative I (50000 DWT)	50,000	40.0	328	8	4,745,000	12	95

*excluding 10% contingency

Note:

a. 2500DWT vessel will use jetty facilities (two grab unloaders of 1000 TPH rated and 750 TPH average capacity) for unloading

b. Ship to Ship Transfer/unloading:
Method: by Ship's Gear and Grab Unloader, Working hour: 20 hr; Grabber: Four Grab unloader with capacity of 250 TPH each (25 ton at each grab),
For lighter of 5000 DWT, eight lighters should be unloaded within 2 - 2.5 days (at a time 4 lighters should be unloaded)
For lighter of 10000 DWT, two lighters should be unloaded within 2 - 2.5 days (at a time 2 lighters should be engaged)

c. Coal requirement has been estimated considering extreme case scenario (100 % load factor, 365days operation time, 6,000 kcal/kg GCV of coal and 30% plant efficiency as provided by NTPC India). Voyage numbers and numbers of Vessel to be engaged will be varied as per requirement of coal.

11.10.3 For Maheshkhali 8320MW LNG and Coal Based Thermal Power Plant

For Maheshkhali thermal power plant, two vessel options (i.e. 80,000 DWT and 50,000DWT) have been considered for calculation. With 80,000DWT vessel, round trip time for each voyage would be 21 day, 34 days and 40 days for Indonesia, South Africa and Australia respectively. In such case number of vessel would be 15, 24, and 28 in case of Indonesian sources, South African Sources and Australian sources respectively. Similarly, voyage time has also been estimated for 50,000DFWT vessel. Details are given in Table 11.13 and 11.14 below:

Table 11.13: Calculation of voyage time for Maheshkhali Power Plant

Vessel type (DWT)	Port to Anchorage/CT Distance, nm	Average speed, knot/hr	Berthing/ Deberthing and Loading time, days	Bad weather	Berthing, Unloading time, Un-berthing, days	Round Trip Sea time in days	Round Trip in days
North Pulau Laut Coal Terminal (NPLCT), Indonesia							
50,000	2420	13	2	1	1	15.5	19.5
80,000	2420	13	2	1	2	15.5	20.5
Richard Bay, SA							
50,000	4721	13	1	1	1	30.3	33.3
80,000	4721	13	1	1	2	30.3	34.3
New Castle, Australia							
50,000	5483	13	1	1	1	35.1	38.1
80,000	5483	13	1	1	2	35.1	39.1

Table 11.14: Voyage planning for Maheshkhali Power Plant

Vessel as per DWT	Time for a round trip (days)	No of available days in an year (excluding 10% contingency)	No of Round trips	Coal Requirement in an year	Nos of vessels in an year	Nos of voyage in a year
North Pulau Laut Coal Terminal (NPLCT), Indonesia						
50,000	19.51	328.00	17.00	18,700,000.00	22.00	374
80,000	20.51	328.00	16.00	18,700,000.00	15.00	234
Richard Bay, SA						
50,000	33.3	328.00	10.00	18,700,000.00	37.00	274
80,000	34.3	328.00	10.00	18,700,000.00	23.00	234
New Castle, Australia						
50,000	38.15	328.00	9.00	18,700,000.00	42.00	374
80,000	39.15	328.00	8.00	18,700,000.00	29.00	234

Note: Coal requirement has been estimated considering extreme case scenario (100 % load factor, 365days operation time, 6000 kcal/kg GCV of coal and 30% plant efficiency as provided by NTPC India). Voyage numbers and numbers of Vessel to be engaged will be varied as per requirement of coal.

11.11 Voyage planning for lighterage operation

11.11.1 For Khulna 1320MW Coal Based Thermal Power Plant

Coal will be transshipped from mother vessel to coal terminal through lighter vessel. Voyage planning for lighterage operation has been exercised for two different alternatives positions of anchorage area of mother vessel (Akram point and Harbaria). Moreover, Three different lighter options- i) vessel of 3000 DWT with 3m – 3.5m draught, ii) vessel of 5000 DWT with 4m to 4.5 m draught and iii) vessel of 10,000 DWT with 5m to 5.5m, have been considered. Ship-to-Ship transfer rate and time of lighter loading vary with unloading capacity of mother vessel and size of the lighter vessel. In general, vessel of 50000 DWT to 80000 DWT capacities usually having 4-7 nos. holds provided with crane facilities. Ship to ship transfer may be carried out by floating transfer vessels of own gear of the mother vessel. In case of own gear of mother vessel, four cranes of having 250 TPH rated capacity each can unload the cargo. On the other hand, two cranes of floating transfer vessel can unload the cargo with 1000 TPH rated capacity each. The details of the voyage calculations are given in Table 11.15 and 11.16 below:

Table 11.15: Calculation of voyage time for lighterage operation

Mother Vessel	Lighter type (DWT)	Mother Vessel anchorage to Project site Distance, NM	Average speed, knot	Berthing/De-berthing and Loading time, days*	Contingency	Unloading time, days**	RT Steaming time in days	Round Trip time in days
Alternative II A: Akram Point Anchorage and Transshipment via Passur River								
80,000	3,000	44	7	0.2	1	0.13	0.5	1.8
	5,000		7	0.4	1	0.21	0.5	2.1
	10,000		7	0.5	1	0.42	0.5	2.4
Alternative III: Harbaria Anchorage								
25,000	3,000	20	7	0.2	1	0.13	0.1	1.6
	5,000		7	0.4	1	0.21	0.1	1.8
	10,000		7	0.5	1	0.42	0.1	2.2
Alternative II B: Akram Point Anchorage and Transshipment via Sibsa River								
80,000	3,000	47	7	0.2	1	0.13	0.3	1.9
	5,000		7	0.4	1	0.21	0.3	2.2
	10,000		7	0.5	1	0.42	0.3	2.5

* Ship- to- Ship transfer shall be carried out by Floating Transfer Vessel

** Vessel will use jetty facilities (two grab unloaders of 1000 TPH rated and 750 TPH average capacity each) for unloading coal at coal terminal

Table 11.16: Voyage planning for lighterage operation

Amount of Coal in a Mother Vessel	Lighter type (DWT)	Time for a round trip	Target days for transshipment and unloading*	Max Nos. of Round trips within the target transshipment and unloading days	Amount of Coal in a Mother Vessel	Nos. of Vessel required to unload a mother vessel	Nos. of voyage required to unload a mother vessel
Alternative II A: Akram Point Anchorage and Transshipment via Passur River							
80,000	3,000	1.8	6	3.0	80,000	9	27
	5,000	2.1	6	3.0	80,000	5	16
	10,000	2.4	6	2.0	80,000	4	8
Alternative III: Harbaria Anchorage							
25,000	3,000	1.6	2	1.0	25,000	8	8
	5,000	1.8	2	1.0	25,000	5	5
	10,000	2.2	2	1.0	25,000	3	3
Alternative II B: Akram Point Anchorage and Transshipment via Sibsa River							
80,000	3,000	1.9	6	3	80,000	9	27
	5,000	2.2	6	2.5	80,000	6	16
	10,000	2.5	6	2.0	80,000	4	8

Note: for smooth operation additional two nos. of vessels have to be kept stand by. Nos. of vessel and voyage would be changed as per coal requirement

From Table 11.15 and 11.16, it is seen that, number of voyage to unload a mother vessel is minimum in case of 25,000 DWT vessels (that will anchor at herbaria as per Alternative III). In that case, numbers of voyage for mother vessel would be higher (see Table 11.10).

Coal terminal may be constructed either at Mongla Port Jetty of at project site. Numbers of lighter vessel and voyage might not be changed for location of terminal. Distance from Mongla port Jetty to Project site is only 1.5 hr to 2hr. In both cases of coal terminal locations, dredging will be required (from Base Creek to Port site or project site) and the main draught obstruction is at Mongla Port Jetty area. At present condition, vessel that can approach to Mongla Port Jetty no 11 can also be able to proceed up to south end of the project. If the coal terminal is constructed at Port Jetty no 11 then dredging will be required from Base Creek to Jetty site and in that case the vessel will also be able to proceed up to the south end of the project site. For maneuvering area, dredging would be required at project site. On the hand, if coal terminal is constructed at project site, the route of Sibsha River can also be used for lighterage operation in future (subject to dredging, bent cutting and permission from DoE and Forest Department). However, a detail morphological study has to be carried out to examine long-term sustainability of the channel of Passur River up to the project site to determine long-term sustainability of the coal terminal location and feasibility of the maintenance dredging activity.

11.11.2 For Chittagong 1320MW Coal Based Thermal Power Plant

Lighterage operation would be required if mother vessel of 50,000DWT is used for coal transportation. In such case, the mother vessel will anchor at "α" Anchorage of the Chittagong Port. In such case, lighter vessel will transship coal from mother vessel to project site coal terminal. Innovative lighters of shallower draught might be considered for transshipment. Two different lighter options- i) vessel of vessel of 5000 DWT with 4m to 4.5 m draught and iii) vessel of 10,000 DWT with 5m to 5.5m draught, have been considered for this planning purpose. Ship-to-Ship transfer rate and time of lighter loading vary with unloading capacity of mother vessel and size of the lighter vessel. In general, vessel of 50,000DWT has 4 to 6 holds provided with crane facilities. Four cranes of having 250 TPH rated capacity each can unload the cargo. The details of the voyage calculations are given in Table 11.17 and 11.18.

Table 11.17: Calculation of voyage time for lighterage operation for Chittagong Power Plant

Mother Vessel (DWT)	Distance between anchorage point to project site , nm	Lighter type (DWT)	Average speed, knot/hr	Berthing/De-berthing time (Days)	Contingency	Unloading time, days	RT Steaming time in days	Round Trip in days
Alfa Anchorage to Project site								
50,000	10	5,000	7	1	0.5	0.25	0.1	1.9
		10,000	7	2	0.5	0.50	0.1	3.1
Kutubdia to Project site								
80,000	24	5,000	7	1	0.5	0.25	0.1	1.9
		10,000	7	2	0.5	0.5	0.1	3.1

Table 11.18: Voyage planning for lighterage operation for Chittagong Power Plant

Mother Vessel (DWT)	Lighter type (DWT)	Time for a round trip	Target days for unloading	No of Round trips	Amount of Coal in a MV Vessel	Nos. of Vessel required to unload a mother vessel	Nos. of voyage required to unload a mother vessel
	Alfa Anchorage to Project site						
50,000	5,000	1.9	3.8	2.0	50,000	5	10
	10,000	3.1	3.8	1.0	50,000	5	5
Kutubdia to Project site							
80,000	5,000	1.9	3.8	2.0	80,000	8	16
	10,000	3.1	3.8	1.0	80,000	8	8

11.11.3 For Maheshkhali 8320MW LNG and Coal Based Thermal Power Plant

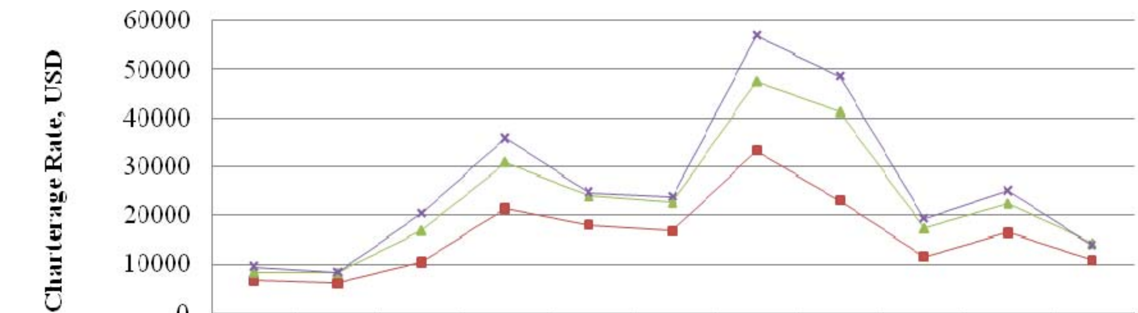
No lighterage operation will required as the mother vessel will directly discharge coal at coal terminal

11.12 Cost Estimation

11.12.1 Methods and assumptions

Charter rate of vessel

Charter rate is always fluctuating in world trade market. For this study, yearly average of last eleven years (2001-2011) has been considered (see Figure 11.4). The charter rate has been collected from market information of Mitsui OSK Line (MOSK, 2011).



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Small Handy	6476	6038	10404	21449	17982	16739	33335	23182	11542	16519	10812
Handy Size	8311	8210	16887	30918	24053	22661	47518	41233	17353	22484	14364
Panamax	9444	8281	20408	35815	24782	23858	56854	48653	19279	25070	13966

Source: MOSK, 2011

Figure 11.4: Historical yearly average of daily charterage rate from 2001-2011

Fuel consumption

Usually two type of fuel is used in vessel. During steaming, fuel oil and diesel oil is consumed and during port stay, only diesel oil is consumed. Fuel price has been assumed following a standard price as per present world market.

Port cost

Port costs have been estimated following the port tariff of the concern port of loading and Mongla Port.

Insurance and Broker commission

Insurance and broker commission have been assumed as 60,000 USD for 25,000 DWT to 80,000DWT vessel following the world standard practice in shipping business. The cost also includes other miscellaneous cost of voyage.

11.12.2 Cost estimation for Khulna Power Plant

Maritime transportation cost for Khulna

Finally, the maritime transportation cost has been estimated for import of coal from North Pulau Laut Coal Terminal, Indonesia, Richard Bay Coal Terminal, South Africa and New Castle Coal Terminal, Australia. All cost has been calculated in USD and finally converted to cost of each unit (metric ton) of coal. Estimations have been made fir different alternative as discussed earlier. The table 11.19 show coal transportation cost. The detail of the cost estimation is attached in the Annex III.

Table 11.13 shows that unit cost of maritime transportation is lowest in case of Indonesia. Transportation cost increases for vessel of low cargo capacity. 80,000 DWT vessels give the lowest transportation cost. This type of vessel has been considered in the Alternative II.

Table 11.19: Maritime Transportation Cost of Coal for Khulna thermal power plant

Ship size (DWT)	Charter cost (USD)	Fuel Cost (USD)	Port cost (USD) for each shipment		Insurance, Broker and Misc. (USD)	Total Cost, Tc (USD)	Unit cost of cargo, ($/ton)
			Loading	Unloading			
North Pulau Laut Coal Terminal to Mongla Port Limit							
25,000DWT under Alternative V	317,232.7	3,029,00	12,979.0	13,943	60,000	707,054.2	28.3
25,000DWT under Alternative III	317,233	294,375.0	12,978.7	13,942.8	60,000	698,529.2	27.9
50,000 DWT under Alternative II	532,329	407,462.1	21,464.0	21,464.0	60,000	1,042,718.8	20.9
80,000 DWT under Alternative II	650,932	536,543.9	30,259.4	30,259.4	60,000	1,307,994.6	16.3
Richard Bay Coal Terminal to Mongla Port Limit							
25,000DWT under Alternative V	523,434	542,178.8	142,546.5	13,942.8	60,000	1,282,102.2	51.3
25,000DWT under Alternative III	539,296	533,539.9	142,546.5	13,942.8	60,000	1,289,324.9	51.6
50,000 DWT under Alternative II	833,210	724,566.9	281,229.6	21,464.0	60,000	1,920,470.7	38.4
80,000 DWT under Alternative II	989,416	946884.6	449,901.5	30,259.4	60,000	2,476,461.9	31.0
New Castle Coal Terminal to Mongla Port Limit							
25,000DWT under Alternative V	618,604	653842.3	37,995.9	13,942.8	60,000	1,384,384.8	55.4
25,000DWT under Alternative III	634,465	645089.4	37,995.9	13,942.8	60,000	1,391,493.5	55.7
50,000 DWT under Alternative II	972,079	874241.0	68,772.2	21,464.0	60,000	1,996,555.7	39.9
80,000 DWT under Alternative II	1,145,640	1,140,488.1	105,703.9	30,259.4	60,000	2,482,091.4	31.0

Note: Alternative V- Berthing at project site, Alternative III-anchorage at Harbaria, Alternative II- Anchorage at Akram Point

Cost of transshipment thorough lighterage operation for Khulna Power Plant

Lighterage cost includes agent cost, stevedore cost and transshipment cost. The transshipment cost has been estimated from existing rate of Inland Water Transport Owner Association of Khulna. Similarly, Stevedore cost has been collected from Stevedore Association of Khulna. The both association has a fixed unit rate (rate for a Ton) for some fixed location. Considering distance of existing routes, rate of transshipment from proposed anchorage point to project site has been re-estimated. The rate also includes an extra cost of 20 Taka for each ton due to coal being hazardous goods. In case of Akram Point, an extra cost has also been considered for transshipment and stevedore as the location is nearer to sea and inside the Sundarbans forest that might be subject to an occupational risk.

Table 11.20: Cost estimation for lighterage operation

Cost Item	Akram Point to		Harbaria to	
	Port Jetty	**Project site**	**Port Jetty**	**Project site**
Transshipment Cost for a ton (BDT)	280	300	180	200
Stevedore cost (BDT) for a ton	100		70	
Total Lighterage Cost for a ton	380	400	250	270
Cost for a ton (USD)	**4.8**	**5.0**	**3.1**	**3.4**

Note: Costs are in USD/metric ton

The estimation shows that per unit transportation cost would be 3 to 5 USD for a ton that varies with location of anchorage area. Cost difference from mother vessel to Mongla port jetty and project site does not vary significantly.

Total cost of coal transportation from source to Khulna power plant project site

The total cost of transportation including maritime transportation cost, insurance, lighterage cost, port cost, and the final cost stands as given in Table 11.21. It has been found that Alternative II – transportation using vessel of 80000 DWT up to Akram Point and then further transshipment through lighters, stands least cost. Cost due to location of coal terminal (either at Mongla Port Jetty or at project site) varies insignificantly. Similarly, cost difference between Alternative V (direct berthing of vessel of 25000 DWT at project site) and Alternative III (Anchorage of 25000 DWT vessel at Harbaria then transshipment through lighters) is 3 to 4 USD/ton (varies with coal sources). It is seen that, the alternative II (transportation using vessel of 80000 DWT up to Akram Point and then further transshipment through lighters) that requires dredging, would save 7 to 19.4 USD/ton (varies with coal sources) than the alternative III (which is based on existing channel situation). This cost would be lower than the maintenance dredging cost.

However, sustainability of the long-term dredging work and morphological behavior of the Passur River need to be studied.

Table 11.21: Total cost to coal transportation from source to Project site

Transportation Plan	Maritime Transportation Cost per unit ton			Lighterage up to Port Jetty	Lighterage up to Plant site coal terminal	Total Cost up to Mongla Port Jetty			Total Cost up to Project site coal terminal		
	Port Cost at NPLCT, Indonesia	RBCT, SA	New Castle Coal Terminal, Australia			Port Cost at NPLCT, Indonesia	RBCT, SA	New Castle Coal Terminal, Australia	Port Cost at NPLCT, Indonesia	RBCT, SA	New Castle Coal Terminal, Australia
Alternative V	28.3	51.3	55.4	N/A	N/A	N/A	N/A	N/A	28.3	51.3	55.4
Alternative III	27.9	51.6	55.7	3.1	3.4	31.1	54.7	58.8	31.3	54.9	59.0
Akram Point Anchorage by 50000 DWT transshipped by lighters (alternative II)	20.9	38.4	39.9	4.8	5.0	25.6	43.2	44.7	25.9	43.4	44.9
Akram Point Anchorage by 80000 DWT transshipped by lighters (Alternative II)	16.3	31.0	31.0	4.8	5.0	21.1	35.7	35.8	21.3	36.0	36.0

Note: Alternative V- Berthing at project site, Alternative III-anchorage at Harbaria, Alternative II- Anchorage at Akram Point

Note: all costs are in USD for each metric ton

11.12.3 Cost Estimation for Chittagong 1320MW Coal Based Thermal Power Plant

Maritime transportation cost

For Chittagong project maritime transportation cost stands as 26.9, 51 USD/ton and 54.5 USD/ton with the option of direct discharge of coal at project site by 25,000DWT vessel for the sources of Indonesia, South Africa and Australia respectively. On the other hand, with another alternative-discharge of coal at Alfa anchorage by 50,000DWT vessel, maritime transportation costs of coal come at 19.5, 37.8 and 38.4 USD/ton for the sources of Indonesia, South Africa and Australia respectively. Table 11.22 shows detail cost estimation.

Cost of transshipment thorough lighterage operation

Lighterage operation cost will be required if coal is to be discharged at Alfa Anchorage. The lighterage cost includes carrying cost, stevedore cost, agent commission, and other miscellaneous cost. The cost information for the estimation has been collected for Inland Water Transport Owner Association, Chittagong and Stevedore Association, Chittagong Detail are presented in Table 11.23 below.

Cost of coal transportation from source to project site

Finally, total transportation costs of coal for Chittagong power plant come at 25.6, 43.9 and 44.5 USD/ton for the sources of Indonesia, South Africa and Australia respectively with alternative I (discharge of coal at Alfa anchorage then transshipped by lighter up to the site). On the other hand, transportation cost stands as 26.9, 51.0 and 54.5 USD/ton with the option of direct discharge of coal at project site by 25,000DWT vessel for the sources of Indonesia, South Africa and Australia respectively. In case of alternative-III, (discharge coal at Kutubdia then transshipped by lighter up the project site) about 22.4, 37.5 and 36.7 USD/ton are the total transportation cost from Indonesia, South Africa and Australia. Details are given in Table 11.24 below.

Table 11.22: Maritime transportation cost for Chittagong power plant

Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
			Loading	Unloading			
NPCT, Indonesia							
Alternative III (80,000DWT)	534,098	497,570.51	39,531.9	9023.9	60,000	1140224.4	14.4
Alternative II (25,000 DWT)	30,1371	288,087.5	12,978.7	8,872.0	60,000	671,309.3	26.9
Alternative I (50,000DWT)	48,4894	394,725.0	25,957.4	9,292.4	60,000	974,868.7	19.5
RBCT, South Africa							
Alternative III (80,000DWT)	892110	947,858.0	449901.5	9023.9	60,000	2,358,893	29.5
Alternative II (25,000 DWT)	52,3434	541,153.4	142,546.5	8,872.0	60,000	1,276,005.9	51.0
Alternative I (50,000DWT)	80,8156	730,481.7	281,229.6	9,292.4	60,000	1,889,160.1	37.8
New Castle Coal Terminal, Australia							
Alternative III (80,000DWT)	1019292	1098548.4	105703.9	9023.9	60,000	2,292,568.2	28.7
Alternative II (25,000 DWT)	61,8604	637,092.8	37,995.9	8,872.0	60,000	1,362,564.5	54.5
Alternative I (50,000DWT)	92,3607	859,210.6	68,772.2	9,292.4	60,000	1,920,882.5	38.4

Note: costs are in USD for each metric ton; Alternative I: Up to Alfa anchorage by 50,000 DWT vessel then upto project site by lighters; Alternative II: Berthing at coal terminal by 25000DWT vessel and Alternative III: Up to Kutubdia anchorage by 80,000DWT then transported up to project site by lighterage

Table 11.23: Lighterage cost for Chittagong power plant

Cost Item	Alfa Anchorage to Project site	Kutubdia to Project site
Transshipment Cost for a ton (BDT)	358	606
Stevedore cost (BDT) for a ton	80	80
Total Lighterage Cost for a ton	438	686
Agent Commission, outside labor, Merchant Labor, and Agent Commission	50	50
Total Lighterage Cost for a ton (BDT)	488	637
Cost for a ton (USD) (considering IUSD = 80tk)	6.1	7.96

Table 11.24: Total transportation cost of coal from source to Chittagong power plant site

Vessel as per DWT	Maritime Transportation Cost per unit ton			Lighterage cost	Total Cost from Source to Project site		
	Port Cost at NPLCT, Indonesia	RBCT, SA	New Castle Coal Terminal, Australia		Indonesia	South Africa	Australia
Berthing at coal terminal by 25000DWT vessel	26.9	51.0	54.5	N/A	26.9	51.0	54.5
Up to Alfa anchorage by 50,000 DWT vessel then up to project site by lighters	19.5	37.8	38.4	6.1	25.6	43.9	44.5
Up to Kutubdia by 80,000 DWT vessel then up to project site by lighters	14.4	29.5	28.7	7.96	22.4	37.5	36.7

Note: all costs are in USD/ton and it is assumes, 1 USD equivalent to 80 taka

11.12.4 Cost Estimation for Maheshkhali 8320MW LNG and Coal Based Thermal Power Plant

For Maheshkhali power plant two alternatives have been considered for cost estimation (Table 10.25). Use of 80,000 DWT vessels for coal transportation will be cheaper. In Maheshkhali, direct discharge of coal at project site has been considered.

Table 11.25: Transportation cost of coal from source to Maheshkhali power plant site

Vessel as per DWT	Source to Project Site		
	NPLCT, Indonesia	RBCT, SA	New Castle Coal Terminal, Australia
Berthing at coal terminal by 50000 DWT vessel	18.6	36.7	37.4
Berthing at coal terminal by 80000 DWT vessel	14.4	29.6	28.8

Note: cost are in USD/metric ton. I USD = 80 BDT has been considered

11.13 Suggested Coal Transportation System

11.13.1 For Khulna 1320MW Coal Based Thermal Power Plant

Following the detail voyage planning and cost estimation, it is suggested that the Alterative plan II would be most cost effective, time saving and reasonable for transporting coal from international sources to project site. The plan includes coal transportation by Handymax/Panamax vessel of 80,000 DWT from source country to Akram Point. Suitable anchorage area is available at Akram point. Then the further transshipment would be by lighterage operation through Passur River. Innovative lighters of shallower draught (3000 DWT to 10,000 DWT having draught of 3.5m -5.5m) should be engaged for this purpose. The plan has been discussed in section 11.5.2 of this chapter. Map 11.6 depicts the suggested coal transportation plan.

A capital dredging would be required at outer bar for length of 20 km. The dredging would be carried out to maintain 12.0 m CD and the channel width should be maintained as 160m. Accordingly, for lighter vessel of 10,000 DWT having draught of 5.5 m, dredging from Base Creek to Project site would be required. The details of the dredging plan have been provided in Table 10.3 of Section 10.3 under Chapter 10. From the Table 11.5, it is seen, adopting alternative plan II (anchorage at Akram Point) provided with dredging at Outer bar, would save transportation cost of around 30 – 40 million USD (varies with annual coal requirement) each year.

11.13.2 For Chittagong 1320MW Coal Based Thermal Power Plant

For Chittagong power plant, alternative-I have been suggested, as it is cost effective and ensure sustainable supply system of coal from source to project site. Map 11.7 depicts the coal transportation plan of the Chittagong TPP. The alternative I states discharge of coal at Alfa Anchorage of Chittagong port by 50,000 DWT vessel then further transshipment up to project site through lighterage operation.

11.13.3 For Maheshkhali 8320MW LNG and Coal Based Thermal Power Plant

As there is a plan of constructing a new coal terminal at green shore of the project site, hence it is suggested to design the terminal targeting vessel of 80,000 DWT provided with 14 m CD design draught. In such case, an approach channel (7km long and 400m wide) from deep sea to project has to be developed by dredging (see Map 11.8).

11.14 Maintenance of inland water way by dredging

11.14.1 Maintenance of inland water way by dredging for Khulna power plant

Inland water way from fairway buoy to project site via Passur river and alternative route via Sibsa river to be maintained properly for smooth navigation of small size, sea going/Maritime vessel and all kind of lighterage vessel. At present vessel, having 4.0 m. depth only may proceed up to project site with tidal advantage. The channel near project site is also very narrow which is not feasible for maneuvering of huge lighterage vessel/Barge with Tug etc. Moreover, river trend gradually decreasing the depth of water in every place. As such, once in a year the channel from MPFWB to project site (via Passur or via Sibsa) to be surveyed and according to survey charts capital dredging (every after 2/3 years) and necessary maintenance dredging to be carried out every year for smooth lighterage operation.

Channel survey work and dredging works may be done by "BIWTA/Mongla Port Authority/BWDB/Bangladesh Navy /Open Tender method by project cost/BPDB's" own cost.

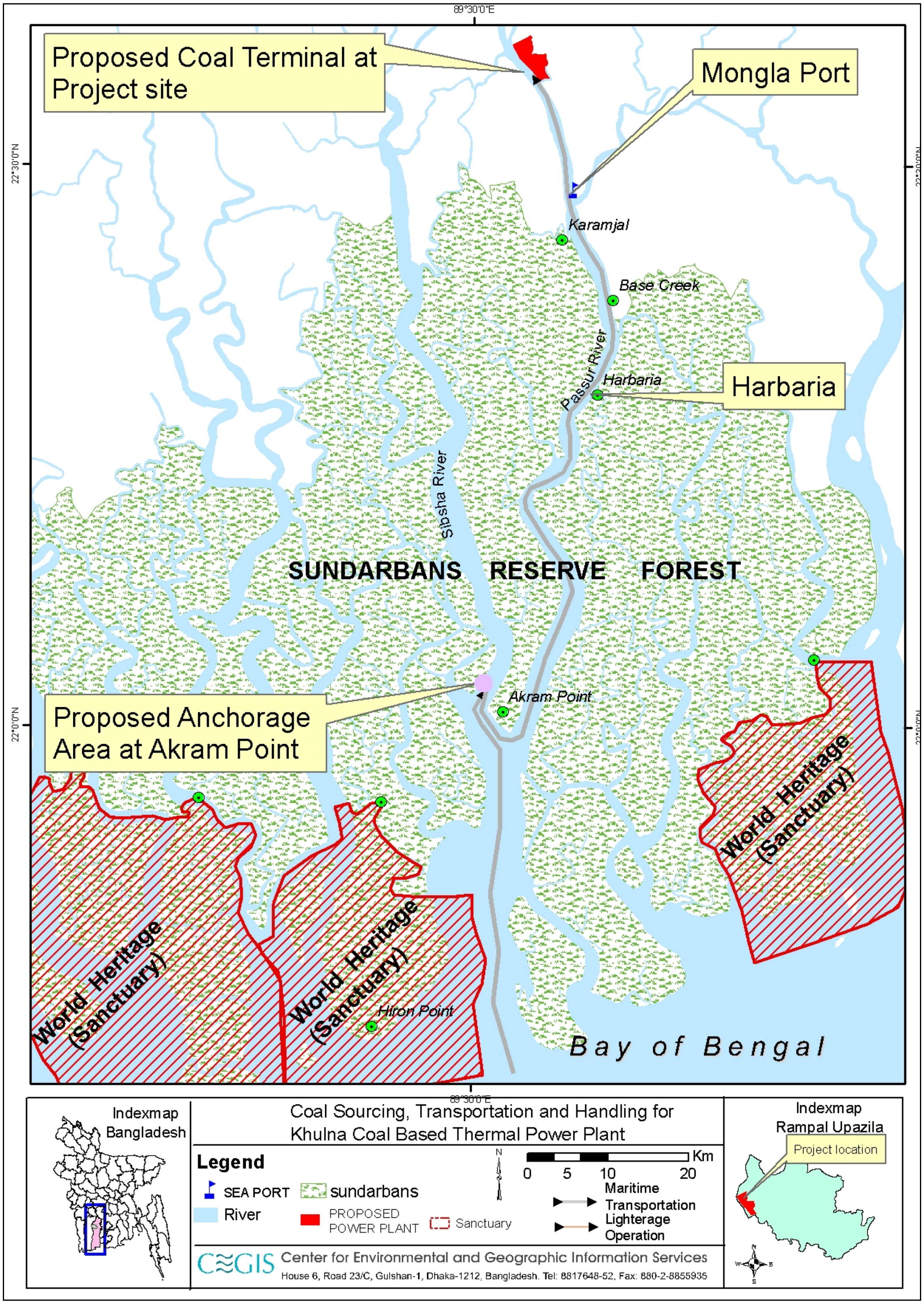
11.14.2 Maintenance of inland water way by dredging for Chittagong power plant

Inland waterway from "A"- Anchorage , CPA to project site via Karnaphuli River to be maintained properly for smooth navigation of small size, sea going/Maritime vessel and all kind of lighterage vessel. At present vessel, having 9.1 m. depth only may proceed up to project site with tidal advantage. The channel near project site is also narrow which is not feasible for maneuvering of huge lighterage vessel/Maritime vessels. Moreover, river trend gradually decreasing the depth of water every year. As such, once in a year the channel from Karnaphuli mouth to project site to be surveyed and according to survey charts capital dredging (every after 2/3 years) and necessary maintenance dredging to be carried out every year for smooth lighterage operation by coastal/Maritime vessels.

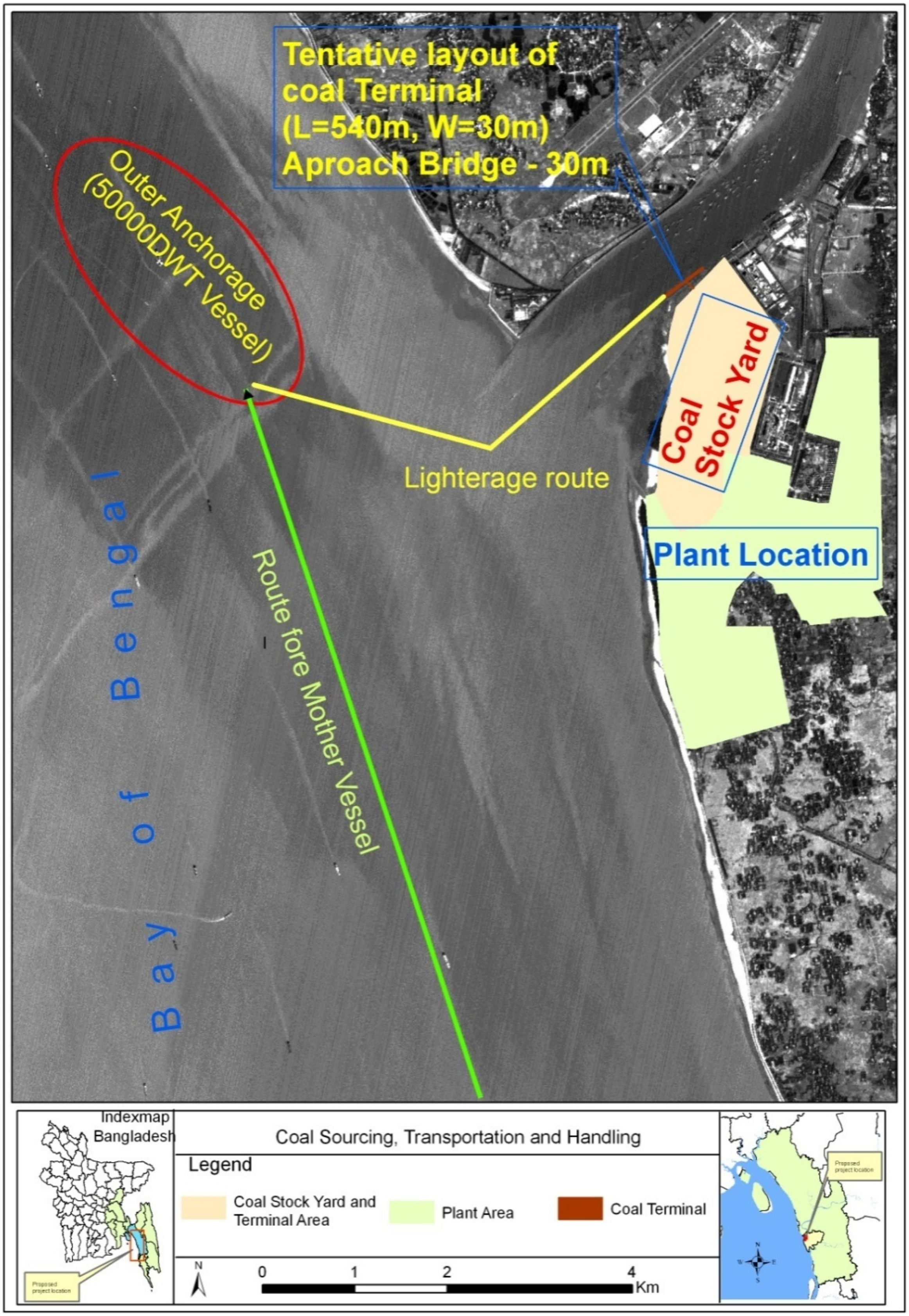
Channel survey work and dredging works may be done by "Chittagong Port Authority/Bangladesh Navy /Open Tender method by project cost/BPDB's" own cost.

11.14.3 Maintenance of inland water way by dredging for Maheshkhali power plant

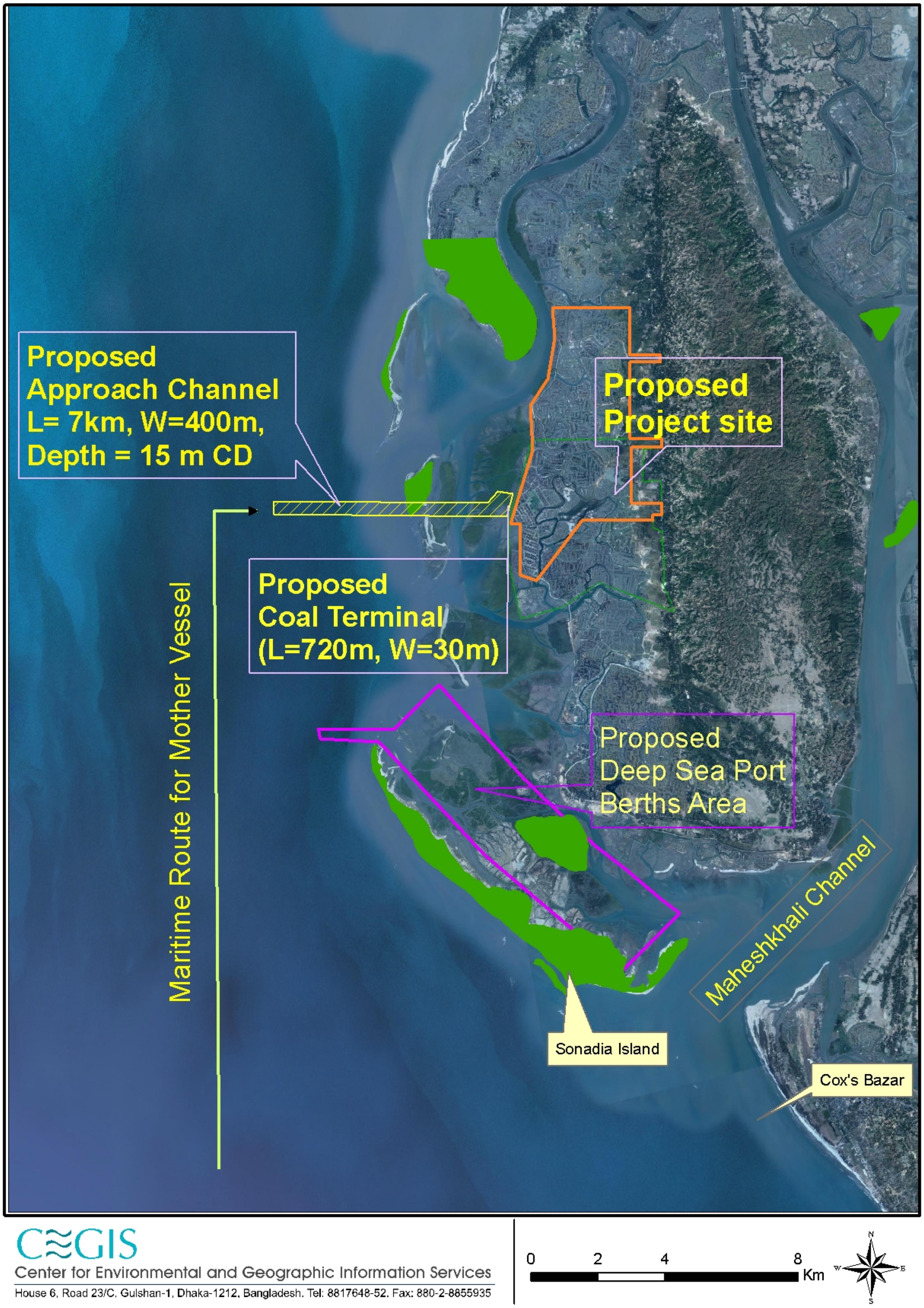
Maintenance dredging will be required for maintaining the design draught of 15m CD in the proposed approach channel and harbor basin area with proper survey regularly.



Map 11.6: Suggested Coal Transportation Plan for Khulna TPP



Map 11.7: Suggested Coal transportation Plan for Chittagong TPP



Map 11.8: Suggested coal transportation plan for Maheshkhali TPP

11.15 Force Majeure

11.15.1 For Khulna power plant

Shipping activities including ship-to-ship transfer, lighterage operation loading and unloading of cargo, stevedore and lighter operation are not possible in all over the year due to heavy rain during monsoon, depression in Bay of Bengal and cyclone affect. In worst case, Bangladesh Meteorological Department, BIWTA and Mongla Port Authority issue notice for closing shipping activities. During closing time due to such bad weather, only bay crossing is prohibited. In case of Mongla Port, there is no observed or recorded data when shipping activities were closed. Attempts were taken to collected data from Mongla Port Authority, Shipping Agents, and through consultation with maritime and inland water masters, stevedores, and ship owner associations. The following table (Table 11.26) compiles summaries the collected information on number of days for which shipping activities and lighterage operations were completely closed in Mongla Port area due to bad weather and depression in Bay of Bengal during last 5 (five) years.

Table 11.26: Numbers of days when shipping activities were closed

Sl No	Month	Number of Days in different years				
		2007	2008	2009	2010	2011
1	January - March	0	0	0	0	0
2	April	4	3	2	4	1
3	May	6	5	3	5	5
4	June	8	6	5	7	5
5	July	5	5	7	8	6
6	August	3	6	5	3	4
7	September	6	4	4	6	6
8	October	4	3	4	5	4
9	November	…	1	2	…	…
10	December	…	…	…	…	…
Total days in a year		36	33	32	38	31
Percent (%) of a year		9.9	9.0	8.8	10.4	8.5

Source: Mongla Port Authority, BIWTA, Shipping Agents.

It is seen that, shipping activities and lighterage operation might not be possible for about 10 % days of a year. And from the experience of Mongla Port Professionals, BIWTA, Shipping Agents, and Inland Water Transport Masters, it can be assumed that shipping activities and lighterage operation in Mongla Port Limits might not be possible for maximum 35-40 days in a year while the maximum continuous period might be up to five days.

11.15.2 For Chittagong and Maheshkhali power plant

Shipping activities including ship-to-ship transfer, lighterage operation loading and unloading of cargo, stevedore and lighter operation are not possible in all over the year due to heavy rain during monsoon, depression in Bay of Bengal and cyclone affect. In worst case, Bangladesh Meteorological Department, BIWTA and Mongla Port Authority issue notice for closing shipping activities. During closing time due to such bad weather, only bay crossing is prohibited. The following table (Table

11.27) compiles summaries the collected information on number of days for which shipping activities and lighterage operations were completely closed in Chittagong Port area due to bad weather and depression in Bay of Bengal during last 5 (five) years.

Table 11.27: Numbers of days when shipping activities were closed in Chittagong area

Sl No	Month	Number of Days in different years				
		2007	2008	2009	2010	2011
1	January - March	0	0	0	0	0
2	April	4	3	3	4	1
3	May	6	5	5	5	5
4	June	8	6	7	7	5
5	July	5	5	7	8	6
6	August	3	6	6	3	4
7	September	6	4	5	6	6
8	October	4	3	5	5	4
9	November	…	1	2	…	…
10	December	…	…	…	…	…
Total days in a year		36	33	40	38	31
Percent (%) of a year		9.9	9.0	10.7	10.4	8.5

Source: Chittagong Port Authority, BIWTA, Shipping Agents.

It is seen that, shipping activities and lighterage operation might not be possible for about 10 % days of a year. In addition, from the experience of Chittagong Port Professionals, BIWTA, Shipping Agents, and Inland Water Transport Masters, it can be assumed that shipping activities and lighterage operation in Chittagong area might not be possible for maximum 35-40 days in a year while the maximum continuous period might be up to six days. Same assumption might be considered for Maheshkhali Power Plant

11.16 Marking of Channel by Aids to Navigation

11.16.1 For Khulna power plant

The channel from MPFWB to project site (78 nautical mile) to be marked properly by lighted buoy and beacons for continuous day and night navigation. At present, there is no night navigation in Mongla Port area. However, for the continuous coal transportation operation by small size maritime ship and inland lighterage vessel port area up to project site and the alternative route via Sibsa River should be marked in proper manner by Aids to Navigation. For identification, the marking points according to the channel the whole route from MPFWB to project site via Passur and via Sibsa to be surveyed. Then as per survey charts the channel to be marked properly by sufficient lighted buoy and beacons/shore marks etc. Survey and marking works may be done by “Mongla Port Authority/BIWTA/Bangladesh Navy” or Open Tender methods. Analyzing the existing hydrographic charts of the Passur River, estimation has been made to identify possible numbers of Lighted buoy, Mooring buoy and Beacon Light. The following table details out the requirement of aids to navigation with indicative costs.

Table 11.28: Estimation of Aids to Navigation for Khulna

Navigational Aids	Detail components	Unit cost (USD)	Requirements	Total cost (USD)
Units of Lighted Buoy	• Buoy • Lantern • Battery • Solar Panel • Chain (180 ft) • Sinker	35,000.00	10 units	350,000.00
Mooring Buoy		5,500.00	10 units	55,000.00
Units of Beacon Light	• Beacon Body • Still Structure stand • Battery • Solar Panel • Lantern	7,000.00	12 units	84,000.00
Total Cost (USD)				**489,000.00**

11.16.2 Marking of Channel by Aids to Navigation for Chittagong Power Plant

The channel from “A”- Anchorage to project site (10 nautical mile) to be marked properly by lighted buoy and beacons for continuous day and night navigation. At present, there is night navigation in Chittagong Port area for small side coastal vessels only. However, for the continuous coal transportation operation by small size maritime ship and inland lighterage vessel port area up to project site should be marked in proper manner by Aids to Navigation. For identification, the marking points according to the channel the whole route from Kutubdia to project site of Anwara/Maheshkhali to be surveyed. Then as per survey charts the channel to be marked properly by sufficient lighted buoy and beacons/shore marks etc. Survey and marking works may be done by “Chittagong Port Authority/BIWTA/Bangladesh Navy” or Open Tender methods. Analyzing the existing hydrographic charts of outer anchorage & Karnaphuli River, estimation has been made to identify possible numbers of Lighted buoy, Mooring buoy and Beacon Light. The following table details out the requirement of aids to navigation with indicative costs.

Table 11.29: Estimation of Aids to Navigation for Chittagong

Navigational Aids	Detail components	Unit cost (USD)	Requirements	Total cost (USD)
Units of Lighted Buoy	• Buoy • Lantern • Battery • Solar Panel • Chain (180 ft) • Sinker	35,000.00	6 (six) units	210,000.00
Mooring Buoy		5,500.00	10 units	55,000.00
Units of Beacon Light	• Beacon Body • Battery • Solar Panel • Lantern • Still Structure	7,000.00	6 (six) units	42,000.00
			Total Cost	**307,000.00**

11.16.3 Marking of Channel by Aids to Navigation for Maheshkhali Power Plant

Lighted buoy and beacons should mark the approach channel properly for continuous day and night navigation. In such, pair of lighted buoy and beacon might be placed each at Sonadia Island and Deep Sea to Approach channel turning. Furthermore, a unit of Beacon light might be placed at coal terminal location. The detail of the requirement and cost are given in Table 11.30.

Table 11.30: Estimation of Aids to Navigation for Maheshkhali

Navigational Aids	Detail components	Unit cost (USD)	Requirements	Total cost (USD)
Units of Lighted Buoy	• Buoy • Lantern • Battery • Solar Panel • Chain (180 ft) • Sinker	35,000.00	4 (six) units	1,40,000
Units of Beacon Light	• Beacon Body • Battery • Solar Panel • Lantern • Still Structure	7,000.00	5 (six) units	35,000
Total Cost (USD)				175,000.00

11.17 Pilotage Service

11.17.1 For Khulna Power Plant

Pilotage service is to be provided to all maritime vessels at MPFWB for entering with coal upto Akram Point/ Harbaria/ Nalian/port jetty/project site etc. Mongla Port Authority will provide Port pilots and Pilotage fees to be paid to the port Authority. Beat pilots for lighterage vessels to be provided from BIWTA and pilotage fees to be paid to BIWTA by lighterage vessels owner. Presently, MPA faces lack of expert pilot. It is to be noted that, at present MPA faces lack of expert pilot.

11.17.2 For Chittagong Power Plant

Pilotage service is to be provided to all maritime vessels at outer Anchorage, Chittagong for entering with coal upto Anwara project site etc. Chittagong Port Authority will provide Port pilots and Pilotage fees to be paid to the port Authority. Beat pilots for lighterage vessels to be provided from BIWTA and pilotage fees to be paid to BIWTA by vessels owner. Lack of expert pilot frequently lingers port stay time.

11.17.3 For Maheshkhali

The proposed project area fall under proposed port limit of the proposed deep-sea port. In that case, pilotage service of deep sea port will be available for this project. However, at present no pilotage service is present for vessel coming to Maheshkhali. If the power plant project comes before deep seaport, then for this project, BPDB may request Chittagong Port Authority to provide their pilotage service for vessel to come with coal for this project.

11.18 Coal transshipment by Rail

The means of rail transportation of coal apply for coal from indigenous and nearby Indian sources, which may not be available during the initial period of the proposed projects. The indigenous sources may be suitable (for future) only for Khulna TPP considering existing railway transportation system. For Chittagong and Maheshkhali TPPs, international sources and seaborne transportation is the feasible option.

One Broad Gauge rail line is in operation from Barapukuria/Phulbari area to Khulna & India and there exist infrastructure for double track broad gauge rail line. The Barapukuria Coal Mine is hooked up with broad gauge (BG) rail line with good loading facilities. But to meet up the quantities of the coal supplies to Khulna Power Plant, loading facilities to be upgraded.

Coal could be transported form Phulbari and other coal deposits (if developed) to project site at Rampal, Bagerhat by rail or a combination of rail and ship. As such, transport will require the establishment of rail loading facilities at the Mine, rail track from Khulna to Project site, rail-unloading facilities at project site of Rampal, Bagerhat. The rail corridor all has a rail gauge (1,676 mm or broad gauge (BG) line.

Identification of the best suitable Transportation Route, for implementation of any project, is a significant factor in terms of Cost-Benefit and Easiness as well. In our case transportation of coal, as fuel, for the proposed project-“Installation of Coal-Based Thermal Power Plants each at Chittagong, Khulna and Maheshkhali” is under consideration. It is needless to note that the Coal will be an imported item and transportation means from the suitable source to the port in Bangladesh will be Water Transport like Ship. This coal is supposed to be unloaded and stored, if necessary, at different ports/jetties warehouse. As such, from these probable ports, transportation of coal to the project sites, from the different ports, is under consideration in terms of this Report. One of the project sites is situated at the estuary of the Karnaphuli River. This site is at the opposite of the Chittagong Port side. Both the probable coal jetty and power plant site are located almost at the same site. Out of the proposed, now, 03(three) Plants, 01(one) is located at Rampal Upazila, dist. Bagerhat. For this plant, Mongla port or jetty at Mongla is concerned. This site is located at about 14 Km apart from the probable jetty point-for coal Terminal. Remaining proposed Power Plant site is situated at Maheshkhali on the bank of the Bay of Bengal.

Attempts were taken to evaluate scopes and option of transportation, to collect information on existing and proposed Railway in and around the proposed area, to identify and describe of the facilities necessary for transportation of coal from port to project sites by rail.

11.18.1 Existing Rail Network

Bangladesh Railway has 2835 route kilometers at the end of the year 2009-2010. East Zone has 1266 route kilometers of MG track only and West Zone has 535 route kilometers of MG 659 route kilometers of BG and 375 route kilometers of DG track. The total length of running track inc3luding track on double line, in the yard and sidings in 3974 kilometers. Unlike most other railways, where all tracks are constructed to the same gauge (spacing between rails), for historical reasons, the Bangladesh Railway network consists of two gauges. Whenever rail operations are being considered in Bangladesh, the issue of track gauge must be taken into account. Bangladesh Railway consists of Broad gauge (BG), Meter gauge (MG) and Dual gauge (DG) sections.

Zone	**Gauge**			
	BG	**MG**	**DG**	**Total**
West	933	677	484	2,094
East	0	1,879	0	1,879
Total	933	2,556	484	3,973
Note (1) Includes approximately 88 km of DG rail line east of the Jamuna River.				

On the Jamuna Bridge restrict the Full loading of BG wagons. On the Jamuna Bridge, the maximum axle load for wagons is 16 tons, and maximum distributed, or trailing load is 4.46 tons per meter. For the Phulbari Coal Mine Project the continuous DG track form Phulbari to Joydebpur, East of the Jamuna Bridge, will allow the shipment of coal by rail using trains of either gauge to a point near Joydepur in the case of BG trains, and to any destination in the East Zone, if MG trains are used.

11.18.2 Physical Characteristics of Existing BR Network

The main physical characteristic of the BR coal transportation network is the nature of rail lines. These are BG or DG and single track (ST) or double track (DT). For railway operations analysis purposes, the BR coal transportation network has been divided into various types.

Existing BR Permissible Train Speeds.

Permissible Train Speeds over Railway Network is shown below-

Gauge	Permissible Speed (km/h)		
	Passenger (all types & Intercity)	**Mixed Trains**	**Goods Trains**
BG	90 km/h	72 km/h	30 km/h non-Vacuum, 45-48 km/h Vacuum wagon.
MG	72 km/h	50 km/h	30 km/h non-Vacuum, 45-48 km/h Vacuum wagon.

11.18.3 Future development plan for Bangladesh Railway (BR)

It is to be intimated that Existing and Future Development plan of Bangladesh Railway, in line with the proposed Bagerhat Thermal power plant project was stated that Bangladesh Railway has already undertaken a project – "Construction of about 53 km long Railway line from Mongla port to Khulna (Map 10.1) which is under process and scheduled to be completed by 2013. All the information, in this respect, is available with the Bangladesh Railway, which is obtainable easily at any time.

On the other hand, the proposed Plant site at Rampal Upazila, Bagerhat is at a distance of about 14 km from Mongla port. The proposed Railway line from Mongla port to Khulna is closer to proposed Thermal power Plant at Bagerhat. As such, it will be easier to undertake a project for construction of Siding Railway line from the proposed main Railway line from Mongla port to Khulna

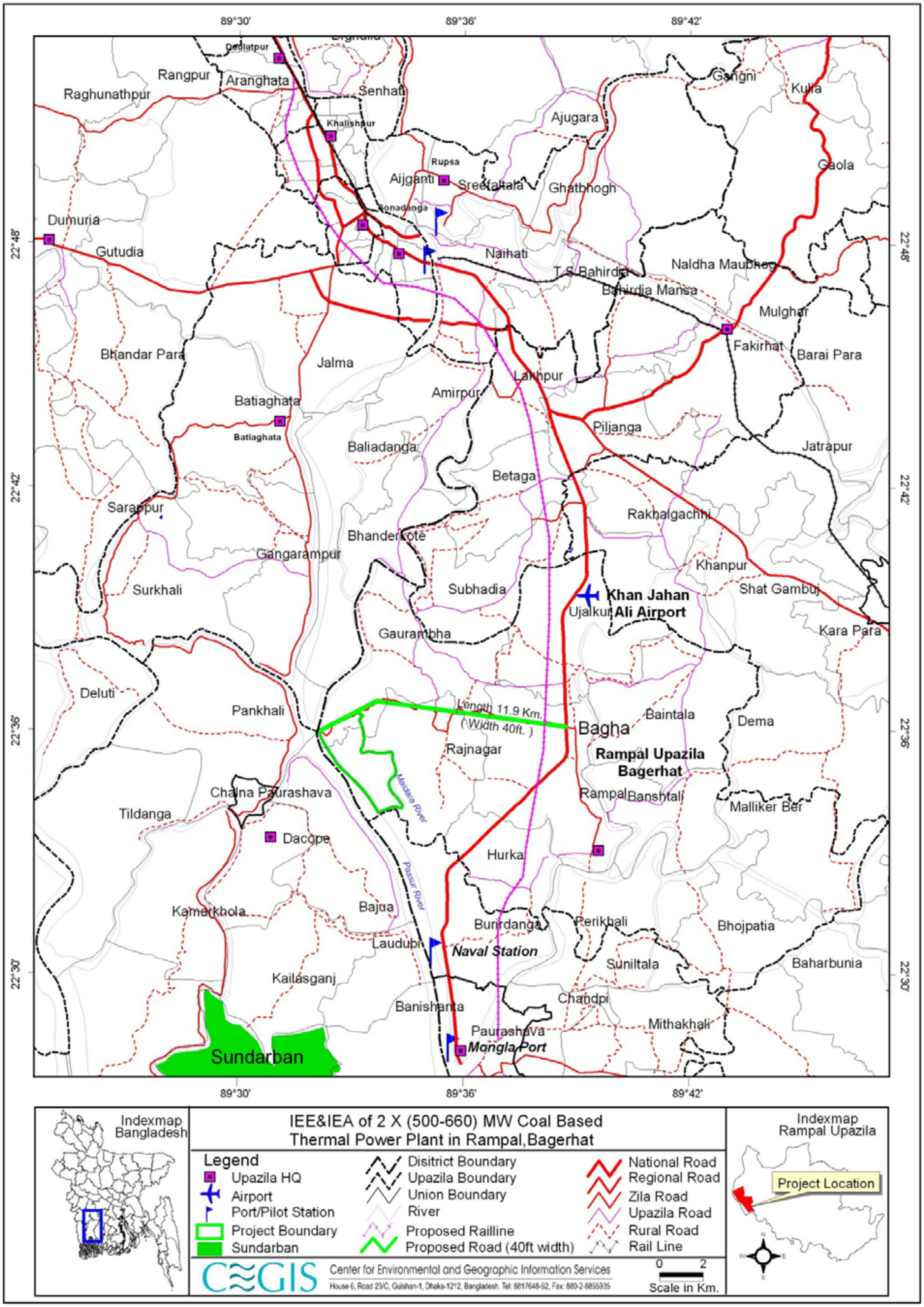
In addition to the Report on Coal-Based Thermal Power Plant at Maheshkhali, it may here be pointed out that a Deep Sea Port (DSP) will be constructed at Sonadia, Maheshkhali, and Cox's Bazar. Necessary actions are in progress in this connection. It is that Road and Railways facilities are unavoidable for transportation of Goods from DSP to different parts of the country and from different areas of the country to Deep Sea Port. Accordingly, it was understood from the Study report of Deep Sea Port project that a Meter Gauge Railway Track from Dohazari Rail Station to Maheshkhali through Chakaria Upazila will be constructed in near future. A Road from there will also be constructed, connecting present Chittagong-Cox's Bazar Road, to Maheshkhali. Hence, the Thermal Power Plant Authority will be in a nice position to avail all these facilities maintaining necessary relationship with the relevant authorities.

11.18.4 Railway transshipment plan for Proposed Power Plant Site at Khulna

If the coal terminal is to be constructed near Mongla Port area, the scope of railway transshipment may come under consideration. A Coal jetty to be constructed, for exclusive use of Plant Authority, providing Railway Track facilities and also Back Up facilities for temporary storage of the imported coal. From the Storage Yard the same will be loaded into the wagon of Goods Train. This coal, by goods train, will be transported to a suitable as well as possible nearest point of the plant site at Rampal, Bagerhat. This point will be a Stack Yard for storage of Coal. From here, the coal will be carried to the Project site in order to use as fuel for the Plant.

Probable transportation procedures from Mongla Port area to the Plant site

The imported coal will be unloaded from a ship and the same will be loaded either directly on truck or on coal jetty. When the coal will be loaded on truck, by using crane, in that case if goods wagon of train can be made available there, at that time, coal from the truck may, directly be loaded into the wagon. Storage at the yard and further loading on truck could be avoided. In other words, there will be a significant achievement in saving both time and money. This operation will be easier and smooth if the Drum Truck is used in both loading from the ship and unloaded into the goods wagon. In this respect, here it may be mentioned that there are different types of goods wagons. Considering the relevant aspects, Open to Sky type Hopper Wagon will be suitable to use. However, as an alternative to this, BKS type wagon may also be used. Plant Authority will be responsible for arrangement for both loading and unloading of the coal. Bangladesh Railway Department may be given responsibility, in terms of probable agreement, for transportation service from Mongla Port area to the Storage point near Plant site. Road transportation may be required for transportation of coal from the storage yard to the using point of the Plant.



Map 11.9: Proposed railway track 'Khulna to Mongla Port'

Rolling Stock Requirements

In order to determine the required fleet for coal transportation, a systematic approach was used:

- the pay load and number of coal trains per day to be dispatched from the Phulbari mine provided the basic input;
- as an intermediate step, the train turnaround times (that is the times required for one complete train cycle to each of the proposed destinations) was determined; and
- finally, the number of loaded trains per day, the turnaround times, and an additional allowance for maintenance/spares were combined to arrive at rolling stock fleet size per year;

Therefore, the number of loaded coal trains to be dispatched daily from Phulbari Mine was determined by considering.

- coal transport requirements and pay load;
- destinations;
- train composition (number and type of locomotives and wagons); and
- 340 days working year.

It will be assumed that an 81 ton (gross weight) loaded wagon with a carrying capacity of 55.4 ton will be retained for trains bound for Rampal Bagerhat. Due to the loading restrictions on the Jamuna Bridge, a 64 gross tone loaded wagon with a carrying capacity of 38.4 ton will be used for trains bond for Gazipur. They will have a wagon length of 11.7 meters. These wagonloads correspond to axle loads of 20.25 ton for Rampal Bagerhat trains, and 16 ton for Gazipur trains. Using the above criteria, the total wagons to be loaded per day was established and then further developed into the number of trains to be run per day.

It is recommended that 4 nos. open hopper full rake consist of 55 tons 60 nos. hopper wagon will carry **3300 tons** coal from Mongla port site to Rampal project site. In this connection, a dedicated full rake with dedicated locomotive and brake van is to be needed. On the other hand first phase consumption will be **13000 million tons** of coal is required for operation of plant. In second phase **26000 million tons** coal will be required for Rampal power plant site in Khulna. The same material will be required for Chittagong power plant site. For Maheshkhali power plant **53000 million tons** coal will be required.

Specifications for rail coal wagons

The rail coal wagons will be rail hopper wagons, with bottom discharge operation, and will be constructed of steel. They will be similar to the “BOBRN” bottom discharge wagons currently in use in bulk haulage in Bangladesh.

The wagons will be open hopper wagons with rapid (pneumatic) bottom discharge doors. The wagons will be air-braked. Each wagon will be open at the top, from where it will be loaded with coal. The coal will be open at the top, from where it will be loaded with coal. The coal will be unloaded form the bottom of each wagon by means of pneumatically operated doors. Line side devices running on a local power source can trigger the door opening mechanism. As the wagons in a rake pass by the triggering devices, their doors open and their contents are unloaded into the below the tracks. Typical parameters follow.

Gross mass of wagon	- 81.0	Tons
Max. Tare mass of wagon	- 25.6	Tons
Carrying capacity of wagon	- 55.4	Tons
Length over coupler faces	- 11.7	Tons

Height	- 3.74	Tons
Width	- 3.50	Tons
Distance between bogie centers	- 6.79	Tons

The wagons will be fitted with AAR `E' high tensile couplers with high capacity draught gear, and CASNUB 22 NLB cast steel bogies, air brakes and parking brakes. They will be rated at 60 km/h.

Specifications for brake vans

The requirement of brake vans stems from Bangladesh Railway operating regulation, which requires that every train be fitted with a brake van at the rear of the train. In the case of those trains traveling from Ishurdi to Gazipur across the Jamuna Bridge, Bangladesh Railway regulations stipulate that a second brake van be used between the locomotive and the first loaded wagon of the train, in addition to the usual brake van at the tail end of the train.

The purpose of the brake van is to allow the train to be supervised from the rear and ensure that cars from the train cannot separate without the crew's knowledge. Should the train part in the middle; the guard in the brake van can apply the brakes on the trailing portion and signal for assistance. This allows the locomotive crew to concentrate on events ahead.

The brake van is also used to monitor the cars and load making up the train, making sure there are no problems-load shifting dangerously, overheating axle boxes on the wagons (hot boxes) that could cause fire, and suchlike. A brake van is also fitted with red lights to enable the rear of the train to be seen at night.

The use of brake vans in the proposed coal trains can only be terminated if the operating regulations of Bangladesh Railway are changed to dispense with the use of brake vans. While this will be a medium term goal for the phulbari coal haulage task; in the interim, it will be assumed that the brake vans will be still be required, and allowance has been made for them in this Railways Works.

The brake vans will have the following specifications.

Gross mass of brake van	- 21.75 tons
Length of brake van	- 15.0 meters

It is to be recommended per kilometer new track of BG line will cost 7-8 core so that of 20 kilometer track (main line + siding line inside the project site) 7x20 = 140-160 core taka will cost to perform of the above project work. It may be less cost after detail field survey and connecting point from the main Railway line from Mongla port to Khulna project line.

Cost estimation of railway for Khulna power plant

This to further inform that one hopper wagon carrying capacity 55 tons 60 wagon in a rake 320 taka per ton carrying fright comes = **1056000 taka per rake carrying cost from Mongla port site to Rumpal Bagerhat project site**. For 8 thousand tons coal per day should required about 2.5 full rakes. For 10 thousand tons coal per day 3 nos. full rake 55 ton 60 nos. open hopper wagon will carry 9900 tons coal will be carried from Mongla port to Rampal Bagerhat project site. For 12 thousand tons capacity about 4 full rake of above capacity will required. For carrying coals Hitachi, Alco series 6061, Bombadian series 6300 of Diesel Electric Locomotive may be used from Mongla port site to Rampal Bagerhat project site. For carrying coals from Mongla, port site to Rampal Bagerhat project site the Bangladesh Railway operational system can be followed.

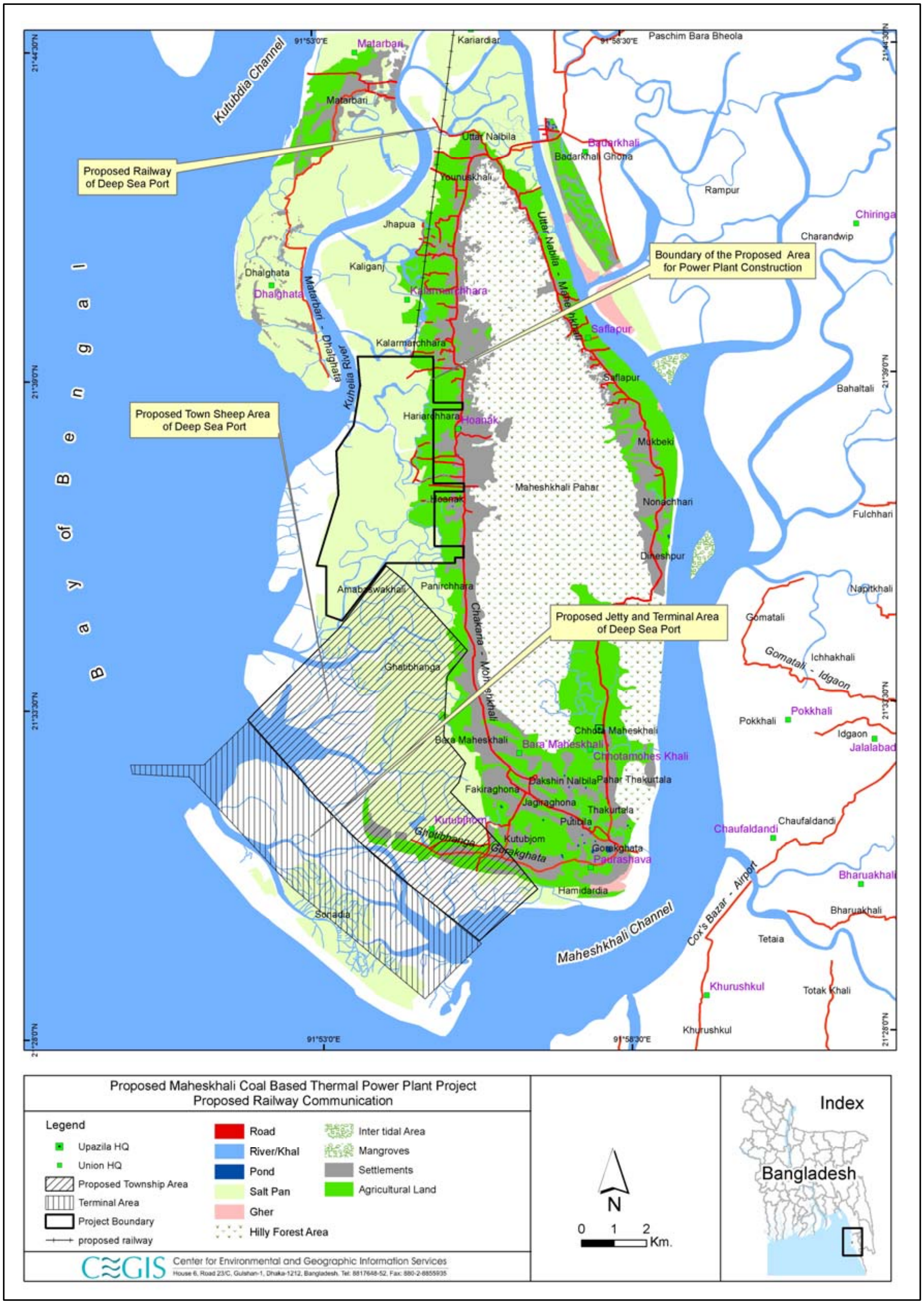
11.18.5 Railway transshipment plan for Proposed Power Plant Site at Chittagong

Both the probable coal terminal site and power plant site are located almost at the same area. As such, transportation of coal by railway does not need. On the other hand, there is, at present, no railway, Even considering the over all aspects, it may be concluded that there is no scope to construct railway there in future also. In the situation, transportation of coal from port site to plant site doesn't come in consideration.

11.18.6 Railway transshipment plan for Proposed Power Plant Site at Maheshkhali

Maheshkhali is an isolated place from the countryside and situated nearby proposed Deep Sea Port at Sonadia Island. This proposed port, being the Deep Sea Port, consisting of a good numbers of additional facilities for operation of coal carrying vessel throughout the year as there will not crop up any Draught problem. On the other hand, there is a possibility to use railway for internal coal handling process, because there will be large amount of coal to be handled which is might not be enough by using conveyor belt.

There is a railway line development proposal in line with proposed Deep Sea Port. The proposal includes development of 40 km railway line from last railhead of Dohazari towards Cox's Bazar. In this connection, a combine rail line cum road alignment measuring about 45 km has been surveyed (reconnaissance) to connect the deep-sea port with the presumptive main line on the main land. In future this rail might be used to transport coal from Coal terminal to different parts of the country to feed other proposed coal based thermal power plant.



Map 11.10: Proposed Railway Track of Maheshkhali Deep Sea Port

11.19 Involvement of Bangladesh Railway Department to have necessary services

Bangladesh Railway to undertake such projects for implementation as Deposit Works. Such some projects of Bangladesh Railway are as follows:

1. Construction of Railway Siding line for 50 MW power plants at Dhulchi, Bhanga of district Faridpur.
2. –Do- of 50 MW Khatakhali power plants at Rajshahi from Horiana railway station.
3. –Do- of 50 MW Amnura Power plant at Chapai Nababgponj.
4. –Do- for Thakurgaon 50 MW Rental power plant.
5. –Do- for Hathazari 50 MW power plant at Chittagong.

Bangladesh Railway undertook all the above projects as Deposit Works for BPDB. Hence future rail way transportation infrastructure for Bagerhat Thermal Power Plant project at Khulna, may, also be constructed by Bangladesh Railway as 'Deposit Work'.

A request letter from the suitable authority of the Power Plant may be submitted to Bangladesh Railway Department stating as well as highlighting the national importance of installation of this power plant. Support, in this regard, from Bangladesh Power Development Board may be taken. It is a usual case for Bangladesh Railway to undertake such work as Deposit Work.

However, sufficient persuasion may be required to achieve it.

11.20 Alternative coal transshipment by Conveyor Belt

Conveyor belt might also be opted for coal transshipment. With Khulna Project, if coal terminal is to be constructed at Mongla Port Jetty, then the received coal might be transported to project site by conveyor belt. However, considering present condition, river transportation of coal is more suitable than conveyor belt. In such case, a coal terminal might be constructed at project site. However, final decision has to be made analyzing trend of morphological changes of the Passur River from Chalna to Mongla. Future navigability of the Passur River should be explored through a detail morphological study.

In case of Chittagong and Maheshkhali, conveyor belt needs to be constructed from coal stockyard of the project site coal terminal to plant site.

This transportation system depends on the consistent functioning of conveyer components. Complete conveyor includes components with an emphasis on performance and reliability for medium and heavy-duty application. The effective running of rollers and pulleys should be constant objective. The integrated transfer point may lead to material spillage, impact damage on conveyor belts, dust emission and poor belt tracking.

Transport by aerial ropeway/conveyor belt has an important role in coal handling due to its easy operation, maintenance, long service life and low cost per ton. The ropeway is normally aligned "as the crow files "(smaller investment cost), overcoming most topographical obstacles, because of its height more than 3m above the ground; also, it does not interfere with animals and persons nor requires the splitting up of properties and the acquisition of extensive rights of way. However for this system electricity associated facility shaft required.

Chapter 12: Coal Terminal

12.1 Development of berthing facilities at Terminal Site

12.1.1 Type of berth

Berthing structure for coal carrying vessels may be considered for open type pier or jetty type structure projecting away from shoreline. It will be R.C.C structure, composed of individual robust R.C.C piles with a thick R.C.C deck slab on it, where cargo (coal) handling crane can move mounted on rail.

12.1.2 Berthing Line

Berthing line is usually placed along the shoreline at the waterside edge of the berth structure where the depth of water is sufficient for the coal-carrying vessel as designed by maritime engineer to take safe berthing and de-berthing throughout the whole season. In case of the siltation near and around the berthing line because of the characteristics of the channel or of the open sea, routine dredging may be carried out to address the draught problem, study for setting of berthing line may be carried out following the bathymetric survey of each site at Mongla, Chittagong and Maheshkhali.

12.1.3 Orientation of the berth

Any berth structure having interface with the shore land directly without bridge/approach jetty is typically oriented along the shoreline. The problems/issues related with the orientation of the berth are very much related with the project site and its adjacent water face shoreline. In the next stage of final report, orientation of berth will be ascertained depending on the available data of design draught for the coal-carrying vessel.

For 1320MW Coal Based Thermal Power Plant in Khulna

Two best options of similar aptitudes may be proposed for consideration and highlighted as follows:

a) Orientation of the berth along with the terminal facilities may be developed at the project site of Rampal Upazila along the river Passur. The same river is flowing nearby the proposed power plant site as well as Mongla Port. From recent bathymetry map of Passur River surveyed by BIWTA, it is observed that narrow channel having draught of 6m to 10m is flowing near power plant site as well as Mongla Port (Map 12.1). This channel can be best used by lighterage vessel carrying coal if the concerned authority undertakes routine dredging. Modal split for carrying and conveying coal can be avoided as in the Mongla port site.

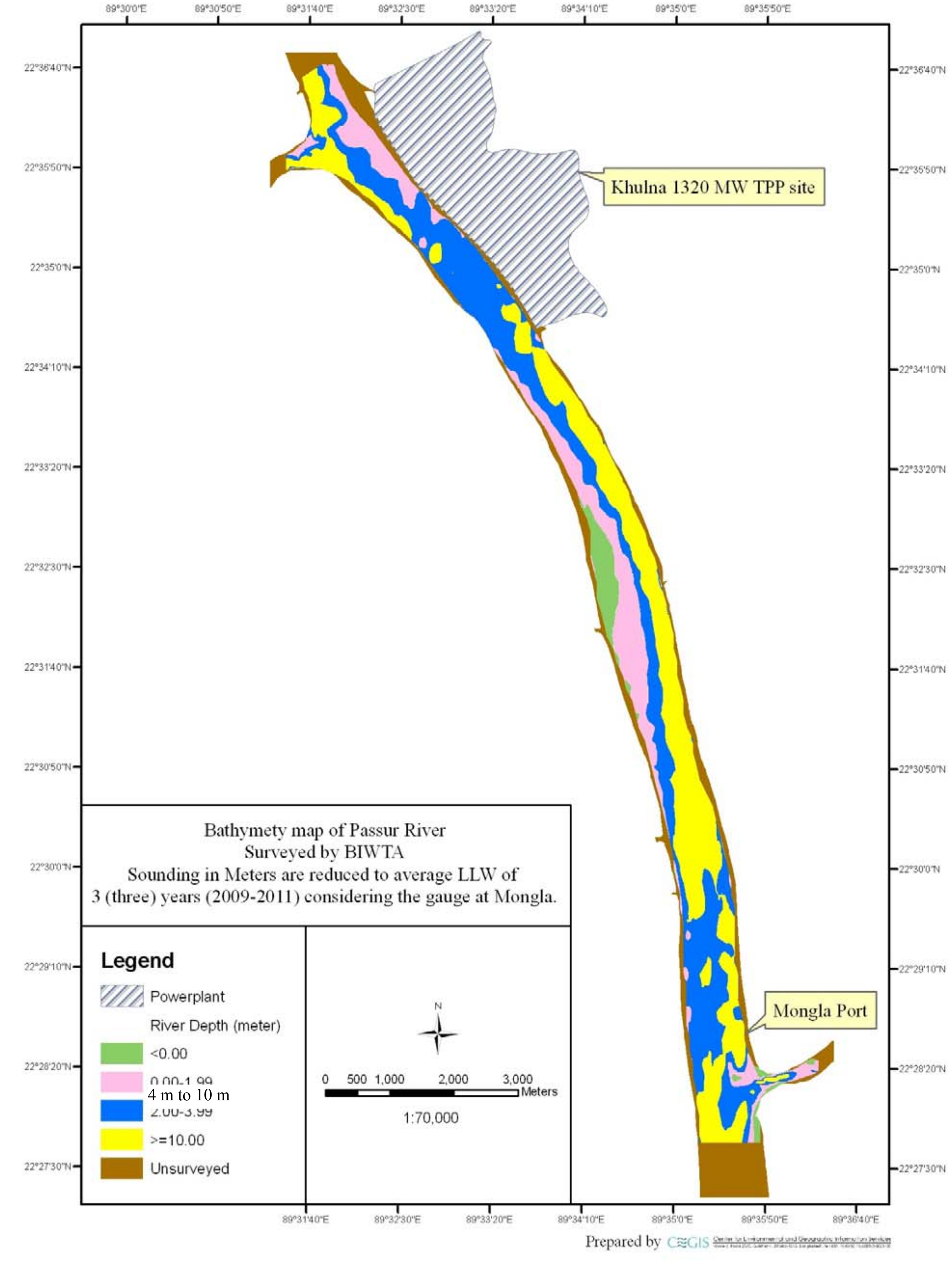


Figure 12.1: Bathymetry of the Passur River from Chalna to Mongla port

b) Orientation of the berth along with terminal facilities may be developed within the port area of Mongla Port. It will be easy for development of terminal facilities along with the berth, because all information/data are readily available in the existing berthing facilities engaged for other cargo. This coal terminal may have all relevant and available supports from Mongla Port. But the coal unloaded at the berth needs to be transported/conveyed by conveyor corridor up to the power plant site covering distance 14 km. With this option, area for proposed Jetty 10 and Jetty 11 of Mongla Port and adjacent 25 acre area might be developed for coal terminal (Figure 12.1 and 12.2).

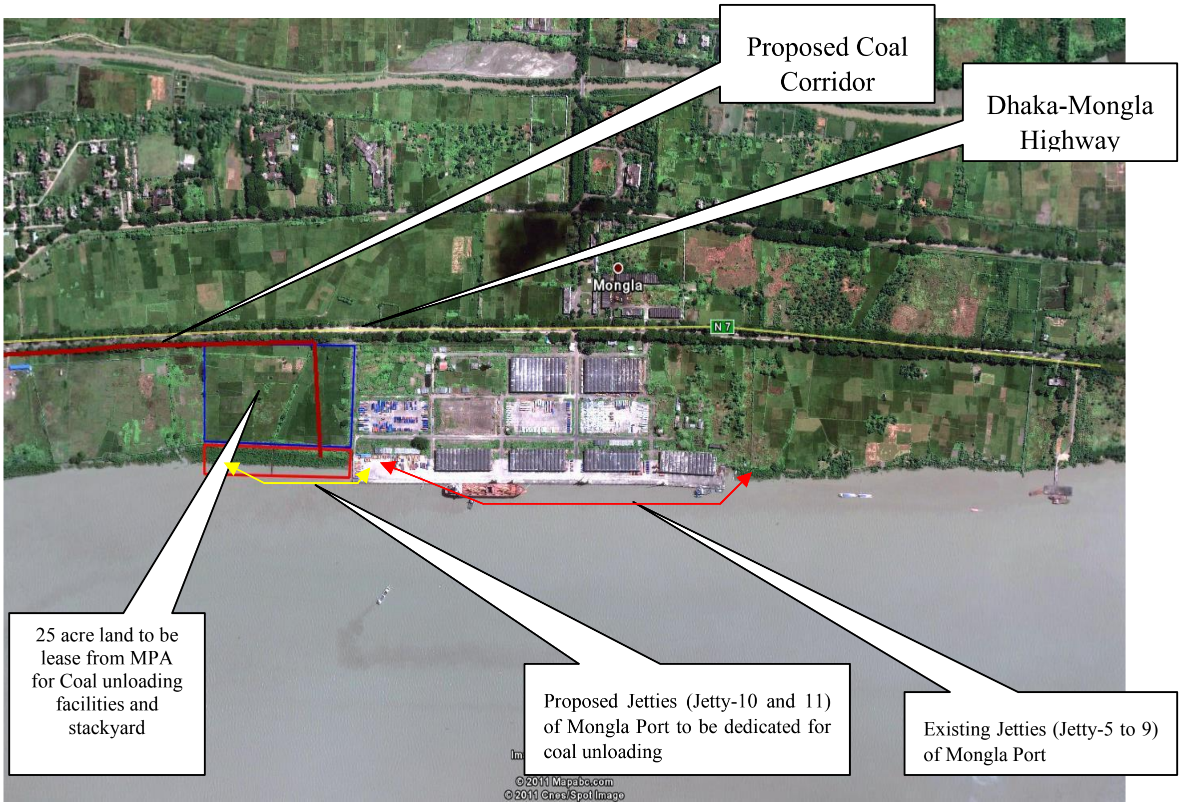


Figure 12.2: Proposed Jetty at Mongla Port.

For 1320MW Coal Based Thermal Power Plant in Chittagong Site

The very situation of the power plant site is at the estuary of the Karnaphuli River. Power plant project site has open water face at the mouth of the Karnaphuli River at one side and exposed to Bay of Bengal at the other side. In view of avoiding extreme environmental hazards like wind, wave, tide and current, the orientation of the berth is proposed inside the river channel rather than open sea. But at the estuary of the Karnaphuli channel has an obstruction because of presence of break water/river training works on both side. Therefore, orientation of berth is proposed to be set up in the inner side of the channel within the project site. A clam water body may be developed by dredging/excavating the adjoining the river bank of the project site covering an area of the proposed berthing facilities along with the minimum maneuvering area of the vessels avoiding channel constriction in the main channel.

For 8320MW LNG and Coal Based Thermal Power Plant in Maheshkhali Site

Maheshkhali site is enormously big and open to Bay of Bengal in the west. In view of having less environmental hazards like wind, wave, tide, current and tidal surge. Orientation of the berth line is preferably proposed to be developed in the inner side of the project land exposed to Bay of Bengal.

Moreover, this project site as a whole needs land development by dredging. This can be done by dredging/excavating the berthing area along with minimum maneuvering area for the vessels and filling the terminal area with the same dredged material. However, in all the cases of development of terminal facilities, maneuvering area for the vessels should be protected from oceanic wave, tide, strong current, and extreme environmental events by erection of strong ruble mound breakwater at least 1 km long across the channel in the downstream.

12.1.4 Approach jetty or bridge

Requirement of approach jetty or bridge linking between berth structure/jetty and the shore area depends generally on the width of the berth structure and the whole berth structure is away from shoreline particularly at the time of lowest water level (LLWL).

It is assumed that the width of the coal berth will be 30m accommodating all functional facilities such as rail mounted crane unloader, carriage way and clearance between berth line and crane rail at the edge of the of structure.

This requirement for approach jetty can be best evaluated through study of the detail bathymetric survey for each site in the next stage of final report.

It is identified that approach jetty or bridge will not be required as the stack yard and plant site are attached and adjacent to the coal terminal.

12.1.5 Revetment Line

Revetment structure is generally placed along the revetment line. Revetment structure is the interface structure retaining soil mass on one side and water on the other side. It should be robust and strong to withstand all loads (vertical and horizontal) accommodating the critical condition. It connects the jetty or approach jetty with shore area for coal stacking and other facilities on the shore structure are required for all the sites- Mongla, Chittagong and Maheshkhali.

12.1.6 Requirement of berths

The number of berths or the total length of the berth at any terminal is dependent upon the following parameters.

I. The annual cargo through put (coal unloading)
II. Vessels fleet composition with maximum size of vessel's LOA and utilization scenarios.
III. Unloading rates of coal
IV. Vessel turn-around time and
V. The terminal operational days in a year

12.1.7 Jetty configuration

The primary operation requirements of the marine structures are to provide the necessary run way or turn table support for loads imposed by ship and crane unloader both in operating condition and in storm-anchored condition. It also includes personnel, vehicles and routine maintenance equipment.

Other important requirements are:

a. Provision of adequate flat deck areas for carrying out routine maintenance on the crane unloaders and other accessories.

b. Generous falls to flat deck surfaces to shed water or permit hosing down.

c. Designing in material and with details that reduce or avoid future maintenance problems.

12.2 Facilities on the shore

12.2.1 General

To make the terminal functional and subsequently making the terminal capable of running with increasing efficiency and conveying from terminal site to power plant site, location of each facility should be such that it becomes as a whole highly interactive making the terminal performance most efficient. These facilities are enumerated as follows:

I. Belt storage shed
II. Shore room for spares
III. Coal Stockyard
IV. Operation Building
V. Control room
VI. Canteen building
VII. Workshop and its annex
VIII. Yard office/ Control room for stack yard
IX. Jetty office
X. Pump hours
XI. Substation

12.2.2 Coal unloading facilities

Operation of the system

A fully mechanized coal handling system is planned at the import berths to achieve an overall economy in the coal handling operation.

The following major equipments are proposed to be deployed for the purpose:

- Rail mounted grab or continuous ship unloader at the import berths.
- Belt conveyor for transport of coal from the berths.
- Rail mounted stackers/reclaimers in the stockyard.

The entire coal handling system has been planned for unloading of the entire coal at the berth and then to the stockyard.

The major problem in interlinking the unloading conveyors with the ship-unloading conveyor is the difference in the capacities of the two systems. To overcome this, a surge bin or a bunker is provided being located at the junction of the berth and the approach trestle. The surge bin could receive coal either from the berth conveyor serving the ship-unloader or the trestle conveyors connecting the berth with the stockyard. Thus when a ship is unloading, entire coal will be moved to the stack yard.

The major components of the coal handling system are:

- Coal unloader (s) at the berths
- Conveyors to the stack yard
- Stacker(s) in the stack yard
- Reclaimer(s) in the stack yard

The systems in detail are described through the following articles:

Ship Unloader at the Import Berth

There are two types of unloading systems for coal:
A) The grab unloading system
B) High capacity continuous unloading system

The salient features of these two systems are explained here under:

Grab Unloaders: The grab unloading system is a common, time-tested proven and reliable concept. It has the advantages of flexibility, adaptability, reliability and ease of maintenance. However, it has some serious disadvantages. A very significant disadvantage is the high accelerating forces caused by the weight of the grab in combination with the batch type operation. These forces limit the maximum through put capacity and result in relatively heavy crane design. Another disadvantage is the need for trimming by front end loaders during unloading of the left-over's at the bottom of the hold of the vessel.

Modern rail mounted grab unloaders are generally gantry type. The essential part of the unloader is the grab bucket. It has a relatively high self-weight. Usually equaling almost half the hoisting capacity of the crane. When unloading, a well-trained crane operator is capable of the positioning the grab almost anywhere inside the hold, keeping the surface of the bulk cargo more or less level.

The filled grab bucket is hoisted out of the hold and brought back to the quay over a hopper between the crane's front legs. The grab load is discharged into the hopper and from the hopper onto one of the belt conveyors running along the berth.

At the last stages of the unloading operation, part of the load will be left against the wall and in the corners of the hold. At that stage, filling the grab gets very difficult, causing a significant reduction in the rate of unloading. To help collect the remaining coal (clean-up operation), front end loaders are lowered into the holds by the crane.

Grab unloaders up to a capacity of 50 ton are now common. The highest capacity grab unloaders built to date are up to 85 ton. The payload of the grab bucket will be about 55% of the hoisting capacity; Nominal crane capacity will be approximately 60 working cycles per hour. The actual unloading rate will not be uniform and will vary considerably during operation. A nominal unloading pattern will be:

60% of the load at 100% capacity (free digging)
25% of the load at 50% capacity
5% of the load at 15% capacity (clean up)

This unloading pattern gives an average unloading rate of 65% of the nominal capacity.

Continuous Unloaders: High capacity continuous unloaders area relatively modern type of equipment, developed over the last 40 years. Initially these unloaders had little success, because effective capacities were disappointing and they are prone to mechanical breakdowns. However, over the past few years, there has been a clear trend in the market towards bucket-wheel type continuous unloader, which has proved to be a well functioning and reliable system.

The basic concept of the continuous unloader is to replace the discontinuous grab operation by a continuous digging and elevating process. Thus, variations in unloading rate are reduced and accelerating forces are minimized resulting in smaller and lighter cranes.

As opposed to grab unloaders, there are many different continuous unloader designs. Presently, two essentially different types of high capacity continuous unloaders are available in the market:

Of these, as indicated earlier, the bucket wheel type continuous unloader has proved to be a functionally reliable system. The digging element of the continuous unloader is a large bucket wheel similar to the wheel of a stockyard reclaimer. The wheel discharges through a grid (removing oversize lumps and tramp iron) on to a vertical conveyor. This elevator moves the coal up to the boom conveyor, which then leads it to a surge-bin between the pegs of the unloader. From here, the coal is discharged on to one of the belt conveyors along the berth.

Comparison of the two systems

Loads on the berth: Continuous unloaders are only slightly lighter than grab unloaders. However, the corner loads of a continuous unloader are considerably smaller. This is due to the reduced forces from the continuous coal unloading as compared to the accelerating forces caused by discontinuous grab unloading process. As a result berth construction for using a continuous unloader can be lighter than what is required for a grab unloader.

Investment Cost: Investment costs for a continuous unloader are about 10% lower than for a grab unloader of comparable capacity. When using a continuous unloader, the belt conveyors towards the stockpile will have a lower capacity (since cream-digging rate is reduced), so investment cost for the belt conveyor are also lower. The reduction of loads on the berth through provision of a continuous unloader will reduce the berth construction costs.

Pollution control: a clear advantage of a continuous unloader is its excellent environmental control. The coal transportation from the hold to the quay conveyor is completely enclosed, minimizing dust generation. Whereas grab loader operation is more likely to generate some pollution by coal, especially though leakage from grab and during discharge into the receiving hopper. However, for modern grab unloaders pollution could be reduced to a minimal level through a number of environmental measures. Most notably, this involves windshields and anti dust skirts around and inside the unloading hopper.

Clean-up Operation: In compassion with a grab unlaoder, the continuous unlaoder needs less clean-up work by front-end loaders. The good accessibility of the bucket wheel unloader to overhang and corners enable a high percentage of the coal to be unloaded unassisted. Practical experience has shown the amount of front-end loader hours needed for a continuous unloader to be half of what is needed with a grab unloader.

Reliability: Both the grab unloader and continuous unloader have proved to be reliably machines. Reliability is estimated at 93% to 99% depending upon the quality of maintenance and operating skills. However, in case of a major breakdown, repair of a continuous unloader will require more time, resulting in long downtime.

Maintenance and repair: The maintenance requirements of a high capacity continuous unloader are substantially higher than the requirements for grab unloader. Also for continuous unloader, maintenance will be more complex and time consuming activity. For either unloaded type major breakdowns that have direct contact with the coal (i.e. grab bucket wheel) in case of such a breakdown, changing the bucket wheel/ elevator section or in-site repairing it, is much more complicated and may result in a very long downtime of the continuous unloader.

Concluding remarks

This comparison covers aspects in favor of continuous unloaders as well as those in favor of grab unloader. As a result, the choice is, either unloader type will be highly dependent on the weight factor that is applied to each aspect. Under the present conditions of Bangladesh, emphasis should be put on the following aspect particularly on coal extraction technology along with the operation of coal-based power plant now being practiced in Barapukuria:

- Proven design
- Simple maintenance requirements
- Ease of repair/minimal risk of long down time.
- Local manufacturing capability/good local availability of spare parts.

Considering all aspects, it is recommended that grab type unloaders should be used.

Typical details of grab unloaders and continuous unloaders are shown in figure 12.3 and 12.4 respectively.

Figure 12.3: Typical Details of Grab Type Ship Unloader

Figure 12.4: Typical Details of Continuous Ship Unloader

12.2.3 Unloading Rate

It is determined that ideally a minimum 26,400 ton of coal per day will be required in the long term plan for each power plant at Khulna and Chittagong. So, it is necessary to provide an unloading rate of at least 30,000 ton/day for each plant including loss and wastage. However, in actual practice, it would be difficult to maintain the rate uniformly. The productivity would be high during the first two days of operation and towards the later stages the output would gradually drop due to operational constraints. The scattered material on the floor of the holds have to be scraped and accumulated with help of front end loaders or dozers and when this is being done, the unloader have to wait. Hence, it is preferable to have more unloaders of smaller capacity so that they can simultaneously operate in different holds.

Assuming 15-18 hours working per day, the average hourly productivity of the unloaders should be 1500 tons. The rated capacity of the unloaders should, therefore, be at least 2000 tons per hour. Hence 2 (two) unloaders of rated capacity of 1000 TPH each are recommended per berth for Khulna And Chittagong Thermal power Plant. Similarly considering coal requirement, 4 (four) unloaders of rated capacity of 1000 TPH each are recommended for Maheshkhali LNG & Coal Based Thermal Power Plant.

12.3 Specification of the Grab Unloader

a) Type: rail mounted travelling type
b) Number:

   For Chittagong and Khulna, power plants

   - Short term; 1320 MW production: 1 no.
   - Long term; 2640 MW production: 2 no.

   For Maheshkhali Power Plant

   - 8320MW production: 4 no

12.3.1 Performance parameter

Performance parameter would be same for all three power plants

- Product to be handled :coal
- Type and size of vessel to be unloaded : 3000-10,000 ton lighterage vessels and 25000-ton mother vessel.

Unloading capacity:

- Rated: 1000 t/h
- Average: at least 750 t/h

The unloading will be suitable for hoisting of a bulldozer, which is required for the final clean-up of the hold, into and out of the vessel hold.

12.3.2 Operation aspects:

- Rail span: 20m
- Lift above top of rail up to grab bottom: 20m
- Lift below top of berth: 27m
- Total lift: 47m
- Hoist load
  - Including grab : 65T
  - Payload (taken as 55%): 35T (44Cu.m)
- Outreach from centre of water side rail: 34m
- Back reach from centre of land side rail: 8m
- Minimum cleaning height under portal beam: 8m
- Distance between crane legs: 20m
- Nominal capacity: 60 cycle/hr
- Average capacity: 40 cycle/hour

- Maximum hoist speed with load
- Maximum trolley travel speed with load
- Class of duty : continuous (24 hrs/ day)
- Climatic conditions : Tropical

12.3.3 Control functions:

The unloader will be controlled by the crane operation from the operation cabin. The operation cabin can be positioned at any position along the grab carriageway, independently from carriage movements the operation can choose from the following two mode of operation:

- Manual: the operator can control all the crane functions with the exception of boom hoisting, from operation cabin. Boom hoisting will be manually controlled from a separate local cabin situated near the engine room. Tower travelling can be controlled from the operator's cabin as well as the local cabin.
- Semi-automatic: in this mode, the grab hoisting and grab travelling will be controlled by means of a program logic controller (PLC), in such way that grab will travel along a trajectory resulting in the shortest grab travelling time. The semi-automatic mode will be engaged and disengaged by the operator from the operator cabin.

The loader will receive instruction through appropriate communication devises from quay control room attendant. Interlocks and safeties will be provided, among other to ensure that starting the unloader takes place only when the receiving system is operational. The operational system situation of the unload and any failures there will be signaled to the central control room through appropriate control cables.

12.3.4 Norms and standard

The unlaoder will be designed and constructed in accordance with the latest state of the art and the applicable standard such as BS, DIN & FEM (federation Europeen de la manutention) & JIS etc.

12.3.5 Special requirements

Personnel safety and access

The unloader will be provided with all personnel safety features and protections as prescribed in the applicable norms. The operation's cabin will be designed in such manner, to allow the safe escape of the operator, in any position of the cabin, to the walkway on top of the carriage supporting structure. Stairs as well as personnel lift will be provided giving access to the various levels and location of the unloader.

The unloader shall be designed for the following maximum wind forces:

- Maximum operation wind force: Beaufort 8, wind speed 20 m/s
- Maximum wind force for structure designed: a maximum wind speed of 50 m/s

General description:

To unload coal from vessels, the quay/berth will be equipped with one rail mounted grab unloader. The unloader will travel on the supporting rails, which are fixed longitudinally on the top of the beam of the deck. Thus, in general, each unloader will operate on one vessel. Thus the travel length of each unloader should be sufficient to each and all holds of the coal vessel.

Each unloader will mainly consist of the following parts:

- A steel portal structure, supported on four (4) wheel bogie arrangements located under the corners of the crane.
- Shutter boom, boom conveyor, tripper car, mast structure.
- An operator's cabin with required controls providing an ample view on the operating areas inside and outside of the vessel holds.
- Electrical house: travelling, luffing and shuttle boom mechanism.
- Deflector chute with drive.
- The electrical power feed and power distribution equipment and lighting.
- The required weighting devices.
- The required safety devices.

12.4 Terminal Layout Plans with coal berth

12.4.1 Khulna Thermal power plant project

The most preferred option for modal system of transportation of coal from origin (mine mouth) to destination (power plant site) has been considered as follows:

a) Mother vessel from origin (coal exporting country) to any anchorage area like fairway buoy or Akram point or herbaria of Khulna (Bangladesh).

b) Transshipment of coal from mother vessels to lighter vessels.

c) Lighter vessels carrying coal to the berths/jetty at power plant site.

Therefore, under any circumstances berthing facilities should be developed for lighter vessels at power plant site and to make the berthing facilities operational in all respects other facilities should be developed on the shore nearby the berthing facility/quay structure as shore facilities.

In the event of the mother vessels with carrying capacity 25,000 ton coal, required 8m draught (minimum) should be provided along the Passur or the Sibsa river from Mongla to power plant site at Rampal Upazila by undertaking capital dredging and routine dredging as required.

As described in the previous articles, that it is difficult for mother vessels as well as lighter vessels for transshipment or loading/unloading in the rainy season (45 days disruption of supply line as declared) and during that period there is potential danger due to extremely rough & hot sea resulting disruption of supply line. Therefore, dry season is obviously preferred for many times more transportation than usual & average.

More over there is possibility of delay/mechanical breakdown of the vessels (mother & lighterage vessels) in the voyage due to unfavorable conditions of wave, tide and current as well as tidal surge etc.

Considering all aspects, optimum size of the berth facilities/quay structure has been recommended.

It may be mentioned that revetment line/ structure, equipment of berths and jetty configuration as well as facilities on the shore have been reflected/illustrated reasonably in terminal layout plan with definite dimensions.

General layout plan of Khulna thermal power plant project at Sapmari, Katakhali along with complete terminal facilities has been illustrated in Annex X. Five option of terminal layout plan with coal berth have been shown in figure 1,2,3,4 & 5 in the Annex X providing maximum fleet utilization. These are expected to occur in certain period of dry season favored by wave, tide etc, which may compensate for coal unloading in the event of disruption of supply line for 45 days in the monsoon. In all option, berthing facilities for ash handling / loading for export or local consumption have been provided.

So, the terminal layout plan has been depicted in view of the following major parameters affecting coal transportation/ handling.

a) Seasonal conditions: dry season is favorable and rain season is disruptive.
b) Capital dredging of the Passur and the Sibsa River.
c) Delay due to unfavorable conditions of wave, wind, tide and current in the advent and departure of rainy season or extreme monsoon.
d) Mechanical breakdown of the vessels (mother and lighterage)
e) Lack of coordination of the terminal operating officials.
f) Ash utilization/ handling and disposal. Major portion of coal-fired ash should be disposed off through waterway. Therefore, it needs berthing facilities.

Quay structure has been configured making 6 blocks, each 90 m long in view of easy dimensioning/spacing of piles ranging from 5.5 m to 6.5 m as well as constrains of R.C.C deck slab because of temperature and shrinkage exposed to the environment. Proposed jetty configuration is also favorable for structural analysis, design and detailing as R.C.C structure.

12.4.2 Chittagong Thermal power plant project

Grab unloader is recommended for installation in the jetty.

Specifications and number of grab unloader are the same as in the Khulna thermal power plant.

The most preferred option for modal system of transportation of coal from origin (mine mouth of coal exporting countries) to destination (power plant site at Anwara) has been considered as follows:

a) Mother vessels from origin (mine mouth of coal exporting countries) to the anchorage area of Chittagong port which is only 8km from the estuary of the Karnaphuli River with Bay of Bengal.

b) Transshipment of coal from mother vessels to lighter vessels

c) Lighter vessels carrying coal to the berths/jetty at power plant site.

So, under any circumstances, berthing facilities should be developed for lighter vessels at power plant site and to make the berthing facilities operational in all respects, other facilities should be developed on the shore land nearby berthing facility/quay structure as shore facilities.

Since the location of the power plant at Anwara is almost at estuary of Karnaphuli River with Bay of Bengal and the outer anchorage area is only 8.0 km from the estuary, minimum time will be required as well as number of lighter vessels to be engaged may be minimum particularly during dry season.

Moreover, there is an added advantage for access of 25,000 DWT capacity mother vessels to the coal terminal. In the extreme cases, this mother vessel has to wait at best 6 hours at the anchorage area during extreme low tide.

There is possibility of delay/ mechanical breakdown of the vessel (mother and lighterage vessels) in the voyage due to unfavorable condition of wave, wind, tide and current as well as tidal surge etc. Another problem of unloading of coal in the jetty and loading in the lighterage vessels may be arising out of the strike/ gherao etc. by operators/labors, which is very normal in Bangladesh.

Considering all aspects, optimum size of the berth facilities/quay structure has been recommended.

It may be mentioned that the revetment line/ structure and jetty configuration as well as facilities on the shore have been reflected/illustrated reasonably in the terminal layout plan with definite dimensions.

General layout plan of Chittagong Thermal Power Plant at Anwara along with the complete terminal facilities has been illustrated in Annex XI. Five options of terminal layout plan with coal berth have been shown in figure 1,2,3,4 and 5 in the Annex XI providing maximum fleet utilization. These are expected to occur in certain period of dry season favored by wind, wave, tide etc., which may compensate for coal unloading in the event of disturbance/ disruption of supply line. In all options of berthing facilities, ash handling/loading facilities for export or local consumption have been provided.

12.4.3 Maheshkhali Thermal Power Plant

Grab unloader is recommended for installation in the jetty.

Specifications are the same as described in Khulna Thermal Power Plant.

Number of grab unloader to be installed is 4 (four).

The most preferred option for modal system of transportation coal from origin (mine mouth of coal exporting country) to destination (Power Plant Site at Hoanak) has been considered as follows:

a) Mother vessels from origin (mine mouth of coal exporting countries) directly to power plant site at Hoanak having carrying capacity 80,000 (Panamax) ton. As the power plant site is open to sea i.e. Bay of Bengal in the West, there should not be any problem of draught for 18m or more, if the massive capital dredging operation is carried out across the approach channel of power plant site at Hoanak, before commissioning of 5,320 MW capacity thermal power plants.

b) If the massive capital dredging operation goes slow, mother vessels of 80,000 DWT may not have access to the plant site. In that case, 50,000 DWT of mother vessels may have access to the coal terminal at the plant site.

c) In addition, lighterage vessels may be engaged through transshipment of coal from mother vessels at anchorage area for Chittagong port or at the nearest area of power plant site at Hoanak.

So, berthing facilities should be developed for both mother vessels and lighter vessels at power plant site at Hoanak and to make the berthing facilities operational in all respects, other facilities should be developed on the shore land nearby berthing facility/quay structure as shore facilities.

There is possibility of delay/mechanical breakdown of vessels (mother and lighter vessels) in the voyage due to unfavorable conditions of wind, wave, tide and current as well as tidal surge etc. Another problem of unloading of coal in the jetty and loading in the lighterage vessels, may be arising out of the strike/ gherao etc. by the operators/labors which is very normal in Bangladesh.

Considering all aspects, optimum size of the berthing facilities/quay structure has been recommended.

It may be mentioned that the revetment line/ structure and Jetty configuration as well as facilities on the shore have been reflected/illustrated reasonably in the terminal layout plan with definite dimensions.

General layout plan of Maheshkhali Thermal Power Plant at Hoanak along with the complete terminal facilities has been illustrated in the Annex XII. One option of terminal layout with coal berth has been shown in figure 1, providing maximum fleet utilization. This is expected to occur in certain period of dry season favored by wind, wave, tide etc., which may compensate for coal unloading in the event of disturbance/disruption of supply line. In all options of berthing facilities, ash handling/ loading facilities for export or local consumption have been provided.

12.5 Indicative cost estimation

12.5.1 Cost estimation for Khulna power plant

Table 12.1 (a): Indicative cost estimate for Khulna Thermal Power Plant

Sl. No.	Description of Item	Quantity	Rate (Tk.)	Unit	Total Amount (Crore Tk.)	Total Amount (Million USD)
1	Grab unloader as specified in art 10.3 in/c surge bin & trestle	2 set	57 crore (FOB)	Each set	114	14.25
2	Revert structure/robust R.C.C retaining wall	900m	2.7 lac	meter	24.3	3.04
3	Berth/quay structure, pile length 45m maximum (in/c fender system), 6 Blocks	16,200 sqm	0.88 lac	sqm	142.56	17.82
				Total	**280.86**	**35.11**

Table 12.1 (b): Shore facilities: plan area basis not each floor

Sl. No.	Description of Item	Quantity	Rate (million Tk.)	Unit	Total Amount (million Tk.)
1	Operating Building	162	0.5	sqm	0.81
2	Control Room	234	0.5	sqm	1.17
3	Overhead Tank	56.25	0.5	sqm	0.45
4	Pump House	36	0.5	sqm	0.18
5	Underground Water Reservoir	126	0.5	sqm	0.5
6	Substation Building	337.5	0.5	sqm	0.20
7	Gate House	40.5	0.5	sqm	0.142
				Total	**5.28**
				Total in USD	**0.07 million USD**

Grand Total = 35.11 + .07 = 35.18 Million USD

Note: *1 USD is assumed Tk. 80.00*

12.5.2 Cost estimation for Chittagong power plant

Table 12.2 (a): Indicative cost estimate for Chittagong Thermal Power Plant Project

Sl. No.	Description of Item	Quantity	Rate (Tk.)	Unit	Total Amount (crore Tk.)	Total Amount (million USD)
1	Grab unloader as specified in art 10.3 in/c surge bin & trestle	2 set	57 crore (FOB)	Each set	114	14.25
2	Revert structure/R.C.C retaining wall	1100m	2.7 lac	meter	29.70	3.71
3	Approach jetty/Bridge connecting shore & Jetty	600 sqm (L = 30m)	0.88 lac	sqm	5.28	0.66
4	Berth/quay structure, pile length 45m maximum (in/c fender system), 6 Blocks	16,200 sqm (L= 540m)	0.88 lac	sqm	142.56	17.82
				Total	**291.54**	**36.44**

Table 12.2 (b): Shore Facilities: plan area basis not each floor

Sl. No.	Description of Item	Quantity (sqm)	Rate (lac Tk)	Unit	Total Amount (lac Tk)
1	Operating Building	162	0.5	sqm	81
2	Control Room	234	0.5	sqm	117
3	Sewage Treatment Plant	56.25	0.5	sqm	28.125
4	Canteen Building	360	0.5	sqm	180
5	Maintenance Building	135	0.5	sqm	67.5
6	Maintenance Workshop	585	0.5	sqm	292.5
7	Fire Station	56.25	0.5	sqm	28.125
8	Overhead Tank	56.25	0.5	sqm	28.125
9	Pump House	36	0.5	sqm	18
10	Underground Water Reservoir	126	0.5	sqm	63
11	Substation Building	337.5	0.5	sqm	168.75
				Total (Lac BDT)	**1072.125**
				Total Million USD	**1.34**

Grand Total = 36.44 + 1.34 = 37.8 Million USD
Note: *1 USD is assumed Tk. 80.00*

12.5.3 Cost estimation for Maheshkhali power plant

Table 12.3 (a): Indicative cost estimate for Maheshkhali Thermal Power Plant Project at Hoanak

Sl. No.	Description of Item	Quantity	Rate (lac Tk.)	Unit	Total Amount (lac Tk.)	Total Amount (million USD)
1	Grab unloader as specified in the relevant article in/c surge bin & trestle	4.00	5700.00	Each set	22,800	28.5
2	Revert structure/R.C.C retaining wall	1100.00	2.70	meter	2,970	3.7125
3	Approach Jetty/Bridge connecting shore & Jetty	1000.00 (L=50m)	0.88	sqm	880	1.1
4	Berth/quay structure, pile length 45m maximum (in/c Fender System), 8 Blocks	21,600.00 (L=720m)	0.88	sqm	19,008	23.76
				Total	**45,658.00**	**57.07**

Table 12.3 (b): Shore Facilities: Plan area basis not each floor

Sl. No.	Description of Item	Quantity (sqm)	Rate (lac Tk)	Unit	Total Amount (lac Tk.)
1	Operating Building	162	0.5	sqm	81
2	Control Room	234	0.5	sqm	117
3	Sewage Treatment Plant	56.25	0.5	sqm	28.125
4	Canteen Building	360	0.5	sqm	180
5	Maintenance Building	135	0.5	sqm	67.5
6	Maintenance Workshop	585	0.5	sqm	292.5
7	Fire Station	56.25	0.5	sqm	28.125
8	Overhead Tank	56.25	0.5	sqm	28.125
9	Pump House	36	0.5	sqm	18
10	Underground Water Reservoir	126	0.5	sqm	63
11	Substation Building	337.5	0.5	sqm	168.75
Total (Lac BDT)					**1072.125**
Total Million USD					**1.34**

Grand Total = 57.07 + 1.34 = 58.41 Million USD

Note: *1 USD is assumed Tk. 80.00*

Chapter 13: Coal Handling Systems

13.1 Introduction

Under this study, the coal handling system comprises coal handling at coal terminal and plant sites. This chapter focuses on coal handling from feeding to bunkering process. In general, a coal based thermal power plant has coal storage and handling facilities, the coal preparation system, the handling system completely depends on amount of coal to be handled.

Khulna Coal Based Thermal Power Plant daily coal requirement considering maximum plant load factor (100%), 365 operation days and 30% efficiency would be 12920 tons (for coal of 6000 kcal/kg GCV). To feed this bulk amount of coal, a bulk and efficient handling system will be required. Coal handling during transportation and unloading shall be based on the power plant capacity of 2 X 660MW.

For external handling, the raw coal from the jetty to the coal storage area shall be transported by single line conveyor belt system. The coal as received by waterway shall be unloaded through rail mounted grab bucket type un-loaders and shall be conveyed to plant end by single stream high capacity conveyor of 2000 THP through series of transfer points. For internal handling the transportation of the crushed coal from the coal storage area up to the coal bunkers a double line belt conveyor system shall be provided. The coal handling plant is proposed to consist of 1200 THP coal conveying system (with 100% standby parallel stream) along with re-claimers, trippers etc.

The installed capacity of Chittagong coal based thermal power plant being same with the Khulna coal based thermal power plant, the coal transportation and conveying system of the Chittagong power plant will be conventionally identical with the difference of the length of the conveyor belt and the related accessories.

Till now no feasibility study has been conducted for Chittagong 1320MW and Maheshkhali 8320MW coal based thermal power plants, the project site of the power plants as a whole has been selected but layouts of the same has not been confirmed.

The project site of Maheshkhali 8320MW LNG & Coal Based power plant has been envisaged but the location and layout of the power plant has not yet been decided. Out of total capacity of 8320MW, 5320MW will be coal based thermal power plant and LNG will run the rest. With this capacity a total quantity of 19 million ton (Approx.) coal will be required per year (considering 100% plant load factor, 365 operation days, 30% plant efficiency and 6000 kcal/kg GCV coal) for Maheshkhali power plant. The dimensions of the conveyor belt, stockyard and related accessories for handling coal to feed the boiler of the power plant will vary

The coal handling system mentioned below is conceptually based on the feasibility report of "(2X660) MW Khulna coal based thermal power plant" prepared by NTPC, India. Since the Coal consumption of both Khulna and Chittagong thermal power plant is same, the coal handling system will also be same for both plants. On the other hand, in case of Maheshkhali Power Plant, the conventional design and construction of the conveyor belt will also be identical to those of the Khulna and Chittagong coal based thermal power plants. However, the detail design would be subject to configuration and layout of the plant, and the fuel consumption. A general coal handling system applicable to proposed Chittagong and Khulna power plant is described below. The same might be applicable to Maheshkhali Power Plant adopting necessary changes in equipment and accessories subject to project site, layout of the plan, capacity and numbers of units.

13.2 Scope of supply and service

Coal handling system within the power plant essentially comprises of the following components and functions:

- Feed hopper (at coal receiving point) including grid, steel structure/ supports and all relevant equipment.
- Magnetic metal separator and tramp iron detector.
- Elevated coal belt conveyor from the coal yard via the junction tower to the ground level belt conveyor.
- Ground level belt conveyor up to the coal crusher.
- Two coal crushers complete with feed hopper, electric drive, necessary supports, explosion and fire protection measure, dust proof housing, classifier, inertisation devices, screening system.
- Traversing and reversible distribution belt conveyors for coal transportation from the crusher to the coal storage area (open and covered storage area).
- Underground hoper (located in the covered coal storage area), slide gate, chutes to the behind belt conveyor system.
- Two coal supply belt conveyors from the coal storage area up to and including two coalbunker tripping conveyors each serving unit.
- Ventilation and dust collecting equipment for all transfer points.
- Steel structure, stair, ladders, walkways, conveyor bridges, necessary supports, discharge hoods.
- All associated equipment such as belt drives, idlers, pulley, belt and pulley scrapers, hold barks.
- Auxiliary equipment such as belt weighting scale, coal sampling devices, all necessary belt safety and protection devices.
- Wash down system to clear the conveyor systems and walkways.
- Dust extraction and suppression system including water spray system, piping, valves, etc.
- Passive safety measure to protect the stored crushed coal against self-ignition
- Coalbunker ventilation system.
- Scaling system
- PLC safety interlocking system.

13.3 Special technical requirements

The coal handling system shall be in accordance with the capacity of the power plant 2 X 660MW.

The following factors shall be taken in to account on system design and equipment selection:

- Safety
- Reliability
- Maintainability
- Minimize indoor and outdoor environment pollution
- Standardization of components

The scope design and supply of the coal handling systems include all the processes from conveyor, which receives coal at coal storage point near jetty to boiler coal bunker.

For Khulna and Chittagong Coal Based Thermal Power Plant the total length of the coal conveyor system which has to be provided to transport the coal from the jetty to the coal storage area is approximately 0.5 km. Between the coal at jetty point and the coal storage area a 1200 THP capacity single line conveyor belt system shall be installed. For the coal transportation from the coal storage area up to the coalbunkers a double line belt conveyor system having capacity of 4000 THP each and the system consisting of the tripper conveyors shall be provided.

The special technical requirements and the capacity of the conveyor belts for Maheshkhali 5320 MW Coal Based Thermal Power Plant will vary upon the basic layout plan and the plant site.

The total coal storage capacity of each of these three power plants will be for 3 months.

13.4 Belt conveyors

Wherever applicable, the belt conveyors shall be lodged in close conveyor bridges. An unilateral walkway with open grid flooring shall be provided parallel to all conveyors. Idler sets shall be provided with labyrinth seals and shall run true. Bearing shall be of the "maintenance free type" lubrication shall be required not more frequent than once per year. Driver pulleys, tail and take-up pulleys shall be of close design. Pedestal bearing shall be provided with labyrinth scales. Belt scrapper shall be arranged at the discharge pulley and if necessary, for tail pulleys.

Material and construction of covering plates and product guides shall be chosen in view of optimum sliding behavior of the product, avoidance of clogging and limitation of noise. Material shall be stainless steel, reinforce fiberglass or equivalent. Rubber aprons for guidance shall be provided. Gears shall be of the slip-on type. Flexible or hydraulic start-up coupling (depending on size and requirements) shall be used. In order to reduce the volume of spare parts, the number of different types of driving units shall be kept to a minimum.

Retention assemblies such as limit switches, true-run switches, belt monitor, etc shall form part of the mechanical equipment of the conveyor belt system. Conveyors of longer length tension carriage or equivalent self-regulation tension devices to be used. Junction tower shall consist of steel framework and outside cladding. Intermediate stair and steps shall be provided with grid floorings. Above the conveyor heads or take-up stations, respectively trolley beams for a payload of 5 tons shall be provided. Distribution of coal to the individual coalbunkers shall be done preferably by a horizontal tripper conveying system. Special care shall be given to selection of the sealing system "bunker0tripper conveyor".

13.5 Magnetic separator and tramp iron

One inline magnetic separator in junction with two tramp metal detectors shall be installed in the conveyors feeding to the coal crusher. One of the tramp iron detectors shall be installed upstream of the magnetic separator and shall activate the magnet, while the other one shall be installed downstream of the magnetic separator and shall stop the conveyor system in case that iron is detected.

Electric magnet shall be used in the magnetic separator provided with its own rectifier. A magnetic separator of the "belt drum" type may be used. Removal of tramp iron may be made manually by using a trolley. This trolley shall be supplied with the system.

13.6 Weighing facilities (belt Scale)

Electrical type belt scale shall be integrated in the conveyor system leading to the boiler. The scale shall have an accuracy of not less than ±1%. Indication of instantaneous conveyance, totalizing and tripping shall be recorded.

13.7 Reclaiming system

Conveyor to the crusher / screen house shall handle the raw coal. The crushed coal shall be conveyed directly to the boiler coalbunkers. In case coal is not needed in the boiler bunkers, the crushed coal shall be sent to coal storage areas. Traversing and reversible belt conveyors shall do the transfer of the crushed coal to the coal storage area and the distribution. Crushed coal storage area shall have a capacity of 180 days based on plant- maximum rating requirement considering the worst quality coal involved. If the coal has high volatile matter, then storage may be made for maximum 30days plus one shipload. The storage area will be operated only for a period when coal is not received from outside.

Suitable traveling type of stacker shall be provided to stack the crushed coal to a height relevant to the availability of space. Necessary platform with drainage facility shall be considered. Soil improvement to improve bearing strength and other requirement shall be considered as required. Reclaiming from both coal storage areas (covered and open storage area) shall be done by portal scraper (considering less fuel oil and less labor requirement of the scraper and large volume of coal) and loaded to underground hoppers for further feeding to downstream conveyors of in plant coal handling. Required number of front-end loader shall also be supplied. Number of front-end loaders shall be adequate to feed the conveyors at 100% maximum rating of boilers.

The overall operating hour of the coal handling plant shall be 16-hour spread over two shifts per day leaving third shift exclusively for routine inspection and maintenance.

The coal storage areas shall be provided with necessary fire water system and compacting/dust suppression system.

Covered/uncovered storage to cater about 90 days requirement shall be provided as part of the total coal storage area of 180 days. The covered storage shall be constructed with structural steel supports and metallic sheet covering. Size and arrangement of the covered storage shall be such that it shall not hamper stacker movement/operation.

Figure 13.1: Pictures of typical portal scraper

13.8 Crushing and screening system

Coal received shall be screened and crushed to the required size of the mill system in the crusher prior to boiler bunkers.

Adequately sized surge hopper, with feeder chutes/flap gate, shall be provided to have maximum flexibility in the flow of coal.

Two crushers shall be provided (one as standby). Coal handling plant shall have crushers for ultimately sizing the coal to (-) 20mm.

Crusher shall be of suitable heavy-duty impact type. Crusher and screens shall be supported suitable and isolated from other foundation work. Necessary ant-vibration dampers shall be provided for crushers and screen foundations.

Screens shall be provided to screen the fines in the coal in order to minimize loading of crusher. The screening and crushing system shall be designed for 2 X 100% to meet the requirement and retain flexibility in operation. Screens shall be of heavy-duty rotary screen or electromechanical screen with a motor. The capacity of the screens and crusher shall be suitable for adequate recirculation design margin. The screened coal shall be sent to boiler coalbunkers directly.

13.9 Bunker feeding system

The capacity of the conveyor system up to bunker feeding conveyors shall be adequate to meet daily requirement in two shifts of 16-hour operation. For Khulna and Chittagong power plants, the proposed Coal handling system shall cater separately individual pick daily requirement of coal for two units in two bunker filling cycle in 16 hours effective operation.

Bunker filling shall be done by a traveling tripper conveyor arrangement. The bunker floor shall be sealed to have effective ventilation system and tripper arrangement shall be given for bunker filling. This system shall also include sealing arrangement, ventilation system and traveling tripper conveyor. Necessary bunker flooring shall be included.

13.10 Dust extraction/ dust suppression/ ventilation system

Dust extraction system shall be provided in the all the junction towers and crusher house to minimize the air pollution problems. Process water shall be sued for dust suppression system. Dust suppression system shall also be provided to the coal storage area. Necessary spray system and arrangement shall be provided in both coal storage areas. Bunker ventilation shall be provided to extract the dust due to bunker filling operation. The system shall be designed for air quality in which particulate matter shall not exceed 5-10 mg/m^3.

13.11 Safety interlocking system

A PC based PLC safety interlocking system for coal-handling system shall be such that sequential starting/ shut-down of the downstream conveying equipment is ensured due to trip condition. The trip-off of the minimum equipment in the safety sequence during abnormal operating conditions shall be ensured also.

The function of the safety interlocking system is as follows:

- Annunciate/indicate signals caused for the equipment that has tripped.
- Prevent restarting of equipment until safe conditions restored.
- Retain flexibility of operation as long as is consisting with safety.
- The interlock provided shall permit one stream operation retaining the flexibility in operation.

Making conveyor safer is a matter of process and design. In addition, these are basic principles that no operation where conveyor is utilized should ignore:

- Not to perform service on conveyor until motor is switched off.
- Service conveyor with only authorized personnel.
- Keep clothing, hair, finger and other parts away of the conveyor.
- Don’t climb, sit, step or ride on conveyor belt any time.
- Don’t remove of alter conveyor guards or safety devices.

- All unnecessary things that may obstruct safe operation should be removed before starting of the conveyor belt.

13.12 Control room

The in-plant coal handling system starting from the crusher up to the boiler bunker feeding tipplers operation including other equipment and components shall be controlled from in-plant coal handling control room.

Chapter 14: Ash Handling and Utilization

14.1 Ash production out of the coal consumption

14.1.1 Ash production out of the coal consumption for Khulna and Chittagong Thermal Power Plant

Based on the specified coal (refer to chapter 9, table 9.15) it is estimated that an amount of 3.1 million tons of coal shall be consumed (considering GCV of 5500 Kcal/kg, AR basis, and coal inflow at 85% plant load, 40% plant efficiency and 290 days operation) by each of the proposed coal based thermal power plants. As per this boundary condition, the annual production of ash in each plant shall be 0.46 million ton (ash content of coal estimated at 15%). Out of this 0.46 million ton 20% shall be bottom ash and 80% shall be dry fly ash, that is approximately 0.1 million ton bottom ash and 0.36 million ton dry fly ashes per year respectively.

14.1.2 Ash production out of the coal consumption for Maheshkhali Thermal Power Plant

In reference to Table 9.15 (chapter 9), it is estimated that an amount of 12.3 million tons of coal shall be consumed (considering GCV of 5500 Kcal/kg, AR basis, and coal inflow at 85% plant load, 40% plant efficiency and 290 days operation) by Maheshkhali coal based Thermal Power plant. As per this boundary condition, the annual production of ash in this plant shall be 1.84 million ton (ash content of coal estimated at 15%). Out of this 1.84 million ton 20% shall be bottom ash and 80% shall be dry fly ash, which are approximately 0.37 million ton bottom ash and 1.5 million ton dry fly ashes per year respectively.

14.2 Ash utilization

The dry ash is taken to buffer hoppers for its onward transportation in dry form to storage silo near plant boundary for utilization. The residue ash can be used in Brick manufacturing, clinker industries, cement industries, compaction purposes, etc. There will be also scope for ash export. At initial stage, the generated ash will be used in and for development of the project area.

Many Cement plants exist in the vicinity, hence, 100% fly ash utilization might be considered. Hundred percent bottom ash utilization might also been considered. However, ash dyke of 100 acres has been planned in case of non-utilization of ash for Khulna Thermal Power Plant and the equivalent of land will be required for Chittagong Thermal Power Plant. Similarly, for Maheshkhali Power Plant, ash dyke area of 300 acre might be considered.

For the purposes, the ash may be utilized:

- Concrete production, as a substitute material for Portland cement and sand
- Embankments and other structural fills (usually for road construction)
- Grout and Flowable fill production
- Waste stabilization and solidification
- Cement clinkers production - (as a substitute material for clay)
- Mine reclamation
- Stabilization of soft soils
- Road sub-base construction
- As Aggregate substitute material (e.g. for brick production)
- Mineral filler in asphaltic concrete

- Agricultural uses: soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards, and agricultural stakes
- Loose application on rivers to melt ice
- Loose application on roads and parking lots for ice control

Among these 13 uses of ash, few uses have high potential and have present market in case of Khulna Thermal power plant. The following sections 12.2.1-12.2.7 discusses potential sectors of ash utilization in case of Khulna Thermal Power Plant.

14.2.1 Ash Demand in Cement production

Fly ash is used as a partial replacement for Portland cement. It can replace up to 30% by mass of Portland cement, and can add to the concrete's final strength and increase its chemical resistance and durability. Recently concrete mix design for partial cement replacement with High Volume Fly Ash (50 % cement replacement) has been developed. For Roller Compacted Concrete (RCC) [used in dam construction] replacement values of 70% have been achieved with processed. Due to the spherical shape of fly ash particles, it can also increase workability of cement while reducing water demand. The replacement of Portland cement with fly ash is considered by its promoters to reduce the greenhouse gas "footprint" of concrete, as the production of one ton of Portland cement produces approximately one ton as compared to zero CO_2 being produced using existing fly ash. New fly ash production, i.e., the burning of coal, produces approximately twenty to thirty tons of CO_2 per ton of fly ash. Since the worldwide production of Portland cement is expected to reach nearly 2 billion tons by 2010, replacement of any large portion of this cement by fly ash could significantly reduce carbon emissions associated with construction.

There is a huge demand of ash in Bangladesh. At present, there are 81 cement industries. Among these around 37 - 40 cement industries are always in production. Grossly, country's annual cement production is around 14 – 15 million ton. Table 13.1 gives present and forecasted cement production and as well as possible ash demands.

Table 13.1: Present and forecasted cement production and ash demand in Bangladesh

Year	Cement Production and future projection (million metric ton)	Required amount of Ash (million metric ton)
2011	14	2.1
2015	18	2.7
2020	25	3.75

Source: Estimated from data of Bangladesh Cement Manufacturer Association

14.2.2 Cleaning Arsenic from Bangladesh's Water

In the largest case of mass poisoning in the world, arsenic contaminates the drinking water of about a hundred million people worldwide. In Bangladesh alone, forty million people are exposed to arsenic levels as high as 1,200 ppb, 240 times the level deemed acceptable by the Bangladeshi government. There are several technologies for Arsenic removal from water. A very recent technology introduced by Ashok Gadgil and his Berkeley Lab is very affordable and practical for rural areas of Bangladesh. The technology called ARUBA-Arsenic Removal by Using Bottom Ash, which has been designed for people of low-income group of Bangladesh.

The technology involves coating particles of coal ash with ferric hydroxide. Sold for around $2 per person for a year's supply, this low cost powder (Arsenic Removal Using Bottom Ash — ARUBA) is affordable to low-income villagers while allowing the factory and local distributors to make a small profit.

In Bangladesh where Arsenic problem is very severe, introduction of this technology would be very practical. In such case, Department of Public Health Engineering (DPHE) might come forward. And BPBD may work together to supply the generated ash to the DPHE or directly to the local people from production end.

14.2.3 Embankment construction

Fly ash properties are unique as an engineering material. Unlike typical soils used for embankment construction, fly ash has a large uniformity coefficient consisting of clay-sized particles. Engineering properties that will affect fly ash’s use in embankments include grain size distribution, compaction characteristics, shear strength, compressibility, permeability, and frost susceptibility. Bangladesh Water Development Board construct embankment in along the river side in different region of the country. In coastal region, BWDB constructs thousands kilometers of coastal embankment. Bangladesh Water Development Board might be an important client having scope of using large volume of the generated ash. BPDB may establish relationship with BWDB by signing a MOU to introduce and encourage ash use in embankment construction.

14.2.4 Pre-stressed Railway Concrete Sleepers

Use of Fly Ash might be used in the manufacture of pre-stressed Concrete Sleepers. Over the years Bangladesh Railway Authority manufactures Concrete Sleepers. BPDB may negotiate with Bangladesh rail way and demonstrate scope of ash utilization in concrete sleeper manufacturing.

14.2.5 Utilization in agricultural field

Ash might be used as fertilizer. Ash acts as soil modifier and source of micro and macro nutrients. There are different studies around the world especially in India shows that, using ash in agricultural field might result better crop yields. Khulna region is famous for leaf vegetables and edible crop production where ash can be used. There is a vast scope of selling the generated ash to the local farmers. However, in that case, farmers should be given proper training on how to use ash in agricultural field.

14.2.6 Brick manufacturing by using coal Ash

Most modern manufacturing processes use a greater proportion of fly ash, and a high-pressure manufacturing technique, which produce high strength brick with environmental benefits. They are widely sued for the inner skin of cavity walls. They are naturally more thermally insulating than normal bricks made with other aggregates. Recently in Bangladesh private brick manufacturing organizations are using these kinds of bricks products because it is more cost effective and good quality of brick. This makes ash utilization in this sector more essential.

14.2.7 Road sub-base construction

The geo-technical and pozzolanic properties of ash enables its use in coal pavement construction in many ways. Compacted pond ash and bottom ash possess adequate bearing strength and meet gradation requirements can be used as a granular sub-base material. Fly ash can be utilized for construction of semi-rigid pavement using lime fly ash concrete and learn cement fly ash concrete. These compositions posses more flexural strength than flexible pavements and can be adopted for high traffic density roads. In the concrete roads and runways, fly ash can be utilized as part replacement of ordinary Portland cement (up to 35%) and sand (5-15%). This would result in lowering the cost of concrete without affecting strength and increase durability.

As such, Bangladesh Roads,& Highway, and LGED could be giant users of ash to be generated from the power plant. BPDB may establish communication with Roads and Highway Department and LGED.

14.3 Ash handling system

The boiler shall be of dry bottom type. The bottom ash extracted in dry form shall be transported through conveyor to intermediate silo (common for both units), and pneumatically transported to BA silo and mixed with fly ash for final disposal in HCSD slurry form to ash dyke. The fly ash shall be conveyed in dry form from the electrostatic precipitator hoppers. This dry ash is taken to buffer hoppers for its onward transportation in dry form to storage silos near plant boundary for utilization. In case of non- utilization, fly ash shall be taken to HCSD system, wherein it shall be mixed in agitator tanks for its ultimate disposal in high concentration slurry form to ash disposal area.

14.3.1 Bottom ash handling system

Bottom ash (BA) is extracted by using a continuously operating dry bottom ash evacuation system.

The bottom ash extracted in dry form from each unit shall be crushed in primary and secondary crusher to granular size of less than 6mm and shall be collected in an intermediate silo (IM silo). BA can be unloaded and transported through trucks from this IM silo. In case of non-utilization of BA ash or disposal through trucks, Ash from IM silo shall be transported to a BA silo near HCSD pump house. This shall be further mixed with fly ash and disposed off in form of HCSD slurry.

Economizer ash shall be handled in dry form through vacuum system. One common buffer hopper and 2 nos (1 working + 1 standby) vacuum pumps are envisaged for 2X660MW units for eco ash conveying.

The BA extraction air compressor for conveying BA shall be used for conveying Eco ash also to BA silo near HCSD pump house. This shall be further disposed off in form of slurry.

14.3.2 Fly ash handling system

Pneumatic conveying system (either vacuum system or pressure system) shall be employed for conveying of fly ash from the electrostatic precipitator hoppers and APH hoppers in dry form. This dry ash shall be taken to buffer hoppers of each unit. The dry ash buffer hoppers shall be located abjection to the ESP. Dry ash from buffer hoppers shall be transported either to HCSD silos to be located near the chimney or to storage silos near the plant boundary. The transportation system shall be provided for each unit for transportation from buffer hoppers to the silos. The user industries shall take the dry fly ash from these storage silos in purpose built closed tankers ensuring environmental standards.

Space provision shall be kept near storage silos for installation of dry fly ash classification system, in future, for users for classified fly ash.

14.4 Ash slurry disposal system

The ash slurry disposal system has been adopted from FR of Khulna power plant.

14.4.1 Fly ash, BA, and economizer ash slurry disposal

The fly ash collected in High Concentrated Slurry Disposal (HCSD) silos near chimney and ECO & BA ash from BA silo shall be mixed with water in an agitator tank at controlled rate to obtain the desired high concentration. HCSD pumps shall further pump the high concentration slurry to ash dyke. One HCSD pump house is envisaged for 2 x 660 MW units. There will be two working streams (one for each unit) and one stand by stream for HCSD pumps. All the pumping streams shall be provided with its individual disposal pipes. No crossover is being envisaged in the disposal piping. About 100 acres of land has been designed for ash disposal area, which is located adjacent to plant boundary. The ash disposal area is planned with a total usable area of about 60 acres for ash storage and 40 acres for starter dyke storage lagoons, maintenance road all along the periphery of the dyke and recirculation system facilities.

14.5 Ash water system

There will be no recirculation from dyke as the disposal of BA and FA system will be only by HCSD. Thus the plant make up shall be used for water requirement of ash handling system throughout the plant life.

14.6 Ash water re-circulation system

HCSD system is supposed to have no excess water. However, a recirculation system is envisaged for pumping any excess decanted water from the dyke. Decanted water from ash pond of HCSD pond will be led to the plant area by using 2x100% (30cum/hr) capacity pumps and the same will be conveyed through one number carbon steel pipe from ash dyke to plant area. This water will be further used in the ash handling system.

14.7 Selling of fly ash

From the market analysis both nationally and internationally, it is evident that dry fly ash has enormous commercial use in all over the world. A draft Policy for utilization of ash generation has been suggested for Coal Fired Thermal Power Plant. Hence, to dispose and utilize the dry fly ash in a commercial and Environment friendly manner, the owner may like to adopt the following Draft policy for disposal of dry fly ash from coal-fired power plant.

14.7.1 Draft policy for disposal of dry fly ash from coal fired power plant:

- There shall be a provision for selection of bidder through competitive price by calling open tender for disposal dry fly ash. The contract period for the dry fly ash will be decided by the BPDB (Owner) during preparation of bid document. The unit price of dry fly ash will be subject to enhancement in respect to the prevailing market price of dry fly ash at that time. However, this enhanced price shall not be less than 5% of the immediate unit price.

- The dry ash shall be received by the contractor and shall be pneumatically conveyed through a proven dense-phase system to a location outside the battery limit of the power station, where the bidder shall have its own plant installation for handling, storage, processing of dry fly ash to achieve 100% eco-friendly utilization followed by facilities for automatic weighing / bagging/ stitching and delivering to the receiver of dry fly ash at its own cost and risk.

- The power plant authority shall provide necessary place to install compressor, motor & pipe line within the power plant boundary by the bidder for receiving the dry fly ash pneumatically to their ash processing plant procurement of land for installation of ash processing plant shall be the responsibility of the bidder for receiving dry fly ash.

- The dry ash shall be weighted by a calibrated weight gauge and will be recorded in presence of the representative of the power plant and that of the receiver of the dry fly ash. No charge shall be imposed upon the ash receiver by the power plant authority for weighting the dry fly ash.

- The cost of dry fly ash shall be in Bangladeshi taka. The earning from selling of dry fly ash shall be treated as the revenue income of the power plant. Necessary VAT/TAX on the price of the dry fly ash shall be borne by the ash receiver.

- Local and international companies/ consortium (individual/ joint venture organization who is willing to install an ash processing plant and experienced in the same field) shall be entitled to participate in the bid for disposal of dry fly ash.

Chapter 15: Abstract Cost

15.1 Coal cost up to Project site

It is expected that the Proposed Power Plant would come in to operation sometime in 2015 to 2020. Prediction of energy price in last few decades proved illogical. Thermal Coal price (FOB) in 2003 was approximately $35 per ton. The same coal price (FOB) in January 2011 became $142 per ton. Again in November 2011, the FOB price of per ton of thermal coal comes down to $122.

However, to prepare the Feasibility Study (FS) a landing cost of coal having a GCV value 5500 Kcal /Kg required to be quoted. As such Table 15.1, summary of the coal price up to Bangladesh has been considered as the base. The required type of coal for Khulna thermal Power plant may collect from a single source or a mixture of multiple sources having different GCV to achieve the optimum CGV of the designed plant. As per study on coal transportation (in Chapter 11), it is suggested to adopt Alternative Plan II that is transportation of coal by vessel of 80,000DWT and transshipped up to project site by lighters for Khulna Thermal Power Plant. For Chittagong Thermal Power Plant the alternative I states discharge of coal at Alfa Anchorage of Chittagong port by 50,000 DWT vessel then further transshipment up to project site through lighterage operation and for Maheshkhali Thermal Power Plant a new coal terminal should be construct at green shore of the project site, hence it is suggested to that 80,000 DWT provided with 14 m CD design draught.

Table 15.1: Coal price under suggested coal transportation plan

Coal Type	Country	FOB Price USD/ton	Transportation USD/ton	CIF USD/ton	CIF/million kcal
Khulna Coal Based Thermal Power Plant					
5500 Kcal/kg	Kalimantan, Indonesia	119	21.3	140.3	25.51
5500 Kcal/kg	Richard Bay, South Africa	101	36.0	137.0	24.91
5500 Kcal/kg	Newcastle, Australia	116	36.0	152.0	27.64
Chittagong Coal Based Thermal Power Plant					
5500 Kcal/kg	Kalimantan, Indonesia	119	25.6	144.6	26.9
5500 Kcal/kg	Richard bay, South Africa	101	43.9	144.9	26.27
5500 Kcal/kg	Newcastle, Australia	116	44.5	160.5	29.18
Maheshkhali LNG & Coal Based Thermal Power Plant					
5500 Kcal/kg	Kalimantan, Indonesia	119	14.4	133	24.18
5500 kcal/kg	Richard bay, South Africa	101	29.6	130	23.64
5500 Kcal/kg	Newcastle, Australia	116	28.8	145	26.34

Note: FOB prices are based on prices estimated in Table 6.2. all prices are in USD/ton

Considering coal from multiple sources having different GCV values to arrive the average value of 5800-6100 Kcal/kg, the CIF price up to Khulna Power Plant site might be considered approximately **USD 140 /ton** (estimated by weighted average method, preference was given to South Africa). The price estimation of FOB has been made adjusting the prices of different coals (different GCV) to 5,500 kcal/kg.

In similar way, CIF price up to Chittagong Power Plant site would be about **USD145/ton** (estimated by weighted average method, preference was given to South Africa) and for Maheshkhali Power Plant site, it would be **USD130/ton** (estimated by weighted average method, preference was given to South Africa).

It seems, CIF price for Chittagong is highest among the three. Because, lighterage cost is higher in Chittagong than Khulna, While, in case of Maheshkhali no lighterage would be required. Besides, vessel size is also smaller in case of Chittagong due to draught restriction that increases transportation cost. It is to be noted that transportation plan for Khulna Power Plant has been framed considering development of river navigability by capital dredging including dredging at outer bar and maintenance dredging. This dredging cost has not been considered in coal price. On the other hand, no dredging would be required for Chittagong Power Plant. In case of Maheshkhali, massive dredging would be required for developing the approach channel from deep-sea port to project site coal terminal.

Table 15.2: Cost for Aids to Navigation

Khulna Coal Based Thermal Power Plant			
Navigational Aids	**Unit cost (USD)**	**Requirements**	**Total cost (USD)**
Units of Lighted Buoy	35,000.00	10 units	350,000.00
Mooring Buoy	5,500.00	10 units	55,000.00
Units of Beacon Light	7,000.00	12 units	84,000.00
Total Cost			**489,000.00**
Chittagong Coal Based Thermal Power Plant			
Units of Lighted Buoy	35,000.00	6 (six) units	210000.00
Mooring Buoy	5,500.00	10 units	55,000.00
Units of Beacon Light	7,000.00	6 (six) units	42,000.00
Total Cost			**307,000.00**
Maheshkhali LNG & Coal Based Thermal Power Plant			
Units of Lighted Buoy	35,000.00	4 (six) units	1,40,000.00
Units of Beacon Light	7,000.00	5 (six) units	35,000.00
Total Cost			**1,75,000.00**

15.2 Dredging Cost

The details of the dredging requirement and cost have been discussed in Section 10.2 of Chapter 10. The summary dredging cost for the suggested coal transportation system has been provided in Table 15.2. The dredging cost would be investment cost that to be borne either by the project authority or GOB. The estimated transportation costs do not include dredging cost

Table 15.3: Dredging cost

Khulna Coal Based Thermal Power Plant		
Sl. No	**Dredging Plan**	**Cost (million USD)**
1	Capital Dredging	
	At Outer Bar	105
	Base Creek to Mongla Port	6.0
	Base Creek to Project site	4.0
	Total	**115**
2	Yearly Maintenance Dredging	
	At Outer Bar (1^{st} year)	21.0
	Base Creek to Mongla Port	6.0
	Base Creek to Project site	3.0
	Annual Maintenance Dredging Cost	**30**
Chittagong Coal Based Thermal Power Plant		
There is no need of Dredging for this site		

Maheshkhali LNG & Coal Based Thermal Power Plant		
Sl. No	**Dredging Plan**	**Cost (million USD)**
3	Development of approach channel (Option-1: 400m wide)	132.12

15.3 Construction of coal terminal at project site

The study suggests construction of coal terminal at project site considering existing condition of river and cost of transportation. However, another study might be carried out to examine the sustainability of the Passur River Channel. However, the indicative cost for coal terminal construction at project site has been given in Table 15.3 and 15.4 below. Construction costs of coal terminal stand at 35.18 million USD, 37.8 million USD and 58.4million USD for Khulna, Chittagong and Maheshkhali TPPc respectively. These costs would be a part of the investment cost of the power plants.

Table 15.4 (a): Cost of Berthing facilities and Unloading facilities for Khulna Thermal Power Plant

Sl. No.	Description of Item	Quantity	Rate (Tk.)	Unit	Total Amount (crore Tk.)	Total Amount (million USD)
1	Grab unloader as specified in art 10.3 in/c surge bin & trestle	2 set	57 crore (FOB)	Each set	114	14.25
2	Revert structure/robust R.C.C retaining wall	900m	2.7 lac	meter	24.3	3.04
3	Berth/quay structure, pile length 45m maximum (in/c fender system), 6 Blocks	16,200 sqm	0.88 lac	sqm	142.56	17.82
				Total	**280.86**	**35.11**

Table 15.4 (b): Cost of shoreline facilities for Khulna power plant

Sl. No.	Description of Item	Quantity	Rate (million Tk.)	Unit	Total Amount (million Tk.)
1	Operating Building	162	0.5	sqm	0.81
2	Control Room	234	0.5	sqm	1.17
3	Overhead Tank	56.25	0.5	sqm	0.45
4	Pump House	36	0.5	sqm	0.18
5	Underground Water Reservoir	126	0.5	sqm	0.5
6	Substation Building	337.5	0.5	sqm	0.20
7	Gate House	40.5	0.5	sqm	0.142
				Total	**5.28**
				Total in USD	**0.07 million USD**

Grand Total = 35.11 + .07 = 35.18 Million USD

Note: *1 USD is assumed Tk. 80.00*

Table 15.5 (a): Cost of Berthing facilities and Unloading facilities for Chittagong Thermal Power Plant Project

Sl. No.	Description of Item	Quantity	Rate (Tk.)	Unit	Total Amount (crore Tk.)	Total Amount (million USD)
1	Grab unloader as specified in art 10.3 in/c surge bin & trestle	2 set	57 crore (FOB)	Each set	114	14.25
2	Revert structure/R.C.C retaining wall	1100m	2.7 lac	meter	29.70	3.71
3	Approach jetty/Bridge connecting shore & Jetty	600 sqm (L = 30m)	0.88 lac	sqm	5.28	0.66
4	Berth/quay structure, pile length 45m maximum (in/c fender system), 6 Blocks	16,200 sqm (L= 540m)	0.88 lac	sqm	142.56	17.82
				Total	**291.54**	**36.44**

Table 15.5(b): Cost of shoreline facilities for Chittagong power plant

Sl. No.	Description of Item	Quantity (sqm)	Rate (lac Tk)	Unit	Total Amount (lac Tk.)
1	Operating Building	162	0.5	sqm	81
2	Control Room	234	0.5	sqm	117
3	Sewage Treatment Plant	56.25	0.5	sqm	28.125
4	Canteen Building	360	0.5	sqm	180
5	Maintenance Building	135	0.5	sqm	67.5
6	Maintenance Workshop	585	0.5	sqm	292.5
7	Fire Station	56.25	0.5	sqm	28.125
8	Overhead Tank	56.25	0.5	sqm	28.125
9	Pump House	36	0.5	sqm	18
10	Underground Water Reservoir	126	0.5	sqm	63
11	Substation Building	337.5	0.5	sqm	168.75
				Total (Lac BDT)	**1072.125**
				Total Million USD	**1.34**

Grand Total = 36.44 + 1.34 = 37.8 Million USD

Note: *One USD is assumed Tk. 80.00*

Table 15.6 (a): Cost of Berthing facilities and Unloading facilities for Maheshkhali Thermal Power Plant

Sl. No.	Description of Item	Quantity	Rate (lac Tk.)	Unit	Total Amount (lac Tk.)	Total Amount (million USD)
1	Grab unloader as specified in the relevant article in/c surge bin & trestle	4.00	5700.00	Each set	22,800	28.5
2	Revert structure/R.C.C retaining wall	1100.00	2.70	meter	2,970	3.7125
3	Approach Jetty/Bridge connecting shore & Jetty	1000.00 (L=50m)	0.88	sqm	880	1.1
4	Berth/quay structure, pile length 45m maximum (in/c Fender System), 8 Blocks	21,600.00 (L=720m)	0.88	sqm	19,008	23.76
				Total	**45,658.00**	**57.07**

Table 15.6 (b): Cost of shoreline facilities for Maheshkhali thermal power plant

Sl. No.	Description of Item	Quantity (sqm)	Rate (lac Tk.)	Unit	Total Amount (lac Tk.)
1	Operating Building	162	0.5	sqm	81
2	Control Room	234	0.5	sqm	117
3	Sewage Treatment Plant	56.25	0.5	sqm	28.125
4	Canteen Building	360	0.5	sqm	180
5	Maintenance Building	135	0.5	sqm	67.5
6	Maintenance Workshop	585	0.5	sqm	292.5
7	Fire Station	56.25	0.5	sqm	28.125
8	Overhead Tank	56.25	0.5	sqm	28.125
9	Pump House	36	0.5	sqm	18
10	Underground Water Reservoir	126	0.5	sqm	63
11	Substation Building	337.5	0.5	sqm	168.75
Total (Lac BDT)					**1072.125**
Total Million USD					**1.34**

Grand Total = 57.07 + 1.34 = 58.41 Million USD

Note: *One USD is assumed Tk. 80.00, the cost excludes cost of breakwater/river training work along the approach channel*

Chapter 16: Environmental Issues of Coal Transportation, Unloading and Handling

16.1 Air pollution

Coal transportation, transshipment, unloading, handling, and stocking activities may generate coal dust and ash that might be dispersed to the surrounding environment if no mitigation measures are adopted. However, as the coal will be imported through ships, it will have sufficient moisture that will scale down propensity of dust generation. All the coal-carrying vessels, FC, FTV shall be equipped with dust suppression system. Hence, dust generation from the ship's holds during shipping and barging activities within the territory of Bangladesh may be minimum. Furthermore, the proposed project plans efficient dust suppression systems, coal stockyard management and air quality management system to limit generation and dispersion of dust particle

16.2 Noise

Noise may be generated from operation of these vessels. Similarly, coal unloading system and handling system may also generate noise. Coal transportation agency shall limit generation within the MoEF's standard of noise adopting noise management plan.

16.3 Wastes from ships

Generally, different types of wastes are produces from ships. The waste includes residue of the bulk (coal in this case), ballast water, bilge water, oil, lubricant, garbage, domestic waste, food and kitchen waste, slurry of sea water, sewage, etc. Discharge of any waste directly to the environment especially within the territory (Exclusive Economic zone) of any Country is strongly prohibited by different IMO Conventions on protecting marine environment. If the regulations mentioned in Chapter 3 are properly enforced by the relevant authorities (MPA, BIWTA and DG Shipping) and followed by the coal transportation agencies, discharge of waste from ships may be minimum.

BPDB should mention enforcement of these conventions in the Coal Supply and Transportation Agreement so that the coal transportation agent feels obligatory to follow these conventions with the aim of preventing pollution from ships. The responsible authorities (MPA, BIWTA and DG Shipping) shall monitor and spot-check the shipping and barging activities.

16.4 Wave erosion

Movement of large number of large bulk carrier, barge and lighter may generate wave on sea and river that might cause erosion along seashore and riverbank. It might also increase the rate of erosion at existing erosion vulnerable areas. Hence, detail study need to be carried out to identify area vulnerable to river and beach erosion within the territory of Bangladesh due to shipping activities for coal transportation. In general, restriction on vessel speed limits risk of erosion. The EIA on Khulna Thermal Power Plant suggests 8 to 7 Knots speed for coal carrying vessel in Passur River. Similar suggestions need to be come out from the EIA of the other two projects.

16.5 Water pollution

Water column may be polluted due to oil spillage, coal spillage and other malpractice like waste discharge, discharge of ballast and bilge water, etc which are prohibited by IMO conventions and ECR 1997. Thence, the responsible authorities should properly enforce these regulations for ensuring minimum water pollution due to shipping and barging activities. Nevertheless, comprehensive environmental management plan should be planned and adopted after carrying out detail study on Environmental Impact Assessment.

16.6 Impact on Fisheries

Movement of large number of vessels and unloading operation may cause disturbance on fish migratory channel and hence on migration. Fish habitat of Passur river, Karnaphuli river, and Maheshkhali Channel and Marine area of Maheshkhali may be affected due to deterioration of water quality (if occur). Fish mortality may increase if the coal carrying vessels practice oil spillage, spillage of hazardous waste material, waste water and discharge of ballast water and bilge water. The high river traffic might also affect fishing activities in the river. Hence, these issues should be taken into consideration in EIA and accordingly relevant mitigation measures and EMP should be suggested.

16.7 Impact on Sundarbans

One of the proposed thermal power plants – Khulna 1320 MW Coal Based Thermal Power Plant is located 14 km away from the Sundarbans. Coal carrying vessels would come to project site across the Sundarbans. As per the proposed plan, ship-to-ship transfer would be going in Akram Point Anchorage.

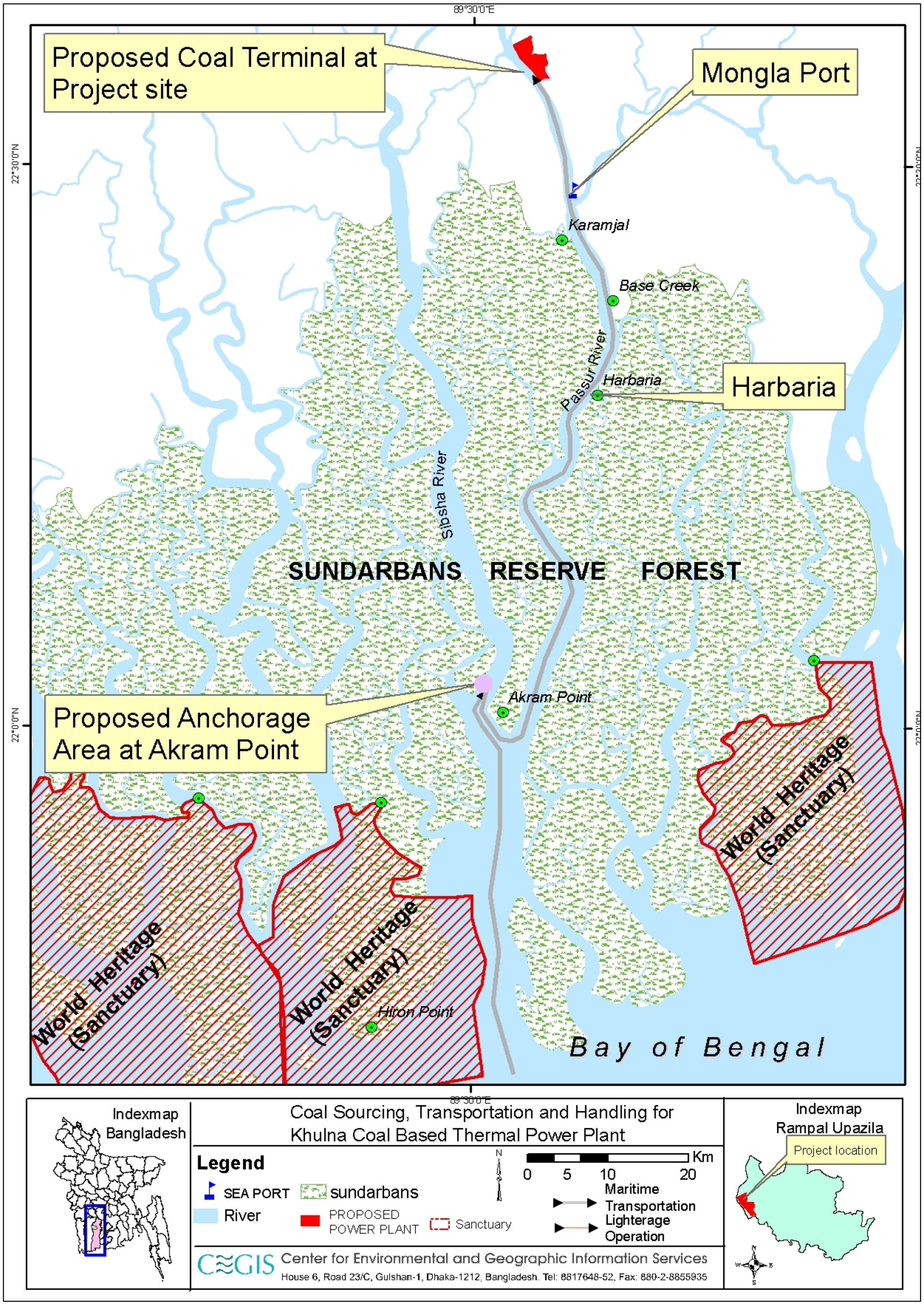
Coal transportation shall be carried out using existing navigational route of MPA and BIWTA. Map 16.1 shows the tentative coal transportation route crossing the Sundarbans. ECR 1997, IMO Conventions, and other relevant regulation as described in Chapter 3 should oblige Coal Transportation Agency. If the responsible authorities properly enforce the rules, no malpractice like discharge of ballast water, bilge water, oily water discharge, waste and wastewater shall take place within the territory of Bangladesh. Thence, the impact might be minimum. However, the responsible agencies should properly enforce the laws and inspect shipping and barging activities.

16.7.1 Terrestrial fauna

At Akram point, ship-to-ship transfer activities, shipping and barging activities shall be carried out keeping a safe distance from the shoreline of the Sundarbans. Standard operational practice shall be followed by the transportation agency. Thence, disturbance to wildlife due to shipping, barging and ship-to-ship transfer activities may be minimum. Noise generation, beaming of light, etc from shipping and barging activities shall be limited; hence, the impact due to noise and light beaming may also be minor.

16.7.2 Aquatic flora

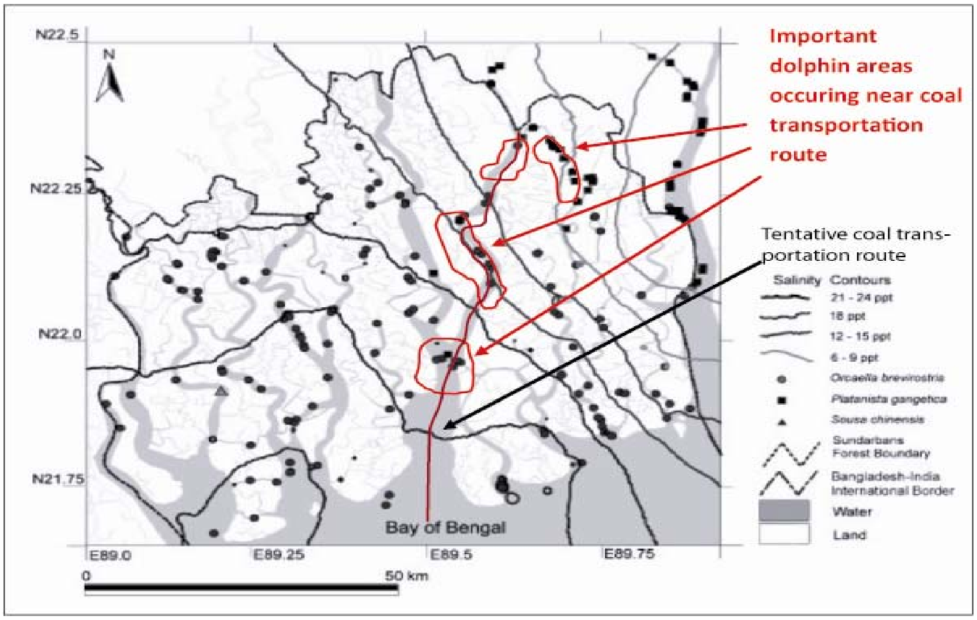
Ballast water, oil spillage and coal dropping might affect pneumatophore of Mangrove plants. The excess traffic loads also possesses risk of intrusion of invasive species. Enforcing IMO conventions especially MARPOL Annexes, HNS Convention and BWM conventions, malpractices of the ships and barges shall be limited. Hence, the impact of such activities on habitat of aquatic flora may be limited also.



Map 16.1: Coal transportation route across the Sundarbans

16.7.3 Aquatic fauna

All kind of shipping and barging activities shall be limited within the existing navigational route of MPA and BIWTA. Hence disturbance swimming, surfacing and surfing of the Dolphin may be moderate The Map 16.2 shows the Dolphin community occurring surrounding the tentative coal transportation route.



Map 16.2: Occurrence of Dolphin colony near tentative coal transportation route

Due to limiting the pollution causing activities, disturbance to migratory bird habitat occurring shallow tidal bars, tidal flood plain and shallow areas of the rivers may be limited. Noise from water vessel may disturb the feeding activities of activities of migratory birds.

16.7.4 Invasive Species

The transportation of imported coal possesses risk of invasion of alien species. Alien species might come through ballast water and by contract of vessel body. The responsible authority to limit the risk of invasion of foreign species shall enforce related IMO conventions and ECR 1997. These invasive species might intrude to Sundarbans ecosystem and/or Passur river ecosystem.

16.8 Impacts on Sea Shore Ecosystem of Maheshkhali and Chittagong

Sea shore of Maheshkhali, especially near Sonadia Islands and Islands of Hoanak are highly rich in biodiversity. The near-shore waters provide important habitat for breeding, growth and development of many inshore and near shore fishes and invertebrate species of the north-eastern part of the Bay of Bengal. Around 70 species of migratory birds visits near shore area of Maheshkhali for resting, roosting, feeding and wintering, and as a staging ground during migration. These include four bird species that are listed as globally threatened - the Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*), Asian Dowitcher (*Limnodromus semipalmatus*), Nordmann's Greenshank (*Tringa guttifer*) and River Lapwing (*Vanellus duvaucelii*). Apart from sea turtles, the presence of two fresh-water turtles is reported: the Bengal-eyed turtle (*Morenia peterci*) and the Indian flap shell turtle (*Lissemys puctata*). The site als the breeding ground of globally threaded marine turtle Olive Ridely.

Oil spillage, ballast ware and other waste from vessels might significantly damage the habitat quality of the seashore ecosystem. Hence, hence coal carrying vessel should be maintaining following IMO conventions, MARPOL Annexes, HNS Conventions, BWM conventions.

Pictures of Sea Shore area of Maheshkhali rich in biodiversity

Chapter 17: Environmental Management Plan

17.1 Impact Mitigation

The environmental issues and impacts discussed in the previous chapter should be taken in to consideration during planning. The environmental issues demands detail environmental assessment prior to project implementation. In the scope of Environmental Impact Assessment these issue have to be examined. The IEE and EIA should suggest measures for pollution avoidance, prevention and mitigation and accordingly recommendation should be made whether it is necessary to reconciliation of the project design and what to modify to ensure environmental protection. Thereafter, all of the identified impacts were further evaluated with and without mitigation measure adoption.

During operation, all the activities should be executed following standard of DoE. The standard is given in Table 17.1.

Table 17.1: Environmental Standard defined in ECR, 1997

Sl. no	Category	Standard	Remarks
1	Noise from Mechanized vehicle	85 dB	As measured at a distance of 7.5 meters from the vessel which is not in motion, not loaded and is at two thirds of its maximum rotating speed
		100 dB	As measured at a distance of 0.5 meter from the vessel, which is in the same condition as above?
2	Ambient Noise Level	45 dB during day and 35 dB during Night	For Silent zone e.g. forest, beach area, Sensitive area, etc
		50 dB during day and 40dBa during night	For residential area
3	Ambient level of Suspended Particulate Matter (SPM)	100 PPM	For sensitive area e.g. Sundarbans, Ecological Critical Area, archeological site, etc
		200 PPM	For residential and Rural area
4	Black some	65 HSU (Hartidge Smoke Unit)	As measured at two third of maximum rotating speed

Within this scope of the study, attempts were made to provide a brief guideline on identifying mitigation measures and formulating environmental management plan. Table 17.2 identifies some mitigation measures that have to be considered during IEE&EIA as well as project design of the proposed power plants.

Table 17.2: Mitigation of Impact

Impact	Consequence. With no mitigation measures	Mitigation/ Enhancement/ Compensation/ Contingency measure	Responsible Institution(s)	Consequence with mitigation measures adopted
Increase of Particulate Matter in local air quality	M	• Adoption of Dust suppression system in Ship's hold, Ship's unloader, coal terminal and conveyor system, stock yard • The vessel to be engaged shall have to be complied with international and national standard e.g. IMO conventions, MARPORL, HNS, etc • Adopt enclose system for coal unloading and transportation (through conveyor belt)	BPDB/ sponsor company/ EPC contractor, Port Authority/BIWTA	Mr
Noise generation	M	• Restrict blowing of whistle within Sundarbans Territory • Switch off / throttle down of all equipment and Machinery when not in use • Introduce speed limitation for vessel during Sundarbans Territory • Anchorage should be allowed at particular location within the Environmental Critical Areas like Sundarbans, Beach, Sea-Shore, Sonadia Island, etc • Enforce Forest Protection Acts • Limiting dropping of coal and escapee during unloading to feeder vessel/lighter vessel	BPDB/ sponsor company/ EPC contractor, Port Authority/BIWTA/DoE	Mr
Deterioration of river water quality	M	• Ensure zero dumping of ballast water, zero oil spillage, zero discharge of waste water, zero waste dumping • Clean Ship Concept might be adopted in carrying coal • Practice of dust suppression should be to moist the coal not to wet the coal	BPDB/ sponsor company/ EPC contractor, Port Authority/BIWTA/DoE	Mr
Wave erosion	Sg	• Plant mangrove forest along the bank of rivers, and sea shores • Plant and conserve native mangrove plants along the River bank and sea shore of coal transportation route • Introduce speed limit of coal transportation vessel	BPDB/ sponsor company/ EPC contractor, Port Authority/BIWTA/BWDB	M

Impact	Consequence. With no mitigation measures	Mitigation/ Enhancement/ Compensation/ Contingency measure	Responsible Institution(s)	Consequence with mitigation measures adopted
		• Reduce speed of the vessel at erosion vulnerable areas • Regular monitoring of erosion		
Increase river traffic accident	Sg	• Proper training for vessel crews, traffic inspectors, in charges, and other concerned professional • All vessel should be provided with GPS, radar and other electronic navigation systems to prevent grounding or collisions, such as depth sounder, radar and radio equipment for communication • All vessel should be complied with rules and regulation of IMO, Port authority, BIWTA and national laws of safety, and environmental conservations • Ensure port/coal terminal inspector, environment and safety manager are enforced	BPDB/ sponsor company/ EPC contractor, Port Authority/BIWTA/Coast Guard/Bangladesh Navy	M
Impact on Fish resources	M	• Awareness growing for fisher and facilitate the fisher to use nets/boats provided with signals and marking • Reduce speed if net is seen • Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping	BPDB/ sponsor company/ EPC contractor/BIWTA/DoF/ DoE	Mr
Impact on Sundarbans Ecosystem and wildlife, Sea Shore Ecosystem and Wild life of Maheshkhali	Sg	• Ensure enforcement of ECA, 1996 and ECR, 1997, Forest Protection Act, and other rules, regulation and treaties for conserving Sundarbans and Ecological Critical Areas • Ensure zero dumping of ballast water, zero oil spillage, zero discharge of waste water, zero waste dumping • Restrict outside lighting of the water vessel during navigation across the Sundarbans • Restrict the beaming of searchlight on Forest area/Sea Shores/Protected Beach/Protected Areas • Use low beam of searchlight during navigation across the Sundarbans/Sonadia Island/Bird Colony • Limiting dropping of coal and escapee during unloading to feeder vessel/lighter vessel	BPDB/ sponsor company/ EPC contractor/ Port Authority/BIWTA/Forest Department/DOE/ Coast Guard	M

Impact	Consequence. With no mitigation measures	Mitigation/ Enhancement/ Compensation/ Contingency measure	Responsible Institution(s)	Consequence with mitigation measures adopted
		• Restrict blowing of whistle within Sundarbans Territory and Ecological Critical Area of Maheshkhali • Introduce speed limitation for vessel in Sundarbans Territory and Ecological Critical Area of Maheshkhali • Anchorage might be allowed at particular location within the Sundarbans area and Ecological Critical Area of Maheshkhali • Anchorage of water vessel only in designated sites • Adoption of Dolphin Conservation Program • Adoption of Marine Environment Protection Program • Adoption of Turtle Conservation Program • Adoption of Shore Bird Conservation Program • Monitoring activities of the Foreign ships during coal transportation • Establish check post for monitoring activities of Foreign ships during coal transportation		

Consequence		**Defined based on combination of the nature mentioned above**
In	Insignificant	No significant negative impact
Mr	Minor	Localized short term degradation of Environmental quality
M	Moderate	Localized long term/ short term, widespread and reversible loss of environmental quality
Sg	Significant	Widespread, long term and reversible loss of environmental quality or Local Long term, irreversible loss of environment
Ct	Catastrophic	Widespread, long term and irreversible loss of environmental quality

17.2 Environmental Management Plan

17.2.1 Dust Suppression System

Dust suppression systems have to be installed at coal receiving terminal and plant site. The system functions (dust suppression) replenishing the evaporated moisture. An integrated system has to be installed to control dust at ship's hold, ship unloader, loaders, stackers, reclaimers, conveyor system (including each transfer point), and stockyard. An automated system may be adopted to suppress the dust maintaining moisture level of coal surface not below 7 – 8%. Sprinklers have to be set up in a way that will spray maximum water in form of mist so that no surplus water will be generated. However, Water collecting and recycling system needs to be installed in line with dust suppression system.

Furthermore, the conveyor system might be covered typed so that it wind action in generating coal dust can be controlled. At transfer points, water sprinkler should be installed.

In case of ship's holds, water sprinkler jets should be provided at the bottom of the boom of the unloaders so that the operator will be able to operate the sprinkler as and when required. In such case, no need to install automated sensor.

The major source of dust generation is stockyard. The entire stockyard should be covered with water sprinkler provided with automated moisture sensor. Sprinkler system provided with electrically operated valves and pumps are standard. Entire system i.e. sensor, valves, pumps should be connected with computerized monitoring and control system.

17.2.2 Air Pollution Management

Operation and maintenance of boiler, ESP, stack has to be carried out regularly as per instruction given in the manufacturer's guideline. At the same time, the quality of the coal has to be maintained as per design of the boiler and to comply with ECR, 1997. The coal shall have to be low sulfur content and having high calorific value. The ash handling system must be regularly inspected and tested to evaluate its performance as per the standard. Regular inspection of boiler, FD and ID fans separation and handling system and other ancillaries shall also be inspected and tested regularly. Safety shall have to be ensured for every time of the life period of the project. Emission level of SO_2, NOx and PM shall also have to be monitored regularly. The environment Manager shall be responsible for regular monitoring of emission level, inspection and testing of mitigation measures, environmental efficiency of the plant and regular reporting of the inspection. The monitoring and inspection report shall have to be submitted to DoE for renewing of Environmental Clearance Certificate.

17.2.3 Transportation and handling of Coal

The vessel to be used for coal transportation shall have to be satisfied all international and national standards. The activity of vessel shall be monitoring to ensure enforcement of mitigation measures. Coast guard might be given responsibility of inspecting whether the vessels are adopting mitigation measures, complying national and international rules of safety and environmental conservation. Besides, an Environment Manager shall be given responsibility of monitoring transportation activities and of auditing environmental efficiency of the transportation system.

Proper dust suppression and self-combustion mitigation system must be adopted. Practice should be to moist the coal but not too wet the coal. However, water treatment plant should be planned and constructed for management of runoff and wash off water from coal stockpile and unloading system.

The unloading system and conveyor system should be enclosed typed that would reduce generation of fugitive dust particle from coal.

17.2.4 Waste Water Management

The water management plan provided with recycling, reuse and treatment of water designed for operating the project shall be inspected regularly. The treatment plants shall have to be maintained as per manufacturer's guideline. Effluent quality shall have to be monitored at different stage of discharge and intake. Before discharging the treated effluent from the central monitoring sump the effluent standard shall have to be complied with ECR, 1997 defined standard for effluent.

17.2.5 Noise Management

All the equipments and mechanical parts shall have to be maintained in good working order to ensure maximum noise generation within limit of DoE's standard. Noise level should be monitoring at different selected location within power plant and nearest community. The greenbelt shall be planted with the aim of dampening the noise level. The boundary wall will also dampen the noise level further. Whether possible, mechanical parts of high noise potential shall be operating provided with acoustic hood. Noise from other non point source like project vehicle, vessel, etc shall be controlled adopting mitigation measures. An Environment Manager shall be given responsibility of monitoring efficiency of the management plan and regular monitoring of noise level.

17.2.6 Solid Waste Management

Waste to be generated from different point sources like office, household, workshops, construction yards, etc shall be efficiently collected, disposed and managed. Waste shall be collected and managed separately as per type. Hazardous waste should be managed separately. Initiatives might be taken for recycling and re-use of waste. On site waste disposal system should be constructed.

In terminal and stockyard, major waste includes coal dust, sand and some organic matter like paper, dry leaves, etc. In addition to waste collection and disposal system, provision should be made for collection of garbage from the ships also. This provision might be achieved by deploying the mobile vans into which the garbage from ships will be loaded by means of a suitable device.

17.2.7 Fly ash utilization

The ash to be generated from the power plant might be used in other developing sectors. There is also local demand of fly ash in cement industries. The fly ash and pond ash might also be utilized in agricultural field. Appropriate utilization of fly ash and pond ash increase crop production.

17.2.8 Water resources management

Water resources should be conserved and prevented from any pollution and hydrological alteration. The internal canals, nearby rivers, tidal creeks should be kept away from any obstruction and waste dumping. No tidal creeks outside the project area should be obstructed for project activities. If any tidal creeks flowing through the project area drains water from outside the project area should be flowing freely without any obstruction. Proper guidelines should be developed for Operation & Maintenance of drains, internal canals, and tidal creeks.

17.2.9 House Keeping

Good housekeeping is one of the prime step of safety. Good housekeeping of mechanical parts, rotator parts, electrical equipments, plant site, green belt, ESP, stack, etc will ensure workplace safety and efficient function of the system.

17.2.10 Greenbelt Development

A green belt shall be developed within the project boundary. This greenbelt will be acting as a buffer zone. The greenbelt will dampen the generated noise from the power plant. This zone will also be acting as safeguard from power plant for nearby community and Power Plant Township. Local tree species should be selected for green belt development. In addition, mangrove plant species should be planted along the riverbank of Passur, and Maidara in case of Khulna and Karnaphuli in case of Chittagong. For Maheshkhali, provision should be kept to conserve existing mangroves of the island located near the project site and proposed approach channel. However, a landscape planning is necessary for obtaining benefit from green belt.

17.2.11 Coal Yard Management

Coal is a self-combustible material. Proper aeration system and water spraying system must be installed to control self-heating of coal in stockpile. The dimension and height of the stockpile should be designed considering self-heating, aeration, wind effect, etc. There should be a continuous monitoring of the inside temperature of coal stockpile.

Coal stocking, handling, and other activities generated large amount of coal dust. The surface moisture of the coal should be maintained in a way that would limit propensity to spontaneously combust and produce dust. Generally, with surface moisture with at least 7%, coal shows low propensity to self-combustion and producing dust. Water must be sprayed on the stockpile if the surface moisture goes below 8%. There should be an automated monitoring and water spraying system. In addition water must be applied on coal:

- As it moves on conveyor belt
- At transfer points
- At stockpile

Care should be taken to control aerosol formation after water spraying. The runoff and wash off from the stockpile and coal unloading system should be treated properly before discharging it to open environment. However, wash off and runoff from stockpile should be limited. The water addition approach should be to moist the coal not to wet the coal. The recommended practice is to fog spray or mist the stockpile surface as frequently as necessary to maintain the surface of the coal in moist condition not in wet condition. This will minimize propensity of self-combustion and dust generation and accordingly no runoff water will be produced.

For regular monitoring and inspection, proper pathway with entry and exit should be provided in stockpile area and conveyor belt.

17.2.12 Ecosystem Management Plan

Ecosystem Management Plan in an integral part of the EMP. Different management plans mentioned in this chapter has been developed with the aim of protecting ecosystem. Implementation of these management plans is essential for safeguarding the ecosystem. The principle should be set that the plant shall be operated ensuring all pollution abatement measures are in order. The following measures should be implementing during different stage of the power plant

- Limiting vegetation clearance and base stripping within project boundary
- Development of Green Belt:
  - Local species should be chosen for green belt development
  - In green belt plant composition should be made considering plant of different height and different canopy size to facilitate deposition of ash
  - Protect existing Mangrove strip along the Passur River
  - Along the Passur and Maidara river bank adjacent to the project area, mangrove species e.g. Gewa, Keora, Sunduri, Bain, etc should be planted
  - Plantation should be made following the guideline of the Department of Forest
- Other management plan suggested in this chapter should be implemented for ensuring safeguard of ecosystem
- Plant operation:
  - Plant should be operated ensuring all pollution mitigation and abatement measures e.g. ash management system, ESP, FGD (incase of coal having high Sulfur content), close cycle cooling system, monitoring system, waste water and effluent treatment plant, etc are in order
  - Implement On-site Waste and Air quality Management Plan
  - Regular inspection and maintenance of the equipment following the manuals of the suppliers
  - Restrict night lights at places where necessary
  - Outdoor lights with shade directed downwards
  - Cut-off time to switch off unnecessary lights at night
- Coal Transportation and Handling:
  - Enforce the Relevant law of restricting Ballast water Dumping in Sundarbans territory
  - Enforce existing law of controlling oil spillage
  - Monitoring activities of the Foreign ships during coal transportation
  - Establish check post for monitoring activities of Foreign ships during coal transportation
  - Limiting coal Spillage and escapee during unloading to feeder vessel/lighter vessel
  - Follow standard practice for shipping and barging operation
  - Restrict blowing of whistle within Sundarbans Territory
  - Introduce speed limitation for vessel in Sundarbans Territory
  - Anchorage should be allowed at particular location within the Sundarbans area
  - Enforce Forest Protection Acts
  - Restrict blowing of whistle near bird colony
  - Awareness building
  - Restrict trapping, killing of migratory Birds and local aquatic birds
  - No trapping and killing of Dolphin
  - Plan measures for accidental oil spillage, refueling
  - Anchorage for water vessel only in designated sites
  - Adoption of Dolphin Conservation Program
  - Restrict outside lighting of the water vessel during navigation across the Sundarbans
  - Restrict the beaming of searchlight on Forest area
  - Use low beam of searchlight during navigation across the Sundarbans
  - Restrict night lights at places where necessary
  - Outdoor lights with shade directed downwards
  - Cut-off time to switch off unnecessary lights at night

17.2.13 Dolphin conservation

All the coal-carrying vessels should be obliged by IMO Conventions signed by GOB and national Environmental Regulations to ensure minimum impact on dolphin community and habitats. Vessels should be plying following the existing navigational routes. Speed of the vessels should be maintained within 7-8 knots. Standard operation practice should be followed in shipping and berging activities. All shipping and berging activities shall ensure zero waste dumping, zero ballast water dumping, zero pollution causing activities as per the IMO Conventions and national Environmental Regulations. DG Shipping, BIWTA, MPA, Coast Guard should regularly inspect shipping and berging activities to enforce the relevant conventions and rules. In addition, following measures should be taken in to account during shipping and berging activities and other project related activities:

- Avoid dredging activities during surfacing and swimming time of Dolphin i.e. at dawn and evening
- No trapping and killing of Dolphin
- Plan measures for accidental oil spillage, refueling
- Anchorage of water vessel only in designated sites
- Throttle down vessel speed if dolphin activities is seen in navigational route
- Keeping noise from shipping and berging activities within the limit of ECR 1997
- Ensure zero waste dumping, zero ballast water, bilge water, oily water, etc dumping

17.2.14 Standard Operational Principle

The power plant shall be operated following the guideline of ECA 1995 and ECR 1997 (and the amendment thereafter). In addition, for ensuring environmental safety, the standard Operational and Maintenance Philosophy of NTPC (discussed in Section 14 of the Feasibility Study Report) which is based on Good International Industries Practices (GIIP)[3] should also be followed. The Good International Industry Practice (GIIP) including the World Bank Group Environmental, Health and Safety Guideline prepared based on Equator Principles[4] should be followed in all aspects of plant operation and maintenance.

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[3] The detail of the GIIP can be found at http://www1.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC%20Sustainability/SiteMap

[4] The Equator Principle (EP) is a credit risk management framework for determining, assessing and managing environmental and social risk. The EPs are adopted by financial institutions and are applied where total project capital costs exceed US$10 million. The details of the EPs can be found at http://www.equator-principles.com/index.php/about-the-equator-principles

17.2.15 Monitoring plan

Table 17.3: Monitoring Plan

Indicator	Location of data collection	Frequency of data collection	Institution(s)
Air quality monitoring • SO_2, NOx, PM	For Khulna ➢ Coal terminal, Stock Yard, township area, nearby village ➢ Sundarbans near • Karamjal • Akram Point • Heron Point For Chittagong • Coal terminal, stock yard, plant site, township area • Mouth of Karnaphuli, • Alfa anchorage • Chittagong port area ➢ For Maheshkhali • Coal terminal, stock yard, plant site, township area • Sonadia Island • Sea Shore • Maheshkhali Upazila Complex	Quarterly	BPDB/DoE
Water quality monitoring (BOD, COD, Heavy metal, pH, salinity, Total hardness, Nitrate, Suspended Solid, Total solid, Temperature, etc)	For Khulna ➢ Coal terminal, • Karamjal • Akram Point • Heron Point For Chittagong • Coal terminal, • Mouth of Karnaphuli, • Alfa anchorage • Chittagong port area ➢ For Maheshkhali • Coal terminal, • Sonadia Island • Sea Shore • Approach channel	Quarterly	BPDB/DoE
Bird Colony, feeding and nesting ground	Within 10km buffer of the project Sea shore area, Akram Point (for Khulna project), Sonadia Island and nearby sea shore area (for Maheshkhali project), Parki beach, Mouth of Karnaphuli (for Chittagong Project)	Quarterly	BPDB/DoE
Benthos	2 km upstream and 2 km Downstream from the thermal plume discharge point sample should be taken at 500 m interval	Monthly	BPDB/DoE

Indicator	Location of data collection	Frequency of data collection	Institution(s)
Ecosystem health of the surrounding: • Fly ash/coal dust deposition on plant leaves • Plant health • Productivity of fruiting plants	5 sample from Homestead ecosystem (at least 2 at down wind direction) within 5km buffer zone 5 Sample from Road side plantation including 2 at downwind direction within 5km buffer zone Akram Point area, and Hiron Point Area (only of Khulna Project) Sonadia Island, sea shore Mangrove (only for Maheshkhali)	Quarterly	BPDB/DoE
Monitoring activities of Water vessel (Ballast water dumping, oil spillage, waste dumping, Beaming of Searchlight, noise generation etc) to be engaged in coal transportation	Hiron point, Akram Point, Monkey point, Karamjal, Mongla port, Jetty location of Project site	Regular monitoring	Coast Guard, Port Authority, Department of Forest
Water quality of river and sea • Oil • Heavy metal • Sulfur content • pH	For Khulna ➢ Coal terminal, • Karamjal • Akram Point • Heron Point For Chittagong • Coal terminal, • Mouth of Karnaphuli, • Alfa anchorage • Chittagong port area ➢ For Maheshkhali • Coal terminal, • Sonadia Island • Sea Shore Approach channel	Quarterly	DoE, BPDB-EPC contractor, Sponsor Company
Erosion/ Sedimentation	**For Khulna:** • Akram point site • Mongla port site • Project site **For Chittagong:** Parki Beach, Bank of Karnaphuli up to Chittagong Port **For Maheshkhali:** Sonadia Island, Matarbari, Sea shore of Hoanok and Kutubjhom	Twice in a year (wet and dry season)	BIWTA/ BWDB/ Sponsor Company

Chapter 18: Conclusion

18.1 Conclusion

Coal sourcing

Considering present world coal market condition, coal availability, coal requirement, and coal quality, coal sourcing from multiple sources has been suggested. The study founds Indonesia is suitable for sub-bituminous coal (GCV 5200 to 5800 Kcal/kg, GAR basis), and South Africa and Australia is suitable for Bituminous coal having GCV of 5800 to 6300 Kcal/kg (GAR basis). Nevertheless, preferences might be given to South African sources considering availability, reliability of the coal traders, suppliers, and producers, coal export friendly government policy and efficient coal supply chain. Though Indonesia is a cheapest (in terms of transportation cost) coal source, reliability of coal suppliers, traders, shippers, local political and social issues, influences of local elites, new Energy Policy of Indonesia, and government's strategy on coal exports are the major challenges that need to be properly handled during sourcing of coal. Australia is also a reliable and sustainable source but the coal market is controlled by the "Big Four (Rio Tinto, Xstrata, BHP Billiton – Mitsubishi and Anglo)", which shows risk of being a monopoly market in future. However, support of the GOB in coal sourcing may overcome these challenges.

In future, Mozambique may be another suitable source for coal considering the present trend of investment in coal exploration and exploitation and infrastructural development in Mozambique.

In parallel to the coal import, initiatives have to be taken to develop indigenous source taking appropriate consideration to mine water management and local issues.

Coal Quality

Due to depletion of coal deposits, decreasing shipping freight, and improved efficiency of the power plants, buyers are now inclined to opt sub-bituminous coal (5,200 – 5,800 kcal/kg). Buyers may get discount in coal price from producer for purchasing coal of this below RB standard (6,000 kcal/kg) and high volatile content, and for high transshipment cost and processing cost. Sourcing of coal below RB standard is also easier at present competitive coal market.

Dredging Requirement for Coal Transportation

For inland transportation of coal for Khulna power plant dredging at Outer Bar and Base creek to project site would be critical. To minimize the coal transportation cost dredging at Outer Bar (Length 20km, channel width 160m and design depth 12 m C.D and Base Creek to Project site will be required (channel width 100m, length 16 km and design depth 5.5 m) for the suggested coal transportation plan. This will not only facilitate coal transportation but greatly improve the overall business of the Mongla port also. The capital dredging at outer bar and Base creek to project site would cost 115 million USD and the maintenance dredging cost would be around 30 million USD in first year. Later, for the subsequent year, the dredging cost would be reducing and in the fifth year the cost would be around 21million USD.

In parallel to the Passur River, the Sibsa - Chunkuri River route (which is being used by the Indian cargo vessel of 700 to 1200 DWT for decades) can be explored as an alternate route to the project site from Akram point. As such, a further study should be carried out on evaluating hydrological, morphological and environmental aspects of the Sibsa route.

For Chittagong TPP no dredging will be required.

For Maheshkhali, an approach channel of 7km with 15m CD design draught shall have to be developed by dredging. Channel width might be 400m as per PIANC guideline. However, considering single channel, it could be reduced up to 200m. However, the width shall have to be decided considering scope of future extension of the project, utilization of coal terminal and traffic volume. If Maheshkhali coal terminal is considered as coal center as prescribed in PSMP (2010), then the width should be 400m. If the channel width is considered as 400 m then the capital dredging cost would be 132.12 million USD on the other hand for 200m width channel the cost would be 69.12 million USD.

Coal Transportation

For **Khulna TPP** the study has evaluated five alternative plans as follows to arrive at a feasible plan:

- Alternative I: Mother vessel up to 80,000 DWT arriving at Mongla Port Fairway Buoy then further transshipment by barges. **(Screened out).**
- Alternative II: Mother vessel up to 80,000 DWT arriving to Akram point anchorage. Dredging of river will be required.
    - Option IIA: purpose built shallower draught coal carrier (3,000 - 10,000 DTW) would discharge coal at coal terminal at plant site or near Mongla Port through the Passur River. For last case, coal has to be transported further by belt conveyor or railway (suggested with some modification).
    - Option IIB: Transport of coal by purpose built shallower draught coal carrier (3,000 - 10,000 DTW) to project site through Sibsa – Chunkuri River. Dredging of river will be required **(screened out).**
- Alternative III: Mother vessel up to 25,000 DWT arriving at Harbaria anchorage then further transshipment by purpose built shallower draught coal carrier up to project site coal terminal or coal terminal at Mongla Port. For last case, coal has to be transported further by belt conveyor or railway (**Screened out**).
- Alternative IV: Mother vessel up to 25,000 DWT arriving to Mongla Port Jetty no. 10 and 11. Transport of coal via belt conveyor or railway to project site **(Screened out).**
- Alternative V: Direct discharge of coal by Mother Vessel up to 25,000 DWT at project site. Dredging will be required **(Screened out).**

Finally, evaluating all of these alternatives, the study suggests the following plan for coal transportation that gives lowest transportation cost and sustainable supply chain:

- Source country to Akram Point by vessel of 80,000 DWT (subject to beam width and length of the vessel) and then further transshipment by purpose built shallower draught coal carrier of 5000 to10,000 DWT having draught of 5.5 m. The transportation cost will be 21.3 USD/ton for Kalimantan, Indonesia, 36.0 USD/Ton for Richard Bay, and Newcastle, Australia. The suggested transportation system considered dredging at outer bar and in the channel between Base creeks to project site.
- Ship-to-ship transfer should be operated by floating transfer vessels

For **Chittagong TPP** the study evaluates three alternative plans as follows to arrive at a feasible plan:

- Alternative I: Mother vessel up to 50,000 DWT discharge coal in Chittagong outer anchorage and coal will be transported by lighterage to site. A coal terminal has to be built at project site (suggested).
- Alternative II: Mother vessel up to 25,000 DWT discharge coal at project site. A coal terminal has to be built at project site **(screened out**).

- Alternative III: Mother vessel up to 80,000 DWT discharge coal at Kutubdia anchorage. Then transport to project site by lighter vessels. It will highly difficult to conduct this transportation process round the year due to severe rough sea events. (**Screened out**).

Finally, evaluating all of these alternatives, the study suggests the following plan for coal transportation that gives lowest transportation cost and sustainable supply chain:

- From source country to Alfa Anchorage by 50,000 DWT vessel (subject to beam width and length of the vessel), then transshipped up to the project site through lighterage operation. The transportation total cost will be 25.6 USD/ton for Indonesian sources, 43.9 USD/ton for South African sources, and 44.5 USD/ton for Australian sources. Higher lighterage cost of Chittagong Port region and smaller vessel size increase the cost compared to Khulna TPP. It is to be noted that, no dredging will be required for the considered transportation plan.
- Ship-to-ship transfer may be carried out by own gear of the mother vessel of floating transfer vessel. Considering the sea state of the open sea, own gear of the mother vessel is preferable.

For **Maheshkhali TPP** the study evaluates two alternative plans as follows to arrive at a feasible plan:

- Direct discharge of coal at project site coal terminal by 50,000 DWT mother vessel (screened out)
- Direct discharge of coal at project site coal terminal by 80,000 DWT mother vessel (suggested)

Finally, the study suggests the following plan for coal transportation that gives lowest transportation cost and sustainable supply chain

- Direct discharge of coal at project site coal terminal by 80,000 DWT (subject to beam width and length of the vessel) mother vessel.
- As such, transportation cost will be 14.4 USD/ton for Indonesian sources, 29.6 USD/ton for South African sources and 28.8 Australian sources.

Force majeure

Lighterage operation might be suspended for short period due to bad weather like heavy rain, depression and cyclone. It is estimated, bad weather might suspend shipping activities in Port area for maximum 40 days in a year. This bad weather condition might longer for maximum five (5) consecutive days in Khulna and six (6) consecutive days in Chittagong and Maheshkhali respectively. It is to be noted that, calm sea state shall have to be developed in Approach channel and Harbor basin of the proposed Maheshkhali Coal terminal by constructing breakwater.

Cost of Coal

Estimation of coal price based on published and collected data shows coal price at mine mouth is lowest in Indonesia but after incorporating the other costs (transportation, insurance, storage, trading surcharge, etc), FOB price becomes lowest in case of South African Sources. The adjusted FOB prices (for 5,500 kcal/kg calorific value, NAR basis) of South African, Australian and Indonesian sources are 101 USD/ton, 116 USD/ton and 119 USD/ton respectively.

Finally incorporating the transportation cost from source to project site, the CIF price estimation of coal stands at 137 USD/ton, 140.3 USD/ton and 152 USD/ton for South African, Indonesia and Australian sources respectively for Khulna TPP.

Similarly, with Chittagong TPP, CIF price for South African, Indonesian and Australian sources come at 144.6 USD/ton, 144.9 USD/ton and 160.5 USD/ton respectively.

In case of Maheshkhali TPP, CIF prices stand at 130 USD/ton, 133 USD/ton and 145 USD/ton for South African, Indonesian and Australian sources.

For feasibility purpose, average coal price (CIF) might be considered as 140 USD/ton for Khulna TPP, 145 USD/ton for Chittagong TPP and 132 USD/ton for Maheshkhali TPP. These prices have been estimated by weighted average method giving preference to South African sources. In case of Chittagong TPP, coal cost becomes highest due to high lighterage cost, and mode of maritime transportation (based on existing draught of the anchorage area and the Karnaphuli River).

It is to be mentioned here that, these estimated prices are only for feasibility study purpose and for reference purpose but might not be applicable for preparation of offtake agreement.

Coal Terminal

Construction of project site coal terminal has been suggested for each power plant. Unloading system might be rail mounted grab unloader. For Khulna and Chittagong two grab unloaders of 1000TPH each have been suggested for each project. On the other hand, four unloaders of same specification have been suggested for Maheshkhali Power Plant. Jetty of 540 m x 30 m has been suggested for Khulna and Chittagong targeting 25,000DWT vessel. For Maheshkhali Coal Terminal, jetty of 720m x 30m has been suggested targeting 80,000DWT vessel. Deck level of each coal terminal has been recommended as + 6.0m C.D.

Ash Utilization

There will be a good scope of ash utilization. At present, ash has a good market demand for cement production. Moreover, it can be used in embankment construction, arsenic-removing technology for drinking water and in agricultural field as fertilizer. The ash to be generated from these proposed power plants can easily be transported to any part of the country. The generated ash of these power plants would be very easily consumed by the cement factories. It may be noted that, in locality of the Khulna TPP and Chittagong TPP project site, there are several cement industries who are importing ash from India.

Environmental Issues

Likely impacts on ecosystem may arise due to noise, oil spillage; discharge of ballast water, coal dust, coal pollution during transshipment etc can easily be avoided and/or mitigated by proper implementation of the suggested Environmental Management plan. Standard Operation Practice should be maintained in shipping, ship-to-ship transferring and barging activities.

Road Map for Coal Sourcing

A road map indicating all necessary engineering and preparatory works for the coal supply of the TPPs has been attached in Annex IV. It has to be noted that the figures used are adjusted according to the knowledge of the consultant and practicality. They are little dissimilar to the figures provided by the BPDB earlier. The table has to be adjusted as soon as the precise figures are available.

For the organization of the BPDB internal professional engineering team managing the coal supply chain (The Core Team) and for conceptual mine development work technical specification have been prepared (Annex V and VI).

18.2 Recommendation

The risks and the detailed recommendations for the individual components are placed at the end of the relevant chapters. The following recommendations are the summary of those chapters. From the experience of the study, international visits, and examination of different cross cutting issues, as well as experience of the consultant, the Coal Sourcing and Transportation Study recommends the following:

- ❑ **Contracting**

- o There are two general strategies to organize the coal supply by
  - ▪ Direct contracting a mine, a trader or any other dealer/middleman
  - ▪ Signing off-take agreements with a mining company in the development phase of a new mine.
- o The Coal Strategy should consider the coal production of the national coal producing organizations as well. A long-term time schedule has to be generated integrating the national and the international coal sources.
- o It is recommended to have direct contracts to the mining companies for the acquisition of import coal. Off-take agreements may be an alternative as well. The mining scene should be monitored to find suitable JV opportunities.
- o Two or three coal supply contracts directly signed with mining companies are recommended. Sometimes traders cannot be avoided (e.g. Richards Bay). Two or three shipping contracts according to the supply agreements have to be signed as well.
- o The government should support the project during the phase of contract establishment. Support of the Embassy of Bangladesh at Jakarta, Indonesia and High Commission of Bangladesh at Canberra, Australia and South Africa to establish the first contact to the major mining companies would be very much appreciated.
- o Establish contact to the marketing departments of up to ten mining companies with the target to select three companies for further contract negotiations (e.g three Australian, three South African, two Indonesian, and two Mozambican companies).
- o The **negotiations** of any long term contract should target at:
  - ▪ discounts for coal qualities below RB standards (6,000 kcal/kg) long term delivery commitments
  - ▪ discounts on shipping rates for high volatile contents of the coal and processing costs.
- o Hedging and swapping should not be excluded but additional risk due to the contracting should be avoided. Optimal use of options should be considered.

- ❑ **Coal supply chain**

- o The coal supply price and the charter rates are subject to fluctuations due to macro- and microeconomic changes. All cost figures provided reflect for this reason only a subjective estimation of the situation at beginning of year 2012.
- o For the reason a very thorough evaluation of the particular country and company situation is recommended in order to achieve an optimal result for the Client.
- o The cost evaluations carried out in this study were made for coal resources from Australia, South Africa and Indonesia. The results show that considering the coal quality the final costs for the total supply chain are rather similar. This again stipulates a continuous and serious monitoring of the individual cost centers, of the time schedule and on the fulfillment of the technical specifications.

- For this reason it is further recommended to the Client to establish an internal professional team focusing on these contract issues on a permanent basis. We as Consultants believe that the Client should invest in the development of such internal “Core Team” for two reasons, cost reasons and for overall convenience.
- As an alternative to this approach, the Client could decide to involve a trading company. However, considering the additional costs involved we believe that the involvement of a trading company will not be a viable alternative.

❑ **Contract monitoring**

- The “Core Team” should be developed and prepared to monitor during the entire contract period
  - the fulfillment of the technical specifications including quality monitoring and sampling
  - Monitoring the environmental compliance of loading, shipping, transferring, barging and unloading activities
  - the time scheduling
  - the contract extensions or negotiations of new contracts
  - any development in the coal market to be able to react on any change

❑ **Equipment availability**

- Since barges of the required size and with the appropriate structural features are not readily available in Bangladesh, it is recommended to inform the locally active shipping companies early enough that such business opportunity is coming up. This will give them the chance to ramp up their equipment to qualify for this future work.

❑ **Dredging and coal terminal facilities**

- The required works for dredging and installation of the coal terminal facilities should be considered critical and made as early as possible to have the possibility for delivery of large parts of the power station equipment directly to the site by ocean going vessels or large barges.
- When constructing the barges, efficient design for shallower draught coal barges should be considered.
- Local shipping companies should be given incentives to enter the business.

❑ **Follow up studies should be carried out covering**

- Preparation on Coal Procurement and Coal Transportation Policy
- Set up and capacity building of a professional team in BPDB (Core Team) for the management of the coal supply activities and the contract monitoring by external consultant
- Institutional arrangement for coal sourcing and transportation (Core Team in BPDB)
- Implementation of coal procurement and transportation and preparation of Coal Supply and Transportation Agreement Documents (Core Team in BPDB)
- Ash utilization Policy
- Mining concept for national coal resources
- Public awareness campaign at location of mines and power plants

Chapter 19: Reference

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Annexure 1: Terms of References

TERMS OF REFERENCE

FOR

CONSULTING SERVICES 0N COAL SOURCING, HANDLING AND TRANSPORTATION OF 2x(500-660) MW EACH COAL BASED THERMAL POWER PLANTS AT CHITTAGONG & KHULNA AND 8320 MW LNG & COAL BASED AT MAHESHKHALI IN BANGLADESH

A. Background Information:

The Power System Master Plan (PSMP) of June 2006 (update) developed least cost generation addition plan up to 2025. This plan includes an optimum mix of base load and peak load plants, corresponding to the electricity demand characteristics of Bangladesh. The PSMP recommended installing 4,000 MW new power plants capacity using coal as fuel by 2025 due to projections of limited gas scenarios. As part of the plan, GOB/ BPDB has decided to add two coal-fired steam power generating units each between 2x(500 – 660) MW at locations of Chittagong and Khulna based on imported coal and 8320MW [Coal based 5,320MW and LNG based 3000MW] imported LNG & Coal based Power plant at Maheshkhali. The proposed power plants will meet electricity demand of the country, which will also address the improved system reliability and reduce load shedding. With a view to implement these projects, BPDB has decided to engage a reputed international Consulting Firms to provide services on best possible coal sourcing, transportation and handling upto proposed locations. It is expected that the international expatriate consultant work effort required to carry out the services described below should be about *2.5 Person* Months (PM). The expatriate consultant is expected to require the support of a local consultant with an input of about 62 PM.

B. Objective:

The objective is to provide consulting services for study on best possible coal sourcing, handling and transportation of proposed locations at Chittagong, Khulna and Maheshkhali. The eventual objective is to develop the projects through interested investors including private participants on Tariff Based Competitive Tendering. The Study reports and recommendations of the consultants will form an integral part of the Request for Proposals distributed by BPDB to interested developers for these Projects.

C. Scope of Services:

The scope of Consulting Services shall include studying of best possible coal sourcing, handling and transportation of same up to proposed locations at Chittagong & Khulna assuming development of the full project scope of 2600 MW at each site and 8320MW [Coal based 5,320MW and LNG based 3000MW] at Maheshkhali having supercritical steam parameters.

D. Implementation Arrangements:

It is expected that the consultants' input to carry out the services described below should be about 2.5 Person-Months for foreign consultants and 62 Person-Months for local consultants. The work of the local consultants shall be coordinated by, and they shall work under the direction of, the Team Leader, which shall be the designated leader of the expatriate consultants. The tenure of Consulting services shall be 3(three) months from the Commencement Date, by which date the Consultants will be expected to have completed the assignment and delivered to BPDB the final Study Report.

The Person-Months and field of expertise of foreign & local experts proposed are shown in Staffing schedule.

Note: local/ International Expert (Coal Sourcing Expert) shall be the Team Leader, and shall coordinate and manage and be responsible for the work of all of the consultants and the International/ Local Consulting Firm shall be responsible for the content of the Study.

E. Detailed Terms of Reference

The Consultant will render Services under and in accordance with these Terms of Reference, the final product of which shall be the delivery to BPDB of a detailed and complete Study report for the development of the aforementioned imported coal power generation projects, which study shall include but not limited to the following:

(i) Best possible sources of coal for the ultimate capacity of the stations (2×500-660 MW at each location with future expansion of each facility of 2×500-660 MW, with 2600 MW) at Chittagong & Khulna site and 8320MW [Coal based 5,320MW and LNG based 3000MW] LNG & Coal based at Maheshkhali.

(ii) Suitability for the delivery of imported coal through an effective and efficient fuel (imported coal) delivery and supply system.

(iii) Ability to dispose efficiently and in a manner that complies with all legal and regulatory requirements of ash generated by the power generation facilities (and the development of a recommended plan for doing so).

2. The Consultant will examine and propose a detailed Coal Handling System at each site that will satisfy the coal delivery requirements of two or more Independent Power Producers and handle adequate deliveries of imported coal for the said generation capacity, which examination and recommendation shall including but not limited to:

(i) Daily requirement of Coal for each plant, including future requirement when capacity will increase. (to be provided by BPDB)

(ii) Identify sources of coal suitable for the proposed machines to be procured.

(iii) Coal specification of available sources including indicative cost at mine mouth and cost of transportation upto proposed sites.

(iv) Options for coal purchasing ie short or long term lease with miner, open market purchase etc.

(v) Capacity of vessel to transport coal from source upto (a) proposed power plants jetty; (b) existing seaports at Chittagong and Mongla and (c) proposed deep-sea port at Chittagong/ Khulna. (Attachment 1 & 2)

(vi) Capacity of feeder vessel, if necessary, or conveyor system to transport coal from port to each power generation plants.

(vii) Identification of land area required for open coal stock yard and dry coal shed area in power plant site and sea port.

(viii) Detailed description of the coal unloading system for each location of plants, including jetty.

(ix) Coal storage facility and handling from stack yard to coal processing system of power plant complying safety regulation.

(x) Identify in detail (a) the coal handling/delivery system that should be within the scope of the first power generation project and (b) the additions/ expansions that would/should be required to the coal handling system by the subsequent projects, with the view that operation of the coal handling/delivery system should not be disrupted or impaired.

3. Study on Planning and Designing of Coal Handling and Transportation facilities

3.1 Study on Coal transshipment up to Bangladesh Coast and unloading

vii. Data collection on:

a. Passur & Karnafully River Bathymetry

b. Current, wave data, etc

viii. Numerical Modeling using specialized software for Tranquility

ix. Wave hindcasting and Tenability analysis

x. Channel dredging studies to navigate Panamax/Capesize vessels to port

xi. Forecasting the numbers of days for which lighterage operation is possible in a year and the continuous periods when the operation is likely to be affected due to unfavorable weather

xii. Working out the dimension and layout of marine facilities such as trestle, offshore berths and their cost of construction

xiii. Selection of optimal unloading system considering numbers of days for unloading, type and specification of the crane, capacity of the associated conveyor belt and cost

xiv. Optimal utilization of existing facilities and possibility of modernization of port required for proposed project

3.2 *Study on Coal handling and transportation to project site*

i. Plan and evaluation the relative merits of all of the three alternative options given in ToR
ii. Comparative study for calculating cost transportation per tonne basis
iii. Study on planning and design of the recommended coal unloading and handling system
    a. Existing and additional facilities
    b. Transportation to port to Project site
    c. Stockpile requirements, handling equipments
    d. Capital cost required for these equipment and construction and financial analysis to establish this capital investment
iv. Examine the possibility of exporting ash generated at power plant
v. Plan and layout necessary logistics required for ash handling and disposal
vi. Study the possibility of a new green field shore based port for exclusive requirement of the project
vii. Analyses of environmental and ecological issues

3. The Consultant shall also examine and propose a suitable ash handling system and management, etc., which shall be evaluated and recommendations made on an individual project and, if appropriate, on a collective basis

4. The Study shall be to level of detail necessary for tendering purposes of (a) the coal handling facility; and (b) the ash disposal facility (if it is to be collectively used by the IPP's).

F. Reporting/Deliverables

The following reports and deliverables are required to be delivered by the Consultants to BPDB hereunder not later than the date specified in relation to each report/deliverable:

1. An inception report is to be provided within two weeks from Commencement Date.

2. A brief progress report would be submitted within six weeks.

3. Draft Study report shall be submitted within 10 weeks from Commencement Date.

4. The final Study report shall be submitted within one week of approval of the draft Study report by BPDB, which final Study report shall incorporate to BPDB's satisfaction all comments on the draft Study Report made by BPDB.

5. All reports shall be submitted in 5 (five) copies including soft copy in CD.

G. Staffing

International:

Sl. No	Position	Person	Month/Person	Person month(s)
1	Coal Sourcing Expert	1	1.25	1.25
2	Maritime Transportation Expert	1	1.25	1.25
	Total	2		2.5

National/Local:

Position	Person	Month/ person	Person month(s)
Coal Sourcing Expert	1	3	3
Maritime Transportation Expert	1	3	3
Local Transportation Expert	1	3	3
Numerical Modeller	1	3	3
Morphologist/Dredging Specialist	1	3	3
Coastal Engineer/Water Resources Engineer	1	3	3
Railway Engineer	1	2	2
Port Engineer	1	3	3
Mechanical Engineer	1	3	3
Electrical Engineer	1	3	3
Environment Expert	1	3	3
Sociologist	1	2.5	2.5
Fishery Biologist	1	2.5	2.5
Ecologist	1	2.5	2.5
Economist	1	2.5	2.5
GIS/RS Expert	1	2.5	2.5
AutoCAD Expert	1	2.5	2.5
Junior Engineer	2	3	6
Junior Environmental Specialist	1	3	3
Field Researcher and Surveyor	2	3	6
Total	22		62

Annexure 1I: List of Potential Coal Suppliers

List of Potential Coal Suppliers

A.1 List of Potential Coal Producers and Exporters in South Africa

Sl.No	Name of Mining Company	Address and Contact Number
1	Anglo American Thermal Coal	Direct : +27 (0) 12 683 7257 Mobile: +27 (0) 83 488 9427 E-mail: esha.brijmohan@angloamerican.com
2	SASOL Mining	**Headquarters:** 1 Sturdee Avenue, Rosebank 2196, Johannesburg, South Africa PO Box 5486, Johannesburg 2000, South Africa Phone: +27 11 441 3449 Facsimile: +27011044103610 Web: www.SASOL.com **Contacts:** ***Andre Coetsee*** Managing executive Telphone: +27 11 441 3383 E-mail: andre.coetsee@SASOL.com ***Khanyi Ntsaluba*** General manager, financing Telphone: +27 11 441 3140 E-mail: khanyi.ntsaluba@SASOL.com
3	Kumba Resources	Kumba is a member of the Anglo American plc group. Direct : +27 (0) 12 683 7257 Mobile: +27 (0) 83 488 9427 E-mail: esha.brijmohan@angloamerican.com
4	Exxaro Resources (Second-largest South African coal producer with capacity of 45 MT per year.)	Pretoria, South Africa Roger Dyason Road, Pretoria West 0183 PO Box: 9229, Pretoria -0001, South Africa Phone: +27 12 307 5000 Facsimile: +27 12 323 3400
5	Optimum coal (South Africa's fourth largest coal exporter, owning 8.44 million tons of export entitlement at Richards Bay Coal Terminal.)	36 Fricker Road, Illovo, 2196 PO Box 411333, Craighall, 2024 Johannesburg, South Africa Phone: +27(0)11 447 3858 Fax: +27(0)11 447 3894
7	Shanduka Resources (Shanduka Coal, 70% owned by global trader Glencore, has a run of mine production of 9 million tonnes.)	167, Postnet Suite Private Bag X9924, Sandton, South Africa E-mail: info@shanduka.co.za Phone: +27 (0)11 305 8900
8	Xstrata Coal (Production from the operations was 17.7 MT per year end of December 2010.)	Enquiry Name Telephone General enquiries info@xstrata.com +41 41 726 6070 Website webmaster@xstrata.com +41 41 726 6070 Phone: +27 11 772 0600
9	Kangra Coal (The company produces around 3 MT per year.)	Kangra Group Ltd PO Box 1096, Vryheid- 3100, South Africa Phone: +27 38 995-0200 Fax: +27 38 995-0203
10	Wescoal (Currently produces 1.2 million tonnes of coal per year from its Khanyisa colliery in South Africa's Mpumalanga province.)	Headquarters, Wescoal 228 Voortrekker Street,Krugersdorp; HASH(0x9e2631c); HASH(0x9e26184) Tel: +27 11 954 2721
11	CIC Corporation	St. Andrews, Inanda Greens, Albertyn Street, Wierda Valley P O Box 784938, Sandton-2146, South Africa Tel: (27) 11 305-1810

Sl.No	Name of Mining Company	Address and Contact Number
		Fax: (27) 11 783-2006
12	Rio Tinto	Procurement South Africa P.O. Box 757550 Sandton 2146, South Africa
13	Umthombo Resources/Coal	13 Fredman Drive 7th Floor Fredman Towers Sandown 2196 P.O.Box 2632, Saxonwold, 2132 Johannesburg, South Africa Phone: +27 11 783 7996

A2. List of Potential Coal Mining Projects in South Africa

Sl. No.	Company	Ongoing Project Name	Comment
1	Anglo American	Mafube	Scope of investment in mine and making offtake agreement as well
		Zondangsfontein	
		Highveld Coal Field	
2	Waterberg Coal Field	Exxaro	as above
3	Sasol	Twistdraai Coal Field	Limited reserves
4	BHP Billiton	Witbank	Scope of offtake agreement
5	Xstrata	Ermelo	Scope of offtake agreement
6	Glencore	Optimum	Scope of offtake agreement
		South pansberg Coal Field	Scope of investment in mine and making offtake agreement as well

B.1: List of Potential Coal Producers and Exporters in Australia

Sl. No.	Name of the company	Contact Information
1	Anglo American Metallurgical Coal Pty Ltd	Anglo American - Australia Anglo American Metallurgical Coal Pty Ltd Level 11, 201 Charlotte Street Brisbane QLD 4000 GPO Box 1410 Brisbane QLD 4001 Tel: +61 7 3834 1333 Fax: +61 7 3834 1390 marketing@anglocoal.com.au
2	BHP Billiton's Ingwe Collieries	***Australia*** BHP Billiton Centre 180 Lonsdale Street,Melbourne Victoria 3000 Phone: (61) 1300 55 47 57 Fax: (61 3) 9609 3015 ***United Kingdom*** Corporate Centres, BHP Billiton Plc Neathouse Place London SW1V 1BH, UK Phone: (44 20) 7802 4000 Fax: (44 20) 7802 4111 ***Singapur*** BHP Billiton Marketing Asia Pte Ltd 10 Marina Boulevard, #50-01 Marina Bay Financial Centre, Tower 2, Singapore 018983 Phone: (65) 6421 6000 Fax: (65) 6421 7000

3	Peabody Energy Australia	BOQ Building, 259 Queen Street Brisbane Queensland 4000 GPO Box 164, Australia Tel: +61 7 3225 5500 Fax: +61 7 3225 5555
4	Rio Tinto Coal Australia	Rio Tinto Coal Australia Pty Limited 123 Albert Street, Brisbane 4000 ,Australia GPO Box 391 Telephone:+61 (0)7 3625 3000 Fax:+61 (0)7 3625 3001 Email:br.info@riotinto.com
5	Xstrata Coal	Head Office, Xstrata Coal Level 38,Gateway 1 Macquarie Place, Sydney NSW 2000 Australia ***James Rickards*** jrickards@xstratacoal.com Phone: +61 2 9253 6789
6	The Ashton Coal Project (It is located approximately 14 km north-west of Singleton in the Hunter Valley, New South Wales. The Ashton Open-Cut and Underground Coal Mines have a current production capacity of approximately 3.9mtpa of high quality Semi-Soft Coking Coal.)	Ashton Coal Operations Glennies Creek Road PO Box 699 CAMBERWELL NSW 2330, Australia SINGLETON NSW 2330 Telephone: (02) 6576 1111 Fax: (02) 6576 1122

B.2: List of Potential Coal Mining Projects in Australia

Sl. No.	Company	Project Name	Comment
1	Several companies	Galilee Basin	Under development
2	Several companies	Surat Basin	Under development

NAME	STATE	LONGITUDE	LATITUDE	COAL TYPE	STATUS	DESCRIPTION	URL
Airly	NSW	150,01477	-33,0977541	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Angus Place	NSW	150,199019	-33,3491572	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Appin	NSW	150,791789	-34,20785	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
Ashton	NSW	151,06667	-32,46667	Coal - black	operating mine	Felix Resources	http://www.felixresources.com.au
Austar	NSW	151,304621	-32,866855	Coal - black	operating mine		
Awaba	NSW	151,549183	-33,026358	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Baal Bone	NSW	150,050002	-33,2668539	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Bengalla	NSW	150,846	-32,2715	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Berrima	NSW	150,265694	-34,4651533	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
Bloomfield	NSW	151,566962	-32,7921887	Coal - black	operating mine		
Boggabri	NSW	150,163344	-30,5904112	Coal - black	operating mine		
Bulga	NSW	151,109984	-32,6868398	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Camberwell	NSW	151,144981	-32,4838394	Coal - black	operating mine		
Chain Valley	NSW	151,550004	-33,1630557	Coal - black	operating mine		
Charbon	NSW	149,977664	-32,896406	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Clarence	NSW	150,24393	-33,4564791	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Cullen Valley	NSW	150,016163	-33,2692882	Coal - black	operating mine		
Cumnock	NSW	150,998616	-32,4030437	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Dendrobium	NSW	150,759992	-34,3768505	Coal - black	operating mine	BHP Billiton	http://www.bhpbilliton.com
Donaldson	NSW	151,607351	-32,8081078	Coal - black	operating mine		
Drayton	NSW	150,911253	-32,3472815	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Duralie	NSW	151,9491	-32,2913602	Coal - black	operating mine	Gloucester Coal	http://www.gloucestercoal.com.au
Glendell	NSW	151,077551	-32,451192	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Glennies Creek	NSW	151,134981	-32,4688395	Coal - black	operating mine	AME Research	http://www.ame.com.au/mines/co/Glennies-Creek.htm
Hunter Valley Complex	NSW	150,992	-32,5104	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Invincible	NSW	150,030003	-33,3268542	Coal - black	operating mine		
Ivanhoe North	NSW	150,010004	-33,3568544	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Liddell	NSW	150,999883	-32,3916007	Coal - black	operating mine	Xstrata plc	http://www.xstrata.com/
Mandalong	NSW	151,449976	-33,1268409	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Mangoola	NSW	150,669987	-32,2968436	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Mannering	NSW	151,534183	-33,2078225	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Metropolitan	NSW	150,996569	-34,1849117	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
Moolarben	NSW	149,785	-32,29	Coal - black	operating mine	Felix Resources	http://www.felixresources.com.au
Mount Arthur	NSW	150,856144	-32,337022	Coal - black	operating mine	Coal Operations Australia Ltd	http://www.coalop.com.au/MAN/index.htm
Mt Owen	NSW	151,099981	-32,3868398	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Mt Thorley	NSW	151,108624	-32,6374098	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Muswellbrook No2	NSW	150,941392	-32,2449882	Coal - black	operating mine		
Myuna	NSW	151,568738	-33,060111	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
NRE No1	NSW	150,869989	-34,3468494	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
NRE Wongawilli	NSW	150,735664	-34,4749209	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
Narrabri	NSW	149,85	-30,52	Coal - black	operating mine		
Pine Dale	NSW	150,065	-33,297	Coal - black	operating mine		
Ravensworth East	NSW	151,071668	-32,395542	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Ravensworth Narama	NSW	151,039983	-32,4568403	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Ravensworth UG	NSW	151,037482	-32,4365624	Coal - black	operating mine	Xstrata plc	http://www.xstrata.com/

NAME	STATE	LONGITUDE	LATITUDE	COAL TYPE	STATUS	DESCRIPTION	URL
Rixs Creek	NSW	151,129982	-32,5268396	Coal - black	operating mine		
Rocglen	NSW	150,19	-30,72	Coal - black	operating mine		
Springvale	NSW	150,105627	-33,4005997	Coal - black	operating mine	Centennial Coal Co Ltd	http://www.centennialcoal.com.au
Stratford	NSW	151,974708	-32,11607	Coal - black	operating mine	Gloucester Coal	http://www.gloucestercoal.com.au
Sunnyside	NSW	150,09	-30,99	Coal - black	operating mine		
Tahmoor	NSW	150,5795	-34,2508	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Tarrawonga	NSW	150,163	-30,638	Coal - black	operating mine		
Tasman	NSW	151,540002	-32,886825	Coal - black	operating mine		
Ulan	NSW	149,749983	-32,2468629	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Wambo	NSW	150,998075	-32,5781508	Coal - black	operating mine		
Warkworth	NSW	151,090164	-32,6070099	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Werris Creek	NSW	150,6395	-31,40698	Coal - black	operating mine		
West Cliff	NSW	150,824388	-34,2175497	Coal - black	operating mine	Illawarra Coal	http://www.illawarracoal.com
West Wallsend	NSW	151,604811	-32,9479107	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Westside	NSW	151,570003	-32,9468247	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Wilpinjong	NSW	149,885	-32,332	Coal - black	operating mine		
Baralaba	QLD	149,803238	-24,164856	Coal - black	operating mine		
Blackwater	QLD	148,807361	-23,6855848	Coal - black	operating mine	BMA	http://www.bmacoal.com
Blair Athol	QLD	147,527	-22,6905	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Boundary Hill	QLD	150,494057	-24,199444	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Burton	QLD	148,172558	-21,588585	Coal - black	operating mine		
Callide	QLD	150,622173	-24,310921	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Cameby Downs	QLD	150,287178	-26,5786217	Coal - black	operating mine		
Carborough Downs	QLD	148,2094	-21,9502	Coal - black	operating mine		
Clermont	QLD	147,630768	-22,6892164	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Collinsville	QLD	147,768557	-20,5676081	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Commodore	QLD	151,279051	-27,9302691	Coal - black	operating mine	Huaneng Power International	http://www.hpi.com.cn
Cook	QLD	148,914684	-23,709213	Coal - black	operating mine		
Coppabella	QLD	148,427187	-21,844554	Coal - black	operating mine	Macarthur Coal Ltd	http://www.macarthurcoal.com.au
Crinum	QLD	148,371006	-23,210105	Coal - black	operating mine	BMA	http://www.bmacoal.com
Curragh	QLD	148,854144	-23,466218	Coal - black	operating mine		
Curragh North	QLD	148,873806	-23,379904	Coal - black	operating mine	Wesfarmers	http://www1.westfarmers.com.au
Dawson	QLD	150,059238	-24,6168259	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Dawson South	QLD	150,030716	-24,876583	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Eastern Creek	QLD	148,015551	-21,2076957	Coal - black	operating mine		
Ensham	QLD	148,497455	-23,4544638	Coal - black	operating mine	Ensham Resources	http://www.ensham.com.au/
Foxleigh	QLD	148,803889	-22,9977778	Coal - black	operating mine	Anglo Coal Australia	http://www.anglocoal.com.au
German Creek	QLD	148,551017	-22,9025714	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
German Creek East	QLD	148,650065	-22,918035	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Goonyella	QLD	147,962045	-21,7923206	Coal - black	operating mine	BMA	http://www.bmacoal.com
Gregory	QLD	148,356348	-23,172246	Coal - black	operating mine	BMA	http://www.bmacoal.com
Hail Creek	QLD	148,406805	-21,505383	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com
Isaac Plains	QLD	148,108	-21,992	Coal - black	operating mine	Aquila Resources Ltd	http://www.aquilaresources.com.au
Jeebropilly	QLD	152,659355	-27,6230172	Coal - black	operating mine	New Hope Coal	http://www.newhopecoal.com.au
Jellinbah East	QLD	148,950644	-23,406874	Coal - black	operating mine	Jellinbah Resources	http://www.jellinbah.com.au
Kestrel	QLD	148,370306	-23,2419722	Coal - black	operating mine	Rio Tinto	http://www.riotinto.com

NAME	STATE	LONGITUDE	LATITUDE	COAL TYPE	STATUS	DESCRIPTION	URL
Lake Lindsay	QLD	148,75306	-23,0343575	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
Lake Vermont	QLD	148,438513	-22,399002	Coal - black	operating mine		
Meandu	QLD	151,911523	-26,813543	Coal - black	operating mine	Tarong Energy	http://www.tarongenergy.com.au
Middlemount	QLD	148,631626	-22,848131	Coal - black	operating mine	Macarthur Coal Ltd	http://www.macarthurcoal.com.au
Millenium	QLD	148,213	-22,025	Coal - black	operating mine		
Minerva	QLD	148,047135	-23,921376	Coal - black	operating mine	Felix Resources	http://www.felixresources.com.au
Moorvale	QLD	148,35358	-21,9955172	Coal - black	operating mine	Macarthur Coal Ltd	http://www.macarthurcoal.com.au
Moranbah North	QLD	147,956742	-21,8713306	Coal - black	operating mine	Anglo Coal Australia Pty Ltd	http://www.anglocoal.com.au/
New Acland	QLD	151,707831	-27,2696278	Coal - black	operating mine	New Hope Coal	http://www.newhopecoal.com.au
New Oakleigh	QLD	152,574788	-27,6116942	Coal - black	operating mine	New Hope Coal	http://www.newhopecoal.com.au
Newlands	QLD	147,901	-21,2544	Coal - black	operating mine	Xstrata	http://www.xstrata.com
North Goonyella	QLD	147,976615	-21,64755	Coal - black	operating mine		
Norwich Park	QLD	148,429355	-22,615826	Coal - black	operating mine	BMA	http://www.bmacoal.com
Oaky Creek	QLD	148,49321	-23,0415843	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Peak Downs	QLD	148,173066	-22,2199145	Coal - black	operating mine	BMA	http://www.bmacoal.com
Poitrel	QLD	148,234381	-22,0412158	Coal - black	operating mine	BMA	http://www.bmacoal.com
Rolleston	QLD	148,410596	-24,4440586	Coal - black	operating mine	Xstrata	http://www.xstrata.com
Saraji	QLD	148,291051	-22,3693791	Coal - black	operating mine	BMA	http://www.bmacoal.com
Sonoma	QLD	147,86	-20,62	Coal - black	operating mine		
South Walker Creek	QLD	148,442713	-21,7709416	Coal - black	operating mine	BMA	http://www.bmacoal.com
Suttor Creek	QLD	147,936756	-21,3798955	Coal - black	operating mine		
Wilkie Creek	QLD	150,960769	-27,0422694	Coal - black	operating mine		
Yarrabee	QLD	149,026371	-23,317678	Coal - black	operating mine	Felix Resources	http://www.felixresources.com.au
Leigh Creek	SA	138,416588	-30,4803594	Coal - black	operating mine	Babcock&Brown (Aust)	http://www.babcockbrown.com.au
Cullenswood	TAS	148,152291	-41,617804	Coal - black	operating mine	Tasmanian Minerals Council	http://www.tasminerals.com.au
Duncan	TAS	148,110498	-41,5551525	Coal - black	operating mine		
Kimbolton	TAS	146,81026	-42,5341135	Coal - black	operating mine	Tasmanian Minerals Council	http://www.tasminerals.com.au
Anglesea	VIC	144,169962	-38,3917509	Coal - brown	operating mine	Department of Primary Industries	http://www.dpi.vic.gov.au
Hazelwood Mine	VIC	146,391003	-38,2689642	Coal - brown	operating mine	Hazelwood Power Corporation	http://www.hazelwoodpower.com.au
Loy Yang	VIC	146,564	-38,2347	Coal - brown	operating mine	PowerWorks	http://www.powerworks.com.au
Maddingley	VIC	144,440161	-37,7042889	Coal - brown	operating mine	Department of Primary Industries	http://www.dpi.vic.gov.au
Yallourn	VIC	146,360402	-38,1950642	Coal - brown	operating mine	CLP Holdings	http://www.clpgroup.com
Ewington	WA	116,25	-33,3624	Coal - black	operating mine	Griffin Coal	http://www.griffincoal.com.au
Muja	WA	116,30951	-33,4205283	Coal - black	operating mine	Griffin Coal	http://www.griffincoal.com.au
Premier	WA	116,286509	-33,3917282	Coal - black	operating mine	Department of Industry and Resources	http://www.doir.wa.gov.au

C.1: List of Potential Coal Producers and Exporters in Indonesia

Sl. No.	Name of Company	Contact Information
1	La-Choga Enterprise Co Ltd.	Mr. I M Piliang Batam Centre Street, Batam State:Kepulauan Riau, Indonesia Zip: 29432 Phone: 62-770-612008 Mobile Phone: 81270012048
2	PT. Kalimantan Prima Coal Holding	Ms. Maemunah Suriaatmaja 138 Jl. S. Parman Street, Jakarta State: Jakarta Raya, Indonesia Zip: 11045 Phone: 62-21-8192192
3	PBR Coal	Mr. Solusi Energi Jln. Perintis Street, Tapin, Binuang, Banjarmasin State: South Kalimantah, Indonesia Phone: 62-24-70080077
4	PT.BORNEO COAL INTERNATIONAL INDONESIA	Mr. eko koenjjoro 28, JL. DELTA FORTUNA, Surabaya State: Propinsi Jawa Timur, Indonesia Zip: 60142 Phone: 62-031-8538837 Mobile Phone: 081934605637 Fax:62-031-8538837
5	PT. ANEKA BUMI BERSAMA	Mr. S.R. Tjandra Raya Margorejo Indah 115 Rk 2&3Street, Surabaya State: Propinsi Jawa Timur, Indonesia Zip: 60237 Telephone:62-81-6510006
6	Ferry Tan	Mr. Ferry tan 24, Tawakal Ujung Raya Street, Jakarta State: DKI Jakarta, Indonesia Zip: 11440 Phone:62-818-06307207
7	PT. SRI REJEKI RESOURCES	Mr Hery Kuncoro 34, JI. Basuki Rahmad Street, Samarinda State: East Kalimanta, Indonesia Zip: 75128 Phone:62-541-749751 Mobile Phone: 6281233224459 Fax: 62-541-749751
8	PT. Bamaco Harisundo Intersains	Mr David PH Perkantoran Tiara Buncit Streer, Blok D / 11, Jakarta State: Jakarta Raya, Indonesia Zip:12740 Telephone:62-21-99588328 Mobile Phone: 62811823967
9	PT PUSAKA PUTRA MANDIRI	Mr. Christian Setiwa lan Astana Anyar Street, Bandung State: Jawa Barat, Indonesia Zip: 40242 Phone: 62-22-92598982 Mobile phone:0811249922

Sl. No.	Name of Company	Contact Information
		Fax: 62-22-85970435
10	PT. Totalindo Mining Resources	Mr. Paku Alam Palma One Building 3rd Floor Suite, jakarta selatan State: Jakarta Raya, Indonesia Zip: 12950 Phone: 62-21-2521065 Mobile phone: 6285888120858 Fax: 62-21-2521064 Web: http://www.totalindomining.com
11	CV. PUTRA INDO ENERGI	Mr. Putra Anggara Street Address: Kusumanegara Street, Jogjakarta State: Daerah Istimewa Yogyakarta, Indonesia Zip: 55165 Phone: 62-8180-4190696 Mobile phone**:** 081804190696
12	Adaro Indonesia, Second-largest coal producer in Indonesia, operates a major coal mine in the Tanjung district of South Kalimantan Province in Indonesia. Production reaching 34 MT in 2006. The company aimed to produce 52 MTin 2012.	Menara Karya, 23rd Floor Jalan H.R. Rasuna Said Block X-5, Kav 1-2 Jakarta 12950, Indonesia Phone: +6221-521-1265 E_mail: cameron.tough@ptadaro.com Web: http://www.adaro.com/
13	PT. Arutmin Indonesia It is a major Indonesian coal mining company managing five mines an international coal export terminal in South Kalimantan. In 2009 it produced 22.42 million tons of coal.	Wisma Bakrie 2, Level 10 Jalan H.R. Rasuna Said Kav. B-2 Jakarta 12920, Indonesia Phone. +62 21 57945678 Fax. +62 21 57987126 Email. marketing AT arutmin.com Website: http://www.arutmin.com/
14	PT. Berau Coal It produced 13 million tones of coal in 2006.	40, Jl. Pemuda Tanjung Redeb 77311, Berau Kalimantan Timur Zip: 114, Indonesia Phone :(62-554) 23400, (62-21) 5794 4625 Fax : (62-554) 23465,(62-21) 5794 4626 Website: http://www.beraucoal.co.id/
15	Bukit Asam It produced 19 million tones of coal in 2006.	Menara Kadin, 15th Floor Jl. H.R. Rasuna Said, Blok X-5 Kav. 2 & 3 Jakarta 12950, Indonesia Telephone: 62-21 525-4014 Facsimile: 62-21 525-4002 Website: http://www.ptba.co.id/
16	PT. Bumi Resources (In 2009 the company produced 63.1 MT of coal, up 19.5% on the previous year.)	Wisma Bakrie II, Jl. H.R. Rasuna Said Kav B-2, 7th floor Jakarta 12920 , Indonesia Tel. +62 21 5794 2080 Fax. +62 21 5794 2070 Website: http://www.bumiresources.com/
17	Kaltim Prima Coal (KPC) (The company states that it's aim was to mine 41.6 MT of coal.)	Mr Djoko Soelistiono, Superintendent Marketing Phone:+62 (549) 52 1402 Facsimile :+62 (549) 521780 or 521914 Email: Marketing@kpc.co.id http://www.kaltimprimacoal.co.id/
18	Kideco	PASIR MINE SITE

Sl. No.	Name of Company	Contact Information
	Production Capacity: In year 2011, they produced 32 million tones of coal, transporting to China, India, Korea and Japan.	Tanah Grogot, Kab. Paser Zip: 49, East Kalimantan, Indonesia Tel:+62 543 22522 http://www.kideco.com/
19	Banpu (IMJTK)	26th-28th Floor, Thanapoom Tower, 1550 New Petchburi Road, Makkasan, Ratchathewi, Bangkok-10400, Thailand Tel:+ 66 2694 6600
20	Antang Gunung Meratus	101, Jl. Achmad Yani Km Street Suatotatakan, Kabupaten Tapin Banjarmasin, South Kalimantan, Indonesia Tel:+62 517 31612
21	Bahari Cakrawala Sebuku	KEM TOWER 17th FLOOR Jl.Landasan Pacu Barat Blok B.10 Kav.2 Kotabaru Bandar Kemayoran 10610 - Jakarta Pusat, Indonesia Tel:+62 21 29987900
22	Borneo Indobara	Plaza BII Tower II 7th Floor 51, Jl M.H Thamrin Street Jakarta 10350, Indonesia
23	Gunung Bayan Pratama	Graha Irama, 12th Floor Jl. HR. Rasuna Said, Blok X-1, Kav. 1-2 12950 - Jakarta Selatan, Indonesia Tel:+ 62 21 526 9868
24	Indexim Coalindo	Jl Hayam Wuruk 27 A Ged Galva Jakarta – 10120, Indonesia
25	Jorong Barutama Greston	Ventura Building, 2nd Floor 26, Jl. RA. Kartini No. 26, Auter Ring Road, Cilandak 12430 - Jakarta Selatan, Indonesia Tel:(021) 7591 2259
26	Kartika Selabumi	Kartika 1 Camp, Kota Bangun Kutai Kertanegara Regency East Kalimantan Province, Indonesia Tel:+62 542 594768
27	Mandiri Intiperkasa	Pro Mandiri Building Komp. Sentra Latumenten 50, Jl. Prof. Dr. Latumenten Street 11460 - Jakarta Barat, Indonesia Tel:+62-21 567 0037
28	Marunda Grahamineral	l. H. Agus Salim 65, Gondangdia Menteng Street 10350 - Jakarta Pusat, Indonesia Tel:+62 21 3916990
29	Riau Baraharum	6th Floor, Mayapada Tower 28, Jl. Jendral Sudirman Kav Street 12920 – Jakarta, Indonesia Tel.:(021) 522 5434
	Trubaindo	26, Jl. R A Kartini (Outer Ring Road- Cilandak) Ventura Building 12430 – Jakarta, Indonesia

C.2: List of Potential Coal Mining Projects in Indonesia

Sl. No.	Company	Project Name	Comment
1	Middle size companies looking for private investors	Several smaller projects	Several projects are on the market

D.1: List of Potential Coal Producers and Exporters in Mozambique

Sl. No	Name of the Company	Contact Information
1	Vale S.A.	Av. Graça Aranha, 26 - 12th floor Rio de Janeiro, Brazil
2	Rio Tinto	2 Eastbourne Terrace London,W2 6LG, UK Tel: +44 (0) 20 7781 1178
3	Beacon Hill Resources	Bairro da Sommerschield Rua da Frente de Libertacao de Mozambique, No. 324 Maputo, Mozambique Tel:+258 21 493 899
4	Ncondenzi Coal Company	Ncondezi Services (UK) Ltd 1 Albemarle Street, London WI5 4HA, UK Tel:+44 20 7183 5404
5	Mozambi Coal	Level 2, 640 Murray Street West Perth WA 6005 PO Box 1571, Australia Phone: +61 (0)8 9321 0774

D.2: List of Potential Coal Mining Projects in Mozambique

Sl. No.	Company	Project Name	Comment
1	Vale S.A.	Several projects	Under development
2	Rio Tinto	Several projects	Under development
3	Benga Mine	Several projects	Under development
4	Zambezi Project	Several projects	Under development
5	Ncondezi Coal Company	Ncondezi Coal Project	Under development
6	ENRC	12 prospecting licenses in Tete province	Under development - good partner
7	Coal India	Several projects	Under development – good partner
8	Jindal Steel and Power	Several projects	Under development – good partner
9	Talbot Group (Australia)	??	Under development
10	Nippon Steel (Japan)	??	Under development
11	Posco (South Corea)	??	Under development

Annex III: Cost Estimation for maritime Coal Transportation

Cost Estimation for maritime Coal Transportation

A. Maritime Transportation Cost Estimation of Coal for Khulna Thermal Power Plant

Table A.1: Calculation of vessel Charterage cost (USD $) from Port of Kalimantan, Indonesia to Port of Mongla, Bangladesh

Ship Size as per Alternative Plans	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt V: Berthing at Project Site by 25000 DWT Vessel	15861.6	20	317233
Alt III: Harbaria Anchorage by 25000 DWT Vessel	15861.6	20	317233
Alt II: Akram Point Anchorage by 50000 DWT Vessel	23144.7	23	532329
Alt II: Akram Point Anchorage by 80000 DWT Vessel	26037.3	25	650932

Charter rates were estimated based on annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table A.2: Calculation of Bunker/Fuel cost for Indonesia for mother vessel

Ship Size as per Alternative Plans	Consumption (ton)/day	Total Days	Fuel price (USD $)/ton	Fuel cost
Fuel Oil Cost during round trip sea time				
Alt V: Berthing at Project Site by 25000 DWT Vessel	22	16.7	700	256666.7
Alt III: Harbaria Anchorage by 25000 DWT Vessel	22	16.0	700	246400.0
Alt II: Akram Point Anchorage by 50000 DWT Vessel	30	16.2	700	339365.4
Alt II: Akram Point Anchorage by 80000 DWT Vessel	40	16.2	700	452487.2
Diesel Oil Cost during round trip sea time				
Alt V: Berthing at Project Site by 25000 DWT Vessel	2.5	16.7	950	39583.3
Alt III: Harbaria Anchorage by 25000 DWT Vessel	2.5	16.0	950	38000.00
Alt II: Akram Point Anchorage by 50000 DWT Vessel	3	16.2	950	46056.73
Alt II: Akram Point Anchorage by 80000 DWT Vessel	3	16.2	950	46056.73
Diesel Oil Cost during port stay				
Alt V: Berthing at Project Site by 25000 DWT Vessel	3.5	2	950	6650
Alt III: Harbaria Anchorage by 25000 DWT Vessel	3.5	3	950	9975
Alt II: Akram Point Anchorage by 50000 DWT Vessel	4	5.8	950	22040
Alt II: Akram Point Anchorage by 80000 DWT Vessel	5	8	950	38000
Total Fuel Consumption				
Alt V: Berthing at Project Site by 25000 DWT Vessel	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			302900.00
Alt III: Harbaria Anchorage by 25000 DWT Vessel				294375.00
Alt II: Akram Point Anchorage by 50000 DWT Vessel				407462.12
Alt II: Akram Point Anchorage by 80000 DWT Vessel				536543.91

Table A.3: Calculation of port cost per ton during loading at North Pulau Laut Coal Terminal (NPLCT), Indonesia Port Cost at NPLCT, Indonesia

DWT	GRT (DWT/2.35)	Harbour dues (GRTx USD 0.08 + 10%VAT)	Quay dues (GRT x USD 0.086)	Light dues (GRT x USD 0.034)	Pilotage charge	Total Port Cost	Port Cost for a ton
25000	10638.3	1702.13	914.9	361.7	10000	12978.72	0.52
50000	21276.6	3404.26	1829.8	723.4	20000	25957.45	0.52
80000	34042.6	5446.81	2927.7	1157.4	30000	39531.91	0.49

Table A.4: Calculation of port cost per ton during unloading at Mongla, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage (inward and outward)	Light dues (NRT x USD 0.06)	Tug Charges (4hr x USD 396)	Dock Levy (USD 0.1 x DWT)	Agent Commission	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
25000	10638.3	7939.0	2563.83	3000.0	476.3	1584	2500	2000	12124.17	13942.8	0.56
50000	21276.6	15878.1	5127.66	4000.0	952.7	1584	5000	2000	18664.34	21464.0	0.43
80000	34042.6	25404.9	8204.26	5000.0	1524.3	1584	8000	2000	26312.55	30259.4	0.38

Table A.5: Final cost calculation

Alternative Plans	Ship size (tons)	Charterage cost	Fuel Cost	Port cost (Source port / Mongla)		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
				Loading	Unloading			
Alt V: Berthing at Project Site by 25000 DWT Vessel	25000 (up to project site)	317232.7	302900.0	12979.0	13943.0	60000	707054.2	28.3
Alt III: Harbaria Anchorage by 25000 DWT Vessel	25000	317233	294375.0	12978.7	13942.8	60000	698529.2	27.9
Alt II: Akram Point Anchorage by 50000 DWT Vessel	50000	532329	407462.1	21464.0	21464.0	60000	1042718.8	20.9
Alt II: Akram Point Anchorage by 80000 DWT Vessel	80000	650932	536543.9	30259.4	30259.4	60000	1307994.6	16.3

Table A.6: Calculation of vessel charterage cost (USD $) from Port of Richard Bay, South Africa to Port of Mongla, Bangladesh

Ship Size as per Alternative Plans	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt V: Berthing at Project Site by 25000 DWT Vessel	15861.63636	33	523434
Alt III: Harbaria Anchorage by 25000 DWT Vessel	15861.63636	34	539296
Alt II: Akram Point Anchorage by 50000 DWT Vessel	23144.72727	36	833210
Alt II: Akram Point Anchorage by 80000 DWT Vessel	26037.27273	38	989416

Charter rates estimated based on annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table A.7: Calculation of Bunker/Fuel cost for Port of Richard Bay, South Africa

Ship Size as per Alternative Plans	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during Round Trip Sea time				
Alt V: Berthing at Project Site by 25000 DWT Vessel	22	30.1	700	463974.36
Alt III: Harbaria Anchorage by 25000 DWT Vessel	22	29.5	700	453608.97
Alt II: Akram Point Anchorage by 50000 DWT Vessel	30	29.6	700	621923.08
Alt II: Akram Point Anchorage by 80000 DWT Vessel	40	29.6	700	829230.77
Diesel Oil Cost during round trip (sea time)				
Alt V: Berthing at Project Site by 25000 DWT Vessel	2.5	30.1	950	71554.487
Alt III: Harbaria Anchorage by 25000 DWT Vessel	2.5	29.5	950	69955.929
Alt II: Akram Point Anchorage by 50000 DWT Vessel	3	29.6	950	84403.846
Alt II: Akram Point Anchorage by 80000 DWT Vessel	3	29.6	950	84403.846
Diesel Oil Cost during port stay				
Alt V: Berthing at Project Site by 25000 DWT Vessel	3.5	2	950	6650
Alt III: Harbaria Anchorage by 25000 DWT Vessel	3.5	3	950	9975
Alt II: Akram Point Anchorage by 50000 DWT Vessel	4	4.8	950	18240
Alt II: Akram Point Anchorage by 80000 DWT Vessel	5	7	950	33250

Total Fuel Consumption

Ship Size		
Alt V: Berthing at Project Site by 25000 DWT Vessel	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**	542178.85
Alt III: Harbaria Anchorage by 25000 DWT Vessel		533539.9
Alt II: Akram Point Anchorage by 50000 DWT Vessel		724566.92
Alt II: Akram Point Anchorage by 80000 DWT Vessel		946884.62

Table A.8: Calculation of port cost per ton during loading at Port of Richard Bay, South Africa

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage (inward and outward)	Light dues (NRT x USD 0.06)	Tug Charges (4hr x USD 396)	Dock Levy (USD 0.1 x DWT)	Agent Commission	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
25000	10638.3	7939.0	2563.83	3000.0	476.3	1584	2500	2000	12124.17	13942.8	0.56
50000	21276.6	15878.1	5127.66	4000.0	952.7	1584	5000	2000	18664.34	21464.0	0.43
80000	34042.6	25404.9	8204.26	5000.0	1524.3	1584	8000	2000	26312.55	30259.4	0.38

Table A.9: Calculation of Unit cost of cargo for port of Richard Bay, South Africa

Ship Size as per Alternative Plans	Ship size (tons)	Charterage cost	Fuel Cost	Port cost (Source port / Mongla)		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
				Loading	Unloading			
Alt V: Berthing at Project Site by 25000 DWT Vessel	25000 (up to project site)	523434	542178.8	142546.5	13942.8	60000	1282102.2	51.3
Alt III: Harbaria Anchorage by 25000 DWT Vessel	25000	539296	533539.9	142546.5	13942.8	60000	1289324.9	51.6
Alt II: Akram Point Anchorage by 50000 DWT Vessel	50000	833210	724566.9	281229.6	21464.0	60000	1920470.7	38.4
Alt II: Akram Point Anchorage by 80000 DWT Vessel	80000	989416	946884.6	449901.5	30259.4	60000	2476461.9	31.0

Table A.10: Calculation of vessel charterage cost (USD $) Port of New Castle, Australia to Port of Mongla, Bangladesh

Ship Size as per Alternative Plans	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt V: Berthing at Project Site by 25000 DWT Vessel	15861.63636	39	618604
Alt III: Harbaria Anchorage by 25000 DWT Vessel	15861.63636	40	634465
Alt II: Akram Point Anchorage by 50000 DWT Vessel	23144.72727	42	972079
Alt II: Akram Point Anchorage by 80000 DWT Vessel	26037.27273	44	1145640

Charter rates estimated based on annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table A.11: Calculation of Bunker/Fuel cost for Port of New Castle, Australia

Ship Size as per Alternative Plans	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during Round Trip Sea Time				
Alt V: Berthing at Project Site by 25000 DWT Vessel	22	36.4	700	560717.9487
Alt III: Harbaria Anchorage by 25000 DWT Vessel	22	35.7	700	550253.8462
Alt II: Akram Point Anchorage by 50000 DWT Vessel	30	35.9	700	753711.5385
Alt II: Akram Point Anchorage by 80000 DWT Vessel	40	35.9	700	1004948.718
Diesel Oil Cost during round trip sea time				
Alt V: Berthing at Project Site by 25000 DWT Vessel	2.5	36.4	950	86474.35897
Alt III: Harbaria Anchorage by 25000 DWT Vessel	2.5	35.7	950	84860.57692
Alt II: Akram Point Anchorage by 50000 DWT Vessel	3	35.9	950	102289.4231
Alt II: Akram Point Anchorage by 80000 DWT Vessel	3	35.9	950	102289.4231
Diesel Oil Cost during port stay				
Alt V: Berthing at Project Site by 25000 DWT Vessel	3.5	2	950	6650
Alt III: Harbaria Anchorage by 25000 DWT Vessel	3.5	3	950	9975
Alt II: Akram Point Anchorage by 50000 DWT Vessel	4	4.8	950	18240
Alt II: Akram Point Anchorage by 80000 DWT Vessel	5	7	950	33250

Total Fuel Consumption

Alt V: Berthing at Project Site by 25000 DWT Vessel	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**	653842.3
Alt III: Harbaria Anchorage by 25000 DWT Vessel		645089.4
Alt II: Akram Point Anchorage by 50000 DWT Vessel		874241.0
Alt II: Akram Point Anchorage by 80000 DWT Vessel		1140488.1

Table A.12: Calculation of port cost per ton during loading at Port of New Castle Coal Terminal, Australia

DWT	GRT (DWT/2.35)	Navigation Service Charge (AUD 0.4312x GRT	Site Occupation for a day	Wharfage Charge DWT* 0.99 AUD	Ship Utility Charge	Port Security Charges	Pilotage (650AUD + 0.606xGRT)	Harbour Pilotage (50% of applicable pilotage rate	Total Cost in AUD	Total Cost in USD
25000	10638.3	4587.2	4752.00	24750.0	882.5	497.00	1288.30	644.1	37401.18	37995.86
50000	21276.6	9174.5	4752.00	49500.0	882.5	497.00	1926.60	963.3	67695.86	68772.23
80000	34042.6	14679.1	4752.00	79200.0	882.5	497.00	2692.55	1346.3	104049.48	105703.9

Table A.13: Calculation of port cost per ton during unloading at Mongla, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage (inward and outward)	Light dues (NRT x USD 0.06)	Tug Charges (4hr x USD 396)	Dock Levy (USD 0.1 x DWT)	Agent Commission	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
25000	10638.3	7939.0	2563.83	3000.0	476.3	1584	2500	2000	12124.17	13942.8	0.56
50000	21276.6	15878.1	5127.66	4000.0	952.7	1584	5000	2000	18664.34	21464.0	0.43
80000	34042.6	25404.9	8204.26	5000.0	1524.3	1584	8000	2000	26312.55	30259.4	0.38

Table A.14: Calculation of Unit cost of cargo from Port of New Castle, Australia

Alternative Plan	Charterage cost	Fuel Cost	Port Cost		Insurance, Broker and Misc	Total Cost, TC (USD)	Unit cost ($/ton)
			NCCT	Mongla			
Alt V: Berthing at Project Site by 25000 DWT Vessel	618604	653842.3	37995.9	13942.8	60000	1384384.8	55.4
Alt III: Harbaria Anchorage by 25000 DWT Vessel	634465	645089.4	37995.9	13942.8	60000	1391493.5	55.7
Alt II: Akram Point Anchorage by 50000 DWT Vessel	972079	874241.0	68772.2	21464.0	60000	1996555.7	39.9
Alt II: Akram Point Anchorage by 80000 DWT Vessel	1145640	1140488.1	105703.9	30259.4	60000	2482091.4	31.0

B. Cost Estimation of Coal for Chittagong Thermal Power Plant

Table B.1: Calculation of vessel charter cost (USD)

Alternative Plans	Ship size (DWT)	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	34742.8	20.5	712673
Alt. II: Direct Discharge of Coal at Project Site by 25,000 DWT Vessel	25,000	15861.6	19.0	301371
Alt. I: Discharge at Outer Anchorage by 50,000 DWT Vessel and transshipment by Lighterage	50,000	23090.2	21.0	484894

Charter rates estimated based on annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table B.2: Calculation of Bunker/Fuel cost for Indonesia

Alternative Plans	Ship size (DWT)	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during sea time					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	40	15.5	700	434358.97
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	22	15.8	700	243833.33
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	30	15.8	700	332500
Diesel Oil Cost during sea time					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	3	15.5	950	44211.54
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	2.5	15.8	950	37604.16667
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	3	15.8	950	45125
Diesel Oil Cost during port stay					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	5	4	950	19000
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	3.5	2	950	6650
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	4	4.5	950	17100
Total Fuel Consumption					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			497570.51

Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25000		288087.50
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50000		394725.00

Table B.3: Calculation of port cost per ton during loading at North Pulau Laut Coal Terminal (NPLCT), Indonesia

Port Cost at NPLCT, Indonesia

DWT	GRT (DWT/2.35)	Harbour dues (GRTx USD 0.08 + 10%VAT)	Quay dues (GRT x USD 0.086)	Light dues (GRT x USD 0.034)	Pilotage charge	Total Port Cost	Port Cost for a ton
80,000	34042.6	5446.81	2927.7	1157.4	30000	39531.91	0.49
25,000	10638.3	1702.13	914.9	361.7	10000	12978.72	0.52
50,000	21276.6	3404.26	1829.8	723.4	20000	25957.45	0.52

Table B.4: Calculation of Port cost per ton during unloading at Chittagong, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
80,000	340425.5	254048.9	61225.79	N/A	15242.9	N/A	2000	N/A	78468.72	90239.0	0.11
25,000	10638.3	7939.0	2563.83	760.6	476.3	1264	2000	650.00	7714.81	8872.0	0.35
50,000	21276.6	15878.1	5127.66	N/A	952.7	N/A	2000	N/A	8080.34	9292.4	0.19

Table B.5: Calculation of Unit cost of cargo for Indonesia

Ship size (DWT)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, TC(USD)	Unit cost of cargo, UC ($/ton)
			Loading	Unloading			
80,000	534098	497570.5	39531.9	9023.9	60000	1140224.3	14.3
25,000	301371	288087.5	12978.7	8872.0	60000	671309.3	26.9
50,000	484894	394725.0	25957.4	9292.4	60000	974868.7	19.5

Table B.6: Calculation of vessel charterage cost (USD $) from Port of Richard Bay, South Africa to Port of Chittagong, Bangladesh

Alternative Plans	Ship size (tons)	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	26037.3	34.3	892110
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	15861.63636	33.0	523434
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	23090.18182	35.0	808156

Charter rates were estimated based on annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table B.7: Calculation of Bunker/Fuel cost for port of Richard Bay, South Africa

Alternative Plans	Ship size (DWT)	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during Sea time					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	40	30.3	700	847359.0
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	22	30.1	700	463085.9
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	30	30.1	700	631480.77
Diesel Oil Cost during round trip					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	3	30.3	950	86249.1
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	2.5	30.1	950	71417.468
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	3	30.1	950	85700.962
Diesel Oil Cost during port stay					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	5	3	950	14250
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25000	3.5	2	950	6650
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50000	4	3.5	950	13300
Total Fuel Consumption					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			947858.01
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25000				541153.37
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50000				730481.73

Table B.8: Calculation of Port cost per ton during unloading at Chittagong, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
80,000	34042.6	25404.9	8204.26	N/A	1524.3	N/A	2000	N/A	11728.55	13487.8	0.17
25,000	10638.3	7939.0	2563.83	760.6	476.3	1264	2000	650.0	7714.81	8872.0	0.35
50,000	21276.6	15878.1	5127.66	N/A	952.7	N/A	2000	N/A	8080.34	9292.4	0.19

Table B.9: Calculation of Port cost per ton during loading at port of Richard Bay, South Africa

DWT	GRT (DWT/2.35)	Port dues ((GRTx R 0.94)+GRTx R 0.28x24 hr) for 1days	Light Dues ((0.57 xGRT)+ R 96.24xGRT)	Barth Dues (R0.25xGRT)	Tug Service Charge	Barthing Staff (R 1532 + (GRT x 0.65))	Pilotage (R 15033+R 0.5 x GRT)	Vessel Traffic Service (GRTxR 0.26)	Security/day	Total Cost in Rand	Total Cost in USD
80000	34042.6	260766.0	3295659.57	8510.6	42558	23659.66	32054.3	8851.1	606.00	3672665.2	449901.48
25000	10638.3	81489.4	1029893.62	2659.6	17431	8446.89	20352.1	2766.0	606.00	1163645.2	142546.53
50000	21276.6	162978.7	2059787.23	5319.1	20496	15361.79	25671.3	5531.9	606.00	2295752.1	281229.63

Table B.10: Calculation of Unit cost of cargo for Port of Richard Bay, South Africa

Alternative Plans	Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	892110	947858.0	449901.5	9023.9	60000	2358893	29.5
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	523434	541153.4	142546.5	8872.0	60000	1276005.9	51.0
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	808156	730481.7	281229.6	9292.4	60000	1889160.1	37.8

Table B.11: Calculation of vessel charterage cost (USD $) from Port of New Castle, Australia to Port of Chittagong, Bangladesh

Alternative Plans	Ship size (tons)	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	26037.27	39.1	1019292
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	15861.63636	39.0	618604
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	23090.18182	40.0	923607

Charter rates were estimated on the basis of annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table B.12: Calculation of Bunker/Fuel cost for Port of New Castle, Australia

Alternative Plans	Ship size (tons)	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during sea time					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	40	35.1	700	984128.2
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	22	35.5	700	546206.4
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	30	35.5	700	744826.9
Diesel Oil Cost during sea time					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	3	35.1	950	100170.2
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	2.5	35.5	950	84236.4
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	3	35.5	950	101083.7
Diesel Oil Cost during port stay					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	5	3	950	14,250.0
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	3.5	2	950	6650.0
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	4	3.5	950	13300.0
Total Fuel Consumption					
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			1098548.4
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000				637092.79
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000				859210.58

Table B.13: Calculation of Port cost per ton during loading at Port of New Castle Coal Terminal, Australia

DWT	GRT (DWT/2.35)	Navigation Service Charge (AUD 0.4312x GRT	Site Occupation for a day	Wharf age Charge DWT* 0.99 AUD	Ship Utility Charge	Port Security Charges	Pilotage (650AUD + 0.606xGRT)	Harbour Pilotage (50% of applicable pilotage rate	Total Cost in AUD	Total Cost in USD
80000	34042.6	14679.1	4752.00	79200.0	882.5	497.00	2692.55	1346.3	104049.48	105703.9
25000	10638.3	4587.2	4752.00	24750.0	882.5	497.00	1288.30	644.1	37401.18	37995.86
50000	21276.6	9174.5	4752.00	49500.0	882.5	497.00	1926.60	963.3	67695.86	68772.23

Table B.14: Calculation of Port cost per ton during unloading at Chittagong, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
80000	34042.6	25404.9	8204.26	N/A	1524.3	N/A	2000	N/A	11728.55	13487.8	0.17
25000	10638.3	7939.0	2563.83	760.6	476.3	1264	2000	650.00	7714.81	8872.0	0.35
50000	21276.6	15878.1	5127.66	N/A	952.7	N/A	2000	N/A	8080.34	9292.4	0.19

Table B.15: Calculation of Unit cost of cargo for Port of New Castle, Australia

Alternative Plans	Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
				Loading	Unloading			
Alt. III: Discharge at Kutubdia by 80,000 DWT Vessel and transshipment by Lighterage	80,000	1019292	1098548.4	105703.9	9023.9	60000	2292568.2	28.7
Alt. II: Direct Discharge of Coal at Project Site by 25000 DWT Vessel	25,000	618604	637092.8	37995.9	8872.0	60000	1362564.5	54.5
Alt. I: Discharge at Outer Anchorage by 50000 DWT Vessel and transshipment by Lighterage	50,000	923607	859210.6	68772.2	9292.4	60000	1920882.5	38.4

C. Cost Estimation of Coal for Maheshkhali Thermal Power Plant

Table C.1: Calculation of vessel charter cost (USD)

Ship size (ton)	Charterage rate (USD/day)	Total round trip (days)	Vessel charterage cost (USD)
50000	30249.8	19.5	590259
80000	34742.8	20.5	712673

Source: Dry Bulk Market, Charterage – annual average of 2010

Table C.2: Calculation of Bunker/Fuel cost for Indonesia

Ship size (ton)	Consumption (million ton/day)	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during sea time				
50000	30	15.5	700	325769.23
80000	40	15.5	700	434358.97
Diesel Oil Cost during sea time				
50000	3	15.5	950	44211.54
80000	3	15.5	950	44211.54
Diesel Oil Cost during port stay				
50000	4	3	950	11400
80000	5	4	950	19000
Total Fuel Consumption				
50000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			381380.77
80000				497570.51

Table C.3: Calculation of port cost per ton during loading at North Pulau Laut Coal Terminal (NPLCT), Indonesia

Port Cost at NPLCT, Indonesia

DWT	GRT (DWT/2.35)	Harbour dues (GRTx USD 0.08 + 10%VAT)	Quay dues (GRT x USD 0.086)	Light dues (GRT x USD 0.034)	Pilotage charge	Total Port Cost	Port Cost for a ton
50000	21276.6	3404.26	1829.8	723.4	20000	25957.45	0.52
80000	34042.6	5446.81	2927.7	1157.4	30000	39531.91	0.49

Table C.4: Calculation of Port cost per ton during unloading at Maheshkhali, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
50000	21276.6	15878.1	5127.66	1521.3	952.7	1264	2000	650	11515.62	13243.0	0.26
80000	340.42.6	25404.9	8204.26	2434.0	1524.3	1264	2000	650.0	16076.59	18488.1	0.23

Table C.5: Calculation of Unit cost of cargo for Indonesia

Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
1	**2**	**3**	**Loading**	**Unloading**	**6**	7	
50000	590259	381380.77	25957.4	13243.0	60000	1070840.1	21.4
80000	712673	497570.5	39531.9	18488.1	60000	1328263.3	16.6

Table C.6: Calculation of vessel charterage cost (USD $) from Port of Richard Bay, South Africa to Port of Maheshkhali, Bangladesh

Ship size (tons)	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
50000	23090.2	33.3	768045
80000	26037.3	34.3	892110

Charter rates were estimated on the basis of annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table C.7: Calculation of Bunker/Fuel cost for Port of Richard Bay, South Africa

Ship size (tons)	Consumption (m ton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during Sea time				
50000	30	30.3	700	635519.2308
80000	40	30.3	700	847358.9744
Diesel Oil Cost during sea time				
50000	3	30.3	950	86249.03846
80000	3	30.3	950	86249.03846
Diesel Oil Cost during port stay				
50000	4	2	950	7600
80000	5	3	950	14250
Total Fuel Consumption				
50000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**			729368.2692
80000				947858.01

Table C.8: Calculation of Port cost per ton during loading at port of Richard Bay, South Africa

DWT	GRT (DWT/2.35)	Port dues ((GRTx R 0.94)+GRTx R 0.28x24 hr) for 1days	Light Dues ((0.57 xGRT)+ R 96.24xGRT)	Barth Dues (R0.25xGRT)	Tug Service Charge	Barthing Staff (R 1532 + (GRT x 0.65))	Pilotage (R 15033+R 0.5 x GRT)	Vessel Traffic Service (GRTxR 0.26)	Security/day	Total Cost in Rand	Total Cost in USD
50000	21276.6	162978.7	2059787.23	5319.1	42558.0	15361.79	25671.30	5531.9	606.00	2317814.1	283932.2
80000	34042.6	260766.0	3295659.57	8510.6	42558.0	23659.66	32054.28	8851.1	606.00	3672665.2	449901.5

Table C.9: Calculation of Port cost per ton during unloading at Maheshkhali, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
50000	21276.6	15878.1	5127.66	1521.3	952.7	1264	2000	650.00	11515.62	13243.0	0.26
80000	34042.6	25404.9	8204.26	2434.0	1524.3	1264	2000	650.00	16076.59	18488.1	0.23

Table C.10: Calculation of Unit cost of cargo for Port of Richard Bay, South Africa

Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, TC (USD)	Unit cost of cargo, Uc ($/ton)
			Loading	Unloading			
50000	768045	729368.3	281229.6	13243.0	60000	1851885.4	37.0
80000	892110	947858.0	449901.5	18488.1	60000	2368358.0	29.6

Table C.11: Calculation of vessel charterage cost (USD $) from Port of New Castle, Australia to Port of Maheshkhali, Bangladesh

Ship size (tons)	Charterage rate (USD $)/day	Total round trip (days)	Vessel charterage cost (USD)
50000	23090.18	38.1	880831
80000	26037.27	39.1	1019292

Charter rates were estimated on the basis of annual average of last 11 years (2001-2011). Source: Mitsui OSK Line, 2011, Market Information of November 2011

Table C.12: Calculation of Bunker/Fuel cost for Port of New Castle, Australia

Ship size (tons)	Consumption (mton)/day	Total Days	Fuel price F.O. (USD $)/ton	Fuel cost
Fuel Oil Cost during sea time				
50000	30	35.1	700	738,096.15
80000	40	35.1	700	984,128.21
Diesel Oil Cost during round trip sea time				
50000	3	35.1	950	100,170.2
80000	3	35.1	950	100,170.2
Diesel Oil Cost during port stay				
50000	4	2	950	7,600.00
80000	5	3	950	14,250.00

Total Fuel Consumption

Ship size (tons)		Fuel cost
50000	**Fuel oil cost Diesel oil cost during sea time and diesel oil cost during port stay**	845,866.35
80000		1,098,548.4

Table C.13: Calculation of Port cost per ton during loading at Port of New Castle Coal Terminal, Australia

DWT	GRT (DWT/2.35)	Navigation Service Charge (AUD 0.4312x GRT	Site Occupation for a day	Wharf age Charge DWT* 0.99 AUD	Ship Utility Charge	Port Security Charges	Pilotage (650AUD + 0.606xGRT)	Harbour Pilotage (50% of applicable pilotage rate	Total Cost in AUD	Total Cost in USD
50000	21276.6	9174.5	4752.00	49500.0	882.5	497.00	1926.60	963.3	67695.86	68772.23
80000	34042.6	14679.1	4752.00	79200.0	882.5	497.00	2692.55	1346.3	104049.48	105703.9

Table C.14: Calculation of Port cost per ton during unloading at Maheshkhali, Bangladesh

DWT	GRT (DWT/2.35)	NRT (GRT/1.34)	Port dues (GRTx USD 0.241)	Pilotage, 35.75 USD per 1000 GRT for each movement	Light dues (NRT x USD 0.06)	Tug Charges (632 USD for each movement	Agent Commission	Berth Occupancy	Sub-Total Port Cost	Total including 15%	Port Cost for a ton
50000	21276.6	15878.1	5127.66	1521.3	952.7	1264	2000	650.00	11515.62	13243.0	0.26
80000	34042.6	25404.9	8204.26	2434.0	1524.3	1264	2000	650.00	16076.59	18488.1	0.23

Source: Port Schedule, New Castle

Table C.15: Calculation of Unit cost of cargo for Port of New Castle, Australia

Ship size (tons)	Charterage cost	Fuel Cost	Port cost		Insurance, Broker and Misc	Total Cost, Tc (USD)	Unit cost of cargo, Uc ($/ton)
1	2	3	**Loading**	**Unloading**	6	7	Col7/Col1
50000	880831	845,866.35	68772.2	13243.0	60000	1868712.8	37.4
80000	1019292	1098548.4	105703.9	18488.1	60000	2302032.8	28.8

Annex IV: Road Map for Coal Sourcing and Transportation

Sl no.	Activities	Time Line (Year)																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	**Coal Power Generation Master Plan (Adjusted Time Plan and Load Capacity)**																				
	Khulna TPP																				
	Construction of 1 st Phase (1320 MW)																				
	Operation of 1st phase (1320 MW)																				
	Construction of 2nd Phase (another 1320 MW)	?																			
	Operation of 2nd phase (another 1320 MW)																				
	Maheshkhali TPP (532 MW)																				
	Construction of 1st phase (2320 MW)		?																		
	Operation of 1st Phse (2320MW)																				
	Construction of 2nd phase (3000 MW)			?																	
	Operation of 2nd Phse (3000MW)																				
	Chittagong TPP																				
	Construction of 1 st Phase (1320 MW)				?																
	Operation of 1st phase (1320 MW)																				
	Construction of 2nd Phase (another 1320 MW)					?															
	Operation of 2nd phase (another 1320 MW)																				
	Total Coal Power Generation (MW) (100% Capacity)	0	0	0	0	0	1320	2640	2640	4960	7960	9280	10600	10600	10600	10600	10600	10600	10600	10600	10600
	Coal Demand for Khulna TPP (million Tons)*	0	0	0	0	0	3.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
	Coal demand for Maheshkhali TPP (million Tons)*	0	0	0	0	0	0	0	5.4	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
	Coal Demand for Chittagong TPP (million Tons)*	0	0	0	0	0	0	0	0	0	3.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
	Total Coal Demand (million Tons)	0	0	0	0	0	3.1	6.1	11.5	18.4	21.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
B	**Indigenious Coal Production Plan**																				
	Barapukuria UG Production (million Tons)	0.8	0.8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Barapukuria OC Production (million Tons)	0	0	0	0	0.5	1	3	5	5	5	5	5	5	5	5	5	5	5	5	5
	2nd Mine in Production (million Tons)	0	0	0	0	0	0	0	0	0	1	2	3	3	3	3	3	3	3	3	3
	Total Indigenious Coal Production (million Tons)	0.8	0.8	1	1	1.5	2	4	6	6	7	8	9	9	9	9	9	9	9	9	9
	Indigenous Coal Production For the proposed TPPs (million Tons)	0	0	0	0	0.5	1	3	5	5	6	7	6	6	6	6	6	6	6	6	6
C	**Total Coal Demand for the Proposed TPP**	0	0	0	0	0	3.1	6.1	11.5	18.4	21.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
	Availabe Indigienious Coal Production for TPPS (million Tons)**	0	0	0	0	0.5	1	3	5	5	6	7	6	6	6	6	6	6	6	6	6
	Total Imported Coal Demand (estimated) (million Tons)	0	0	0	0	0	1.7 ***	3.1	6.5	13.4	15.5	17.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
D	**Engineering Work Required**																				
	Public Relation Campaign (mine sites TPPs)																				
	Setting up of "Core Team" for Coal Sourcing																				
	Training of the "Core Team"																				

	Advise to the "Core Team"
	Core Team in Full Function
	Duties of the "Core Team"
	Management of coal supply
	Contract monitoring
	Mining concept for Indigineous coal resources
	Implementation of Mining Concept
F	**Dredging Works for Shipping and Barging******
	Capital Dredging Works for Khulna TPP
	Maintainence Dredging Works for Khulna TPP
	Capital Dredging Works for Maheshkhali TPP
	Maintainence Dredging Works for Maheshkhali TPP

*Adjusted load capacity (to 85%) and 290 day of operation and 40% plant efficiency

** Indigeneous coal can make supply to KTPP only, and the rest to be used at mine mouth power plant

*** considering stocking of the indigenous production of the last year at plant site stockyard

**** No dredging is required for Chittagong TPP

Annex V: Organization of the Coal Supply Team

Required information

- Electrical Power Demand and Distribution Master Plan
- Electrical Generation Master Plan
- Time Schedule for Coal Demand Master Plan

Note: Task 1 should start immediately after finalization of decision-making process. Work in Task 5 will be carried out in parallel to Tasks 2, 3 and 4, resulting in an iterative process.

1. Status evaluation for the existing coal in BPDB for the management of the logistics in charge of the entire coal supply chain.

Required information: Clear descriptions of the duties and responsibilities of this Core Team and clear identification of the position in the organigram (Project Management Function)

Individual duties:

- Identification of the individual team members. Preparation of brief job descriptions for the most important key positions (e.g. senior mining engineer/geologist, logistic specialist, port and shipment expert, conveying specialist, monitoring expert, contract/legal expert).
- All other organizational issues re left to the internal organization of BPDB.
- Establish a working relationship between Consultant and the Core Team enabling the knowledge transfer (initial phase of cooperation).
- Provide support to the Core Team after the initial phase.

Target: Establish a high performance team to manage after a setting-up period (initial phase) the entire logistic coal supply chain

2. Coal acquisition according to time schedule

Required information: Long-term coal demand Master Plan. Decision of BPDB is available to establish an own Core Team for the management of the logistics in charge of entire coal supply chain.

Individual duties:

- Investigate any valid opportunity for an farm-in possibility in any of the major coal producing countries allowing off-take agreements and providing supply security.
- Establish contact to the most suitable mining companies in South Africa (3 companies), Australia (3 companies), Indonesia (3 companies), Mozambique (2 companies) ad New Zealand (1 company)
- Preparation of Technical Specifications
- Prepare evaluation matrix for the identification of the mining companies best prepared for this duty
- Establish a short list of the companies qualifying for further negotiations (max. 5 companies)
- Start negotiating the supply and delivery details
- Assistance to the Board during the tender evaluation.
- Prepare recommendations for the Board for final contract negotiations

- Establish a contract monitoring and environmental awareness plan
- Setting up of systematic data files concerning data from suppliers, traders, shipping companies. Additionally information on any coal supply contracts published in the business papers should be evaluated and questioned.

Target: Prepare 3 coal delivery contracts with mining companies from 2 countries, ready to sign.

Get the Core Team of BPDB involved in all the above-mentioned issues

3. Sea-transport, coal shipping contracts

Required information: Ports of origin, ports of destination, total volumes and volumes per individual shipping, and total time schedule are available

Individual duties:

- Establish contact to the most suitable shipping companies
- Prepare evaluation matrix for the identification of the shipping companies best prepared for this duty
- Preparation of tender documentation, Technical Specifications and evaluation matrix.
- Establish a short list of the companies qualifying for further negotiations (max. 5 companies)
- Start negotiating all logistic details necessary
- Establish contact between coal supply and shipping company
- Assistance to the Board during the tender evaluation.
- Prepare recommendations for the Board for final contract negotiations
- Establish a contract monitoring and environmental awareness plan

Target: Prepare 3 sea-freight contracts with selected shipping companies, ready to sign

Get the Core Team of BPDB involved in all the above-mentioned issues

4. Shipping contract for barging within Bangladesh

Required information: Loading port or ship, type of loading, point of destination, unloading facilities, total volumes per time interval and volumes per individual shipping, and total time schedule are available

Individual duties:

- Prepare environmental awareness plan
- Establish contact to the most suitable shipping companies (mainly national companies will be eligible)
- Explain the technical duties, the environmental awareness plan and the overall expectations during workshops to the local shipping companies
- Preparation of tender documentation, Technical Specifications and evaluation matrix.
- Prepare evaluation matrix for the identification of the shipping companies best prepared for this duty
- Establish a short list of the companies qualifying for further negotiations (max. 5 companies)
- Start negotiating all logistic details necessary

- Establish contact between sea transport companies and barging shipping company
- Assistance to the Board during the tender evaluation.
- Prepare recommendations for the Board for final contract negotiations

Target: Prepare 3 barging contracts with selected shipping companies, ready to sign

Get the Core Team of BPDB involved in all the above-mentioned issues

5. Contract preparation considering specifics of coal supply contracts, national legislation and tax particularities

Required information: The technical details and organizational issues have been resolved.

Individual duties:

- Establish contacts to law companies in Bangladesh capable to assist with this duty.
- Establish contact to a lawyer formerly working for an internationally active coal mining company involved in the preparation of coal supply contracts.
- Preparation of coal supply, sea transport and barging contracts.
- Evaluate the tax implementation of the contracts by an tax consultants from Bangladesh.
- Assist in the negotiation process.

Target: Prepare the basic contracts for the coal sourcing, the sea-shipment and the barging duties.

Get the Core Team of BPDB involved in all the above-mentioned issues

Annex VI: Development of a Mining Concept for the Coal Resources in Bangladesh

General information required

- Long-term coal demand Master Plan
- Time Schedule for Coal Demand Master Plan
- Official commitment to the mining of the viable national coal resources

6. **Summary of the current evaluation status for the coal deposits planned to go into production**

Required information:

- Long-term coal demand Master Plan.
- Available mining concepts
- Feasibility Studies
- Environmental Impact Assessments

Individual duties:

- Prioritize the projects according to their mineability and coal availability
- Establish a realistic coal supply plan based on the coal deposits in Bangladesh
- Integrate the volumes of the national coal supply plan in the overall coal supply plan for Bangladesh
- Evaluate the social and environmental ramifications under which mining will find acceptance
- Cary out resource and reserve evaluation studies for the known occurrences

Target:

- Optimize the input of the national coal resources
- Optimize the infrastructural input for the areas of future mining
- Establish an environmental friendly mining operation

7. **Public relation campaigning**

Required information:

- Results from previous awareness campaigns

Individual duties:

- Contact the NGOs in the region.
- Prepare information material, simple and with self-explaining drawings
- Establish information meetings and a permanent information centre
- Present the positive input of the project on te infrastructure
- Define the expectations on an Environmental Impact Assessments
- Keep in permanent contact with the population affected

Target:

- Establish a consensus between the local population and the targets of the mining operation on a permanent asis
- Prepare the base for an environmentally friendly mining operation

8. **Preparation of an open-pit mining concept for Barapukuria**

Required information:

- Summary reports of the status of the underground mining.
- Summary of the considerations for an open-pit mining operation
- Status of the public awareness campaigning
- Receive the total coal acquisition cost (per t of coal) as a benchmark for the upper cost limit of a mining operation in Bangladesh (not considering the indirect benefits of an industrial operation in the region)

Individual duties:

- Prioritize the projects according to their mineability and coal availability
- Establish a realistic coal supply plan based on the coal deposits in Bangladesh
- Integrate the volumes of the national coal supply plan in the overall coal supply plan for Bangladesh
- Develop a mine concept based on an detailed resource evaluation
- Develop a detailed mine plan
- Planning of the mine ing infrastructure, equipment and other investments
- Evaluate the social and environmental ramifications under which mining will find acceptance
- Development of a concept utilizing the pumped out mine waters for the watering of the crops in the surrounding of the mine.
- Preparation of a Cash-Flow analyses covering all cash items over the entire mine lifetime

Target:

- Start an open-pit mining operation in order to optimize the coal recovery and to reduce the production costs per t of coal mined.
- To contribute to the national coal supply strategy with a domestic production.

9. Transfer experience made at Barapukuria to the other coal occurrences

Required information:

- Evaluate the experiences made at Barapukuria.
- Technical information from other coal occurrences in Bangladesh

Individual duties:

- Development of mining concepts, based on technical experiences made at Barapukuria
- Benefit from the public relation work implemented at Barapukuria
- Preparing of detailed mining concepts based on resource evaluations
- Carry out simplified Cash-Flow analyses for the individual mine sites

Target:

- Develop other mines based on the experience gathered at Barapukuria
- Optimizing the mining experience in order to develop as much a economically feasible of the national coal deposits.

Annex VII: Presentation on Coal Mining Activity, Moolarben Coal Mine Company Ltd.

Moolarben Site Presentation

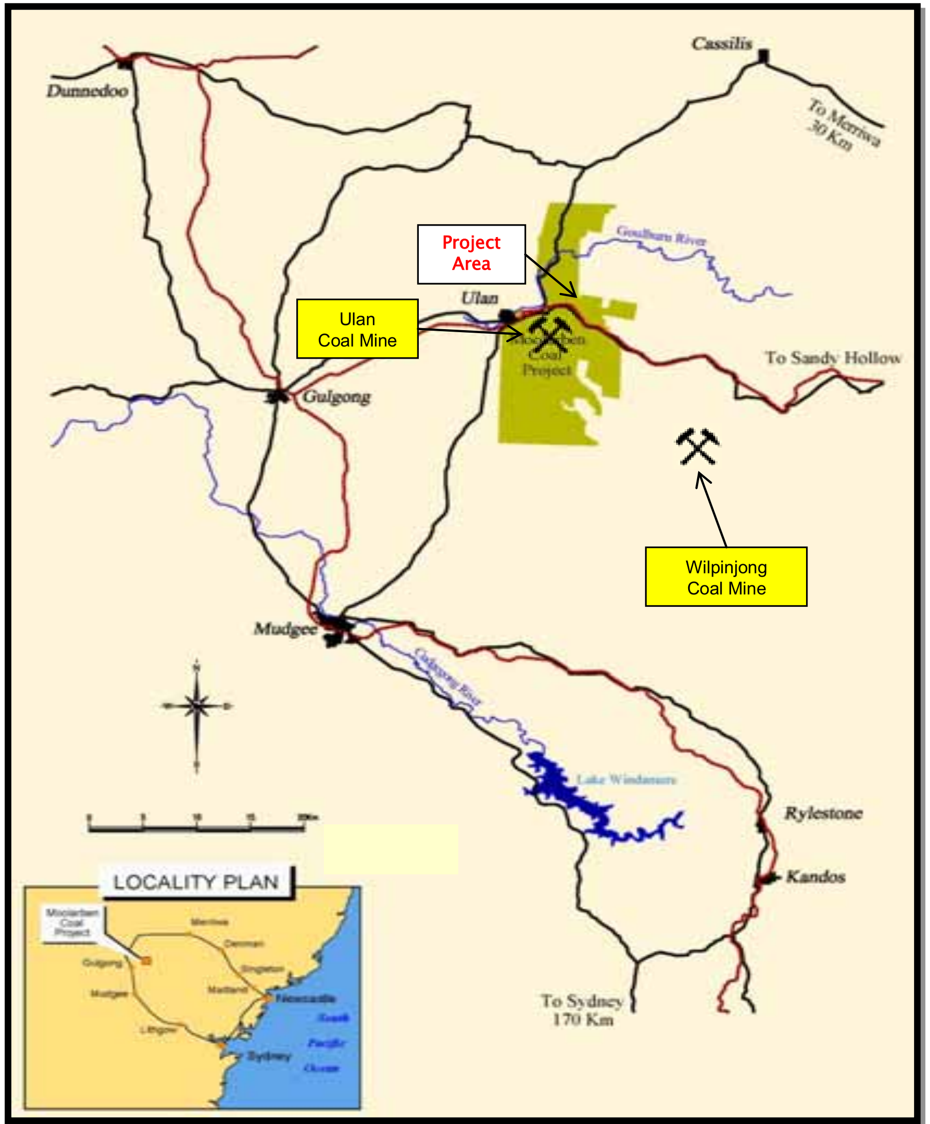
MARCH 2012

YANCOAL
兖煤澳大利亚有限公司

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

Overview

- Moolarben Coal Mine is a joint venture owned 80% by Yancoal Australia, 10% by Sojitz & 10% by a consortium of Korean power companies
- Located in the Western Coalfields of NSW, approximately 40 km north of Mudgee
- Currently an open-cut operation, with an underground operation being developed
- All saleable coal is export thermal quality
- Coal exported mainly via Newcastle Coal Infrastructure Group (NCIG) port and some via PWCS
- Construction commenced in early 2009 with the first coal shipment of coal in June 2010



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Geology

- Primary coal seam is the Ulan seam, which is part of the Illawarra Coal Measures
- The Ulan seam is 6m – 15m thick
- Low strip ratio (LOM strip ratio of 3.3x)
- Seam structure is generally uniform and mined in 2 working sections, with the seam dipping at 2˚ to the NE
- It is expected that coal produced from the UG1 and UG2 areas will have low ash and will be able to bypass the CHPP

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Reserves and Resources

Reserves			
Mt	Proved	Probable	Total
Open cut 1	20.5	2.9	23.4
Open cut 2	-	15.4	15.4
Open cut 3 West	-	11.5	11.5
Open cut 4	24.6	165.6	190.2
Underground 1	14.4	9.5	23.9
Underground 2	0.1	8.2	8.3
Underground 4	23.2	19.1	42.3
Total Reserves (100% basis)	**82.8**	**232.2**	**315.0**

Resources				
Mt	Measured	Indicated	Inferred	Inferred
A1	10.7	17.3	10.7	38.7
A2	65.3	97.8	36.1	199.2
B1	23.1	39.0	12.8	74.9
B2	24.8	41.2	15.4	81.4
C1	20.2	36.9	10.4	67.5
C2	36.8	63.8	17.8	118.4
CL	27.1	33.6	11.3	72.0
DTP	8.8	13.7	4.6	27.1
DWS	90.4	131.7	41.9	264.0
ETP	30.7	54.9	18.7	104.3
EBT	24.5	43.7	17.4	85.6
ELW	14.0	24.8	11.3	50.1
Total Resources (100% basis)	**376.4**	**598.4**	**208.4**	**1,183.2**

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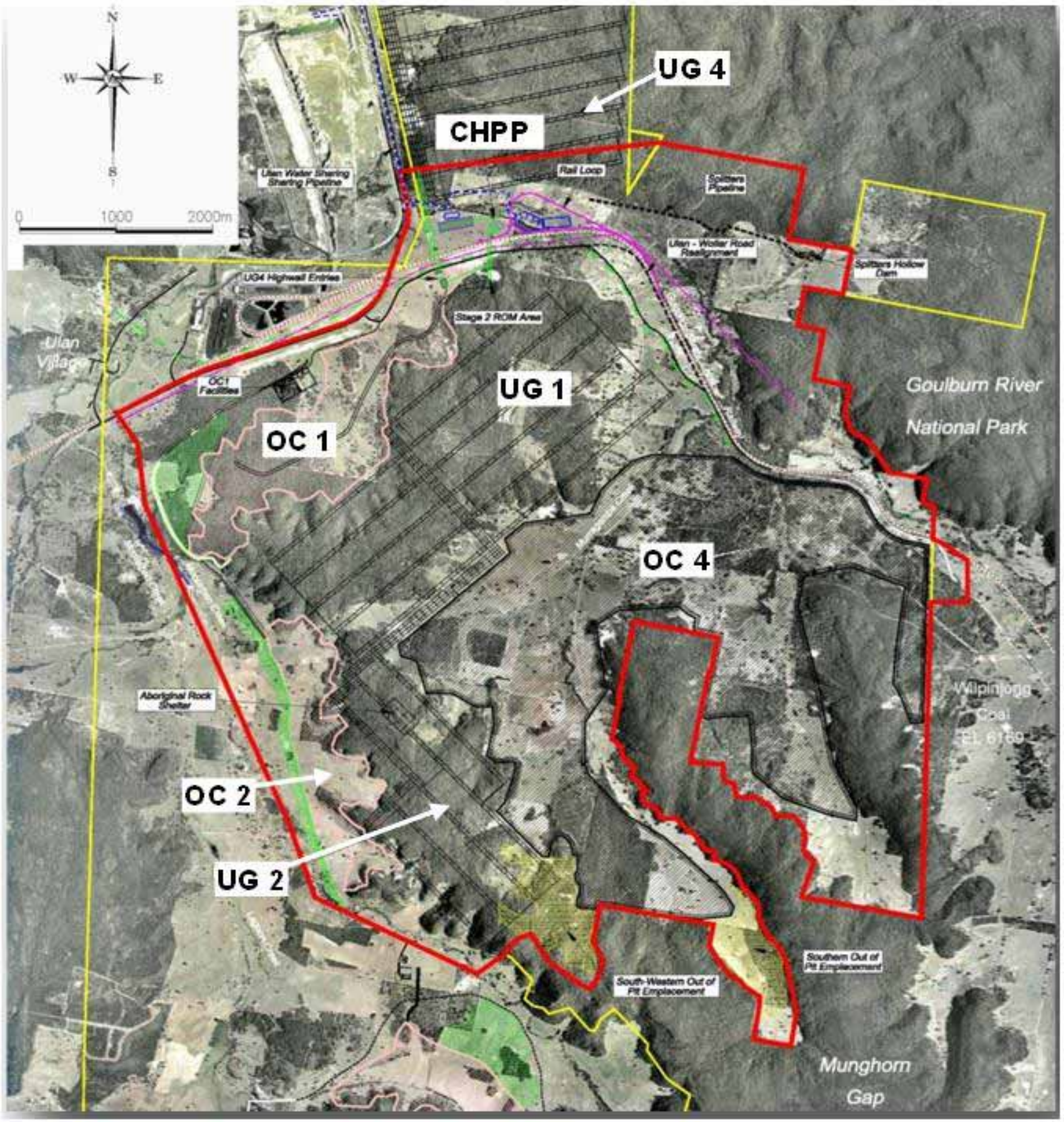
Mine & Exploration Leases



Approvals Overview

- Moolarben currently has approval to produce up to 10Mtpa of product coal (with an 8Mtpa ROM restriction on its open-cut operations and a 4.2Mtpa ROM restriction on its underground operations)
- Since commencing mining operations in May 2010, Moolarben has achieved its initial Stage 1 approved capacity of 7.0Mtpa ROM production yielding total saleable production of 5.0Mt (100% equity basis) in 2011
- Yancoal has now re-submitted its Stage 2 planning application to increase open-cut ROM production capacity to 13Mtpa and the underground mine to reach ROM production of 4.2Mtpa
- Yancoal is currently considering a further planning application to increase ROM production from the underground areas by using either a high reach longwall machine or Longwall Top Coal Caving (LTCC), in excess of these proposed Stage 2 applications
- Subject to mining leases and other requisite approvals being granted, which requires the purchase of the Stage 2 development lands not owned by Yancoal (or the entering into of a commercial arrangement with the relevant landholders), the Stage 2 development area will encompass mining of the areas marked OC4, UG1 and UG2 on the map of Moolarben operations (slide 6)

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

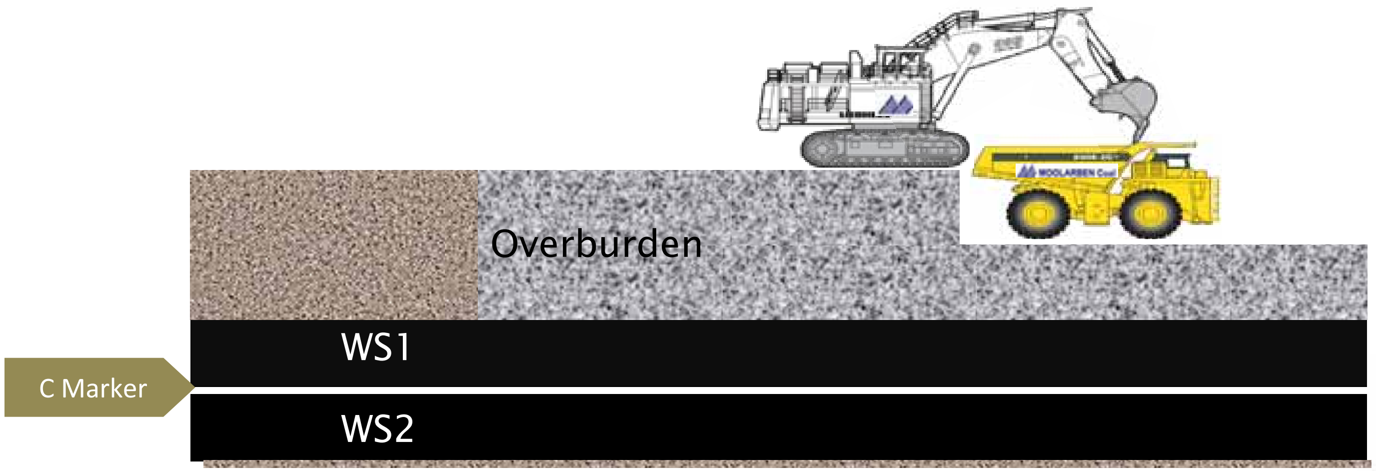
Mining operations overview

Mining Process

- Overburden Blasted, minimal free-dig. (15 to 40m thick)
- Overburden Removed by 996 excavators
- Ulan Seam is blasted, and mined by R9350 Excavator
- Ulan Seam mined in 2 working sections – WS1 & WS2
- "C" Marker parting is removed as waste

Fleet

Equipment	No.	Type
Liebherr 996	2	Excavator
Liebherr 9350	1	Excavator
Komatsu WA1200	1	FEL
Komatsu 830E	12	Dump Truck
Sandvik	2	Blast Drill Rig
Komatsu 475	5	Track Dozer
Komatsu 375	3	Track Dozer
Komatsu WD900	1	Wheel Dozer
Komatsu 785	2	Watertruck
Komatsu GD825	2	Graders



Mining Section

MOOLARBENCOAL
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CHPP Operations

- Washplant nameplate: 1,800tph
- Train load-out rate: 4,500tph
- 100% of OC coal is washed
- Plant Rate:
  - Working Section 1 – 1,600tph (2 Stage Washing)
  - Working Section 2 – 2,000tph (Single Stage Washing)
- Washing Method:
  - Single and 2 Stage washing mode
  - Coarse Coal – Dense Medium Separation (Dense Medium Cyclone)
- Fine Coal – Spirals and Flotation (Jameson Cells)
- Expected Yield: 62%

ROM under construction

Product Stockpile System under construction

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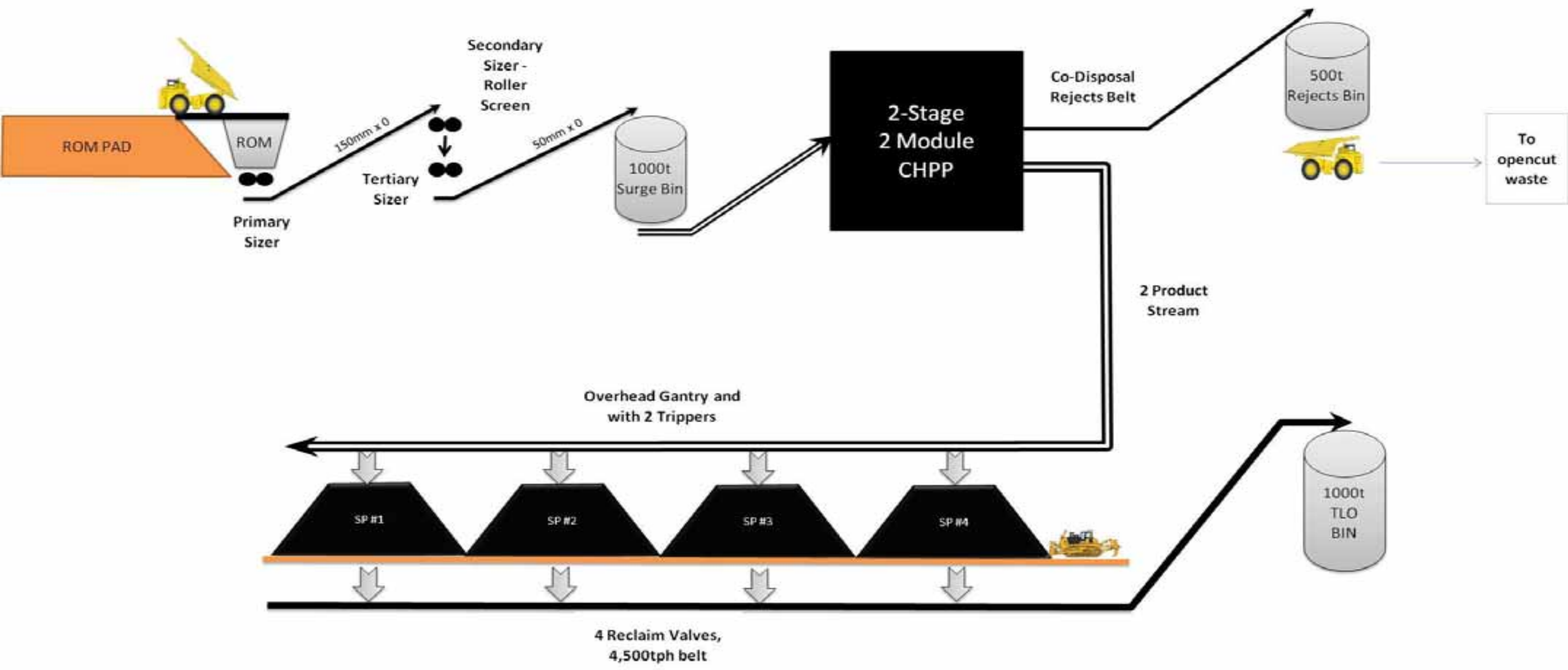
CHPP Flow sheet



Environmental Management

- Noise and dust management critical, with close proximity of private residences and Ulan school
- Environmental Monitoring system in-place at key locations
- Extensive erosion and sediment controls in-place
- Extensive archaeological and heritage surveys carried out
- Spoil reshaping ongoing and rehabilitation established
- All open cut mining equipment fitted with noise attenuation equipment

Rail Loop erosion control and drainage


Environmental Monitoring

MOOLARBENCOAL
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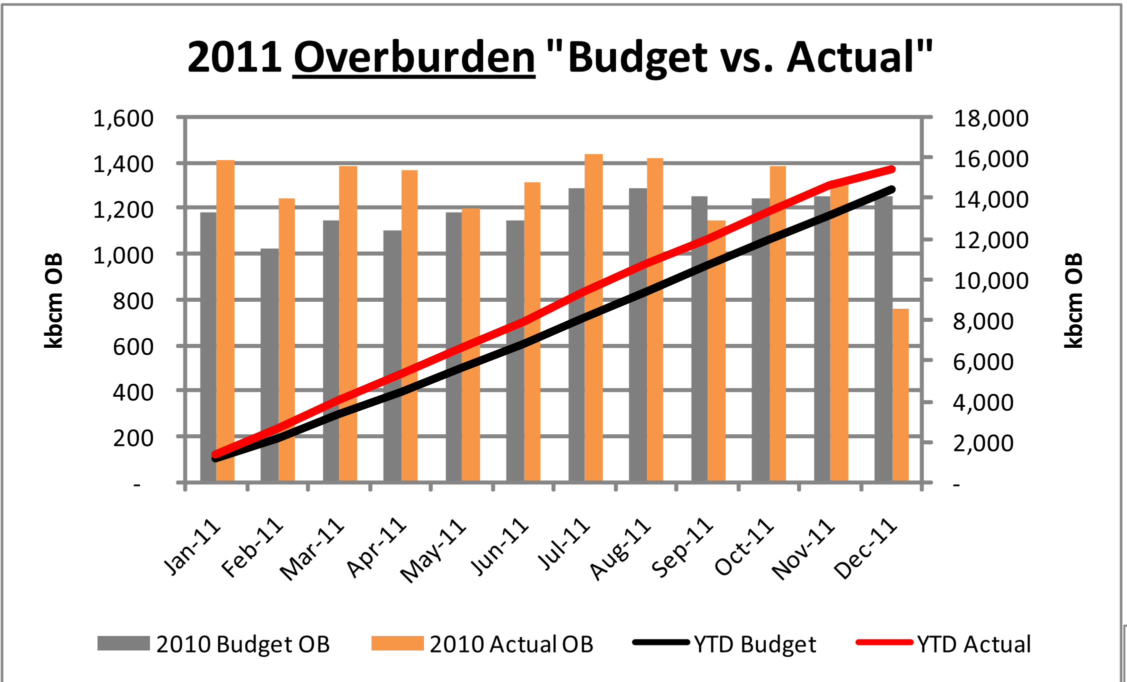
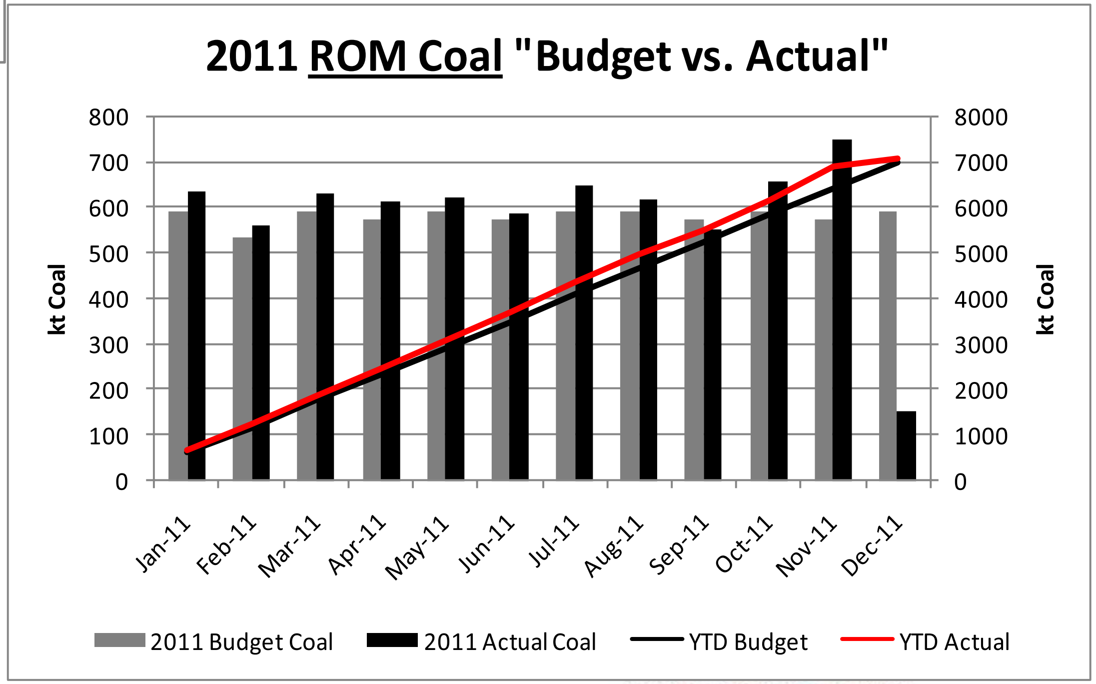
2011 Performance

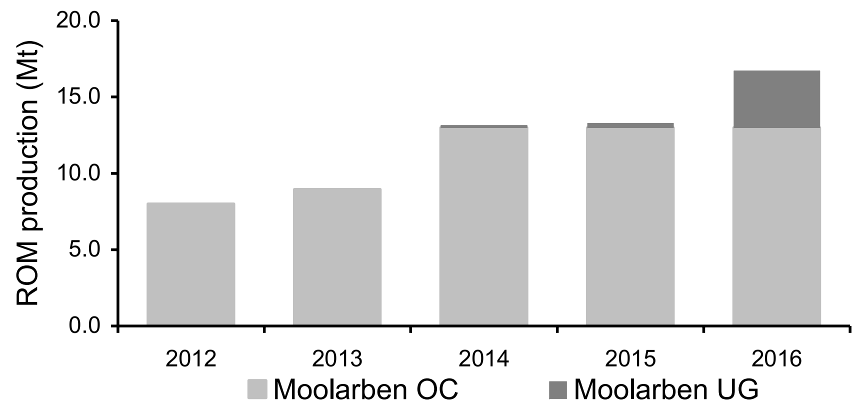




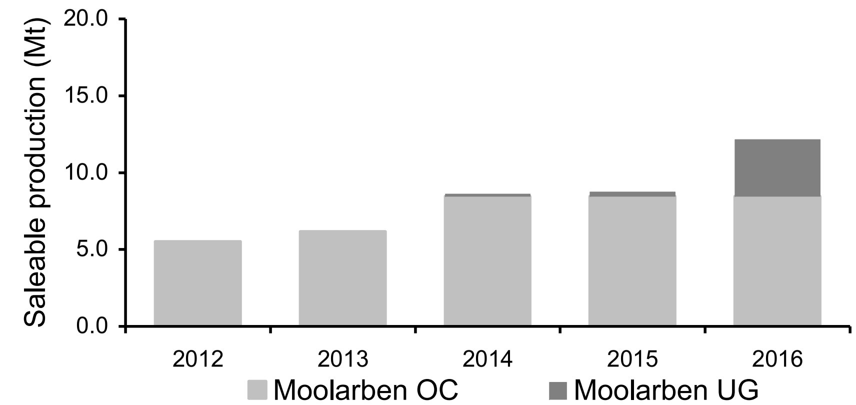
Organic growth strategy

- Expected mine life of ~25 years for both the open-cut and underground operations
- Following stage 2 approval production will increase in line with the growth strategy
- Moolarben OC mine is well positioned on the cost curve and has a life of mine strip ratio of 3.3:1
- CHPP yield will average ~70% by including some underground coals which can by-pass the CHPP
- Underground production is expected to commence in 2016 in line with available port allocation

ROM production Forecasts (Mt, 100% Basis)



Saleable production Forecasts (Mt, 100% Basis)



Note: these estimates relate to future expectations and therefore involve known and unknown risks and uncertainties. The actual production is likely to vary on an annual basis as a function of supply, demand and other market conditions.

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

Port and Rail

- Moolarben has an established rail loop and loading facilities
  - Train loading via a private rail loop, capable of holding 2 full size trains
  - Above and below rail capacity of 5.7Mt and 4.8Mt respectively in 2012, expected to increase in line with production profile

- NCIG is the primary port, with some coal via PWCS:
  - Port capacity of 5.2Mtpa through NCIG and 0.6Mtpa through PWCS in 2012
  - Expected to increase to 8.3Mtpa at NCIG as the port reaches its full capacity of 66Mtpa
  - Granted a provisional allocation of a further 3.5Mtpa from the PWCS T4 development which will increase total allocation across the two ports to over 12Mtpa

- It is anticipated that Yancoal will be able to source incremental additional port and rail capacity to underpin its production profile

Train Load-out system under construction

NCIG Ship-loader No.1

MOOLARBENCOAL
PART OF THE YANCOAL AUSTRALIA GROUP

YANCOAL
兖煤澳大利亚有限公司

MOOLARBEN COAL
PART OF THE YANCOAL AUSTRALIA GROUP

Annex VIII: Presentation on NCIG Coal Terminal Operation

Newcastle Coal

INFRASTRUCTURE GROUP

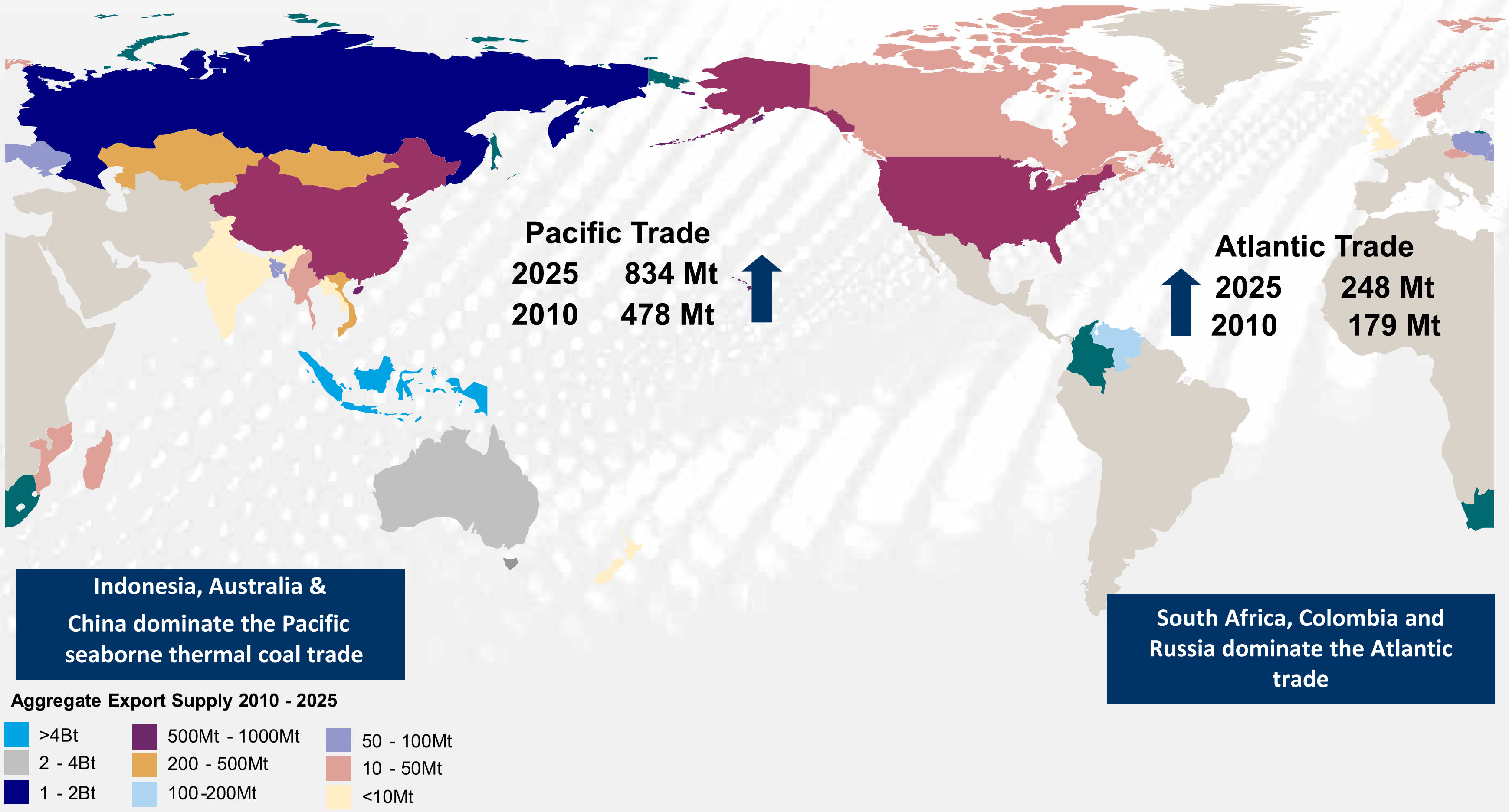
NCIG PRESENTATION

February 2012

Muster Location

Global Thermal Coal Trade

Newcastle Coal INFRASTRUCTURE GROUP



Indonesia, Australia & China dominate the Pacific seaborne thermal coal trade

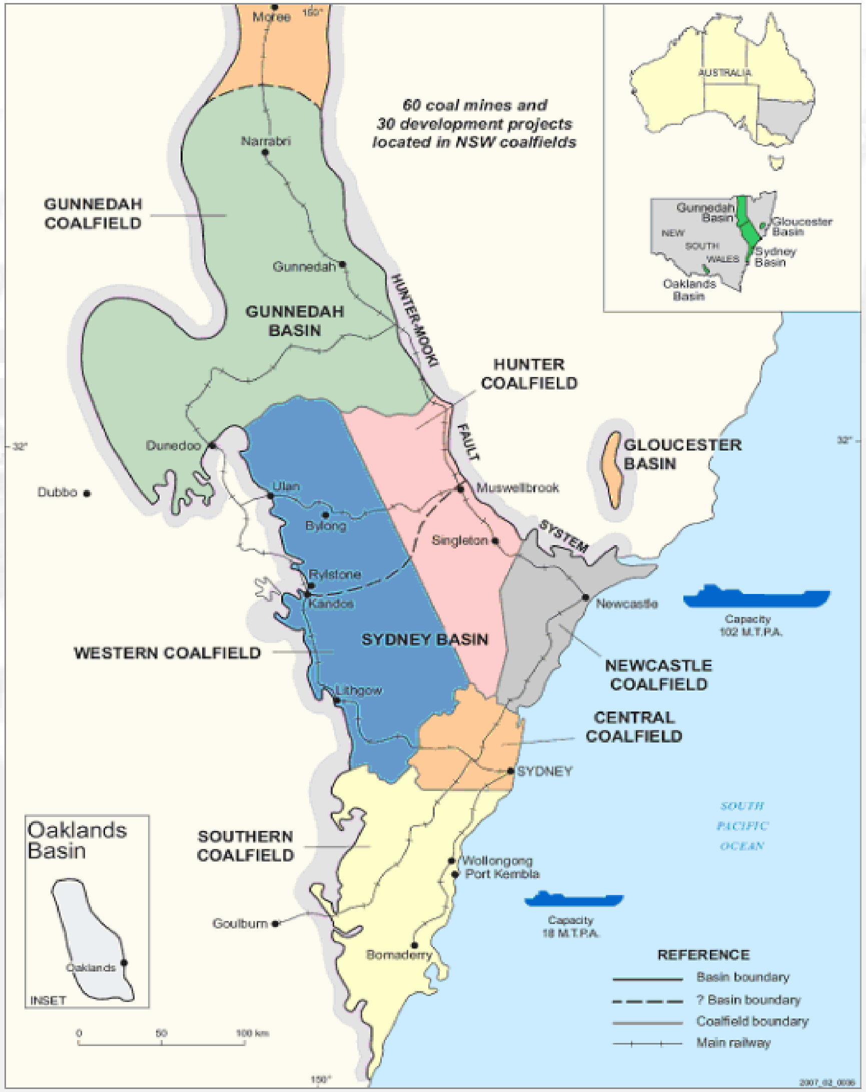
South Africa, Colombia and Russia dominate the Atlantic trade

Source: Wood Mackenzie

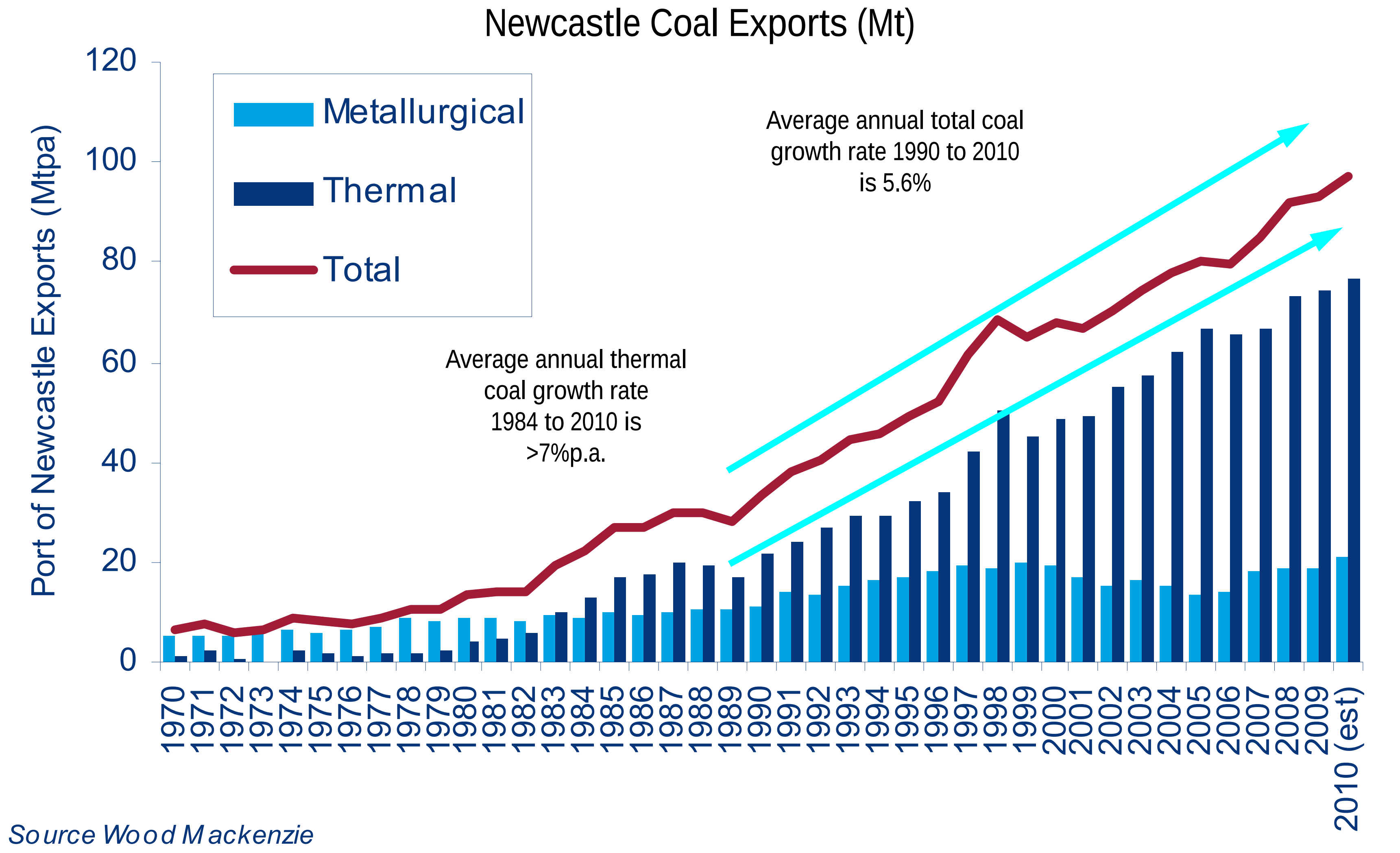
Hunter Valley Coal Chain (HVCC)

Newcastle Coal
INFRASTRUCTURE GROUP

- **Coalfields**
  - Newcastle
  - Hunter
  - Gunnedah
  - Gloucester
  - Western (Northern end)
- **Mines**
  - 40 Coal mines
  - 13 Producers
  - 27 Load points
- **Rail**
  - 2 Track network owners
  - 4 Above rail operators
- **Terminals**
  - 2 Terminal owners
  - 3 Coal export terminals
- **Port**
  - Newcastle



Historical Newcastle Coal Exports



Source Wood Mackenzie

Long Term Growth for Newcastle

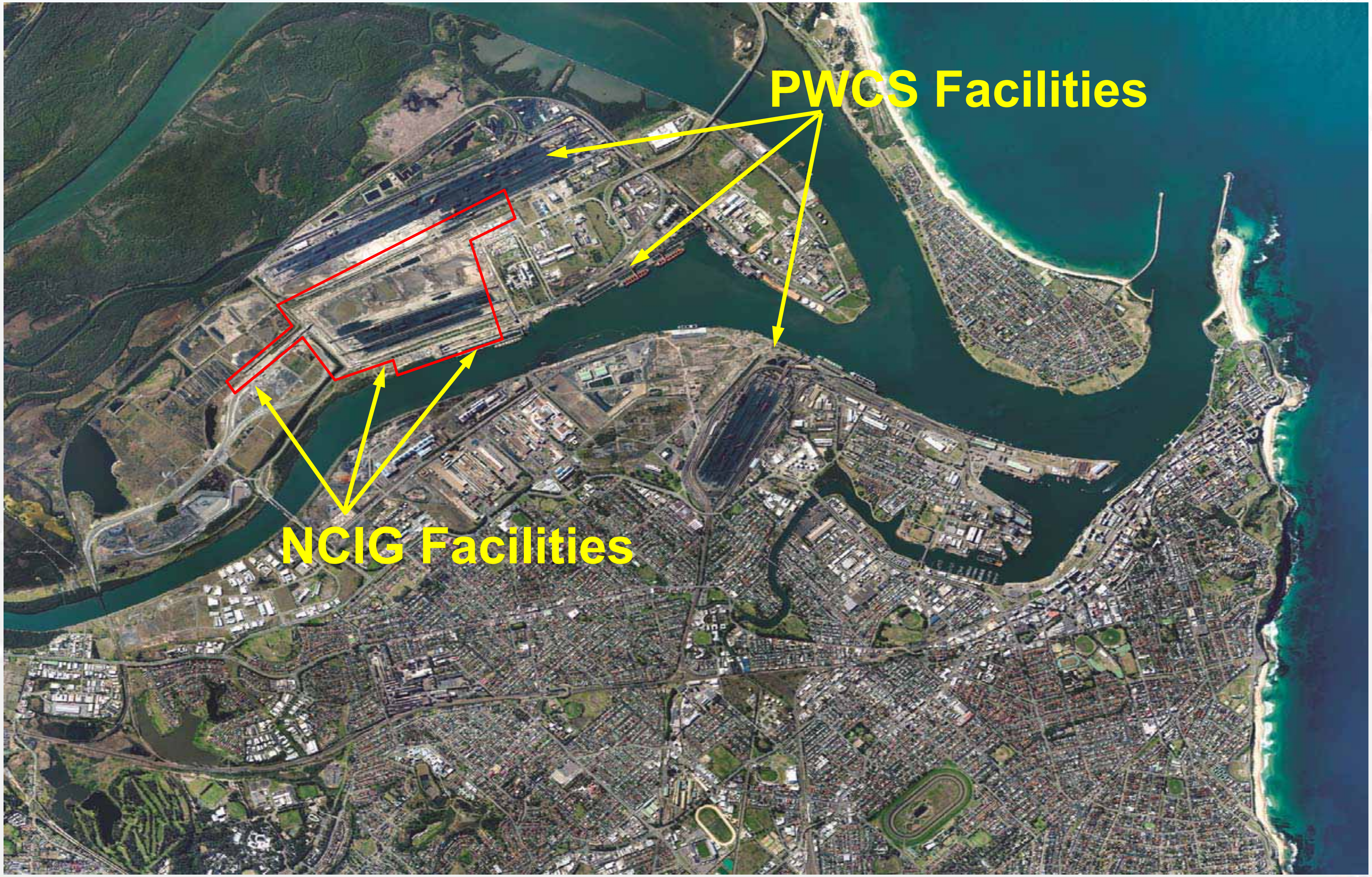
- Long Term Agreements in Place for Future (NPC / PWCS / NCIG)
- Expansions
  - Newcastle Port Services
    - Extra pilots being trained
    - Increased tug fleet to 8 (dual movements)
  - Terminals
    - PWCS expanding Master Plan Completion & Stage 4
    - NCIG expanding Stage 2AA and 2F
  - Rail network
    - ARTC Master plan to >200Mt
    - $1B to be spent 2009 to 2012
  - Trains
    - 8 new trains set in 2010 with 10 new train sets in 2011

Newcastle Port Capacity (Mtpa)

Owner	Terminal	Current Capacity	Committed Capacity	Potential Capacity	TOTAL
PWCS	Carrington	25			25
PWCS	Kooragang	83	34		117
NCIG	NCIG	30	36		66
PWCS	*Terminal 4*			*Approx. 120*	*120*
TOTAL		**138**	**70 (208)**	**120**	**328**

Newcastle Port

Newcastle Coal
INFRASTRUCTURE GROUP



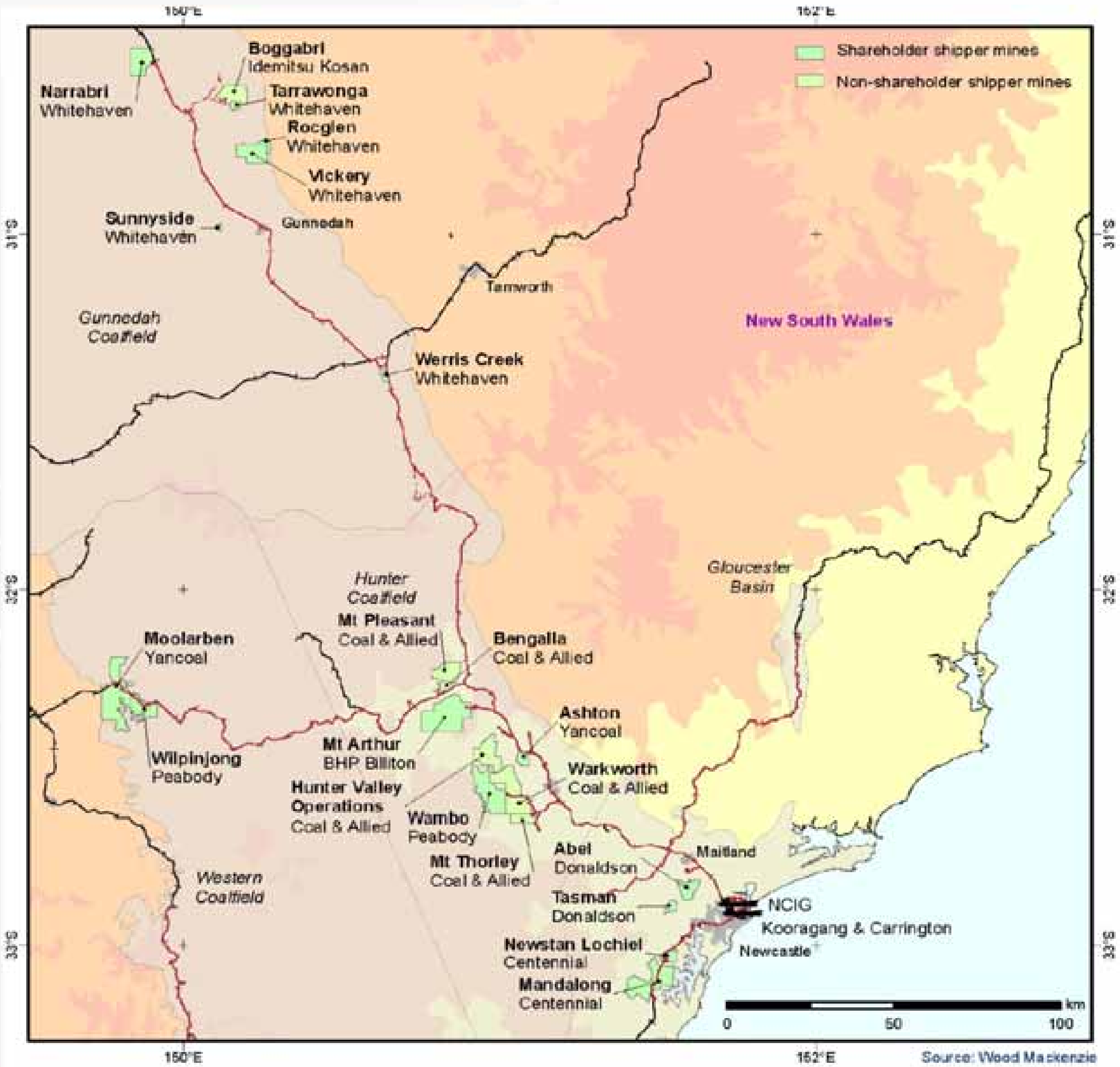
Newcastle Coal Infrastructure Group

- Established in 2004
- **Objective:** To address infrastructure shortages in the Hunter Valley coal chain and to ensure adequate long term coal loading capacity is available at the Port of Newcastle
- The current NCIG shareholders are significant producers with substantial Newcastle, Hunter, Gunnedah and Western coalfields reserves with plans for substantial export growth
- NCIG's shareholders are:

Parent	Shareholder
BHP Billiton	Hunter Valley Energy Coal
Peabody	Peabody Energy
Yanzhou Coal Mining	Felix Resources
Gloucester Coal	Donaldson Coal
Whitehaven	Whitehaven Coal
Banpu	Centennial Coal

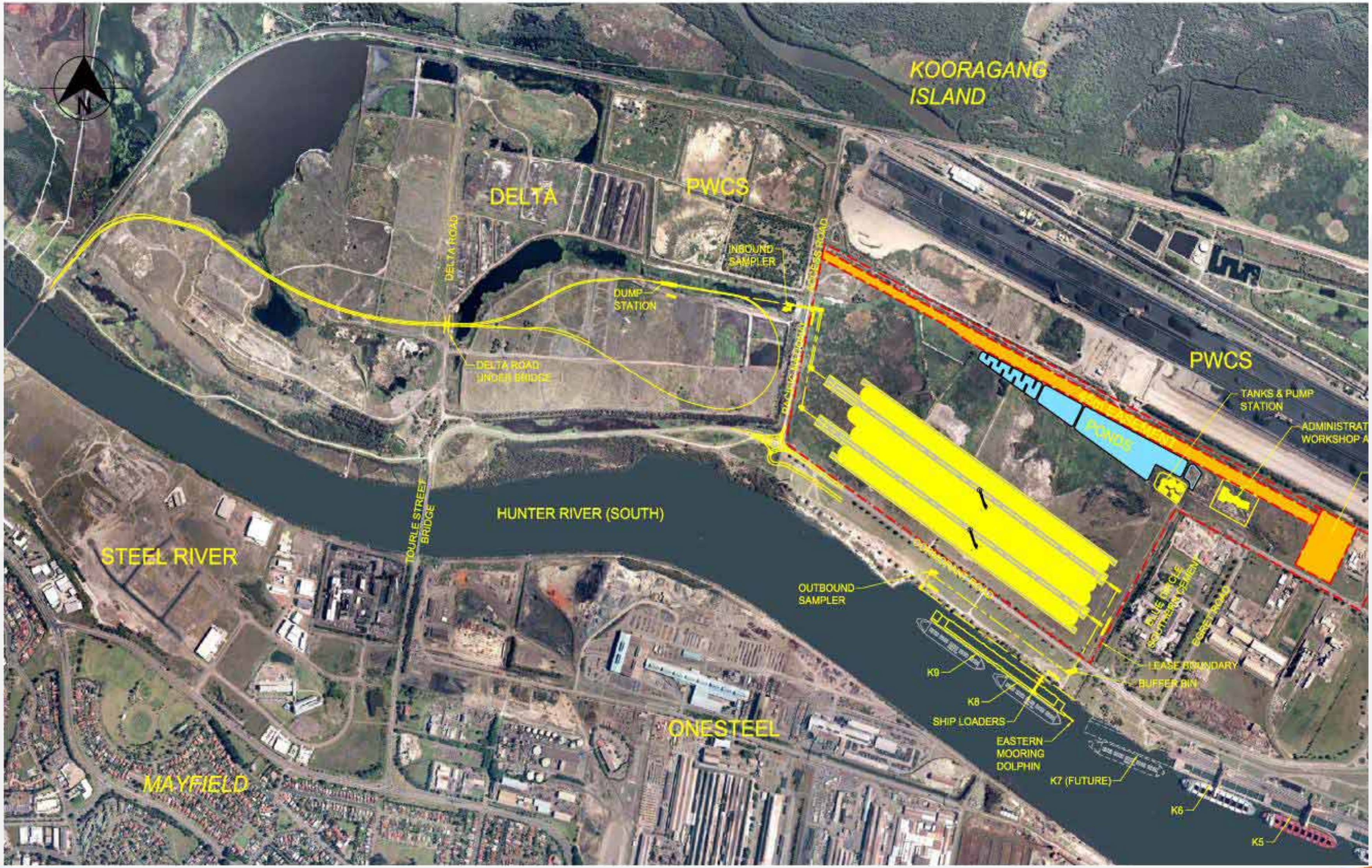
NCIG Source Mines

Newcastle Coal INFRASTRUCTURE GROUP



Stage 1 - Layout

Newcastle Coal
INFRASTRUCTURE GROUP



Stage 1 – Progress Construction

Newcastle Coal INFRASTRUCTURE GROUP

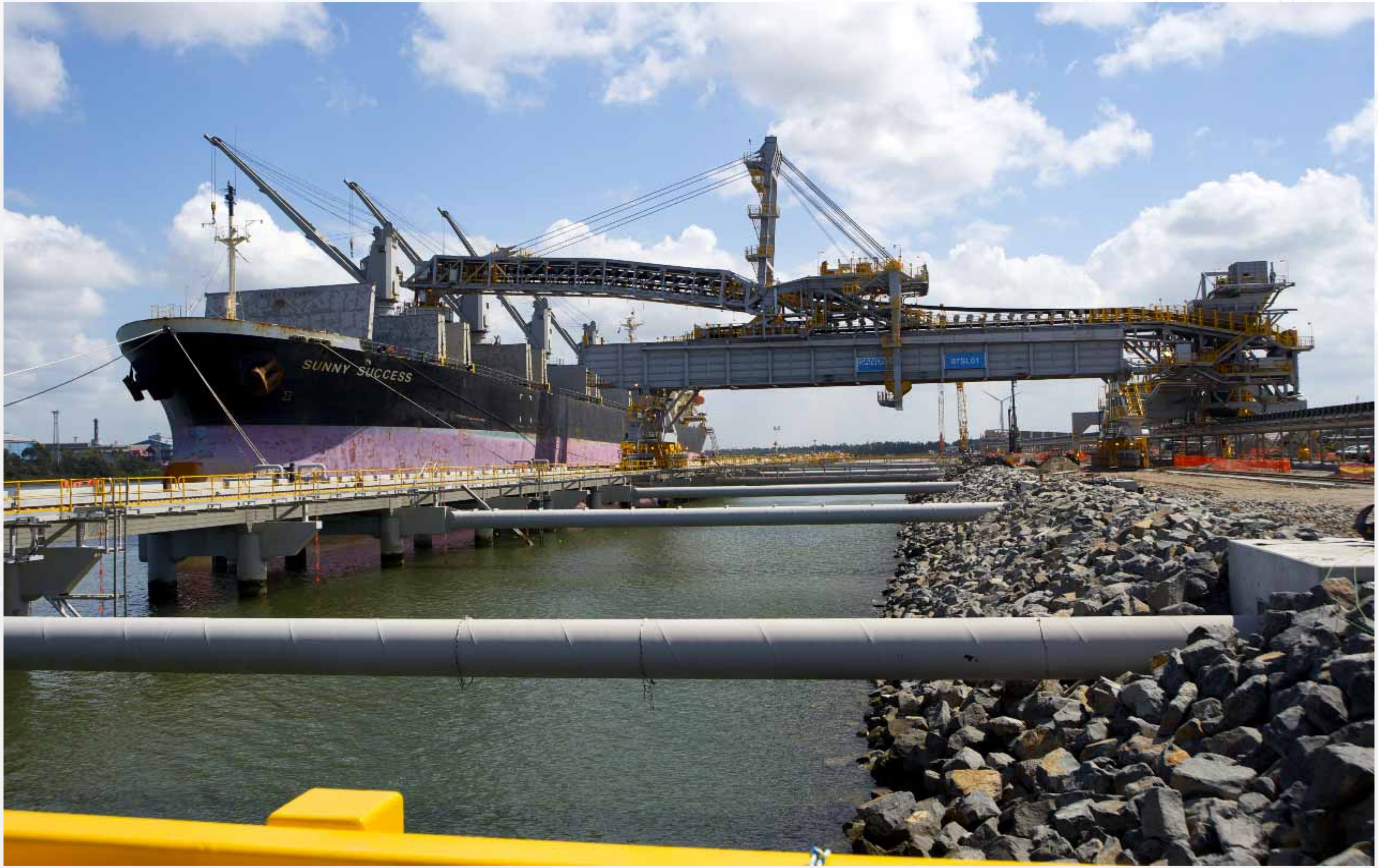
- Financial close February 2008
- Engineering work completed
- Dredging commenced Q4 2007
- Construction commenced Q2 2008
- > 5000 construction people inducted (peak 850)
- 4.4 million man hours worked, (2000 man years worked) one LTI
- S/R 1 commenced operation February 10
- S/R 2 commenced operation in May 2010
- S/L 1 commenced operation March 2010
- At 30Mtpa 2011

First Export Coal on Ground – March 2010

Newcastle Coal INFRASTRUCTURE GROUP

First Ship – March 2010

Newcastle Coal
INFRASTRUCTURE GROUP



First Panamax Vessel – May 2010

Newcastle Coal INFRASTRUCTURE GROUP

Two Berth Operation – August 2010

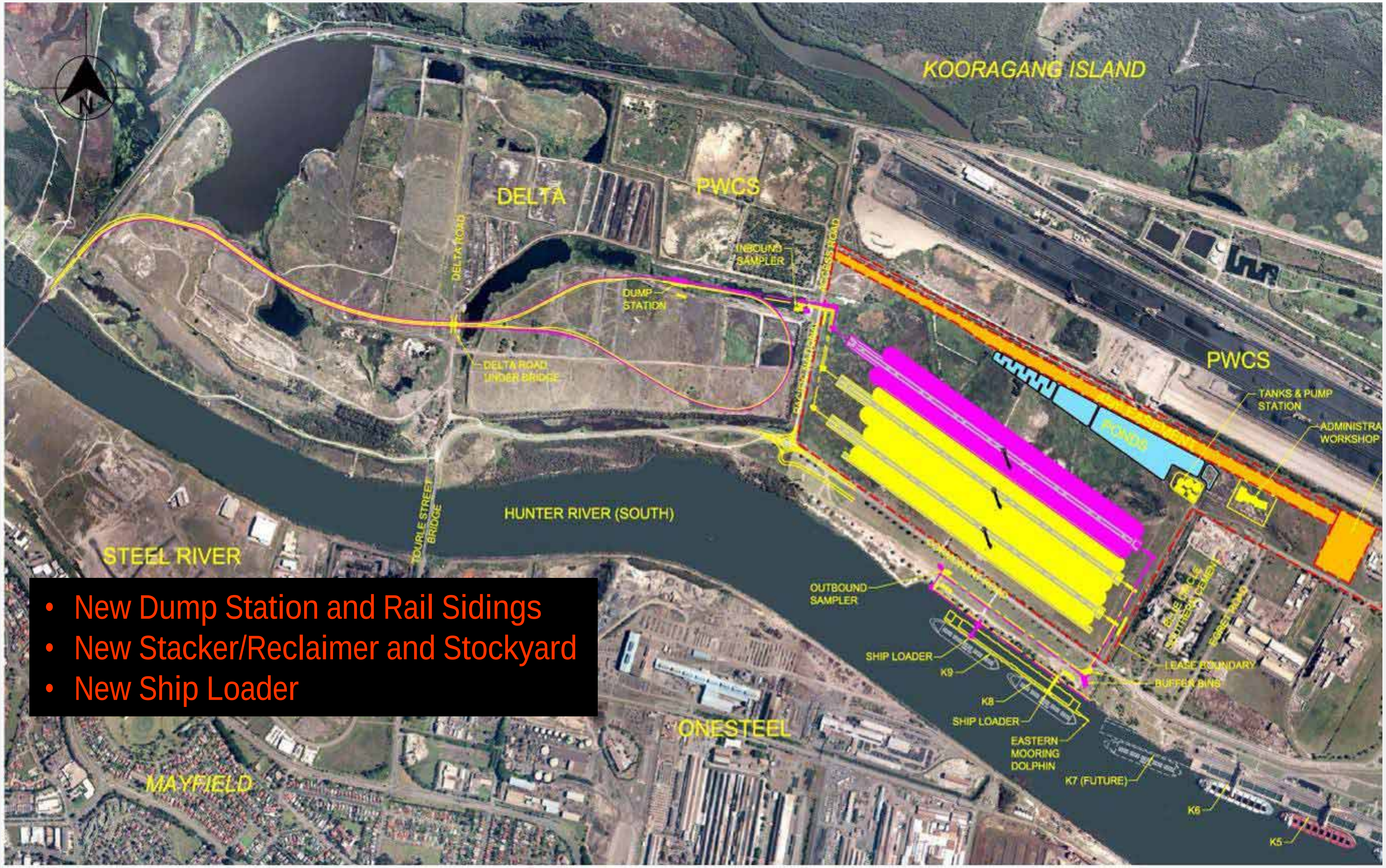
Newcastle Coal
INFRASTRUCTURE GROUP

First Cape Vessel – September 2011

Newcastle Coal
INFRASTRUCTURE GROUP

Expansion Stage 2AA – 53 Mtpa

Newcastle Coal INFRASTRUCTURE GROUP



- New Dump Station and Rail Sidings
- New Stacker/Reclaimer and Stockyard
- New Ship Loader

Stage 2AA – Construction Progress

Newcastle Coal
INFRASTRUCTURE GROUP

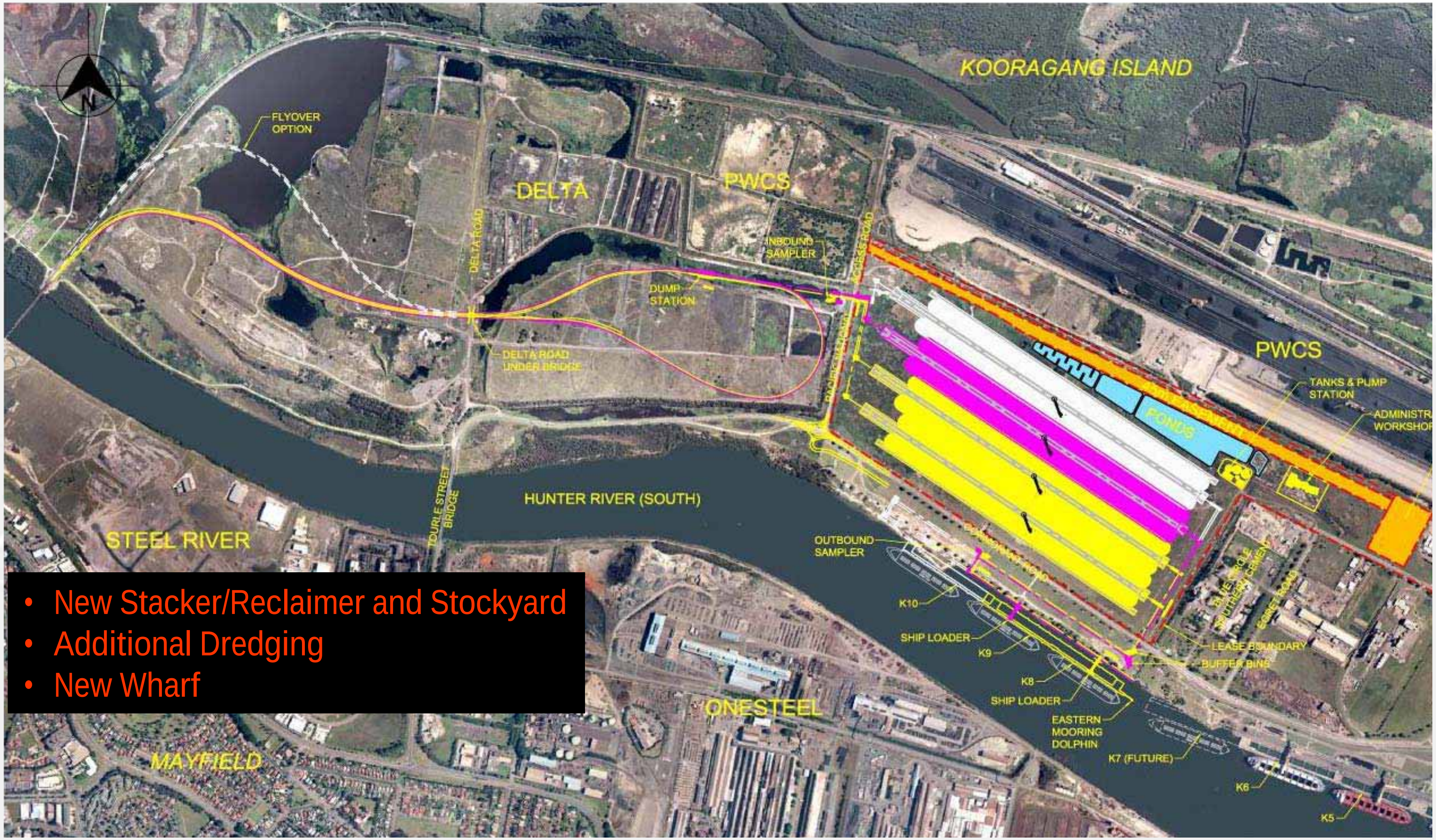
- Financial close August 2010
- Engineering work completed
- Construction commenced Q3 2010
- > 3000 construction people inducted (peak 600)
- 0.8 million man hours worked, zero LTI
- Construction 70% complete
- S/R 3 components on site and being assembled
- S/L 2 due to arrive on heavy lift vessel November 11
- New shuttles installed CV01, CV08 and CV09

Stage 2AA – Operations Progress

Newcastle Coal
INFRASTRUCTURE GROUP

- Two new shippers
  - Rio Tinto
  - Idemitsu
- Start commissioning in Mid 2012
- First shipment planned 2nd Half 2012
- At 53Mtpa 2013

Expansion Stage 2F 66 Mtpa



- New Stacker/Reclaimer and Stockyard
- Additional Dredging
- New Wharf

Stage 2F – Progress

Newcastle Coal
INFRASTRUCTURE GROUP

- Financial close achieved August 2011
- Engineering design work already commenced
- Order placed for S/R 4
- Construction commenced Q3 2011
- First shipment planned Mid 2013
- At 66Mtpa capacity 2014

Rail Operators

- Three Above Rail Operators using NCIG (QRN, PN, SSR)
- Trains up 1.6 klm's in length
- Train payload varies 3kt to 8.5kt
  - QRN – 7.2kt
  - PN – 8.5kt, 6.1kt, 5.4kt and 3.1kt
  - SSR – 3.1kt
- Automatic open / close wagon doors
  - air operated doors
  - mechanical operated doors
- Discharge times < 1 hour

Dump Station Operation

Newcastle Coal
INFRASTRUCTURE GROUP

- Trains unload at 8,500tph
- Wagons unloaded in Dump station into dump hopper
- Trains travel through the dump station without stopping while discharging the coal
- Various types of wagons with each wagon containing between 75t and 95t with the number of wagons in a train varying from 42 to 91 wagons

Yard Machines – Stacker / Reclaimer

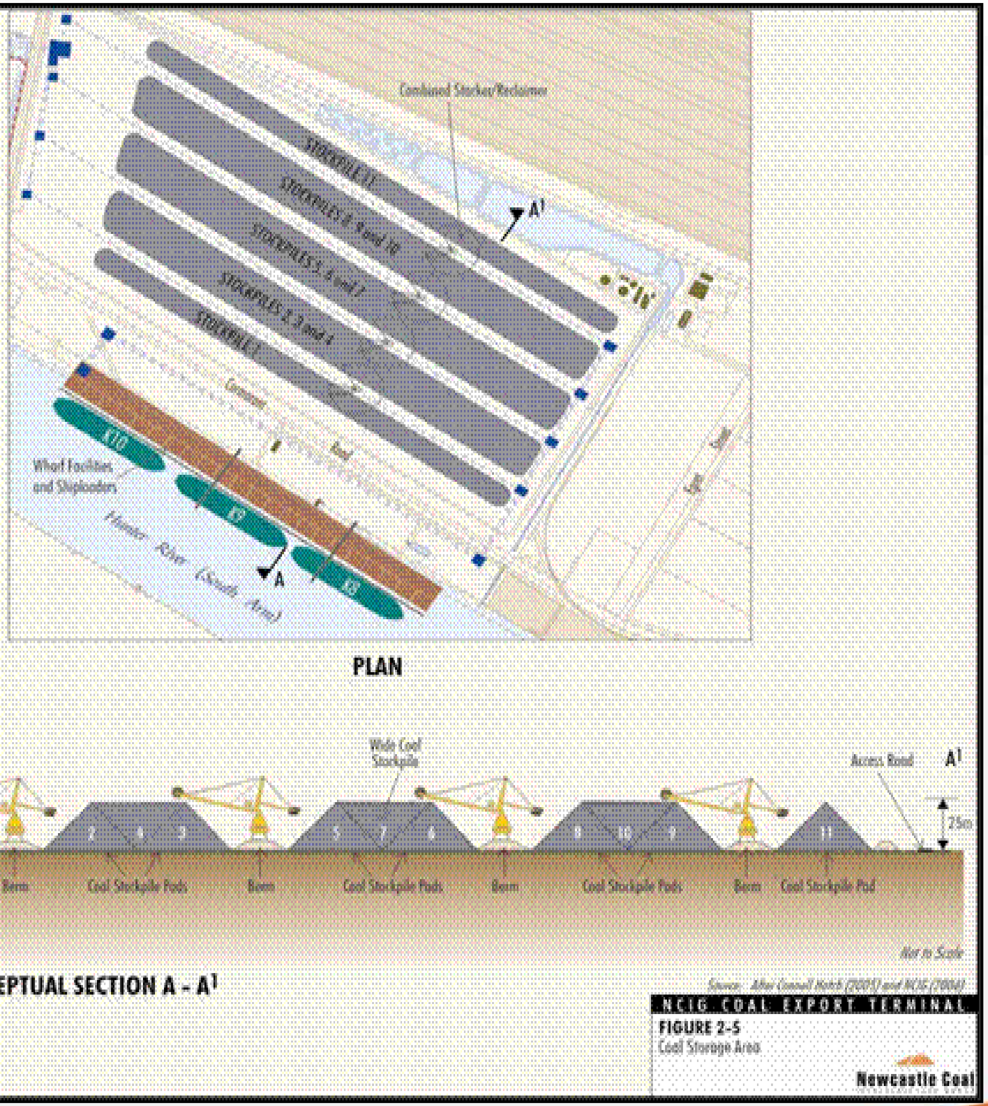
Newcastle Coal
INFRASTRUCTURE GROUP

- Sandvik design – 8500tph
- Machine between each stockyard pad
- Each Machine fully automated
- Can either be in stack mode or reclaim mode

Stockyard Operations

- Narrow stockpiles at northern and southern end
- Wide stockpiles in the middle areas
- Coal stacked to 21 metres high
- 80% area allocated to dedicated stockpiles
- Each contracted shipper is allocated a dedicated area

Stockyard


Combined Stacker/Reclaimer
STOCKPILE 11
STOCKPILES 8, 9 and 10
STOCKPILES 5, 6 and 7
STOCKPILES 2, 3 and 4
STOCKPILE 1
Wharf Facilities and Shiploaders
Hunter River (South Arm)
PLAN
Shiploader
Conveyor
Access Road
Coal Stockpile (Typical)
Wide Coal Stockpile
Access Road
Existing Surface Level (Approx)
Hunter River (South Arm)
Selected Rock Fill
Coal Stockpile Pad
Berm
Coal Stockpile Pads
Not to Scale
CONCEPTUAL SECTION A - A1
NCIG COAL EXPORT TERMINAL
FIGURE 2-5
Coal Storage Area
Newcastle Coal

Outloading Operation

- Coal is reclaimed by an S/R and transported to the Buffer bin
- Coal is stored in the buffer bin (2000t)
- Coal is fed from the buffer bin via conveyor to the shiploader
- Coal passes through the outbound sample plant just prior to the wharf
- Outbound sample plant is operated by independent superintendent company

Shiploading Operation

- Shiploading system rated at 10,500tph
- Coal is fed from the buffer bins
- Able to accommodate vessels up to 300m LOA
- Able to load vessels up to 50m beam
- Load plans allow a maximum of two pours per hatch
- Maximum of two trim pours



Wharf Operation

Newcastle Coal INFRASTRUCTURE GROUP

- Each berth capable of taking Cape sized vessels
- A spare berth is available for stage 1 and stage 2F
- Spare berth minimises the effects of deballasting and waiting on tides for departing capes
- Berth pocket depth 16.5m
- Shipping channel depth 15.2m
- Sailing draft on tide between 15m and 15.6m

Coal from Newcastle to the World

Newcastle Coal INFRASTRUCTURE GROUP

THANK YOU

Newcastle Coal
INFRASTRUCTURE GROUP

Annex IX: List of the Agencies Consulted during International Visits

Stakeholder Group	Name	Company's Name	Position	E-mail	Address	Remarks
			Australia			
Coal Trader	Tadahiro (Tad) Kinoshita	Sojitz Australia Limited	Managing Director	Kinoshita.tadahiro@sea.sojitz.com	ABN:16 000 213 132 Level 13,MLC Centre 19-29 MARTIN Place ,Sydney NSW 2000 (mail) G.P.O.Box 3321, Sydney NSW 2001 Australia Phon:(02)9234-0822 Fax:(02) 9235-1080	Allowed Sojitz Japan in arranging the program
	Toru (Terry) Shindo	Sojitz Australia Limited	General Manager	shindo.toru@sea.sojitz.com	ABN:16 000 213 132 Level 13,MLC Centre 19-29 MARTIN Place ,Sydney NSW 2000 (mail) G.P.O.Box 3321, Sydney NSW 2001 Australia Phon:(02)9234-0932 Fax:(02) 9234-0912 Mobile:0400126826	Who was responsible to arrange the complete program and accompanied the delegations during visiting Australia
Coal Terminal Operator	Rod Dove	PORT WARATAH COAL SERVICES LIMITED	Tour Officer	reception@pwcs.com.au rod.dove@pwcs.com.au	PO Box 57 Carrington NSW 2294 Australia Phone:02 4907 2000 Fax:0249073000	Briefed the delegations about the PWCS
	Paul Beale	Newcastle Coal infrastructure Group	General Manager			Briefed the delegations about the NCIG
Coal Producer	Frank Fulhan	Moolarbencoal	General	ffulhan@moolarben	Locked Bag 2003	Briefed the delegations

Stakeholder Group	Name	Company's Name	Position	E-mail	Address	Remarks
			Manager	coal.com.au	Mudgee NSW 2850 4250 Ulan Road Ulan NSW 2850 ABN:59077939569 Tel:02637615500 Fax:0263761599 Mobile:0417719392	about the Moolarben coal mine
Mine Investor	Cameron Fennell	Yancoal Australia Ltd	Logistic Co-ordinator			
Singapore						
Coal Suppliers	Capt.Arun Dua	SAPPHIRE PACIFIC PTE LTD		dua_aman@hotmail. com	3 Shenton Way #25-03 Shenton House Singapore 068805 Tel:+6562250969 Fax:+6562247209	Mr. Arun Dua organized all meetings, in Singapore and Indonesia and also arranged mine visit and loading point visit in Indonesia
Advocates &Solicitors	Joseph Lopez	Joseph Lopez &Co	Barrister	jl@joseph-lopez.com	1 Coleman Street #07-09B The Adelphi Singapore 179803 Tel:63394040 Fax:63373405	
Shipper	Vivek Datar	TATA NYK	Assist. General Manager (Chartering)	vivek@tatanykshipping.com	10 Anson Road #21-06/06A International plaza Singapore 079903 Phone:+65622166 ext.899 Fax:+6562254930 Mobile:+6591280992	Mr. Vivek Datar briefed the delegations about coal transportation system in Indonesia
Ship Brokers	ADITYA NUGRAHA	PCN (PT.PROLIDO	Director	aditya@lcp-coal.com	43rd floor ,Menara BCA JI,M.H.Thamrin Kav.1	

Stakeholder Group	Name	Company's Name	Position	E-mail	Address	Remarks
		CIPTR NUSANTARA)			Jakarta Pusat 10310 Tel.(+62-21)23586068-69 Fax. (+62-21)23586070 Hp.+628118601531	
			Indonesia			
Shipper	Dandang Sonda	PT.INDO DHARMA TRANSPORT		dandangsonda@idt-shipping.co.id	JI.Berlian No.10 Bidara Cina,Jatinegara Jakarta Timur 13330 Indonesia Tel:+62 21 8591 4358 Fax:+622185914356 Mobile:+628128012 996	Organized the program in Jakarta Indonesia and briefed the delegation about coal business, coal mining, coal transportation in Indonesia
	Capt. Y.Paul Barkey	PT.INDO DHARMA TRANSPORT		Capt.yohanpaulbarkey@idt-shipping.co.id	JI.Berlian No.10 Bidara Cina,Jatinegara Jakarta Timur 13330 Indonesia Tel:+62 21 8591 4356 Fax:+622185914360 Mobile:+62811583514	
Coal Producers	HENRY SOETIO	PT.LESTARI CIPTA PERSADA (Coal Mining –Heavy Equipment)		henry@borneoprima.com	43^{rd} floor ,Menara BCA JI,M.H.Thamrin Kav.1 Jakarta Pusat 10310 Tel.(+62-21)23586068-69 Fax. (+62-21)23586070 Hp.+6281358868888	Briefed about coal mining activities
Coal Producers	ADITYA NUGRAHA	PCN (PT.PROLIDO CIPTR NUSANTARA)	Director	aditya@lcp-coal.com	43^{rd} floor ,Menara BCA JI,M.H.Thamrin Kav.1 Jakarta Pusat 10310 Tel.(+62-21)23586068-69	

Stakeholder Group	Name	Company's Name	Position	E-mail	Address	Remarks
					Fax. (+62-21)23586070 Hp.+628118601531	
Coal Producers	Mohammad Veroniko,ST	PT.BARATAMA INTI GEMILANG			JI.Danau Sunter Ruko Terrace Bolk A No.16 Jakarta Utara	Briefed about coal mining and coal exporting activities
Coal Producers	Capt.Massod Farooqui	P.T BORNEO RESOURCES INTERNATIONAL		masood@ borneoresources.com	Menara Kain ,30th Floor,JI.H.R. Rasuna Said Block X-5,Kav 2-3,Jakarta Selatan 12950,Indenesia Phone:+62-21-5289-1902 Fax:+62-21-5299-4599	briefed the delegation about coal business, coal mining, coal transportation in Indonesia
Inspector and Auditor of coal carrier, Coal Quality Assurance Agent		SUCOFINDO				

Annex X: Tentative Layout of Coal Terminal with Different Fleet Composition for Khulna Thermal Power Plant

Figure 1: General plant layout with coal terminal facilities

Figure 2 to 6 shows Option 1 to 5 of different Fleet Composition with same Jetty Configuration

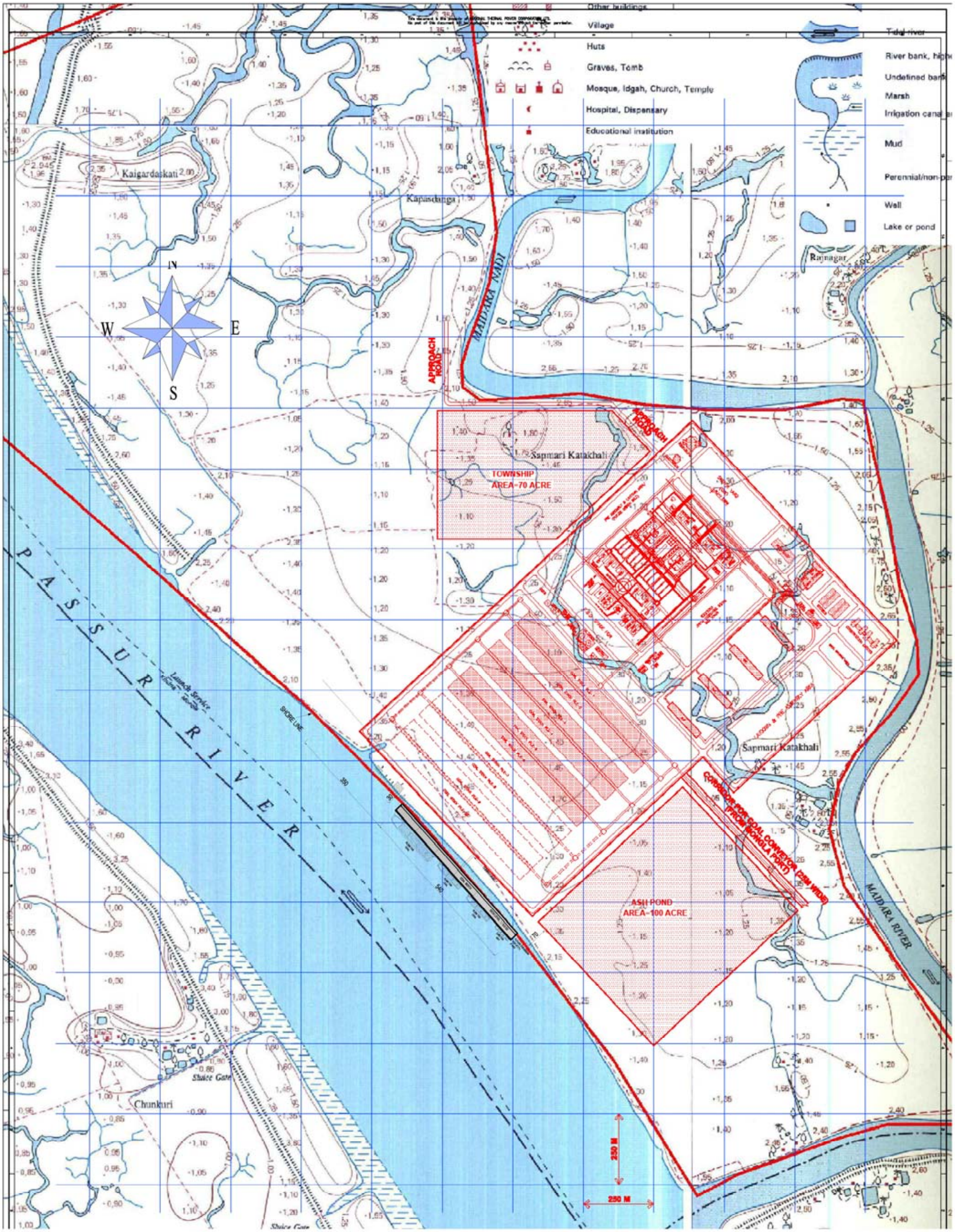


Figure 1: General layout of the power plant with coal terminal facilities

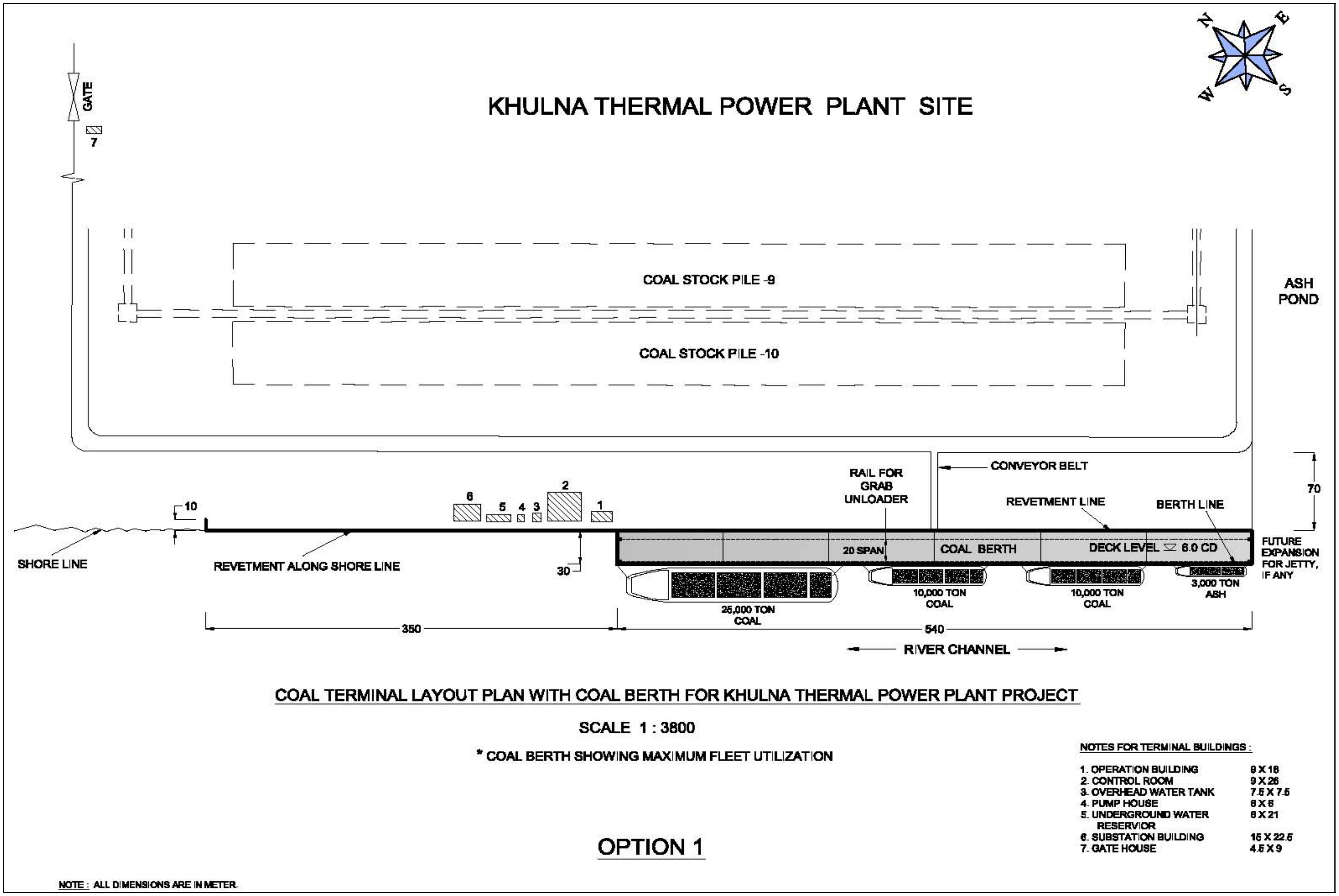


Figure 2: Tentative Layout of Coal Terminal with fleet composition-1

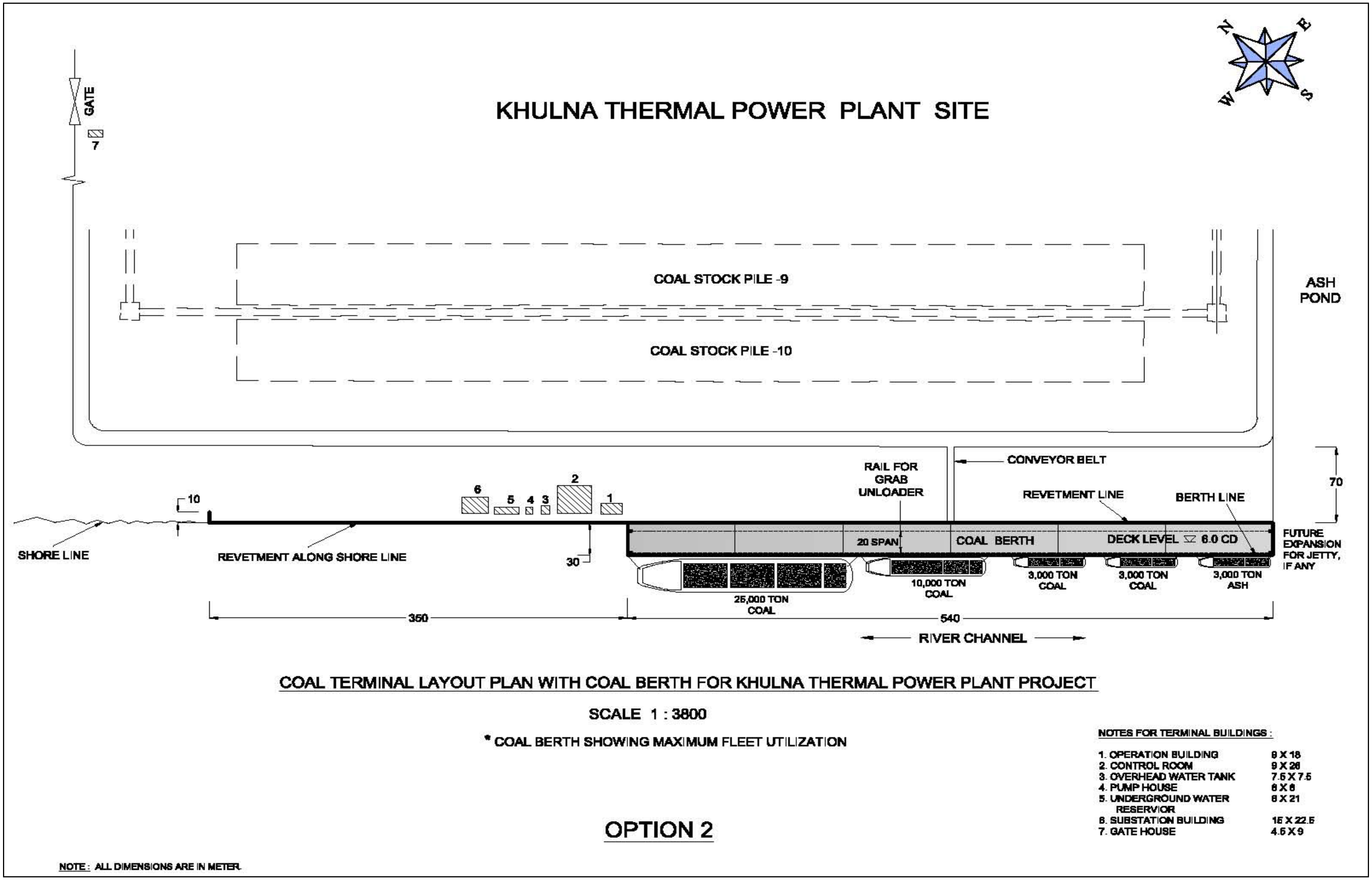


Figure 3: Tentative Layout of Coal Terminal with fleet composition-2

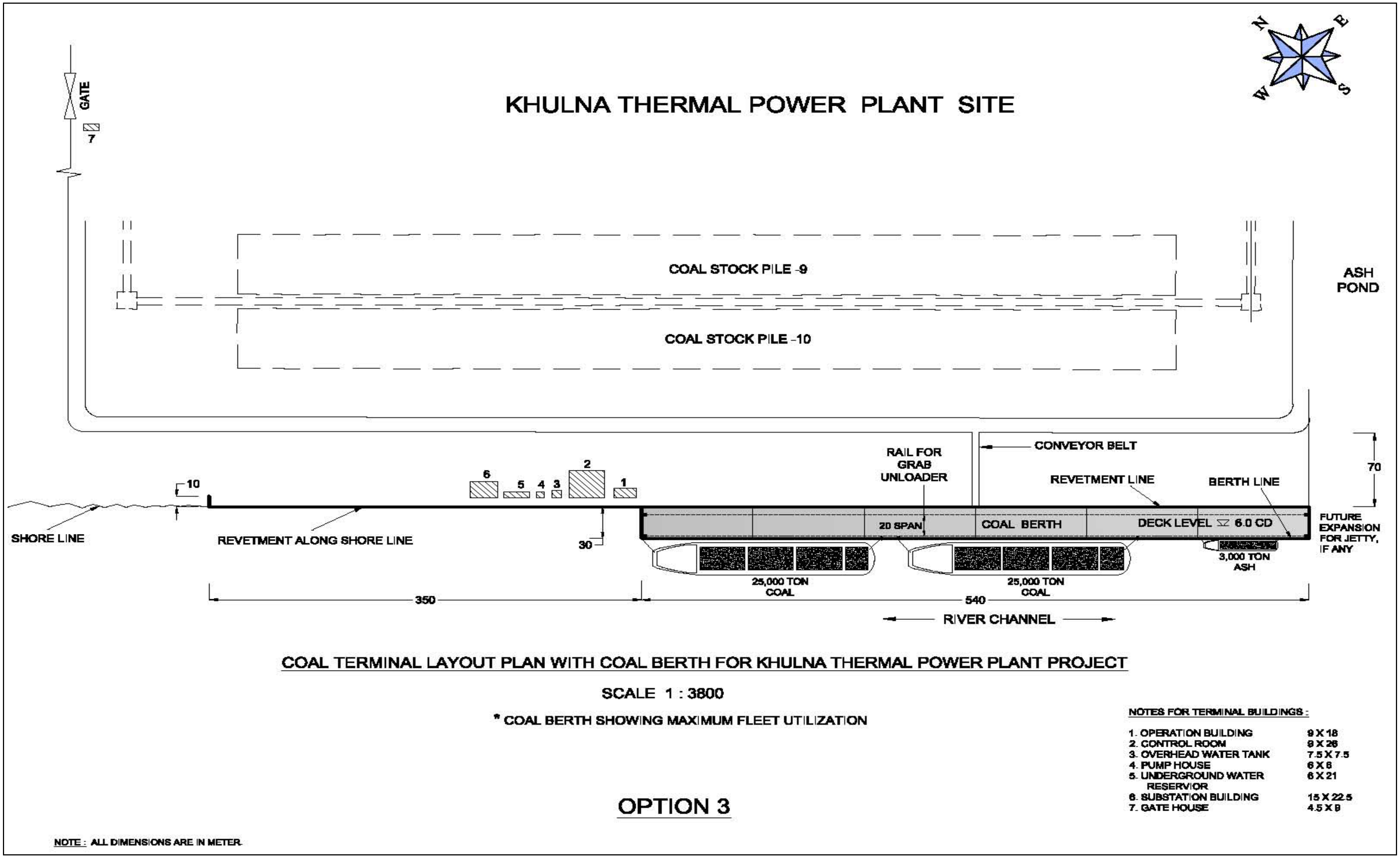


Figure 4: Tentative Layout of Coal Terminal with fleet composition-3

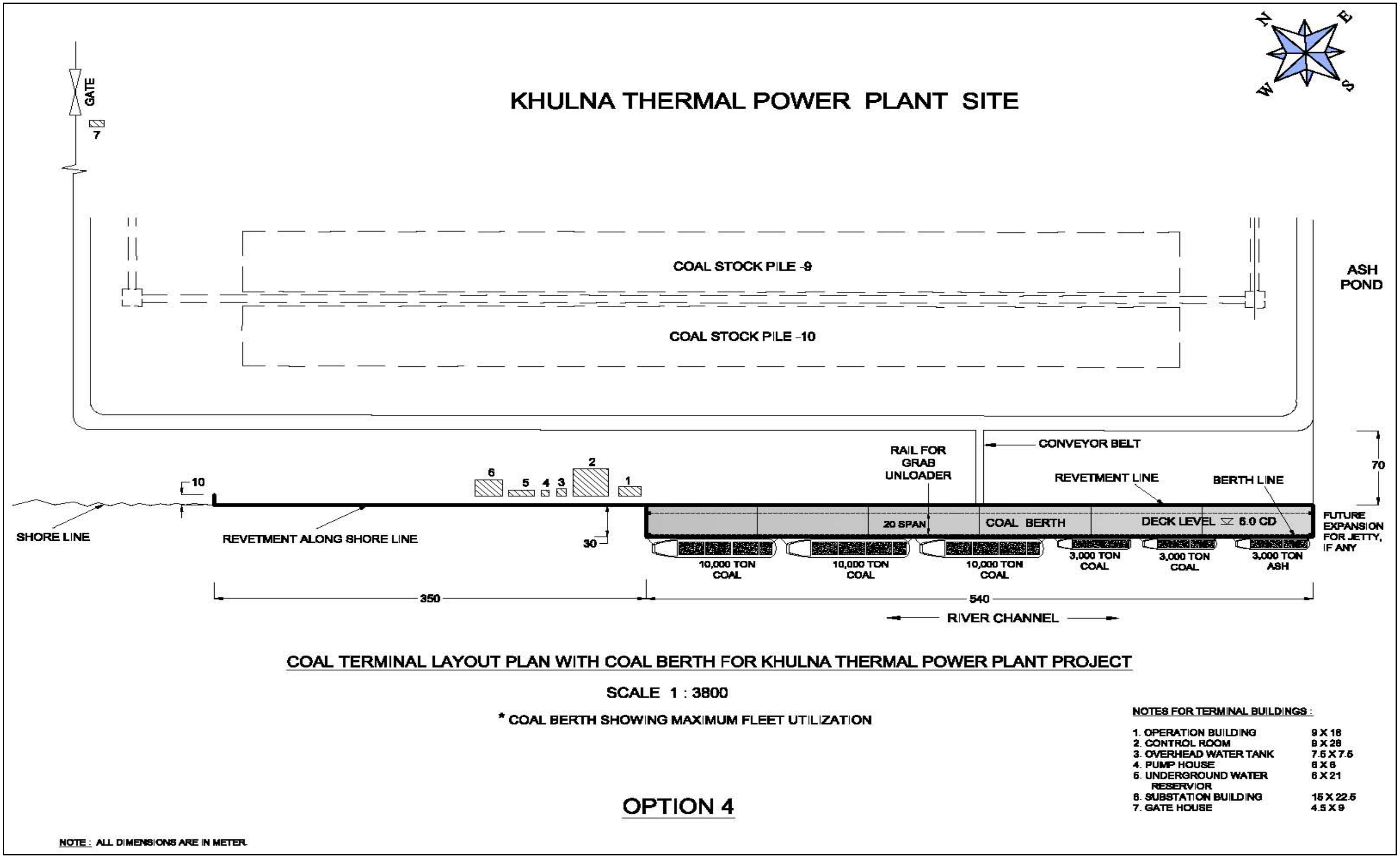


Figure 5: Tentative Layout of Coal Terminal with fleet composition-4

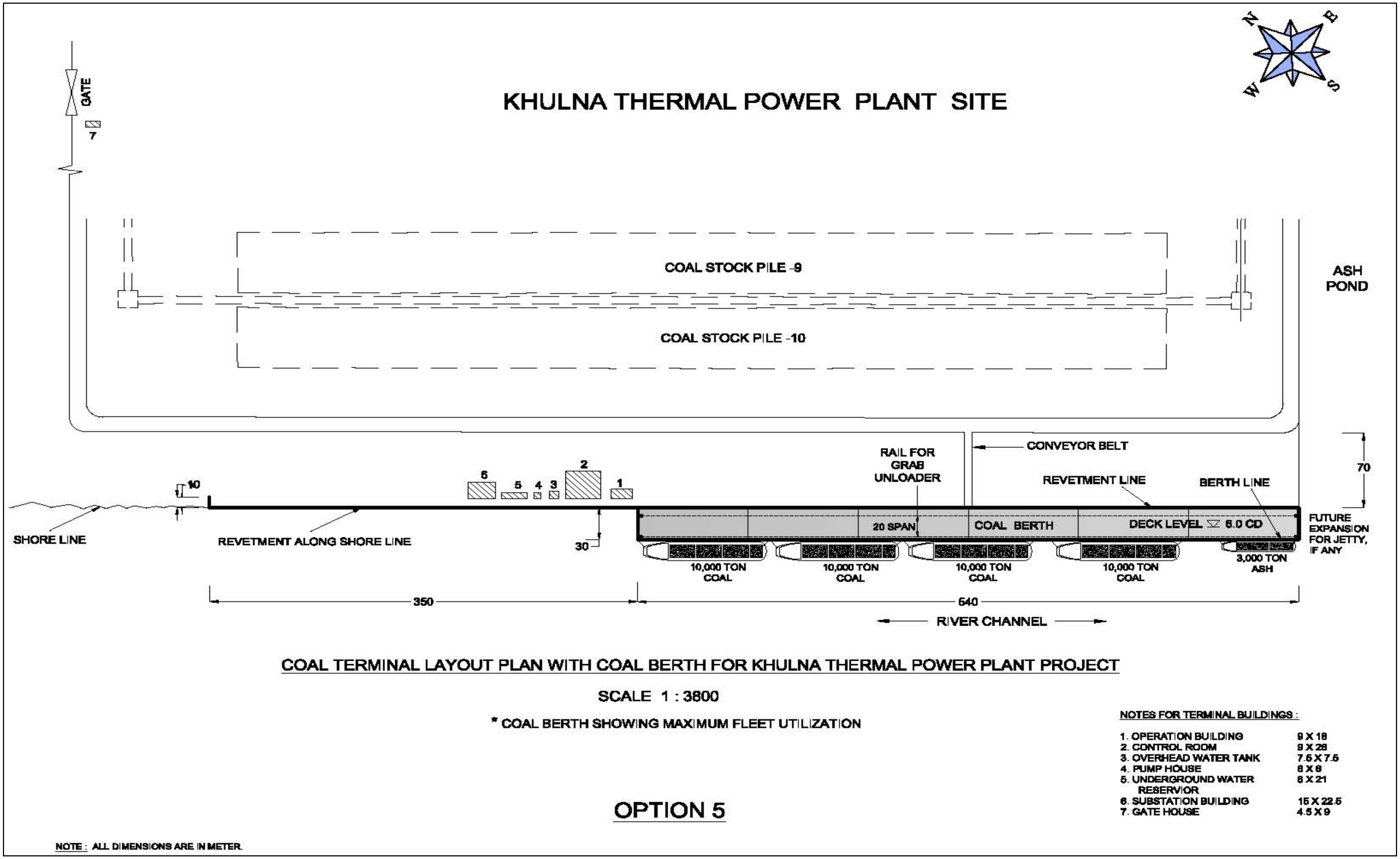


Figure 6: Tentative Layout of Coal Terminal with fleet composition-5

Annex XI: Tentative Layout of Coal Terminal with Different Fleet Composition for Chittagong Thermal Power Plant

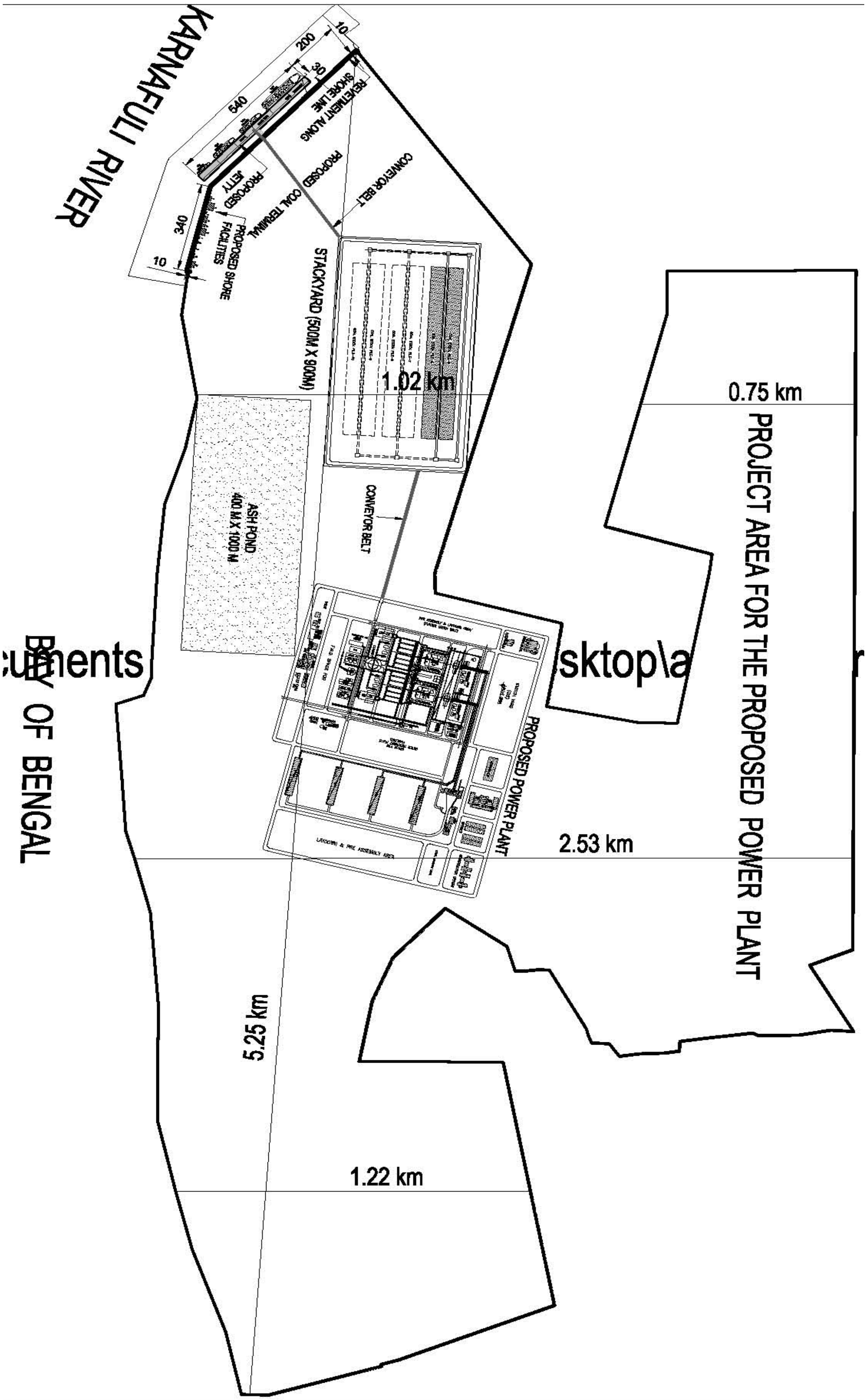
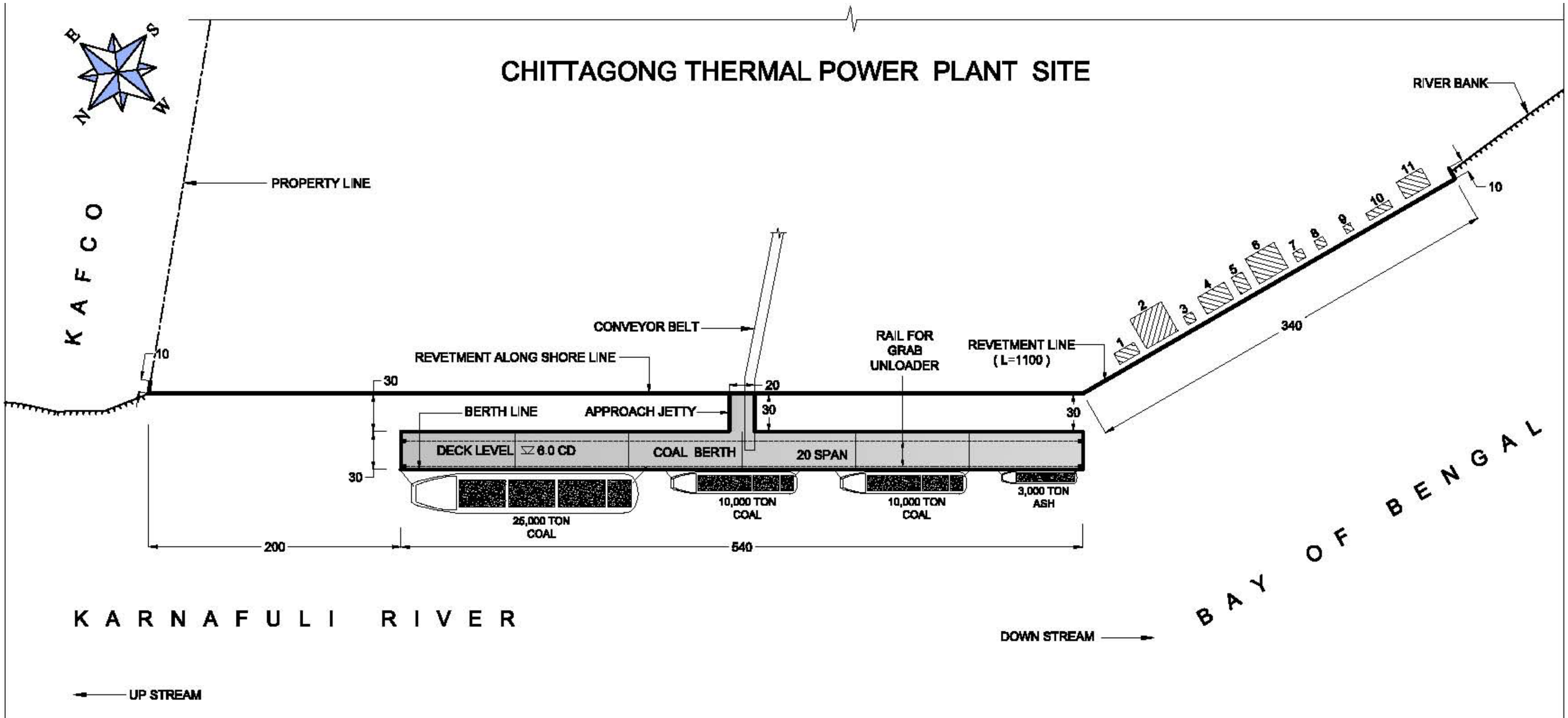


Figure 1: General conceptual layout of the power plant with coal terminal facilities



COAL TERMINAL LAYOUT PLAN WITH COAL BERTH FOR CHITTAGONG THERMAL POWER PLANT PROJECT

SCALE 1 : 3800

* COAL BERTH SHOWING MAXIMUM FLEET UTILIZATION

OPTION 1

NOTES FOR SHORE FACILITIES :

1. OPERATION BUILDING	9 X 18
2. CONTROL ROOM	9 X 26
3. SEWAGE TREATMENT PLANT	7.5 X 7.5
4. CANTEEN BUILDING	15 X 24
5. MAINTENANCE BUILDING	9 X 15
6. MAINTENANCE WORKSHOP	22.5 X 26
7. FIRE STATION	7.5 X 7.5
8. OVERHEAD WATER TANK	7.5 X 7.5
9. PUMP HOUSE	6 X 6
10. UNDERGROUND WATER RESERVOIR	6 X 21
11. SUBSTATION BUILDING	15 X 22.5

NOTE : ALL DIMENSIONS ARE IN METER.

Figure 2: Tentative Layout of Coal Terminal with fleet composition-1

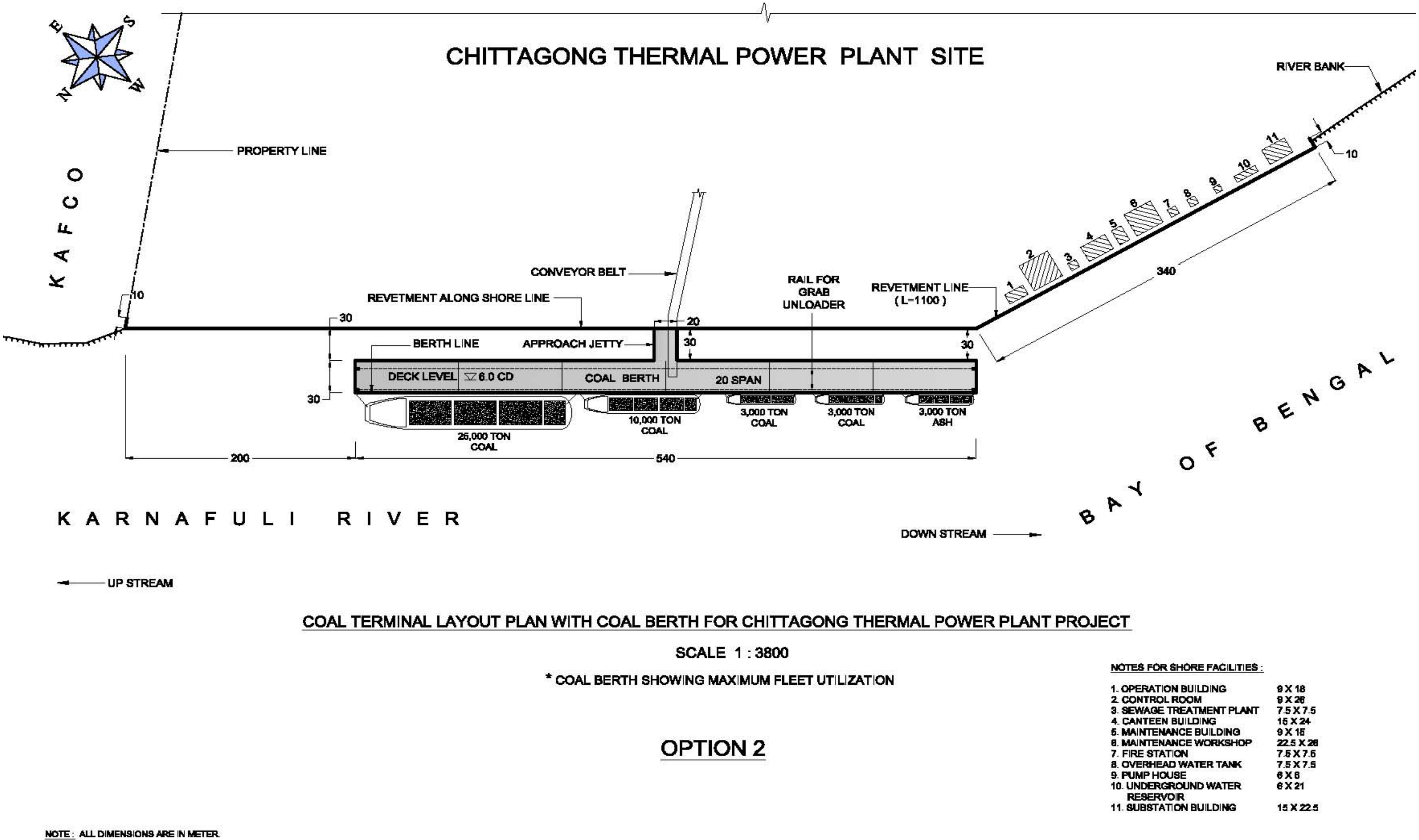


Figure 3: Tentative Layout of Coal Terminal with fleet composition-2

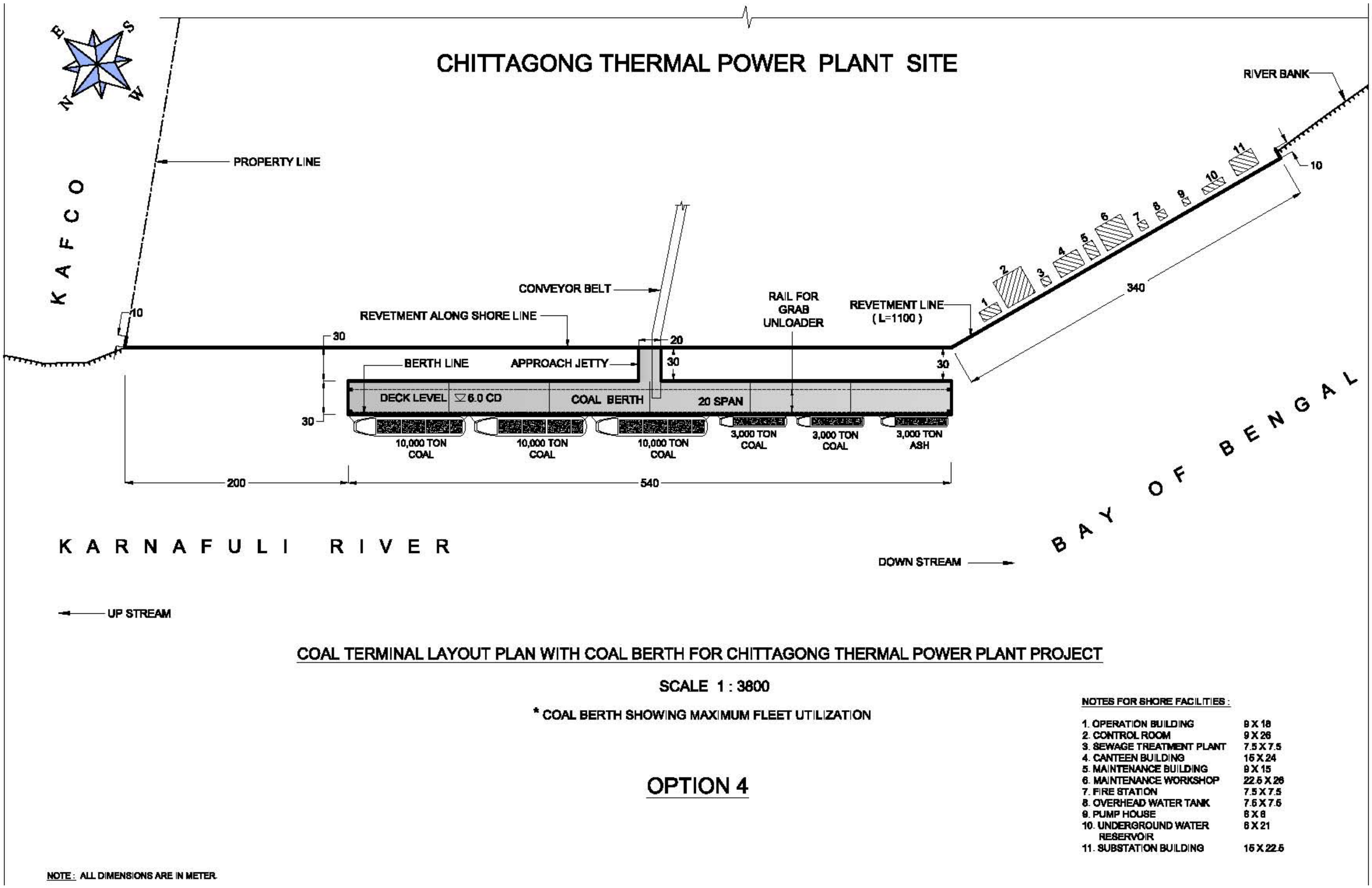


Figure 4: Tentative Layout of Coal Terminal with fleet composition-3

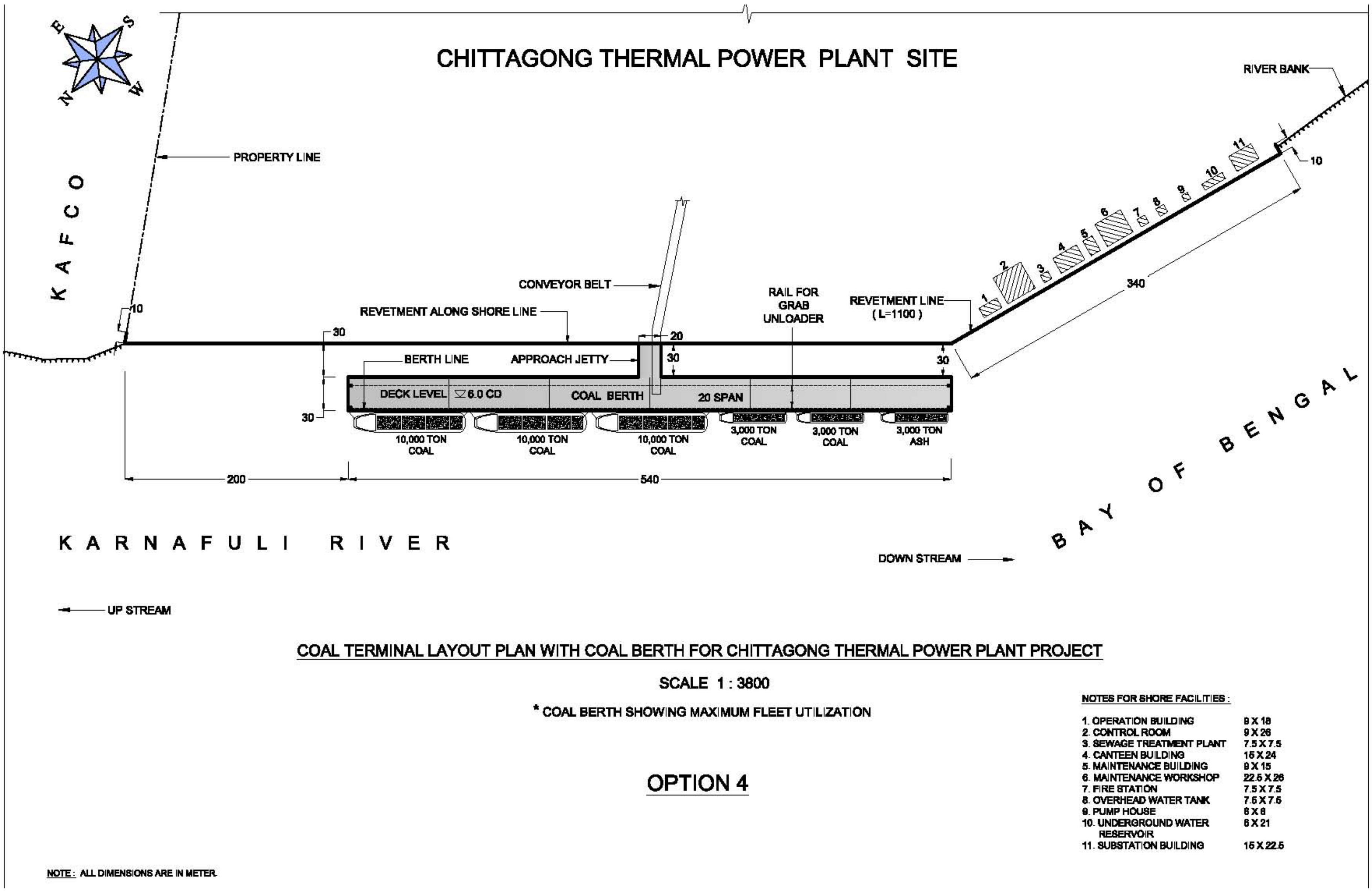


Figure 5: Tentative Layout of Coal Terminal with fleet composition-4

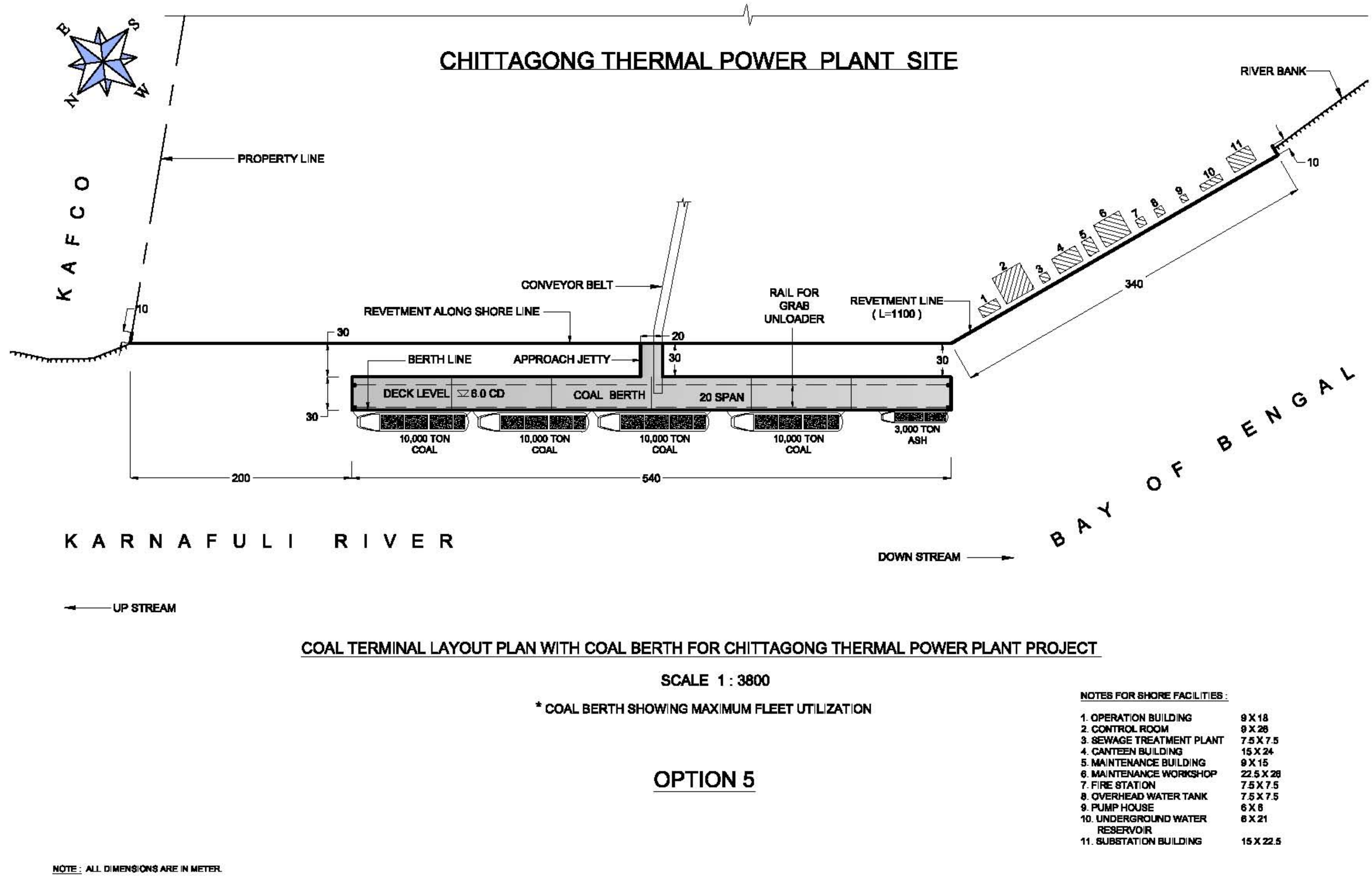


Figure 6: Tentative Layout of Coal Terminal with fleet composition-5

Annex XII: Tentative Layout of Coal Terminal with Different Fleet Composition for Maheshkhali Thermal Power Plant

Figure 1: General Plant Layout with coal terminal facilities

Figure 2: Jetty Configuration: Option-1

Figure 3: Jetty Configuration: Option-2

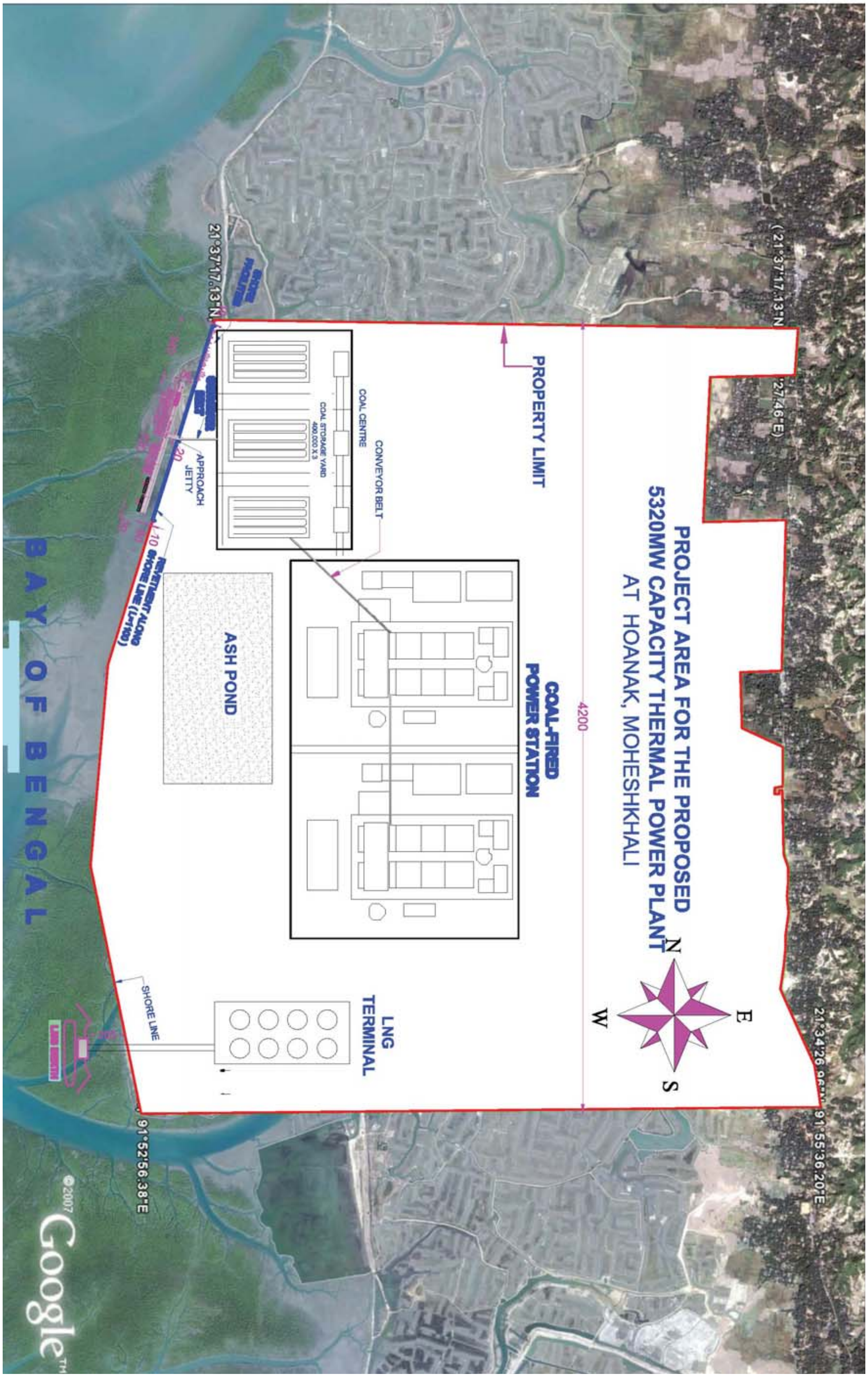


Figure 1: Conceptual general plant layout with Coal Terminal facilities

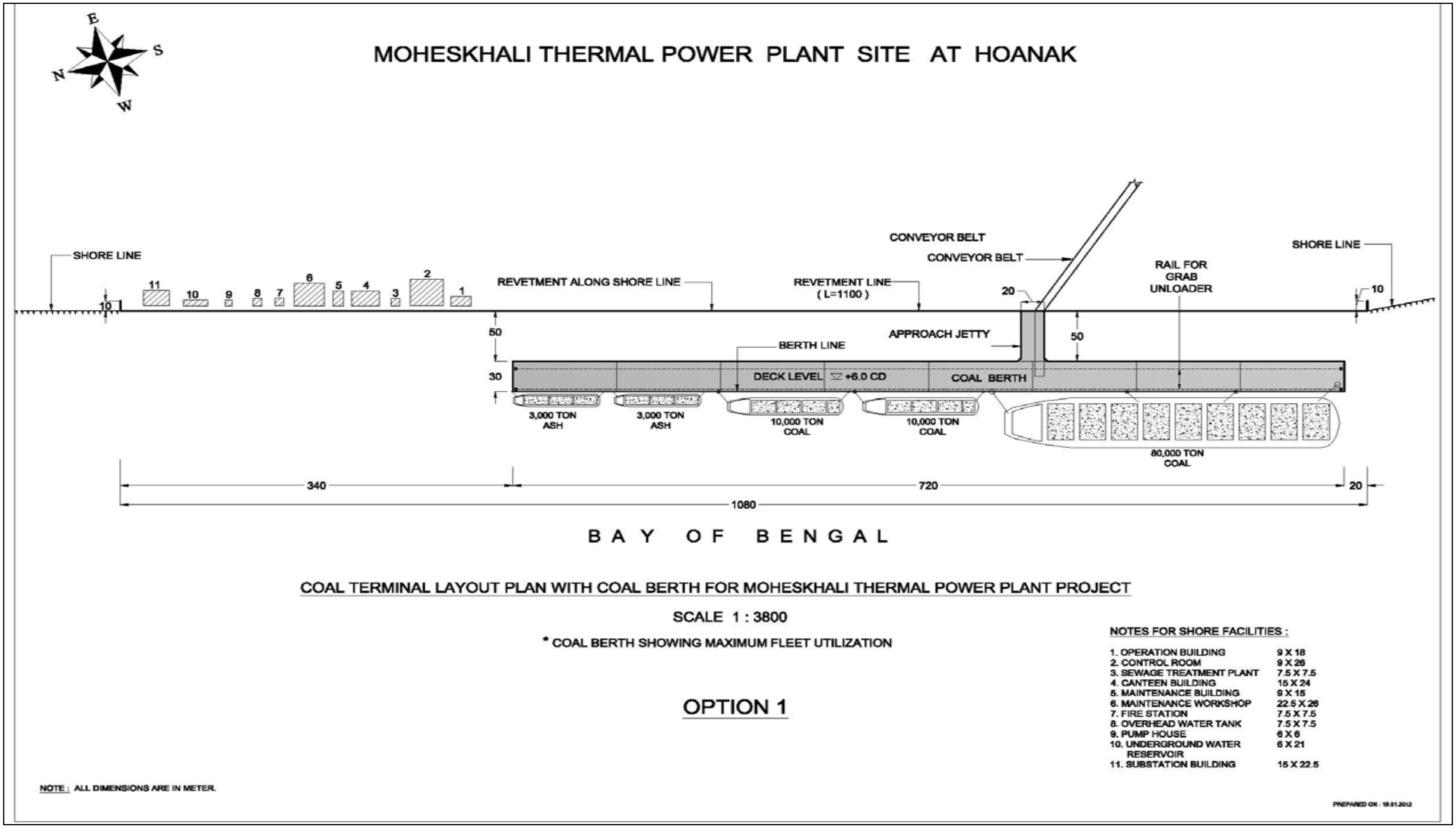


Figure 2: Coal Terminal layout with fleet composition

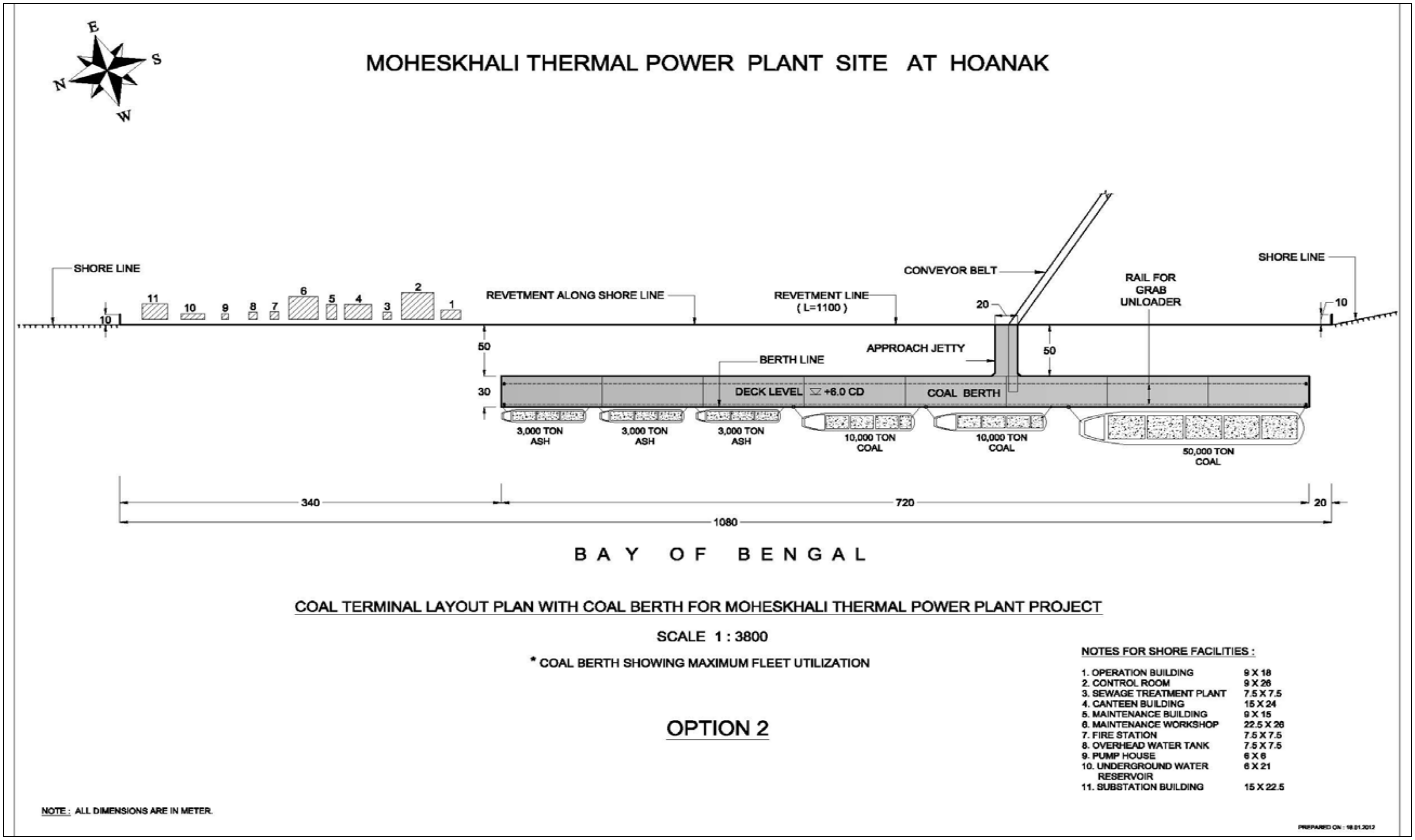


Figure 3: Coal Terminal layout with alternative fleet composition

Annex XIII: Comments and Response Matrix

Annex XIII: Comments and Response Matrix

Serial No	Section/description as enumerated in the final report	Comments	Response
		1. Comments from NTPC	
1.	Comments as given in earlier version not taken care by CEGIS / BPDB, some of them are repeated as below , also no point wise reply to our observations submitted.	a) Forecasting number of days for which literage operation is feasible in year is not indicated. In the report time considered is round the year. With oceanographic data, number of years of operation is to be indicated. b) Details of jetty facilities to be constructed at plant end and its facilities are not indicated	a. Section 10.15 of the DFR and 11.15 of the FR discuss about the numbers of the day for which lighterage operation may not be possible. It has been estimated from the historical data, maximum 35-40 days in a year bad weather condition may disturb or suspend lighterage operation b. Detail of the plant site coal terminal (jetty facilities) has been discussed in section 11.1 and 11.2 of the DFR and 12.1 and 12.2 of the FR.
2.	Observations on revised Draft Report as below		
	a) Executive Summary		
	At sheet (ii)	1. Coal Transportation The report indicates "coal from source country to project site by vessel of 80,000 DWT and then transshipment by shallower vessels of 5000 to 10,000 DWT. A total of 59 voyages will be required each year to transport annual coal requirement of 80,000 DWT from source to Akram point. Further number of mother vessels considered for annual coal requirement as considered are five (5) for coal from Indonesia, eight (8) for South Africa and nine (9) for Australia" It may be noted in the report, at Chapter 9, type of vessels as considered at alternatives not matching with calculations. Also in calculations the number of vessels &	1. The mentioned tables were revised incorporating the name of the alternative plan for better understanding. Bad weather days forecasting for a year is for consideration of coal stockyard requirement. This is extreme case , but voyage planning has been made considering average weather condition . Bad weather considered in voyage planning is only for contingency likely to be occurred during round trip time.

Serial No	Section/description as enumerated in the final report	Comments	Response
		turnaround time along with bad weather days are not matching. Same to be reviewed and checked for correctness.	
	At sheet (iii),	2. Coal Terminal The report indicates size of Jetty as 540 m x 30 m and have considered two numbers grab unloaders of 1000 MTPH capacity. The basis of jetty size is not clear, it may be clarified what shall be the size & number of vessel that will be handled by Jetty to establish the size. Also the basis of capacity of grab unloader of 1000 TPH is not clear. For finalizing the capacity of grab unloader, the unloading time & receipt conveyor capacity needs to be established. Also in the report the capacity of receipt conveyor to plant end have been indicated as 4000 TPH. This may be corrected.	2. The basis of the considerations behind selection of unloading system has been discussed in section 12.2.2 and 12.2.3 of the FR and 11.2.2 and 11.2.3 of the DFR.. Similarly, consideration behind the selection of jetty facilities have been discussed in section 11.4 of the DFR and 12.4 of the FR. The capacity of the conveyor belt from ship unloader to stockyard has been suggested as 4000 TPH considering the future extension (another 1320 MW units) of the project. It is to be noted that the as per discussion with the NTPC, the coal handling system has been written from the feasibility study report of the Khulna TPP.
		3. Scope of study through conveyor system, Rail transportation system, evaluation of landed cost of coal per ton at plant boundary for each proposed coal transportation option along with financial analysis to be elaborated.	3. Coal transportation through conveyor system and rail transportation system have been screened out as the coal terminal has been suggested to construct at plant site. Hence, cost estimation for these two alternatives has not been made. However, cost estimation for conveyor system and rail transportation system were not included in the ToR.
3	Chapter 3: Legislative Framework	1. Relevance of these rules and regulations to the project needs to be highlighted.	The relevance of different rules and regulation mentioned in the said chapters has been discussed

Serial No	Section/description as enumerated in the final report	Comments	Response
			in Table 3.1 of the DFR and FR. In addition, relevancy of each rule/law/policy has also been discussed in the respective sections.
4	Chapter 4: Approach and Methodology	Under approach & Mythology, every sub heads needs to be elaborated with work outs and basis of consideration. CEGIS have written one para under each sub heads.	The approaches and methodologies adopted in carrying out the study have properly discussed providing with adequate information and description in the relevant sub-sections of the Chapter 4.
5	Chapter 5: Stakeholder Consultation	1. Other coal suppliers apart from Sasol Mining (Pty) Limited, SA not explored. Suppliers from other countries should also be explored	1. Stakeholder consultations were made with the coal producers having vast experience and capacity of large volume of export. SASOL is one of the major coal producers in South Africa. Visits have also been made to Australia, Indonesia and Singapore with the aim of exploring coal sourcing opportunity and collecting necessary information. The DFR submitted on May 2012 was prepared incorporating a chapter (chapter 7) experience gathered from international visits. The same has also been included in Chapter 8 of the FR. In addition, a list of potential coal producers/mines has been attached in Annex II.
		2. Opinions & suggestion of Chittagong Port Authority have been listed out. CEGIS, may indentify which of these suggestions needs to be implemented and document to take care of the same.	2. Opinion and suggestion of different stakeholders including Chittagong Port Authority have been reviewed carefully and appropriate opinions and suggestions have been considered during formulating the suggestions and recommendations provided at the end of each chapter and in the Chapter 18

Serial No	Section/description as enumerated in the final report	Comments	Response
			(conclusion and recommendations).
		3. In earlier report as well as in this report transportation through the Passur River considered. Now as alternative Sibsa River considered and no details given either in write up or in map. Kindly clarify.	3. Section 9.1 of the DFR and section 10 of the FR discuss the bathymetry of the Sibsa and the Passur river. Map 10.2 and 10.3 (9.2 and 9.3 in DFR) of the FR shows related maps on river bathymetry.
6	Chapter 6: Potential Coal Sources	1. CEGIS have estimated coal reserves for various mine block in Bangladesh, among which only Barapukuria coal block is presently producing 0.8 m MT of coal and balance mines (Khalashpir, Phulbari, Jamalgonj & Dighipara) are either under techno study or awaiting clearance and projected coal production is about 6 – 7 years. Under such estimation to run 2 x 660 MW Khulna power plant which requires coal of min. 5.4 lac MT per year CGEIS to pin point domestic and international coal source and quantity.	1. Coal resources, reserves, quality, present status have been discussed in the mentioned in Chapter 6 of the DFR and Chapter 7 of the FR as well. 7.2, 7.3 and 7.4 of the FR pin point the scope of using indigenous sources for the proposed power plant. Chapter 9 of the FR discusses about the international sources and section 9.9 to 9.13 are the specific observation, suggestion of the study.
		2. CEGIS have also indicated rail connection from each coal block & Mongla port to plant end. However, the description of railway network and facilities at either end have not been described.	2. Railway network might be used only in case of domestic and Indian sources of coal, which are not available for the proposed plants at present situation. When decision would come for indigenous sources or Indian sources, a detail study may be carried out for evaluation of the railway network and facilities. The ToR of the present study does not cover this.
7	Chapter 7 : Suitable Coal Sources	1. CEGIS have worked out the coal availability at Indonesia, South Africa, Australia, China & India and have indicated per ton cost for each grade of coal. The cost of coal is as per the available price in the respective country	1. Cost of coal including transportation and port handling has been estimated separately in section 9.11, and 11.12 and finally summed up in section 15.1 of FR. The same has also been discussed in Chapter 8, 10 and 14 of the DFR. 2. In the DFR, landed cost has been estimated for

Serial No	Section/description as enumerated in the final report	Comments	Response
		however, the workout cost for per ton including handling, transporting etc has not been worked out. 2. CEGIS may work out the landed per ton cost at plant end for each quality of coal and recommend the best option available. 3. Cost study for domestic coal with respect to road/rail and Conveyor transportation to plant end may also be worked out. 4. Under Cl. 7.4, it is stated "Inter governmental dialogue may be made to arrive a special coal supply contract with India". It may be clarified as to what is the source of coal in India and its specification / price to meet the plant requirement.	different quality of coal. And in the FR (section 11.12 and 15.1), landed cost (CIF) has been estimated for different sources of coal and adjusted to the same quality for better understanding and comparison following the discussion made in different meeting with BPDB. 3. As per the ToR, cost estimation has been made for potential coal sources. At present situation, domestic sources are not in position to supply coal for the proposed power plant. 4. The study states that at present, India being one of the large coal importers, export very little and low grade coal only to its neighbor country (including Bangladesh). Only, considering the relationship with India, GOB may approach to India for coal sourcing. The price, quality, quantity would be defined as per the inter-governmental dialogue.
8	Chapter 9: Coal Transportation	1. CEGIS have described different type of vessels and have given various Alternatives for handling different vessels along with its merits & demerits. CEGIS have suggested Alternative-I, however, as per Alt-I, China max vessel of 3,80,000 tons DWT considered which have more demerit than merit. Also in various calculations for turnaround time & vessels, this size vessels not considered. Max. size considered as 80,000 DWT. Also number of bad days are only 1, which may not be correct. CEGIS may correctly select the suitable alternative.	1. Screening of alternative plans have been carried at two steps, Cost estimations have been carried out for the alternative plans remains after first screening. The Alt.-I was screened out at first steps. The number of the Bad day considered in voyage planning was to address the contingency and regular bad weather event may happen during a single trip time. This bad weather does not mean the extreme weather event.

Serial No	Section/description as enumerated in the final report	Comments	Response
		2. Various alternatives for selection of smaller vessel CEGIS may review the same as the calculations / selections are not clear.	2. For better understanding the tables showing different calculation have been revised mentioning different vessel types and alternatives clearly.
		3. During presenting alternatives, CEGIS have indicated new anchorage locations Viz, Harbaria Anchorage, this is also not clear from the report regarding locations.	3. Harbaria Anchorage is not any new location, at present most of the mother vessels (handysize vessel) coming to Mongla Port anchor at Harbaria taking tidal advantage. Map 11.6 of the FR (10.6 of DFR) may be referred to find the location of the Harbaria Anchorage.
		4. CEGIS may also elaborate the transshipment method for unloading coal onto shallow water draught vessel.	4. Section 11.8.1 of FR discusses about the method of ship-to-ship transfer.
		5. The anchoring points of trans shipper and shallow water draught vessels to be clearly indicated with the traffic already at Mongla Port.	5. In the sections 11.5.2 and 11.6.1 of the FR suggests Akrampoint as an anchorage location for Mother vessels and trans-shipper for Khulna TPP, Alfa anchorage of Chittagong Port Authority for Chittagong TPP considering existing traffic of the ports. Map 11.6 and 11.7. show the tentative anchorage location.
		6. A traffic study round the year for various vessels movement in Mongla port to be elaborated.	6. Traffic study is not covered under the ToR of this study.
		7. At 9.9, under Cost estimation, CEGIS have not estimated any cost under respective heads, CEGIS to include costing for each sub heads indentified to establish the total cost.	7. Chapter 15 lists down all estimated cost under different heads.
		8. At sl. 9.15, Coal transshipment by Rail; CEGIS have indicated coal shall be	8. The mentioned section pointed out the means of existing rail network from the region of

Serial No	Section/description as enumerated in the final report	Comments	Response
		transported from Phulbari Coal Mine to project site by Rail. It is also indicated that the rail infrastructure is to be established. It may be noted that at Chapter 6, Potential Coal Sources, CEGIS have indicated that appropriate decision needed for earliest development of coal deposit and at Sl. No. 6.1.3, have indicated "only Barapukaria Coal Mine has been developed which produce around one million MT of coal per year".	Barapukuria Coal Mine, Phulbari Coal Deposits, and other northern coal deposits to the project site just for giving information to indicate future potential. This rail network may be useful in case of sourcing coal from the northern part of the country as well as India (nearby sources) when coal will be available in that area. The study suggests, in parallel to coal import, development of indigenous coal should also be considered for future.
		9. CEGIS have also considered all five mines which shall be developed in next 6 – 7 years for coal generations, Rail linkage from these mines to plant may also be explored for future.	9. Further study may be carried out for this purpose as the ToR of the present study does not cover this.
		10. At Sl. No. 9.15.1 & 9.15.2, CEGIS to elaborate the rail transshipment plan from Mongla port to the plant area which needs to be implemented and same shall be executed by whom along with cost / clearance etc.	10. Within the scope of this study, existing rail transportation system from indigenous sources to the proposed power plants has been described. At present, Bangladesh Railway has a plan of installing rail line between Khulna to Mongla port. As such, a side line from Mongla –Khulna rail line to the project site needs to be constructed in case of coal from indigenous sources.
9	Chapter 10 : Coal Terminal	1. CEGIS, to describe the navigational route and what all facilities required along the route from Mongla port to plant end.	1. Section 11.16 and 11.17 discusses about the other navigational facilities (Pilotage services, aids to navigation, etc).

Serial No	Section/description as enumerated in the final report	Comments	Response
		2. At proposed jetty at plant end, CEGIS, to describe how number of small vessels received is handled and how many are unloaded at a time.	2. Section 12.4 discusses about the consideration of numbers of vessel numbers to be received and number of vessel to be unloaded at a time.
		3. CEGIS to include Bathymetric survey for round the year.	3. BIWTA, MPA, and Bangladesh Navy carry out bathymetry survey periodically (once in 5 year)/yearly as per requirement. No round year bathymetric survey data is available.
		4. At sl. No. 10.1.6, CEGIS to work out and indicate following : a) Annual Cargo through put b) Vessel fleet and its composition c) Unloading rates of coal in conjunction of grab unloaders d) Vessels turnaround time e) The terminal operation days in a year. Jetty configuration	4. Vessel fleet and its composition, unloading rate in conjunction of grab unloader and daily operation hour for terminal, etc have been discussed in Chapter 12. Further detail may be carry out after detail design of the project.
		5. CEGIS to incorporate details of facilities and equipment which shall be required at Jetty end.	5. The facilities and equipment required at berth, shoreline and at terminal have been identified and discussed in section 12.1, 12.2, 12.3, and 12.4.
		6. It may be noted that Stacker Reclaimers shall be provided at Plant end and no stock shall be kept at jetty end.	6. The final layout of the jetty has been designed considering stockyard at plant end.
10	Chapter 11: Coal Handling System	CEGIS may describe the coal handling system in the jetty area, for Coal transportation from Jetty area to plant end and handling of coal inside power plant a brief write-up along with various equipment have been prepared and	The FR has been prepared incorporating the coal handling system provided by NTPC

Serial No	Section/description as enumerated in the final report	Comments	Response
		handed over to BPDB, same may be incorporated	
11	Chapter 12: Ash Handling and Utilization	Industries in the vicinity of the plant that may be interested in long term tie for supply of fly ash have not been identified. This is necessary for ensuring 100% utilization of ash.	The cement factories of Bangladesh are interested to buy ash from the plant. Identification of users including industries interested in long term tie for supply of ash may be carry out during implementation of the project. Within the present scope of the study, all potential sectors of ash utilization e.g cement production, brick manufacturing, embankment construction, land reclamation, etc. have been identified.
12	Chapter 13: Environmental Impact of Coal Transportation	Relevant laws and regulations need to be outlined along with the environmental acceptance limits for pollutants in air, water, noise etc. as per law	All relevant rules and regulation are discussed in Chapter 3. It is to be mentioned here that, for environmental aspect a detail study is being carry under EIA. The scope of the coal sourcing study covers addressing of all relevant environment issues only
13	Other observations	1. Include plant layout along with jetty near plant boundary as given by BPDB.	Annex X, XI and XII of the FR contain drawings showing plant layout and jetty location.
		2. CEGIS may incorporate location of jetty near plant and incorporate actual co-ordinate.	Map 11.1, 11.2 and 11.3 of FR give location of coal terminal with actual co-ordinate.
14	**Comments from Director, Design and Inspection-1, BPDB**		
		In the draft final report, coal price of the three coal sources Indonesia, South Africa and Australia has been given. But in the cost calculation per ton for coal transportation,	All cost have been estimated based on present market price. For charterage rate, yearly average rate (index rate) of last 11 years have been considered

Serial No	Section/description as enumerated in the final report	Comments	Response
		Charter cost, one off or long term is not mentioned	
15	Comments from Director, Design and Inspection-3, BPDB		
	Bathymetric map of Sibsa-Passur River	1. Some of the Hydrographic chart of the Sibsa River are incomplete which is needed to be completed with the help of Bangladesh Navy Authority. The report is necessary to identify which way is more useful in between the Passur and the Sibsa river.	Finally, the study suggests the Passur River route for transportation of coal for Khulna TPP considering allowable draught, length and beam of the vessel. If BPDB plans to consider Sibsa as an alternative route in case of any adverse situation, then further study may be carry out in future.
		2. Whenever the Sibsa river way is accepted then again the road way might be required. But if the Passur river is used then they have to pass the Mongla port, where the section 3-3 and 4-4 of the Passur river is quite narrow. For this part suggestion from the consultant need to be cleared.	No land transportation shall be necessary in case of Sibsa route. The study examined the issue of allowable beam and length of vessel in case of the Passur and Sibsa and finds the Passur River suitable for transportation of coal by the suggested vessels for the proposed power plants.
	Bathymetric map of Chittagong Cost	Required permissible draught and width are available	As per the recent bathymetric survey data of the Chittagong Coast and the Karnakhuli River, the permissible draught and width satisfy requirement of the Project
	Bathymetric map of Mahesh Khali Cost	The survey report of the Adjacent Sea has been done in January 2010. That report should be collected if the survey is updated.	The study has incorporated the available recent survey data (2010).
		The Bathymetry Survey Reports which have been prepared very recently, should be collected. The maximum and minimum draught might be adjusted with the hourly tide level for 24 hour considering the tidal behavior of the river.	The study has incorporated the available recent survey data (2010). Section 10.7 gives the anticipated and observed tidal data for the Chittagong-Maheshkhali coast and the Passur River. In addition Annex XIV contains, anticipated tide table published by CPA and anticipated max permissible draught published

Serial No	Section/description as enumerated in the final report	Comments	Response
			by MPA.
16	**Comments from the consultant, BPDB**		
	In article 5.1 , at page 32 of chapter 5	One participant Mr. Abul Kalam Azad, Secretary will be from power division not water division.	Corrected in the FR.
	In article 5.4.2, at page 33 of chapter 5	South Africa coal mining productivity shown 6500 Tones/ year where correction in necessary.	The correct figure would be 6500 tones/Man-Year. Corrected in the FR
	In article 9.10, at page 86 of chapter 9	Days should be mentioned for the round trip	Mentioned in the FR
	In article 9.10, at page 86 of chapter 9	No of round trip will be col-3/col-2, to be corrected.	The table has been revised in the FR
	In article 9.10, at page 86 of chapter 9	No of voyage in a year will be col-4xcol-6	The table has been revised in the FR
	In article 9.11, at page 87 of chapter 9	Mother vessel position to the site distance, such as word position was not understand	The table has been revised in the FR
	In article 9.12, at page 88 of chapter 9	Unit of time for a round trip was not mentioned	The table has been revised in the FR
	In article 9.12, at page 88 of chapter 9	Akram point anchorage to project site through Sibsa and Passur river and Harbaria anchorage to project site. Map is required showing these three routes.	Map 11.6 of the FR shows the coal transportation route.
	In article 7.1.14 & 7.3, at page 50 of chapter 7&9	Khulna coal based power plant will run for 30 years but prediction of coal cost for the said period not mentioned. Costs of coal interns of \$/Gj or cents? MMBTU may also be provided.	Energy price is unpredictable. It is not possible to predict coal price for the next 30 years. The cost mentioned in the report is for feasibility study only. Coal cost has been estimated for per ton. In addition, Table 15.1 shows the cost per million

Serial No	Section/description as enumerated in the final report	Comments	Response
			kcal.
	In article 7.4, at page 52 of chapter 7	Fig 7.3 and 7.4 show sales from 1996-2025 with future estimation since no future estimation is available.	these figures are not available in the report
	In article 9.15.9, at page 102 of chapter 9	Insert unit between the word thousand and coal.	corrected in the FR
17	**Comments of System Planning, BPDB**		
		Clause 1.1> 6'"line> "(At present, 47% of the total population of Bangladesh has access to electricity but reliable and quality supply of power is still a far away should be replaced by at present 50% of the .... away).	Corrected in the FR
		Clause 1.1> 8'n line> "(To meet up these, the Government of Bangladesh has formulated a Power System Master Plan (PSMP) should be replaced by Power Svstem Master Plan 2010 (PSMP 2010).	Corrected in the FR
		Table 5.1> "(Temperature of flue gas at stack-Design condition 140" temperature may be replaced by 140°c). This temperature seems too high regarding plant efficiency.	Corrected in the FR
		Clause 2.3> 8th line> "(The basin plant information is given in following table should be replaced by basic plant information .... table).	Correction in the FR
		Table 3.1> "(Coal Sourcing-Master Plan on Coal Power Development, 2010 may be replaced by Power System Master Plan 2010)".	Corrected in the FR

Serial No	Section/description as enumerated in the final report	Comments	Response
		Clause 5.3 > 3rd line > "(carried out under Power System Master Plan)" may be removed.	Corrected in the FR
		Table 5.1> Misspelling of Ministry name and wrong designation for Secretary.	Corrected in the FR
		Clause 5.4.2>11th line> annual coal mining productivity for South Africa 6500 tonnes/year seems too low. Should be checked.	The figure would be 6500 ton/Man-year. The same has been corrected in the FR
		Clause 6.1.1 > 7th line> Mentions carbon content of Sub-bituminous coals to be up to 10% which needs to be corrected.	Corrected in the FR
		Clause 7.3.2> 2nd line>The term may be "Reserve to Production (RP)" not "Reserve to Prove" and need further checking.	Corrected in the FR
		Coal market is quite volatile. No prediction has been made for future prices of coal, which is very important for the Khulna plant having a life time around 30 years. Same goes for transportation costs. Map 8.1 > important points like Akram point, Harbaria etc. may be demarcated on the Map for better understanding.	Coal Price is unpredictable. Besides, price forecasting is beyond the scope of the ToR Corrected in the Final Report

Annex XIV: Anticipated Permission Draughts Published by Mongla Port Authority and Chittagong Port Auhtority

MONGLA PORT AUTHORITY(BANGLADESH)
ANTICIPATED PERMISSIBLE DRAUGHTS OF PUSSUR RIVER (PART – 1)
FOR THE MONTH OF JANUARY TO JUNE , 2012.
(FROM FAIRWAY BUOY TO BASE CREEK).

(IN METRES)

	D R A		U		G		H		T		S		
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
1	0004	7.89	0043	7.39	-------	------	0211	7.42	0258	7.66	0428	8.29	1
	1300	7.77	1417	7.48	1258	7.48	1513	7.73	1519	7.84	1640	8.12	
2	0054	7.72	0219	7.24	0053	7.24	0356	7.59	0409	7.89	0525	8.46	2
	1408	7.72	1559	7.52	1450	7.45	1622	7.89	1622	7.96	1739	8.21	
3	0204	7.56	0417	7.26	0318	7.21	0459	7.84	0505	8.13	0615	8.60	3
	1531	7.73	1716	7.68	1623	7.59	1715	8.07	1716	8.09	1832	8.30	
4	0331	7.50	0534	7.41	0452	7.39	0546	8.11	0553	8.34	0702	8.69	4
	1650	7.83	1802	7.85	1721	7.79	1758	8.24	1804	8.20	1921	8.35	
5	0500	7.54	0617	7.58	0544	7.62	0627	8.34	0636	8.51	0747	8.72	5
	1744	7.95	1839	8.01	1803	7.98	1838	8.36	1849	8.28	2010	8.36	
6	0557	7.65	0654	7.75	0624	7.85	0704	8.52	0718	8.61	0834	8.69	6
	1824	8.08	1913	8.13	1840	8.14	1915	8.45	1935	8.32	2100	8.31	
7	0636	7.75	0728	7.89	0700	8.06	0741	8.64	0802	8.63	0921	8.61	7
	1859	8.17	1945	8.22	1914	8.26	1955	8.48	2022	8.30	2149	8.23	
8	0711	7.84	0801	8.00	0734	8.22	0821	8.67	0848	8.58	1008	8.49	8
	1932	8.24	2015	8.27	1946	8.33	2037	8.44	2111	8.20	2239	8.12	
9	0745	7.91	0833	8.08	0808	8.33	0904	8.61	0937	8.46	1054	8.35	9
	2004	8.29	2045	8.28	2019	8.36	2123	8.32	2203	8.06	2331	8.02	
10	0817	7.96	0907	8.12	0844	8.38	0951	8.48	1028	8.30	1141	8.21	10
	2035	8.31	2118	8.24	2057	8.31	2211	8.14	2258	7.90	--------	------	
11	0850	8.00	0944	8.11	0923	8.34	1041	8.30	1122	8.14	0026	7.95	11
	2105	8.30	2155	8.15	2137	8.20	2304	7.94	2359	7.77	1232	8.07	
12	0925	8.01	1025	8.04	1006	8.23	1139	8.11	------	------	0128	7.92	12
	2137	8.26	2234	8.00	2220	8.03	--------	-------	1222	7.99	1330	7.95	
13	1003	8.01	1110	7.93	1053	8.06	0011	7.75	0111	7.69	0238	7.93	13
	2214	8.19	2317	7.81	2306	7.81	1252	7.96	1329	7.89	1437	7.87	
14	1046	7.98	---------	------	1150	7.87	0141	7.65	0232	7.70	0349	8.01	14
	2254	8.08	1205	7.78	-------	------	1417	7.90	1440	7.84	1548	7.86	
15	1133	7.92	0009	7.59	0007	7.58	0320	7.70	0349	7.81	0449	8.12	15
	2338	7.93	1325	7.64	1311	7.72	1540	7.94	1551	7.85	1655	7.92	
16	---------	-------	0147	7.39	0151	7.42	0438	7.87	0449	7.96	0535	8.25	16
	1230	7.84	1514	7.63	1453	7.69	1648	8.04	1653	7.90	1744	8.00	

Contd........2

PART - 1 (IN METRES)

DRAUGHTS													
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
17	0032	7.74	0356	7.38	0349	7.47	0532	8.06	0535	8.10	0612	8.36	17
	1349	7.77	1648	7.77	1623	7.81	1740	8.14	1741	7.97	1821	8.09	
18	0158	7.56	0526	7.54	0510	7.66	0612	8.22	0611	8.23	0644	8.44	18
	1527	7.78	1753	7.95	1728	7.97	1820	8.22	1818	8.04	1854	8.16	
19	0349	7.51	0622	7.73	0602	7.86	0645	8.35	0641	8.33	0714	8.50	19
	1656	7.91	1839	8.09	1815	8.10	1852	8.28	1848	8.10	1926	8.21	
20	0525	7.61	0703	7.87	0642	8.02	0712	8.44	0707	8.39	0746	8.53	20
	1802	8.06	1916	8.18	1852	8.19	1918	8.31	1915	8.14	1957	8.24	
21	0627	7.76	0737	7.98	0714	8.14	0735	8.50	0734	8.43	0816	8.54	21
	1851	8.19	1948	8.23	1923	8.24	1942	8.33	1945	8.15	2030	8.25	
22	0713	7.87	0808	8.05	0742	8.23	0758	8.53	0804	8.43	0847	8.53	22
	1931	8.27	2017	8.24	1949	8.26	2009	8.32	2016	8.14	2104	8.24	
23	0752	7.96	0836	8.09	0806	8.29	0826	8.52	0835	8.41	0921	8.50	23
	2006	8.31	2043	8.22	2012	8.25	2039	8.28	2048	8.11	2143	8.22	
24	0827	8.00	0902	8.11	0828	8.31	0858	8.48	0908	8.37	0959	8.45	24
	2040	8.31	2109	8.17	2037	8.22	2110	8.21	2122	8.05	2227	8.20	
25	0901	8.02	0929	8.10	0855	8.31	0930	8.40	0942	8.31	1042	8.38	25
	2112	8.28	2137	8.09	2106	8.16	2142	8.11	2201	7.99	2317	8.18	
26	0934	8.02	0959	8.05	0926	8.25	1005	8.31	1022	8.25	1130	8.29	26
	2142	8.21	2208	7.97	2137	8.06	2218	8.00	2247	7.94	-------	------	
27	1006	7.99	1034	7.94	0959	8.15	1045	8.20	1109	8.18	0013	8.16	27
	2212	8.11	2240	7.81	2208	7.93	2303	7.89	2342	7.90	1224	8.19	
28	1039	7.93	1111	7.80	1033	8.02	1134	8.10	-------	-------	0121	8.16	28
	2243	7.97	2311	7.62	2240	7.77	------	-------	1202	8.10	1333	8.08	
29	1116	7.84	1154	7.63	1112	7.87	0002	7.80	0047	7.90	0243	8.20	29
	2317	7.80	2348	7.42	2320	7.61	1238	8.03	1306	8.04	1458	8.03	
30	1159	7.71			------	-------	0123	7.79	0205	7.97	0400	8.31	30
	2355	7.59			1205	7.74	1400	8.02	1421	8.01	1617	8.07	
31	-------	-----			0021	7.47			0323	8.12			31
	1253	7.57			1330	7.66			1535	8.05			

NOTE : 1) ALL INCOMING AND OUTGOING VESSELS WILL NEED TO REACH FAIRWAY BUOY AND HIRAN POINT RESPECTIVELY ON OR BEFORE THE TIME SHOWN ABOVE.
2) THE PERMISSIBLE DRAUGHTS FOR P P JETTIES AND OTHER JETTIES (FACTORIES) WILL BE CONSIDERED AS PER THE DECLARED DRAUGHT FROM TIME TO TIME.
3) THE DECLARED DRAUGHTS MAY BE REDUCED OR INCREASED IF SITUATION COMPEL.

M ENAMUL HAQUE
COMMANDER BN
HARBOUR MASTER

MONGLA PORT AUTHORITY(BANGLADESH)
ANTICIPATED PERMISSIBLE DRAUGHTS OF PUSSUR RIVER (PART – 11)
FOR THE MONTH OF JANUARY TO JUNE , 2012.
(FROM BASE CREEK TO MB – 1 BUOY).

(IN METRES)

D R A U G H T S													
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
1	0550	7.24	0618	6.84	0533	6.87	0801	6.65	0841	7.17	1007	7.84	1
	1841	7.26	1927	7.03	1818	7.06	2105	7.08	2116	7.44	2233	7.77	
2	0641	7.08	0748	6.58	0635	6.59	0944	6.83	0955	7.40	1101	7.96	2
	1937	7.20	2116	6.99	2021	6.90	2217	7.26	2219	7.58	2324	7.81	
3	0756	6.91	0952	6.57	0908	6.47	1055	7.12	1055	7.63	1145	8.04	3
	2044	7.19	2237	7.10	2201	7.00	2311	7.43	2309	7.68	------	------	
4	0915	6.83	1111	6.72	1038	6.68	1148	7.39	1143	7.81	0012	7.83	4
	2153	7.23	2342	7.25	2308	7.19	2354	7.55	2352	7.74	1224	8.09	
5	1024	6.84	------	------	1142	6.96	------	------	-------	-----	0059	7.85	5
	2259	7.32	1210	6.93	2357	7.36	1230	7.59	1222	7.93	1305	8.10	
6	1127	6.93	0029	7.36	1228	7.20	0031	7.63	0034	7.77	0149	7.84	6
	2356	7.41	1252	7.11	0035	7.47	1308	7.74	1258	8.01	1353	8.07	
7	------	-----	0104	7.43	1306	7.40	0107	7.68	0119	7.78	0241	7.81	7
	1219	7.04	1327	7.28	0108	7.54	1345	7.84	1339	8.03	1446	8.02	
8	0040	7.46	0134	7.49	1342	7.55	0149	7.68	0210	7.75	0331	7.76	8
	1300	7.16	1402	7.42	0141	7.60	1425	7.88	1426	8.01	1539	7.95	
9	0113	7.49	0205	7.55	1419	7.66	0236	7.64	0300	7.69	0421	7.69	9
	1336	7.27	1441	7.53	0220	7.61	1507	7.87	1514	7.96	1633	7.88	
10	0143	7.52	0243	7.57	-------	-----	0323	7.57	0349	7.61	0512	7.62	10
	1412	7.39	1523	7.58	1500	7.71	1549	7.82	1602	7.88	1729	7.80	
11	0215	7.56	0325	7.53	0303	7.57	0409	7.46	0439	7.52	0608	7.55	11
	1453	7.47	1606	7.57	1542	7.70	1632	7.75	1655	7.79	1831	7.70	
12	0255	7.56	0407	7.43	0347	7.47	0458	7.33	0534	7.41	0709	7.49	12
	1537	7.51	1647	7.51	1621	7.65	1721	7.63	1757	7.66	1937	7.60	
13	0338	7.52	0449	7.30	0430	7.35	0554	7.16	0639	7.29	0814	7.46	13
	1621	7.49	1730	7.44	1702	7.57	1824	7.48	1910	7.53	2041	7.52	
14	0421	7.44	0535	7.14	0516	7.18	0706	6.98	0757	7.23	0917	7.48	14
	1706	7.44	1818	7.35	1750	7.46	1946	7.33	2030	7.46	2138	7.48	
15	0505	7.33	0634	6.94	0614	6.98	0850	6.92	0927	7.27	1015	7.54	15
	1751	7.40	1920	7.23	1852	7.30	2123	7.30	2141	7.45	2228	7.48	
16	0553	7.20	0754	6.73	0731	6.76	1031	7.09	1041	7.40	1102	7.64	16
	1843	7.36	2047	7.14	2020	7.17	2235	7.38	2235	7.46	2312	7.51	

Contd.......2

PART – 11 (IN METRES)

DRAUGHTS													
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
17	0656	7.04	0943	6.66	0931	6.71	1130	7.29	1128	7.51	1140	7.72	17
	1946	7.31	2228	7.18	2205	7.20	2324	7.44	2315	7.48	2351	7.57	
18	0817	6.89	1116	6.81	1104	6.91	------	------	1158	7.61	-----	------	18
	2104	7.28	2336	7.30	2312	7.32	1211	7.44	2347	7.52	1212	7.79	
19	0946	6.83	-----	------	------	------	0000	7.48	------	-----	0026	7.63	19
	2232	7.31	1215	7.00	1201	7.14	1242	7.54	1219	7.70	1241	7.85	
20	1110	6.89	0024	7.40	0000	7.41	0028	7.53	0018	7.56	0100	7.71	20
	2342	7.39	1259	7.17	1241	7.30	1307	7.64	1241	7.78	1309	7.91	
21	------	-----	0102	7.47	0036	7.48	0056	7.56	0050	7.60	0135	7.79	21
	1214	7.01	1334	7.30	1313	7.43	1329	7.71	1306	7.82	1341	7.97	
22	0033	7.46	0135	7.52	0106	7.53	0125	7.57	0123	7.62	0214	7.85	22
	1303	7.14	1408	7.41	1342	7.53	1351	7.74	1333	7.85	1417	8.00	
23	0115	7.51	0207	7.54	0135	7.56	0155	7.54	0157	7.63	0256	7.86	23
	1344	7.25	1441	7.47	1411	7.60	1414	7.73	1403	7.87	1457	8.00	
24	0151	7.53	0240	7.52	0205	7.55	0225	7.50	0233	7.64	0341	7.83	24
	1423	7.34	1515	7.48	1440	7.61	1438	7.72	1437	7.87	1538	7.97	
25	0227	7.54	0310	7.46	0233	7.49	0256	7.45	0312	7.62	0427	7.79	25
	1501	7.39	1544	7.44	1503	7.58	1506	7.70	1513	7.85	1620	7.93	
26	0304	7.51	0333	7.38	0258	7.41	0330	7.40	0355	7.58	0515	7.76	26
	1539	7.39	1607	7.40	1522	7.54	1538	7.67	1553	7.81	1712	7.89	
27	0337	7.45	0353	7.29	0322	7.33	0407	7.32	0441	7.52	0609	7.77	27
	1614	7.36	1626	7.36	1543	7.52	1615	7.61	1639	7.76	1819	7.83	
28	0405	7.38	0418	7.21	0350	7.26	0452	7.22	0536	7.49	0712	7.78	28
	1644	7.33	1651	7.33	1610	7.48	1702	7.51	1742	7.69	1939	7.76	
29	0429	7.31	0451	7.08	0424	7.15	0553	7.10	0640	7.49	0824	7.81	29
	1711	7.30	1727	7.23	1646	7.40	1814	7.38	1900	7.65	2102	7.73	
30	0456	7.21			0506	6.98	0714	7.06	0750	7.56	0939	7.88	30
	1741	7.25			1734	7.24	1952	7.34	2021	7.66	2213	7.74	
31	0532	7.06			0608	6.77			0902	7.69			31
	1821	7.16			1855	7.06			2133	7.71			

NOTE : .

1) THE DECLARED DRAUGHTS MAY BE REDUCED OR INCREASED IF SITUATION COMPEL.

M ENAMUL HAQUE
COMMANDER BN
HARBOUR MASTE

MONGLA PORT AUTHORITY(BANGLADESH)
ANTICIPATED PERMISSIBLE DRAUGHTS OF PUSSUR RIVER (PART – 11I)
FOR THE MONTH OF JANUARY TO JUNE , 2012.
(FROM MB -1 BUOY TO P.P. JETTY).

(IN METRES)

DRAUGHTS													
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
1	0550	6.04	0618	5.64	0533	5.67	0801	5.45	0841	5.97	1007	6.64	1
	1841	6.06	1927	5.83	1818	5.86	2105	5.88	2116	6.24	2233	6.57	
2	0641	5.88	0748	5.38	0635	5.39	0944	5.63	0955	6.20	1101	6.76	2
	1937	6.00	2116	5.79	2021	5.70	2217	6.06	2219	6.38	2324	6.61	
3	0756	5.71	0952	5.37	0908	5.27	1055	5.92	1055	6.43	1145	6.84	3
	2044	5.99	2237	5.90	2201	5.80	2311	6.23	2309	6.48	-------	------	
4	0915	5.63	1111	5.52	1038	5.48	1148	6.19	1143	6.61	0012	6.63	4
	2153	6.03	2342	6.05	2308	5.99	2354	6.35	2352	6.54	1224	6.89	
5	1024	5.64	------	------	1142	5.76	------	------	------	------	0059	6.65	5
	2259	6.12	1210	5.73	2357	6.16	1230	6.39	1222	6.73	1305	6.90	
6	1127	5.73	0029	6.16	1228	6.00	0031	6.43	0034	6.57	0149	6.64	6
	2356	6.21	1252	5.91	0035	6.27	1308	6.54	1258	6.81	1353	6.87	
7	------	------	0104	6.23	1306	6.20	0107	6.48	0119	6.58	0241	6.61	7
	1219	5.84	1327	6.08	0108	6.34	1345	6.64	1339	6.83	1446	6.82	
8	0040	6.26	0134	6.29	1342	6.35	0149	6.48	0210	6.55	0331	6.56	8
	1300	5.96	1402	6.22	0141	6.40	1425	6.68	1426	6.81	1539	6.75	
9	0113	6.29	0205	6.35	1419	6.46	0236	6.44	0300	6.49	0421	6.49	9
	1336	6.07	1441	6.33	0220	6.41	1507	6.67	1514	6.76	1633	6.68	
10	0143	6.32	0243	6.37	-------	------	0323	6.37	0349	6.41	0512	6.42	10
	1412	6.19	1523	6.38	1500	6.51	1549	6.62	1602	6.68	1729	6.60	
11	0215	6.36	0325	6.33	0303	6.37	0409	6.26	0439	6.32	0608	6.35	11
	1453	6.27	1606	6.37	1542	6.50	1632	6.55	1655	6.59	1831	6.50	
12	0255	6.36	0407	6.23	0347	6.27	0458	6.13	0534	6.21	0709	6.29	12
	1537	6.31	1647	6.31	1621	6.45	1721	6.43	1757	6.46	1937	6.40	
13	0338	6.32	0449	6.10	0430	6.15	0554	5.96	0639	6.09	0814	6.26	13
	1621	6.29	1730	6.24	1702	6.37	1824	6.28	1910	6.33	2041	6.32	
14	0421	6.24	0535	5.94	0516	5.98	0706	5.78	0757	6.03	0917	6.28	14
	1706	6.24	1818	6.15	1750	6.26	1946	6.13	2030	6.26	2138	6.28	
15	0505	6.13	0634	5.74	0614	5.78	0850	5.72	0927	6.07	1015	6.34	15
	1751	6.20	1920	6.03	1852	6.10	2123	6.10	2141	6.25	2228	6.28	
16	0553	6.00	0754	5.53	0731	5.56	1031	5.89	1041	6.20	1102	6.44	16
	1843	6.16	2047	5.94	2020	5.97	2235	6.18	2235	6.26	2312	6.31	

Contd.......2

PART – 111 (IN METRES)

D R A U G H T S													
DATE	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
17	0656	5.84	0943	5.46	0931	5.51	1130	6.09	1128	6.31	1140	6.52	17
	1946	6.11	2228	5.98	2205	6.00	2324	6.24	2315	6.28	2351	6.37	
18	0817	5.69	1116	5.61	1104	5.71	-------	-------	1158	6.41	--------	------	18
	2104	6.08	2336	6.10	2312	6.12	1211	6.24	2347	6.32	1212	6.59	
19	0946	5.63	--------	------	--------	-------	0000	6.28	------	-------	0026	6.43	19
	2232	6.11	1215	5.80	1201	5.94	1242	6.34	1219	6.50	1241	6.65	
20	1110	5.69	0024	6.20	0000	6.21	0028	6.33	0018	6.36	0100	6.51	20
	2342	6.19	1259	5.97	1241	6.10	1307	6.44	1241	6.58	1309	6.71	
21	-------	------	0102	6.27	0036	6.28	0056	6.36	0050	6.40	0135	6.59	21
	1214	5.81	1334	6.10	1313	6.23	1329	6.51	1306	6.62	1341	6.77	
22	0033	6.26	0135	6.32	0106	6.33	0125	6.37	0123	6.42	0214	6.65	22
	1303	5.94	1408	6.21	1342	6.33	1351	6.54	1333	6.65	1417	6.80	
23	0115	6.31	0207	6.34	0135	6.36	0155	6.34	0157	6.43	0256	6.66	23
	1344	6.05	1441	6.27	1411	6.40	1414	6.53	1403	6.67	1457	6.80	
24	0151	6.33	0240	6.32	0205	6.35	0225	6.30	0233	6.44	0341	6.63	24
	1423	6.14	1515	6.28	1440	6.41	1438	6.52	1437	6.67	1538	6.77	
25	0227	6.34	0310	6.26	0233	6.29	0256	6.25	0312	6.42	0427	6.59	25
	1501	6.19	1544	6.24	1503	6.38	1506	6.50	1513	6.65	1620	6.73	
26	0304	6.31	0333	6.18	0258	6.21	0330	6.20	0355	6.38	0515	6.56	26
	1539	6.19	1607	6.20	1522	6.34	1538	6.47	1553	6.61	1712	6.69	
27	0337	6.25	0353	6.09	0322	6.13	0407	6.12	0441	6.32	0609	6.57	27
	1614	6.16	1626	6.16	1543	6.32	1615	6.41	1639	6.56	1819	6.63	
28	0405	6.18	0418	6.01	0350	6.06	0452	6.02	0536	6.29	0712	6.58	28
	1644	6.13	1651	6.13	1610	6.28	1702	6.31	1742	6.49	1939	6.56	
29	0429	6.11	0451	5.88	0424	5.95	0553	5.90	0640	6.29	0824	6.61	29
	1711	6.10	1727	6.03	1646	6.20	1814	6.18	1900	6.45	2102	6.53	
30	0456	6.01			0506	5.78	0714	5.86	0750	6.36	0939	6.68	30
	1741	6.05			1734	6.04	1952	6.14	2021	6.46	2213	6.54	
31	0532	5.86			0608	5.57			0902	6.49			31
	1821	5.96			1855	5.86			2133	6.51			

NOTE : .

1) THE DECLARED DRAUGHTS MAY BE REDUCED OR INCREASED IF SITUATION COMPEL.

M ENAMUL HAQUE
COMMANDER BN
HARBOUR MASTER

MONGLA PORT AUTHORITY(BANGLADESH)
ANTICIPATED PERMISSIBLE DRAUGHTS OF PUSSUR RIVER (PART – 11)
FOR THE MONTH OF JULY TO DECEMBER , 2011.
(FROM BASE CREEK TO MB – 1 BUOY).

(IN METRES)

	D R A		U		G		H		T		S		
DATE	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
1	0036	7.75	0130	8.06	0229	8.14	0240	8.08	0409	7.79	0448	7.55	1
	1247	7.95	1339	8.16	1457	8.10	1539	7.89	1704	7.56	1739	7.40	
2	0111	7.86	0212	8.10	0329	8.07	0340	7.98	0510	7.67	0546	7.44	2
	1317	8.03	1421	8.17	1554	8.01	1628	7.79	1801	7.45	1834	7.34	
3	0149	7.95	0302	8.08	0421	8.00	0437	7.89	0621	7.53	0652	7.31	3
	1355	8.08	1513	8.12	1645	7.91	1720	7.67	1910	7.36	1937	7.30	
4	0234	7.98	0358	8.03	0512	7.92	0539	7.76	0745	7.41	0803	7.21	4
	1439	8.09	1609	8.05	1740	7.77	1822	7.51	2038	7.34	2043	7.32	
5	0323	7.96	0450	7.97	0612	7.81	0655	7.60	0911	7.40	0909	7.16	5
	1528	8.06	1705	7.96	1847	7.60	1945	7.38	2207	7.45	2144	7.39	
6	0416	7.92	0543	7.92	0728	7.68	0840	7.52	1016	7.45	1006	7.16	6
	1622	8.00	1804	7.85	2014	7.45	2150	7.42	2300	7.58	2237	7.49	
7	0510	7.87	0642	7.85	0922	7.63	1014	7.61	1100	7.50	1057	7.20	7
	1722	7.94	1913	7.71	2217	7.49	2300	7.60	2333	7.70	2323	7.59	
8	0606	7.85	0753	7.77	1048	7.75	1108	7.72	1135	7.56	1143	7.25	8
	1827	7.86	2033	7.58	2325	7.65	2345	7.73	2358	7.80	------	-----	
9	0708	7.83	0927	7.73	1141	7.86	1146	7.78	------	-----	0003	7.65	9
	1938	7.78	2213	7.55	-------	-----	-------	------	1207	7.60	1225	7.30	
10	0815	7.83	1100	7.81	0010	7.77	0016	7.82	0024	7.88	0039	7.68	10
	2050	7.70	2329	7.64	1218	7.93	1214	7.83	1241	7.64	1303	7.35	
11	0928	7.83	1157	7.89	0043	7.84	0037	7.91	0052	7.91	0111	7.67	11
	2203	7.67	-------	-----	1247	7.97	1238	7.89	1315	7.64	1340	7.41	
12	1047	7.87	0019	7.73	0107	7.91	0056	7.99	0121	7.90	0142	7.67	12
	2313	7.68	1237	7.95	1310	8.02	1306	7.92	1350	7.63	1419	7.46	
13	1152	7.92	0056	7.80	0129	7.98	0120	8.03	0151	7.86	0217	7.66	13
	-------	-----	1309	7.98	1335	8.05	1336	7.91	1427	7.62	1500	7.49	
14	0010	7.72	0126	7.85	0153	8.01	0146	8.02	0224	7.81	0257	7.62	14
	1238	7.95	1335	8.02	1403	8.04	1408	7.86	1506	7.58	1545	7.48	
15	0055	7.77	0154	7.89	0218	8.00	0212	7.97	0259	7.73	0340	7.56	15
	1314	7.97	1402	8.03	1430	8.00	1439	7.80	1547	7.52	1631	7.45	
16	0134	7.80	0223	7.90	0241	7.96	0239	7.91	0337	7.65	0425	7.47	16
	1346	7.97	1429	8.03	1456	7.94	1512	7.73	1632	7.46	1718	7.41	

Contd........2

PART – 11 (IN METRES)

	D R A		U		G		H		T S			
DATE	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
17	0210	7.80	0251	7.89	0302	7.92	0308	7.84	0420	7.55	0515	7.39	17
	1417	7.95	1454	8.00	1522	7.88	1547	7.64	1724	7.39	1810	7.40	
18	0246	7.78	0315	7.86	0327	7.89	0341	7.76	0517	7.45	0615	7.30	18
	1447	7.93	1516	7.97	1553	7.81	1627	7.55	1825	7.37	1907	7.41	
19	0319	7.74	0336	7.85	0401	7.83	0423	7.65	0640	7.37	0726	7.21	19
	1514	7.91	1541	7.95	1630	7.71	1718	7.43	1934	7.42	2012	7.44	
20	0349	7.72	0402	7.85	0445	7.73	0521	7.50	0805	7.37	0843	7.16	20
	1543	7.90	1613	7.91	1718	7.55	1834	7.33	2045	7.54	2122	7.50	
21	0418	7.72	0439	7.83	0544	7.55	0713	7.39	0918	7.43	0957	7.15	21
	1616	7.89	1653	7.82	1834	7.34	2009	7.36	2150	7.68	2231	7.57	
22	0452	7.72	0525	7.75	0810	7.42	0858	7.48	1019	7.49	1104	7.17	22
	1653	7.85	1742	7.65	2052	7.33	2128	7.55	2246	7.81	2334	7.62	
23	0531	7.71	0625	7.59	0950	7.58	1003	7.63	1113	7.53	------	------	23
	1736	7.77	1852	7.42	2212	7.54	2229	7.76	2332	7.89	1204	7.22	
24	0618	7.67	0903	7.50	1048	7.78	1054	7.76	-------	------	0026	7.65	24
	1828	7.62	2131	7.38	2308	7.77	2317	7.93	1202	7.55	1257	7.28	
25	0722	7.59	1024	7.66	1132	7.92	1136	7.83	0009	7.92	0110	7.66	25
	1950	7.45	2242	7.56	2350	7.94	2351	8.04	1251	7.57	1344	7.35	
26	0929	7.60	1121	7.83	-------	-----	-----	------	0045	7.92	0151	7.65	26
	2157	7.47	2334	7.74	1206	8.00	1213	7.87	1342	7.58	1429	7.39	
27	1042	7.72	-------	------	0020	8.07	0016	8.11	0128	7.88	0232	7.61	27
	2300	7.58	1202	7.95	1234	8.06	1254	7.87	1432	7.57	1512	7.41	
28	1136	7.83	0013	7.89	0041	8.16	0048	8.13	0218	7.80	0313	7.56	28
	2348	7.70	1232	8.04	1306	8.09	1344	7.85	1519	7.54	1554	7.40	
29	------	-----	0042	8.02	0110	8.19	0129	8.08	0308	7.72	0352	7.50	29
	1215	7.91	1255	8.12	1350	8.06	1437	7.79	1604	7.49	1634	7.37	
30	0025	7.83	0109	8.12	0150	8.15	0218	7.99	0356	7.63	0430	7.44	30
	1242	7.99	1323	8.17	1446	7.99	1527	7.72	1650	7.45	1714	7.35	
31	0056	7.95	0143	8.17			0312	7.89			0508	7.36	31
	1307	8.08	1403	8.17			1614	7.64			1755	7.31	

NOTE : .

1) THE DECLARED DRAUGHTS MAY BE REDUCED OR INCREASED IF SITUATION COMPEL.

M ENAMUL HAQUE
COMMANDER BN
HARBOUR MASTER

MONGLA PORT AUTHORITY(BANGLADESH)
ANTICIPATED PERMISSIBLE DRAUGHTS OF PUSSUR RIVER (PART – 11I)
FOR THE MONTH OF JULY TO DECEMBER , 2011.
(FROM MB -1 BUOY TO P.P. JETTY).

(IN METRES)

D R A U G H T S													
DATE	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		DATE
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
1	0036	6.55	0130	6.86	0229	6.94	0240	6.88	0409	6.59	0448	6.35	1
	1247	6.75	1339	6.96	1457	6.90	1539	6.69	1704	6.36	1739	6.20	
2	0111	6.66	0212	6.90	0329	6.87	0340	6.78	0510	6.47	0546	6.24	2
	1317	6.83	1421	6.97	1554	6.81	1628	6.59	1801	6.25	1834	6.14	
3	0149	6.75	0302	6.88	0421	6.80	0437	6.69	0621	6.33	0652	6.11	3
	1355	6.88	1513	6.92	1645	6.71	1720	6.47	1910	6.16	1937	6.10	
4	0234	6.78	0358	6.83	0512	6.72	0539	6.56	0745	6.21	0803	6.01	4
	1439	6.89	1609	6.85	1740	6.57	1822	6.31	2038	6.14	2043	6.12	
5	0323	6.76	0450	6.77	0612	6.61	0655	6.40	0911	6.20	0909	5.96	5
	1528	6.86	1705	6.76	1847	6.40	1945	6.18	2207	6.25	2144	6.19	
6	0416	6.72	0543	6.72	0728	6.48	0840	6.32	1016	6.25	1006	5.96	6
	1622	6.80	1804	6.65	2014	6.25	2150	6.22	2300	6.38	2237	6.29	
7	0510	6.67	0642	6.65	0922	6.43	1014	6.41	1100	6.30	1057	6.00	7
	1722	6.74	1913	6.51	2217	6.29	2300	6.40	2333	6.50	2323	6.39	
8	0606	6.65	0753	6.57	1048	6.55	1108	6.52	1135	6.36	1143	6.05	8
	1827	6.66	2033	6.38	2325	6.45	2345	6.53	2358	6.60	------	------	
9	0708	6.63	0927	6.53	1141	6.66	1146	6.58	------	------	0003	6.45	9
	1938	6.58	2213	6.35	-------	------	-------	------	1207	6.40	1225	6.10	
10	0815	6.63	1100	6.61	0010	6.57	0016	6.62	0024	6.68	0039	6.48	10
	2050	6.50	2329	6.44	1218	6.73	1214	6.63	1241	6.44	1303	6.15	
11	0928	6.63	1157	6.69	0043	6.64	0037	6.71	0052	6.71	0111	6.47	11
	2203	6.47	-------	-----	1247	6.77	1238	6.69	1315	6.44	1340	6.21	
12	1047	6.67	0019	6.53	0107	6.71	0056	6.79	0121	6.70	0142	6.47	12
	2313	6.48	1237	6.75	1310	6.82	1306	6.72	1350	6.43	1419	6.26	
13	1152	6.72	0056	6.60	0129	6.78	0120	6.83	0151	6.66	0217	6.46	13
	-------	-----	1309	6.78	1335	6.85	1336	6.71	1427	6.42	1500	6.29	
14	0010	6.52	0126	6.65	0153	6.81	0146	6.82	0224	6.61	0257	6.42	14
	1238	6.75	1335	6.82	1403	6.84	1408	6.66	1506	6.38	1545	6.28	
15	0055	6.57	0154	6.69	0218	6.80	0212	6.77	0259	6.53	0340	6.36	15
	1314	6.77	1402	6.83	1430	6.80	1439	6.60	1547	6.32	1631	6.25	
16	0134	6.60	0223	6.70	0241	6.76	0239	6.71	0337	6.45	0425	6.27	16
	1346	6.77	1429	6.83	1456	6.74	1512	6.53	1632	6.26	1718	6.21	

Contd.......2

PART – 111 (IN METRES)

DATE	D R A U G H T S												DATE
	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		
	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	TIME	METRE	
17	0210	6.60	0251	6.69	0302	6.72	0308	6.64	0420	6.35	0515	6.19	17
	1417	6.75	1454	6.80	1522	6.68	1547	6.44	1724	6.19	1810	6.20	
18	0246	6.58	0315	6.66	0327	6.69	0341	6.56	0517	6.25	0615	6.10	18
	1447	6.73	1516	6.77	1553	6.61	1627	6.35	1825	6.17	1907	6.21	
19	0319	6.54	0336	6.65	0401	6.63	0423	6.45	0640	6.17	0726	6.01	19
	1514	6.71	1541	6.75	1630	6.51	1718	6.23	1934	6.22	2012	6.24	
20	0349	6.52	0402	6.65	0445	6.53	0521	6.30	0805	6.17	0843	5.96	20
	1543	6.70	1613	6.71	1718	6.35	1834	6.13	2045	6.34	2122	6.30	
21	0418	6.52	0439	6.63	0544	6.35	0713	6.19	0918	6.23	0957	5.95	21
	1616	6.69	1653	6.62	1834	6.14	2009	6.16	2150	6.48	2231	6.37	
22	0452	6.52	0525	6.55	0810	6.22	0858	6.28	1019	6.29	1104	5.97	22
	1653	6.65	1742	6.45	2052	6.13	2128	6.35	2246	6.61	2334	6.42	
23	0531	6.51	0625	6.39	0950	6.38	1003	6.43	1113	6.33	------	-----	23
	1736	6.57	1852	6.22	2212	6.34	2229	6.56	2332	6.69	1204	6.02	
24	0618	6.47	0903	6.30	1048	6.58	1054	6.56	-------	-----	0026	6.45	24
	1828	6.42	2131	6.18	2308	6.57	2317	6.73	1202	6.35	1257	6.08	
25	0722	6.39	1024	6.46	1132	6.72	1136	6.63	0009	6.72	0110	6.46	25
	1950	6.25	2242	6.36	2350	6.74	2351	6.84	1251	6.37	1344	6.15	
26	0929	6.40	1121	6.63	-------	------	-----	-----	0045	6.72	0151	6.45	26
	2157	6.27	2334	6.54	1206	6.80	1213	6.67	1342	6.38	1429	6.19	
27	1042	6.52	-------	-----	0020	6.87	0016	6.91	0128	6.68	0232	6.41	27
	2300	6.38	1202	6.75	1234	6.86	1254	6.67	1432	6.37	1512	6.21	
28	1136	6.63	0013	6.69	0041	6.96	0048	6.93	0218	6.60	0313	6.36	28
	2348	6.50	1232	6.84	1306	6.89	1344	6.65	1519	6.34	1554	6.20	
29	------	-----	0042	6.82	0110	6.99	0129	6.88	0308	6.52	0352	6.30	29
	1215	6.71	1255	6.92	1350	6.86	1437	6.59	1604	6.29	1634	6.17	
30	0025	6.63	0109	6.92	0150	6.95	0218	6.79	0356	6.43	0430	6.24	30
	1242	6.79	1323	6.97	1446	6.79	1527	6.52	1650	6.25	1714	6.15	
31	0056	6.75	0143	6.97			0312	6.69			0508	6.16	31
	1307	6.88	1403	6.97			1614	6.44			1755	6.11	

NOTE : .

1) THE DECLARED DRAUGHTS MAY BE REDUCED OR INCREASED IF SITUATION COMPEL.

M ENAMUL HAQUE
COMMANDER BN
HARBOUR MASTER

June 2012

Sun	Time	Ht.(m)	Mon	Time	Ht.(m)	Tue	Time	Ht.(m)	Wed	Time	Ht.(m)	Thu	Time	Ht.(m)	Fri	Time	Ht.(m)	Sat	Time	Ht.(m)
															1	0432	0.65	2	0531	0.55
																1037	4.26		1126	4.45
																1717	0.72		1814	0.62
																2256	4.03		2346	4.16
3	0624	0.46	4	0033	4.27	5	0120	4.36	6	0208	4.4	7	0257	4.4	8	0347	4.35	9	0438	4.26
	1209	4.59		0713	0.38		0800	0.34		0846	0.33		0933	0.38		1019	0.48		1106	0.62
	1906	0.56		1252	4.69		1337	4.74		1425	4.74		1514	4.7		1605	4.61		1657	4.46
				1954	0.52		2041	0.51		2127	0.51		2211	0.53		2255	0.56		2339	0.62
10	0531	4.13	11	0026	0.73	12	0118	0.88	13	0217	1.05	14	0327	1.13	15	0437	1.08	16	0532	0.95
	1155	0.79		0628	3.98		0731	3.83		0842	3.75		0952	3.79		1048	3.93		1133	4.09
	1751	4.25		1250	0.99		1353	1.17		1508	1.26		1629	1.2		1729	1.05		1815	0.92
				1849	3.99		1952	3.73		2101	3.56		2211	3.54		2308	3.64		2353	3.79
17	0616	0.82	18	0032	3.94	19	0105	4.07	20	0136	4.18	21	0207	4.28	22	0242	4.34	23	0320	4.34
	1212	4.24		0654	0.73		0729	0.67		0802	0.62		0837	0.59		0913	0.58		0952	0.62
	1854	0.84		1246	4.36		1316	4.45		1345	4.54		1416	4.62		1453	4.65		1532	4.62
				1929	0.81		2003	0.8		2036	0.77		2111	0.73		2147	0.71		2224	0.71
24	0401	4.3	25	0445	4.23	26	0533	4.18	27	0033	0.77	28	0132	0.83	29	0243	0.87	30	0359	0.85
	1033	0.7		1116	0.79		1206	0.88		0631	4.14		0742	4.14		0900	4.22		1009	4.36
	1615	4.53		1701	4.41		1753	4.26		1305	0.98		1418	1.04		1538	1.02		1653	0.91
	2303	0.72		2345	0.74					1855	4.1		2009	3.98		2126	3.96		2236	4.03

July 2012

Sun	Time	Ht.(m)	Mon	Time	Ht.(m)	Tue	Time	Ht.(m)	Wed	Time	Ht.(m)	Thu	Time	Ht.(m)	Fri	Time	Ht.(m)	Sat	Time	Ht.(m)
1	0507	0.76	2	0607	0.66	3	0027	4.32	4	0114	4.46	5	0200	4.55	6	0244	4.58	7	0328	4.55
	1108	4.52		1159	4.66		0701	0.57		0751	0.51		0838	0.5		0923	0.55		1005	0.63
	1758	0.81		1856	0.73		1245	4.78		1329	4.87		1413	4.9		1458	4.87		1542	4.79
	2336	4.17					1948	0.68		2035	0.66		2118	0.66		2158	0.67		2236	0.69
8	0412	4.49	9	0455	4.39	10	0541	4.25	11	0029	0.91	12	0115	1.08	13	0216	1.26	14	0339	1.33
	1046	0.73		1127	0.85		1209	0.99		0631	4.07		0730	3.9		0841	3.79		0958	3.85
	1626	4.65		1711	4.44		1759	4.18		1257	1.17		1357	1.34		1519	1.41		1645	1.3
	2312	0.72		2349	0.79					1853	3.88		1954	3.6		2108	3.46		2230	3.52
15	0455	1.22	16	0553	1.04	17	0017	3.95	18	0052	4.15	19	0122	4.33	20	0152	4.47	21	0225	4.56
	1103	4.03		1153	4.24		0638	0.89		0716	0.79		0752	0.7		0828	0.64		0905	0.62
	1748	1.11		1836	0.97		1231	4.42		1302	4.57		1330	4.7		1359	4.82		1434	4.86
	2332	3.72					1916	0.89		1952	0.85		2026	0.8		2101	0.76		2136	0.73
22	0302	4.57	23	0341	4.52	24	0421	4.48	25	0506	4.44	26	0008	0.73	27	0101	0.81	28	0212	0.94
	0944	0.66		1024	0.73		1104	0.8		1149	0.86		0558	4.38		0707	4.28		0832	4.22
	1512	4.82		1552	4.71		1635	4.58		1724	4.42		1242	0.95		1350	1.06		1515	1.1
	2212	0.73		2247	0.73		2325	0.72					1824	4.2		1941	3.98		2108	3.87
29	0336	0.99	30	0457	0.9	31	0606	0.76												
	0955	4.29		1106	4.44		1202	4.62												
	1641	1.02		1757	0.86		1858	0.72												
	2232	3.95		2341	4.15															