Chapter 6 Study of Construction Plan

6.1 Connection with Gas Pipeline

Gas will be supplied to the Bheramara CCPP through the gas pipeline constructed by the ADB loan and the gas pipeline branched off from the CGS. CGS will be located at gas pipeline which is branched off from some midpoint (between Ishwardi and Kushtia) of a 240 km, 30 inch gas pipeline which is laid between Hatikumrul and Khulna. The amount of gas volume supplied to Bheramara CCPP will be measured by CGS.

The related land for gas pipeline from the downstream side of the CGS to the Bheramara CCPP will be acquired by NWPGCL, constructed gas pipeline by the Contractor and managed gas pipeline by gas company after completion of the project. Figure I-6-1-1 shows the related site drawing of the CGS and Bheramara CCPP.

The CGS inlet pressure is 1,000 psig, and the CGS outlet pressure is 300 to 350 psig. The route of gas pipeline to be laid from the CGS to Bheramara CCPP was planned to be constructed considering the problem with land acquisition and pressure drop of gas pipeline. As a result, the gas supply pressure at the inlet of the Bheramara CCPP is about 298 psig. This does not meet the gas pressure required by the gas turbine. It is necessary to install compressors at the Bheramara CCPP.

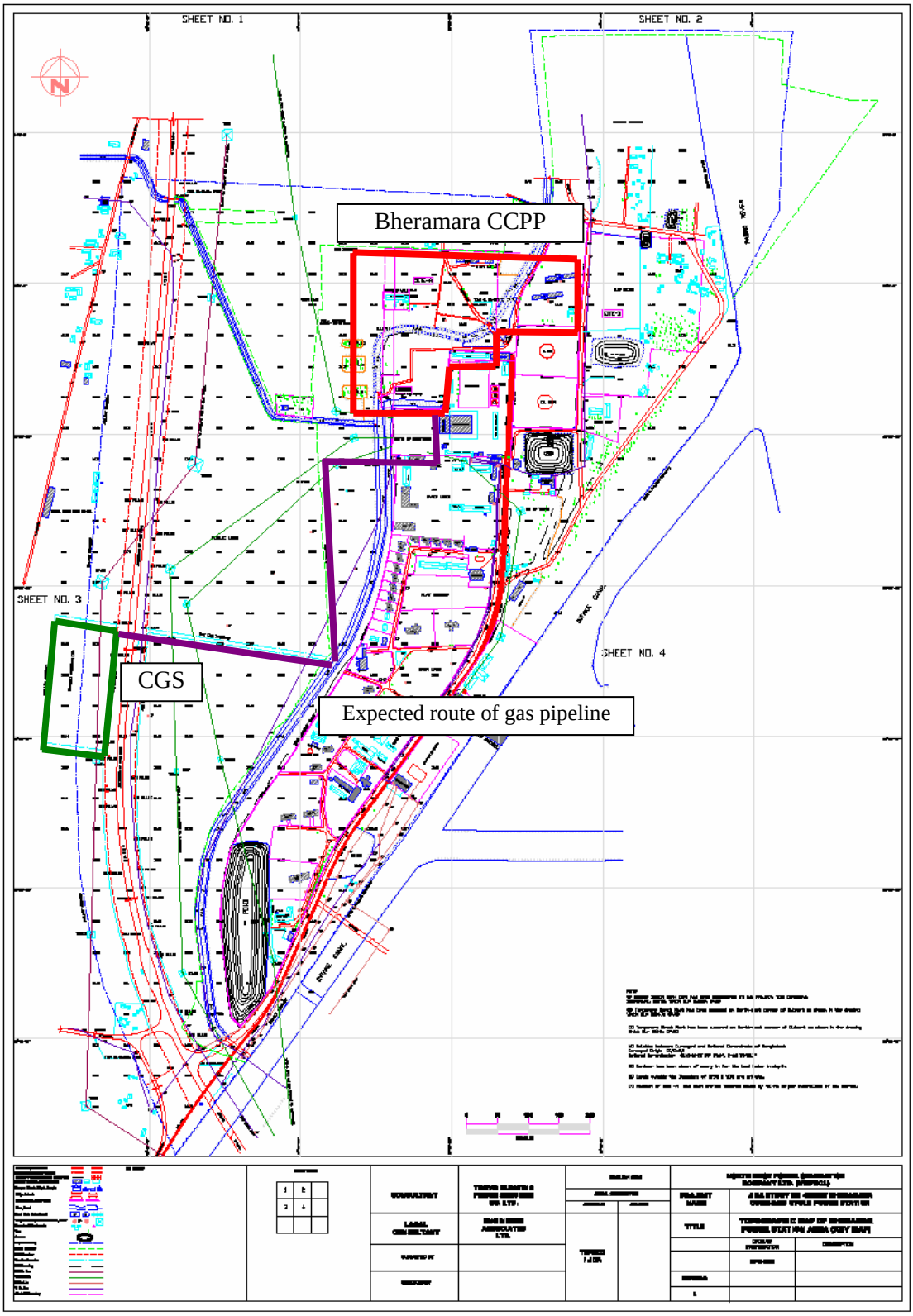


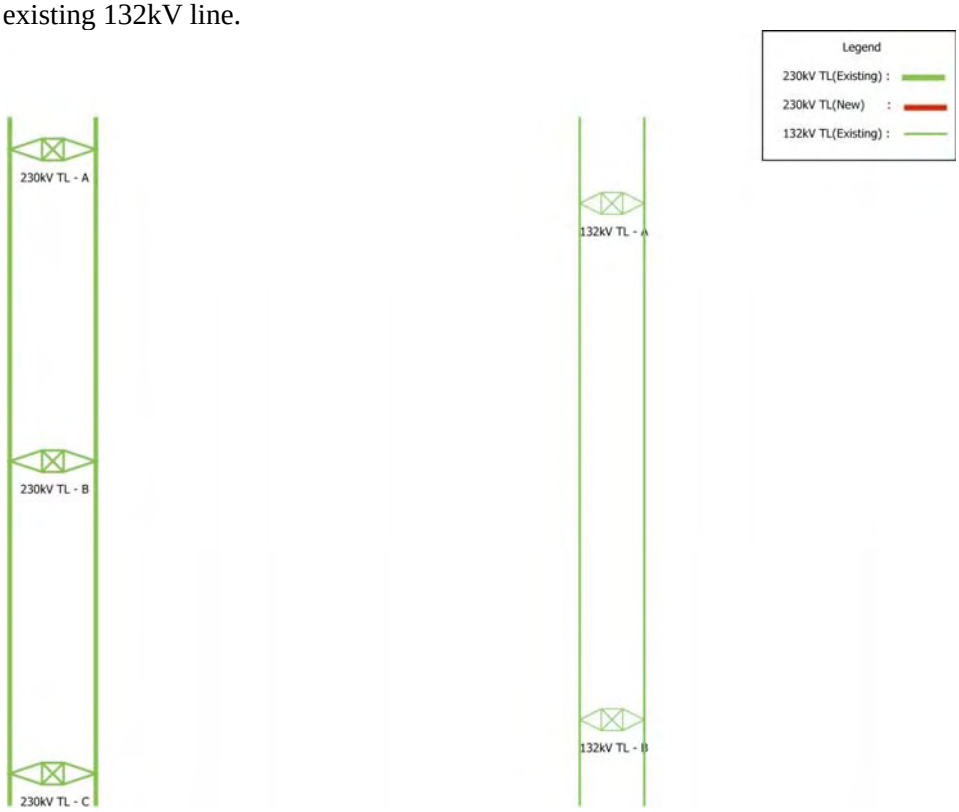
Figure I-6-1-1 Gas pipeline from CGS to Bheramara CCPP

6.2 Connection with Transmission Line

As described on section 5.5.17, the construction schedule is shown in case of selecting case 1.

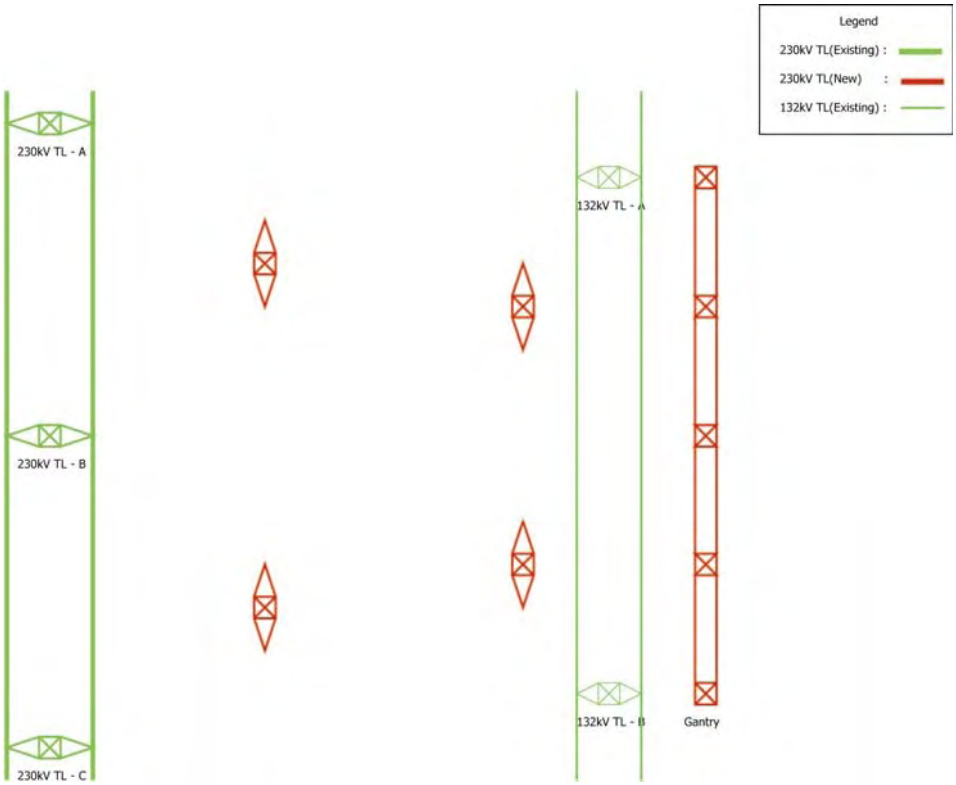
(1) Initial condition

Existing 230kV line and 132kV line are passing side by side around Bheramara power station. In order to connect existing 230kV line and Bheramara substation, 230kV line should cross over existing 132kV line.



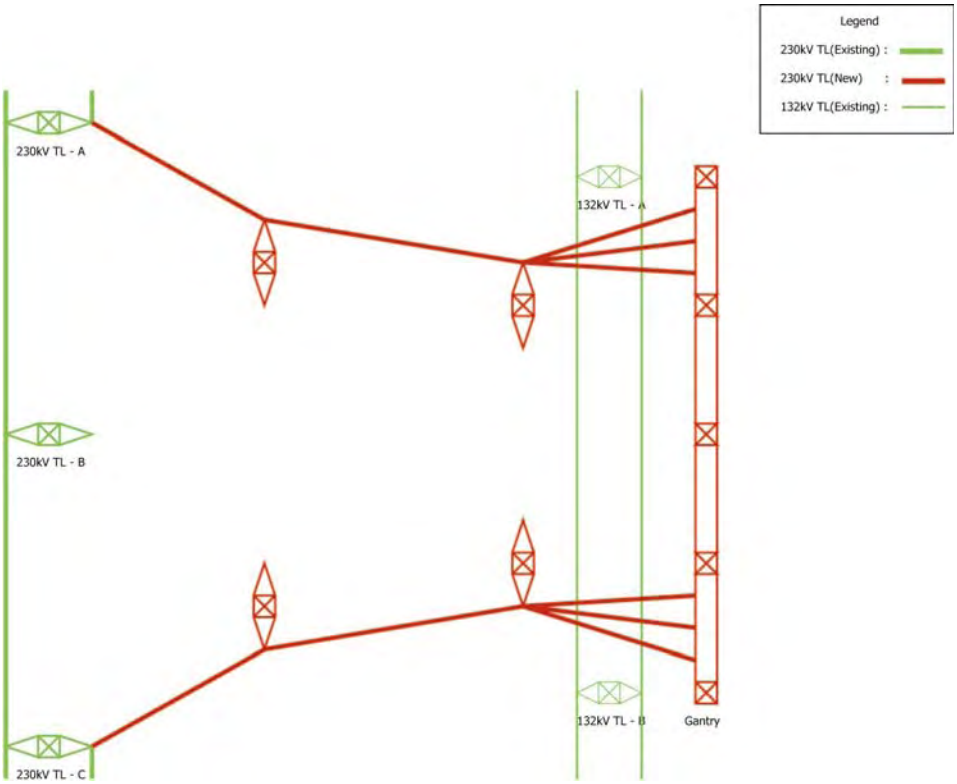
(2) Construction of tower and gantry to connect with Bheramara substation

Gantry as well as towers of 230kV line should be constructed.



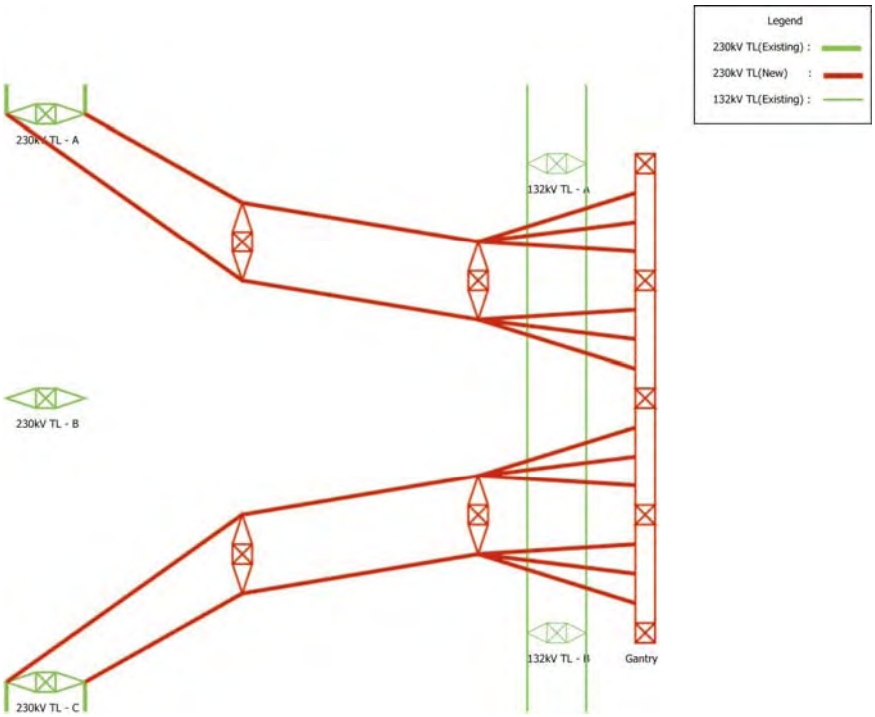
(3) Stinging and removal of one circuit

After stopping supplying power of the circuit under construction, the same circuit should be strung to connect with Bheramara substation. Then, power will be supplied by this circuit via Bheramara substation.



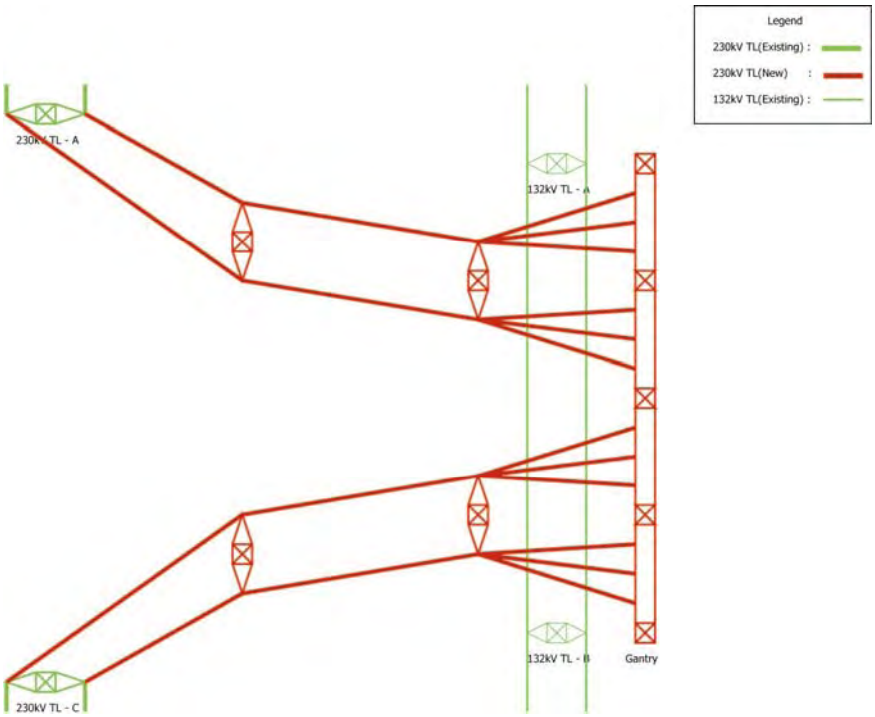
(4) Stinging and removal of another circuit

After stopping supplying power of the circuit under construction, the same circuit should be strung to connect with Bheramara substation. Then, power will be supplied by both circuits via Bheramara substation.



(5) Removal of existing tower

Finally, 230kV TL-b should be removed.



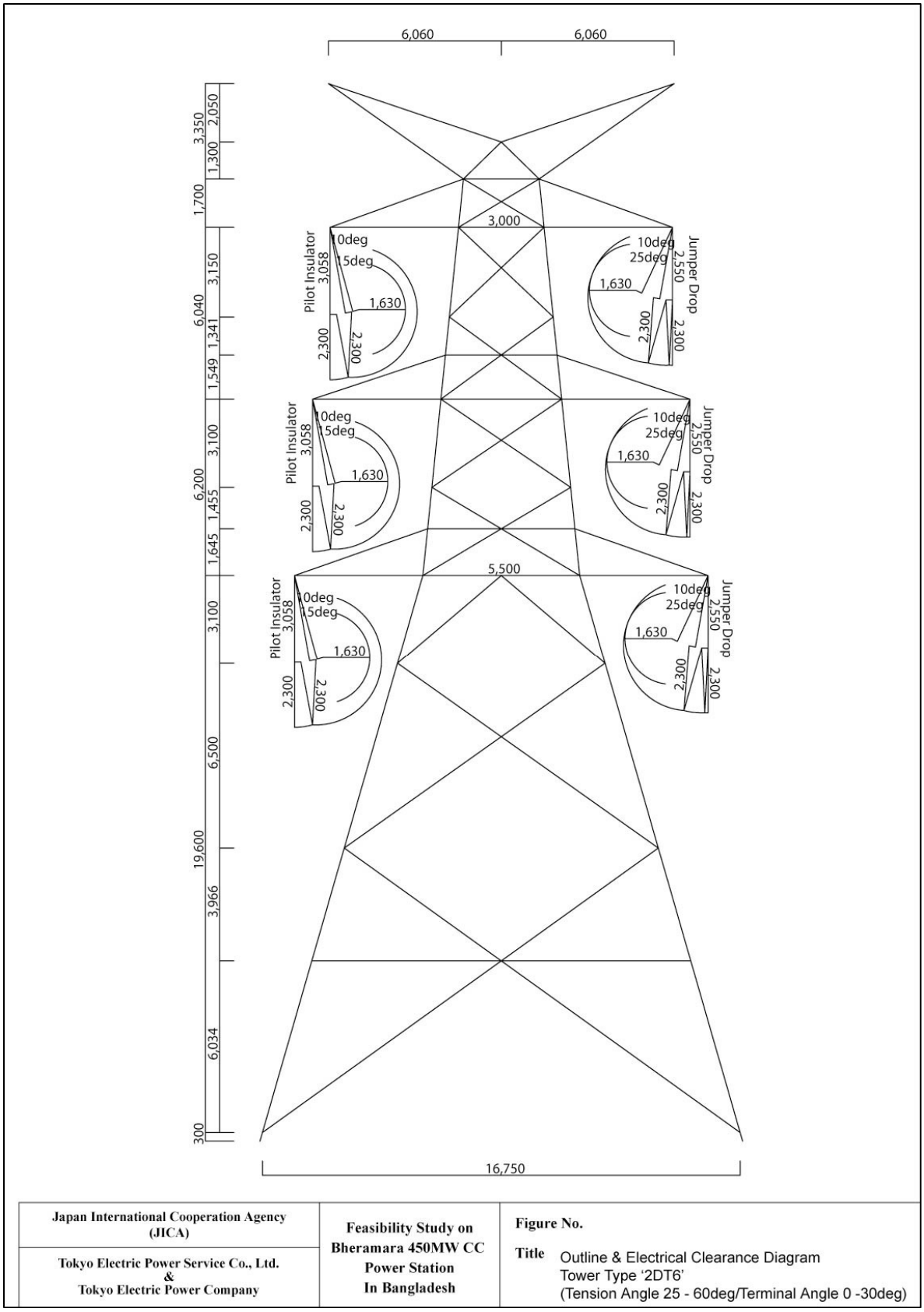


Figure I-6-2-1 Configuration of tower

6.3 Facilities for Construction

(1) Jetty

Jetty for heavy weight and large cargoes transported by channel transportation is not near Bheramara site.

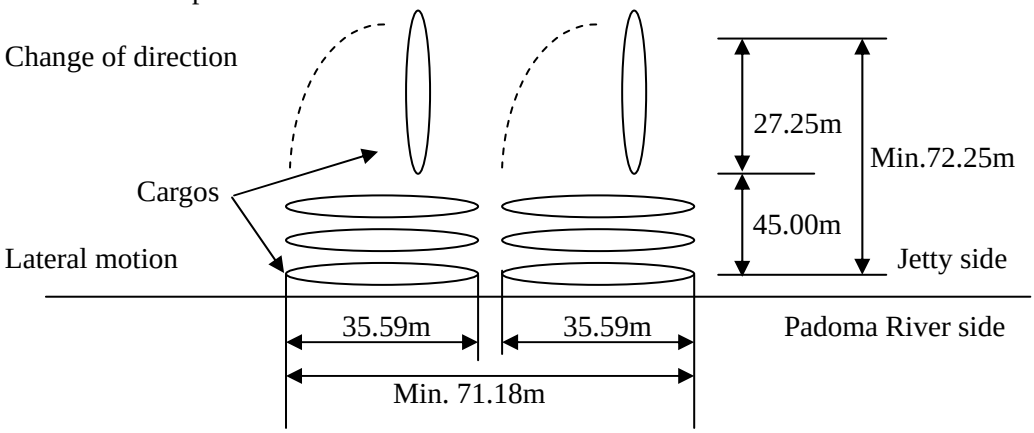
Jetty will be used as unloading facility for heavy weight equipment in construction stage and maintenance after construction.

Jetty will be also planned as a part of storage yard in construction stage.

Jetty shall be constructed as permanent facility.

1) Necessary area

Jetty size has 100m length two barges (600 ton barge size is length of 35.59m x width of 12.22m) can touch down in construction stage and 75m width lateral motion and direction change of equipments after unloading is possible. Therefore jetty size with100m length x 75m width shall be planned.



2) Layout plan

Layout plan of jetty is shown in Figure I-6-3-1.

3) Jetty structure

Jetty size has 100m length x 75m width.

The structure is open type wharves on vertical piles.

(2) Storage Yards

1) Necessary storage yard area

Storage yard name	Necessary area (m^2)
Storage yard for equipments and materials	27,000
Batcher plant	5,000
Ware house and office	6,000
Total area	38,000

2) Layout plan

Layout plan is shown in Figure I-6-3-1.

Storage yard area including jetty is 43,000 m^2.

Storage yard is used as temporary facility in construction stage.

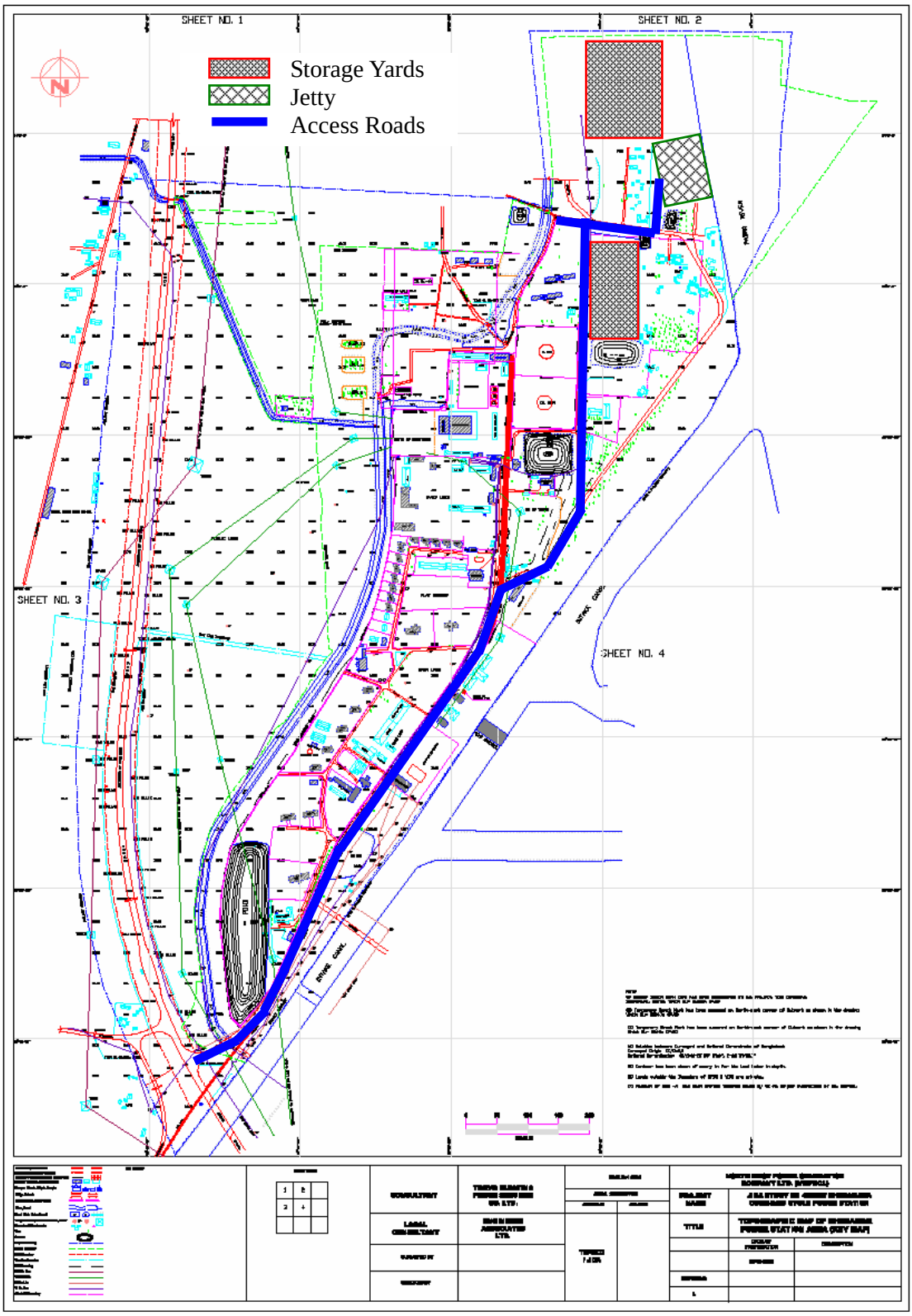


Figure I-6-3-1 Layout plan of jetty, storage yard and access road

(3) Access Roads

Access roads plan from jetty or highway road are shown in Figure I-6-3-1.

1) Overland transportation route from jetty to Bheramara site

At the jetty, heavy weight equipments will be loaded on to the trailer from the barge by the 600 ton floating crane and off loaded on the project storage yard either by suitable crawler crane or by jacking method.

Access road width from jetty to project site will be 8m.

No relocation of residents needs for this approach road.

2) Overland transportation route from highway to Bheramara site

The length of the existing approach road to the project site is about 2km.

Access road width from jetty to project site is 8m.

This approach road from near the entrance gate at project site along the intake canal and river side will be extended.

No relocation of residents needs for this approach road.

(4) Others

The Contractor shall ensure the following during construction period.

- To construct temporary area in the new plant area.
- To arrange an outdoor storage space adequate for storage of new plant equipment and materials and for temporary site office during the execution of the Contract.
- To provide and maintain all temporary structure required including warehouse, change houses for workmen, sheds, etc.
- To provide his own field office complete with telephone so that the Employer can reach him or his official representative and/or the Consultant at all times.
- To provide his own watchman service to ensure security and safety of the equipment and materials.
- To provide and maintain his own laboratory facilities.
- Not to use the Employer’s existing storage, toilet and washroom facilities.
- To provide but not limited to all rigging, planking, tools, supplies, scaffolding, guard batteries, warning lights, construction equipment, compressed air, testing apparatus and precision instrument required to complete his work.
- To move all temporary erection facilities described above after the completion of the works unless otherwise desired by the Employer.

6.4 Temporary Utility Supply

During construction period, the Contractor shall supply but not limited to all fuel, electricity, all raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for construction.

During commissioning period, the Contractor shall supply but not limited to all raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for commissioning.

Chapter 7 Environmental and Social Consideration

7.1 Outline of the proposed site

7.1.1 Location of the proposed site

The proposed sites regarding the survey on the environment and the social consideration are located in Khulna Division, Kushtia District, Bheramara Upazila, Bahirhar Union and their surroundings.

7.1.2 Outline of the natural environment

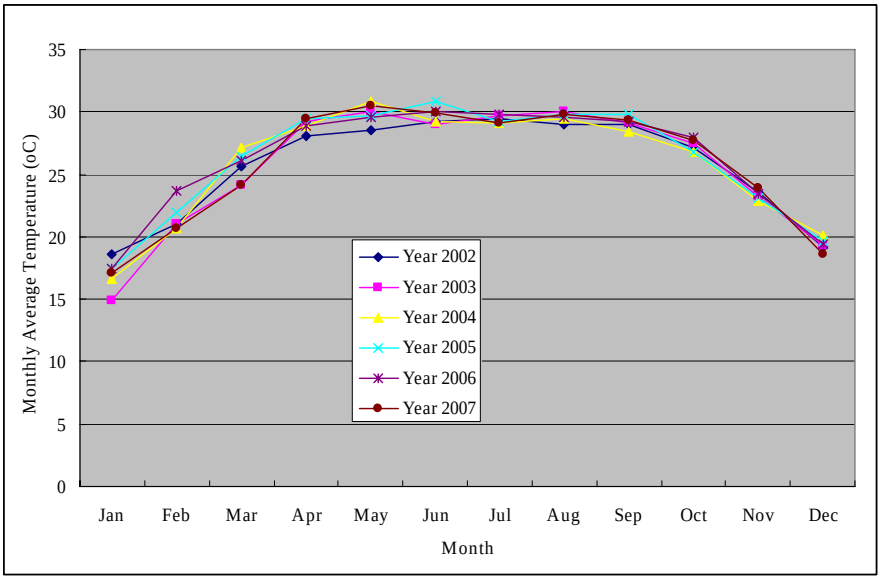
(1) Climate condition

The year of Bangladesh is said to be broadly classified into four seasons; winter from December to February, summer from March to May, the monsoon season from June to September, and autumn from October to November. Winter a relatively dry season with little rain, having an average temperature of about 20°C. In summer, the whole country is covered with a tropical cyclone and much rainfall, and the temperature rises to a level of 20°C to 30°C. In the monsoon season, cyclones occur in the Bengal Bay bringing heavy rainfall. About 75% of the annual precipitation is concentrated in this period.

a) Temperature

There is a meteorological observatory in Ishurdi, 21 km northeast of the project site. Figure I-7-1-1 shows the monthly average temperature during the period from 2002 through 2007 obtained at this station.

There is little change according to the year. The seasonal change in temperature is almost constant throughout the year. In winter from December to February, the transition of temperature is kept within the range from 15°C to 24°C. In the period from March to May, the temperature rises to 30°C. In the monsoon season from June to September, the temperature remains at a little below 30°C. It falls to about 24°C in October and November. The maximum monthly average temperature is 36.5°C in May 2004, and the minimum average temperature is 8.2°C in January 2003.

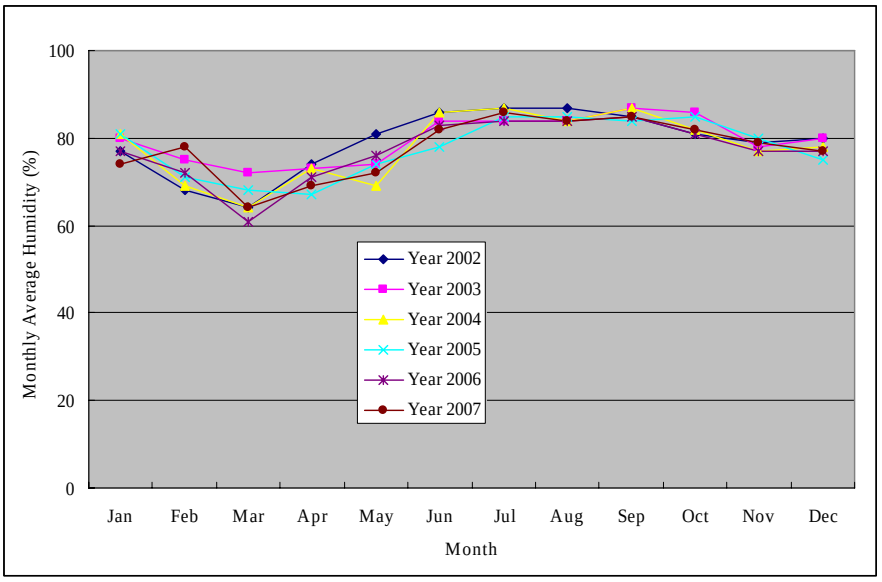


Source: the data of the Ishurdi meteorological observatory

Figure I-7-1-1 Monthly average temperature

b) Humidity

Figure I-7-1-2 shows the monthly average humidity measured at the meteorological observatory in Ishurdi.



Source: the data of the Ishurdi meteorological observatory

Figure I-7-1-2 Monthly average humidity

The seasonal change in humidity is almost constant throughout the year as well. In the winter period from December to February, humidity is reduced from about 80% to 70%. In March, humidity is reduced to the lowest level of about 60% to 70%. After that, humidity exceeds 80% during the monsoon season from June until October. A slight reduction in humidity is observed in November.

c) Precipitation

Table I-7-1-1 shows the monthly average precipitation during the period from 2002 to 2007 observed at the meteorological observatory in Ishurdi.

Table I-7-1-1 Monthly average precipitation

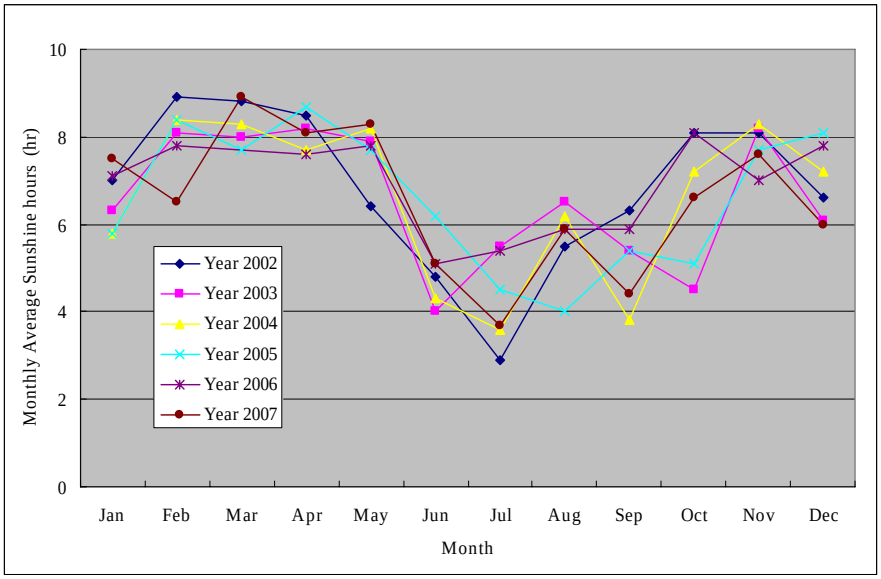
Average Precipitation	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Year 2002	15	2	62	72	177	296	253	227	240	75	47	0	1466
Year 2003	0	24	73	89	58	353	134	87	145	134	0	5	1102
Year 2004	0	0	0	127	125	292	397	156	541	151	0	0	1789
Year 2005	14	3	75	13	89	199	378	246	137	664	0	1	1819
Year 2006	0	0	2	74	213	199	233	244	277	4	40	0	1286
Year 2007	0	35	22	30	50	269	516	285	220	131	15	0	1573

Source: the data of the Ishurdi meteorological observatory

The annual precipitation reaches a level of 1,100 mm to 1,800 mm. The precipitation is mainly concentrated from July to September (October in 2005). Conversely, there is no rainfall in some of the months from November to February. As described above, there is a marked difference in the rainfall between the rainy season during the monsoon season and other dry seasons.

d) Sunshine hours

Figure I-7-1-3 shows the monthly average sunshine hours from 2002 to 2007 observed at the Ishurdi meteorological observatory.



Source: the data of the Ishurdi meteorological observatory

Figure I-7-1-3 Monthly average sunshine hours

Sunshine hours are related to rainfall. Sunshine hours tend to be reduced from June through September during the monsoon season, and tend to increase from February through May.

e) Wind direction and wind velocity

Table I-7-1-2 shows the monthly average wind velocity and prevailing wind direction from 2002 to 2007 observed at the Ishurdi meteorological observatory.

Table I-7-1-2 Monthly average wind velocity and prevailing wind direction

	Year 2002		Year 2003		Year 2004		Year 2005		Year 2006		Year 2007	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
Jan	2.1	NW	2.8	N	2.5	N	3.0	NW	2.4	NW	2.4	NW
Feb	2.7	NW	2.7	NW	2.8	N	4.2	W	3.2	W	2.6	NW
Mar	2.9	S	2.8	S	3.7	S	3.1	S	2.8	W	3.0	W
Apr	3.7	S	3.4	S	3.7	S	3.5	S	2.8	S	2.9	S
May	3.7	SE	3.4	SE	4.1	S	3.6	S	3.0	SE	2.7	S
Jun	3.9	SE	3.5	S	2.6	S	3.3	SE	2.8	S	3.2	SE
Jul	2.8	S	3.9	SE	3.8	SE	3.2	SE	4.1	SE	3.3	SE
Aug	3.3	SE	3.5	SE	4.6	SE	2.4	S	4.1	SE	3.0	SE
Sep	4.0	SE	3.4	SE	6.5	E	4.3	E	4.5	SE	3.6	SE
Oct	1.9	W	2.4	W	3.2	N	2.2	NE	2.2	N	1.9	NE
Nov	2.9	N	2.5	N	2.1	N	2.4	N	2.1	N	2.2	N
Dec	2.3	N	2.2	N	2.7	N	2.6	N	2.2	NW	2.2	NW

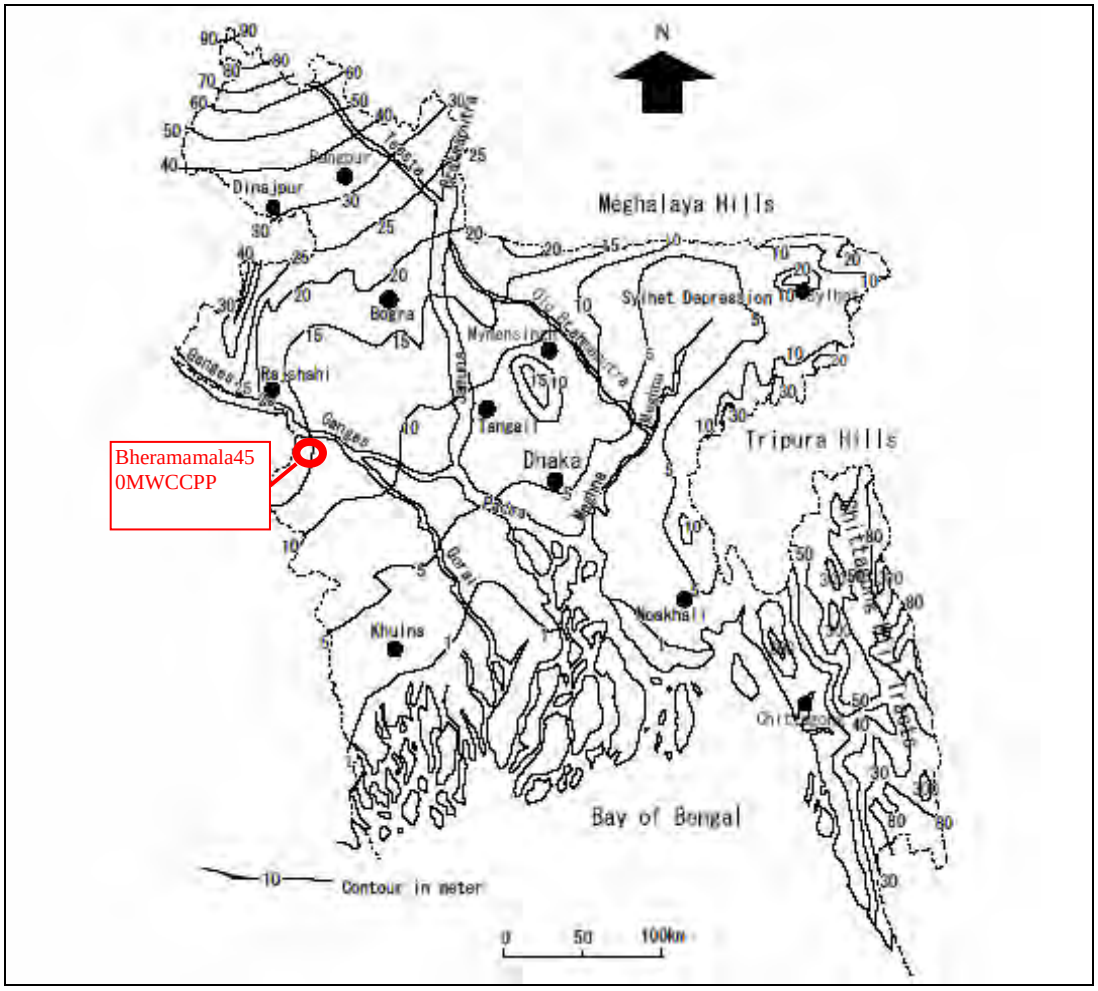
Source: the data of the Ishurdi meteorological observatory

The north to northwestern wind is prevailing in winter from October to February. The south to southeastern wind is prevailing in the monsoon season from March to September.
The wind velocity tends to increase in the monsoon season from June to September. It is the highest in September when the south to southeastern wind is prevailing. In October through February, when the west to north wind is prevailing, the wind velocity undergoes an abrupt reduction.

(2) Topography and Underground water

a) Topography and Drainage

Bangladesh borders India on the East, West, and North, and borders Myanmar to the southeast. It faces Bengal Bay in the south. The topographical features of Bangladesh can be broadly classified into the eastern hilly district centering on the hilly land of Chittagong, and the flood plain of the river accounting for the greatest proportion. They include Teesta, Jomuna, Brahmaputra, Shurma, Kushiyara, Ganges, the Ganges flood plain, and the Chittagong coastal plain and four wetlands. As shown in Figure I-7-1-4, the country is flat.



Source：: Tao OKA (2004): Flood and disaster in Bangladesh; Annual Report of Disaster Prevention Research Institute, Kyoto University

Figure I-7-1-4 Topographical features of Bangladesh

b) Geology and Soils

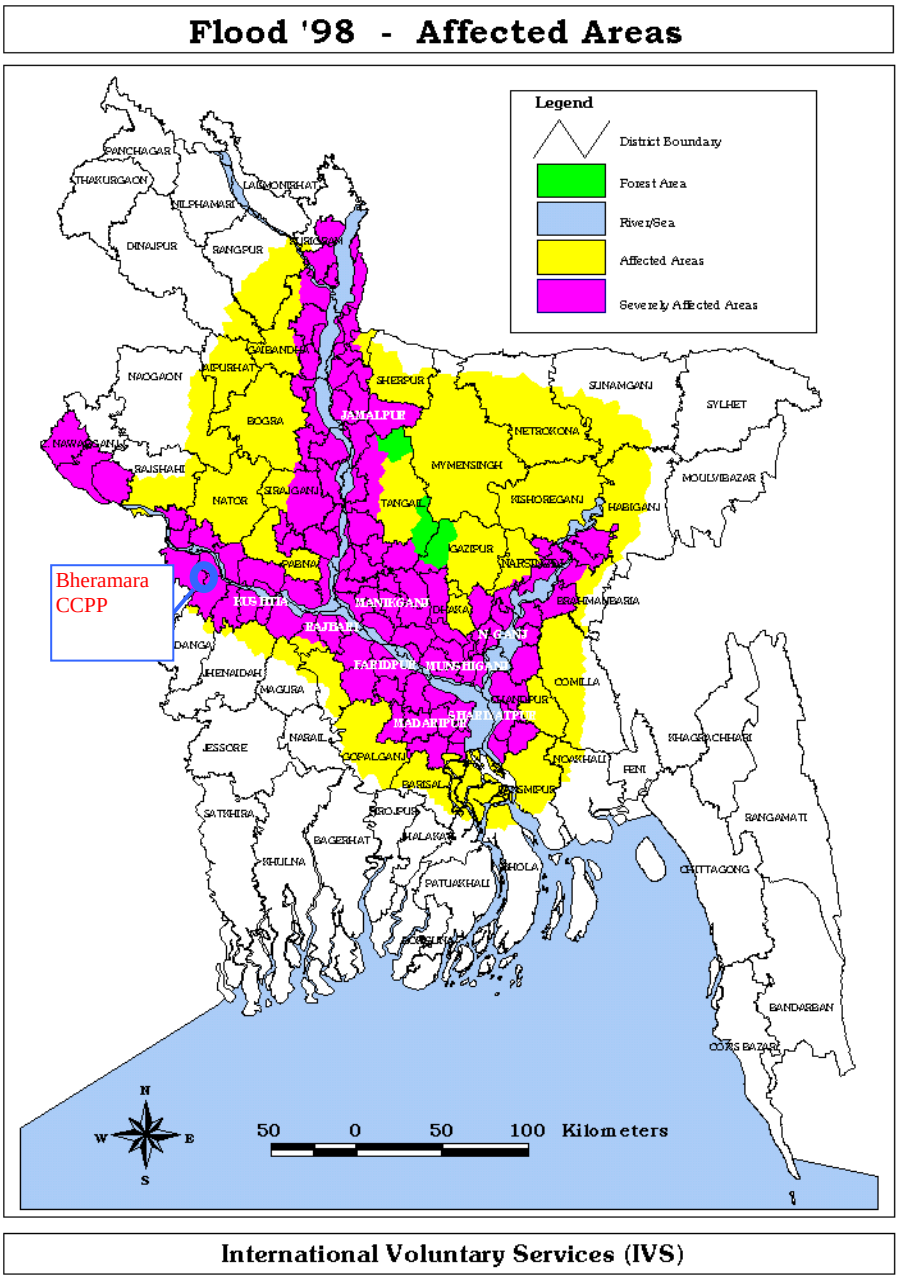
Chapter 4.6.4 shows geological condition of the Bheramara site and the surroundings.

c) Hydrology

Details concerning hydrology of Padma River which flows near the Bheramara site is described in Chapter 4.6.5. Bangladesh faces flood damage almost every year and had been hit hard in 1998.

The situation of damage is described in Figure I-7-1-5.

The annual average maximum water level at Padma River in the past has exceeded the warning level in 12 years out of 30 years. In 1998, it exceeded the warning level for more than 1 m, however, the existing power stations which have been operating for 20 years have not suffered from any flood damage.



(Source：Bangladesh Water Development Board)

Figure I-7-1-5 Area affected from massive flood damage in 1998

d) Underground water

Chapter 4.6.5 describes details of underground water at the Bheramara site and the surroundings.

(3) Air quality, noise and water quality

a) Air quality

To ensure power source and security, one sampling point for survey was in the existing power station, two sampling points were installed to the west of the existing power station and one sampling point was at an north landing place near the existing power station (Figure I-7-1-6).

As Chapter 7.1.2 described above, precipitation differs largely between the rainy season and others. Since the conditions of air quality change due to precipitation, the surveys were conducted from June 8th to 11th (dry season), and from Sep. 3rd to 6th (rainy season).

The weather conditions during the survey in June were such that the wind from the southeast to the south was prevailing and the wind velocity was as low as about 0 m/s to 2.5 m/s. Precipitation was not observed. In September, the wind from the south was prevailing and the wind velocity was as low as 0 to 2.0 m/s. Precipitation of 0.2 mm and 1.5 mm on Sep. 4th and 5th respectively were observed.

Table I-7-1-3 shows the present condition of atmospheric quality around the site. The survey results showed overall high value during the dry season compared to the rainy season. Sampling points at both dry and rainy season showed PM10, SOx and NOx to be far below the ambient air quality standards for the residential area. Even PM10 with relatively high value of concentration reached only half of its standards. From the seasonal aspect, dry season showed overall higher value compared to the rainy season. As for the survey point, the point in the north side of the existing power station showed higher value.

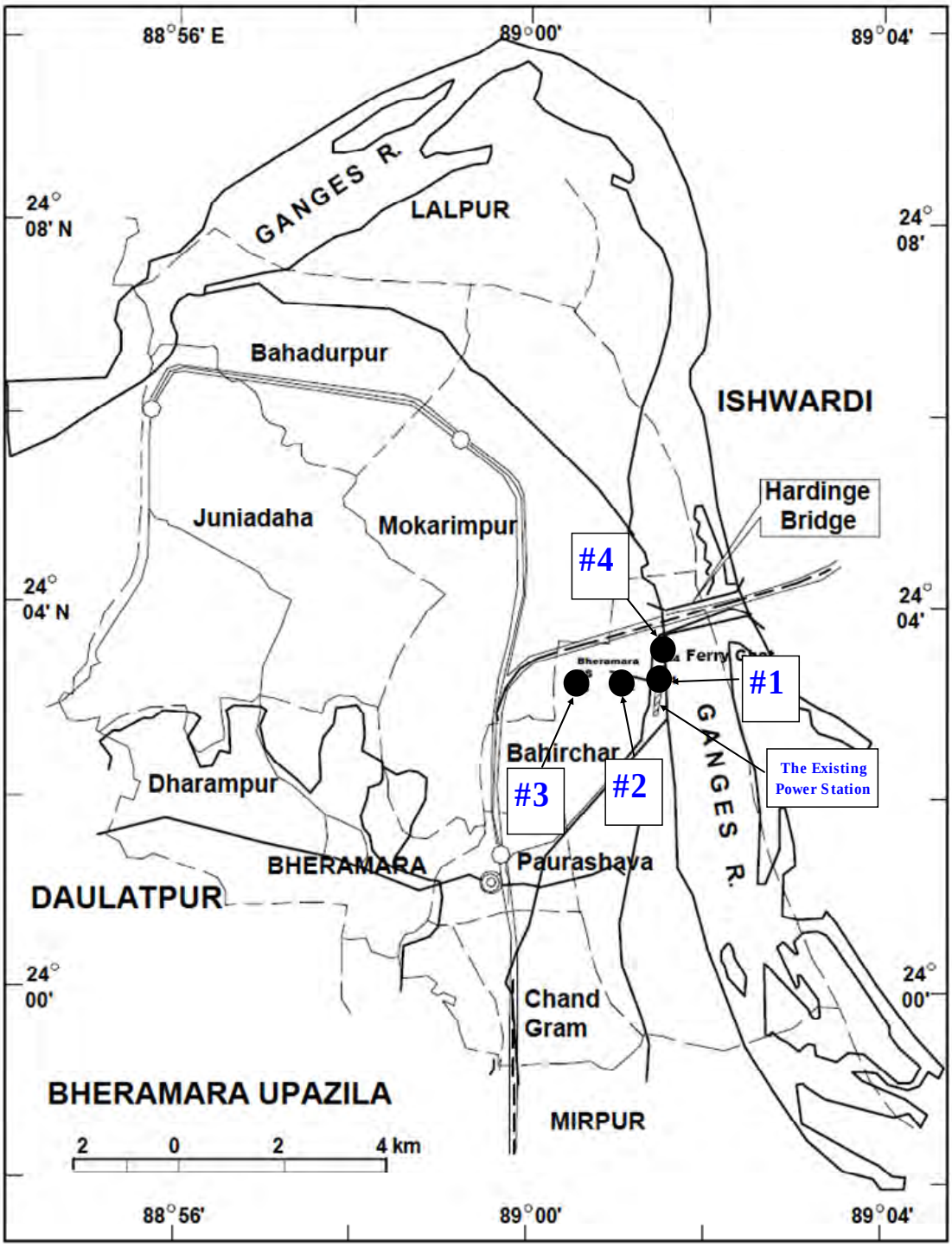


Figure I-7-1-6 Location points of measuring air quality

Table I-7-1-3 Present condition of the air quality (dry season: 2008 June 8-11)

Date	Sampling Point	Duration Time	SPM/PM_{10} $\mu g/m^3$	SPM/$PM_{2.5}$ $\mu g/m^3$	SO_X $\mu g/m^3$	NO_X $\mu g/m^3$
08/06/2008	**St-1** : Office of Manager, Bheramara Power Station, Kushtia	24 hours	105.89	51.46	17.45	21.55
09/06/2008	**St-2** : Residential Area, 1km away from Bheramara Power Station, Kushtia	24 hours	101.33	42.12	12.35	14.22
10/06/2008	**St-3** : Residential Area, 3km away from Bheramara Power Station, Kushtia	24 hours	97.45	36.44	11.25	13.75
11/06/2008	**St-4** : Ferrighat near Bheramara Power Station, Kushtia	24 hours	112.55	53.25	18.35	22.25
Bangladesh standards for Residential Area			200	-	80	80

Source: Analysed by Department of Environment, Khulna Divisional Office, Boyra, Khulna

Table I-7-1-4 Present condition of the air quality (rainy season: 2008 Sep.3-6)

Date	Sampling Point	Duration Time	SPM/PM_{10} $\mu g/m^3$	SPM/$PM_{2.5}$ $\mu g/m^3$	SO_X $\mu g/m^3$	NO_X $\mu g/m^3$
03/09/2008	**St-1** : Office of Manager, Bheramara Power Station, Kushtia	24 hours	95.05	37.80	8.9	12.7
04/09/2008	**St-2** : Residential Area, 1km away from Bheramara Power Station, Kushtia	24 hours	96.15	36.90	8.2	10.6
05/09/2008	**St-3** : Residential Area, 3km away from Bheramara Power Station, Kushtia	24 hours	89.20	32.50	7.9	10.1
06/09/2008	**St-4** : Ferrighat near Bheramara Power Station, Kushtia	24 hours	100.15	38.90	9.1	11.8
Bangladesh standards for Residential Area			200	-	80	80

Source: Analysed by Department of Environment, Khulna Divisional Office, Boyra, Khulna

b) Noise Level

Three sampling points were selected. They were located about 1 km south of the existing power station, about 1 km west of the existing power station, and about 1 km east of the existing power station(Figure I-7-1-7).

At each sampling point, measurements were carried out in the residential area and on the road side.

The environmental standards designated by Khulna environmental agency (DOE) are 70 dBA during day hour (06:00 to 21:00) and 60 dBA during night for road side. For the residential area, 55 dBA during day hour and 45 dBA during night hour.

The present situation of the noise level around the site (June 9th – 11th, 2008) is as shown in Table I-7-1-5.

All sampling points did not exceed the standards in the quiet residential area both day and night. However, there were some times when the maximum noise level exceeded the standards on the road side.

This is due to drivers honking their horns since consecutive data could not been obtained through equipment (with only direct-reading function) available for the survey.

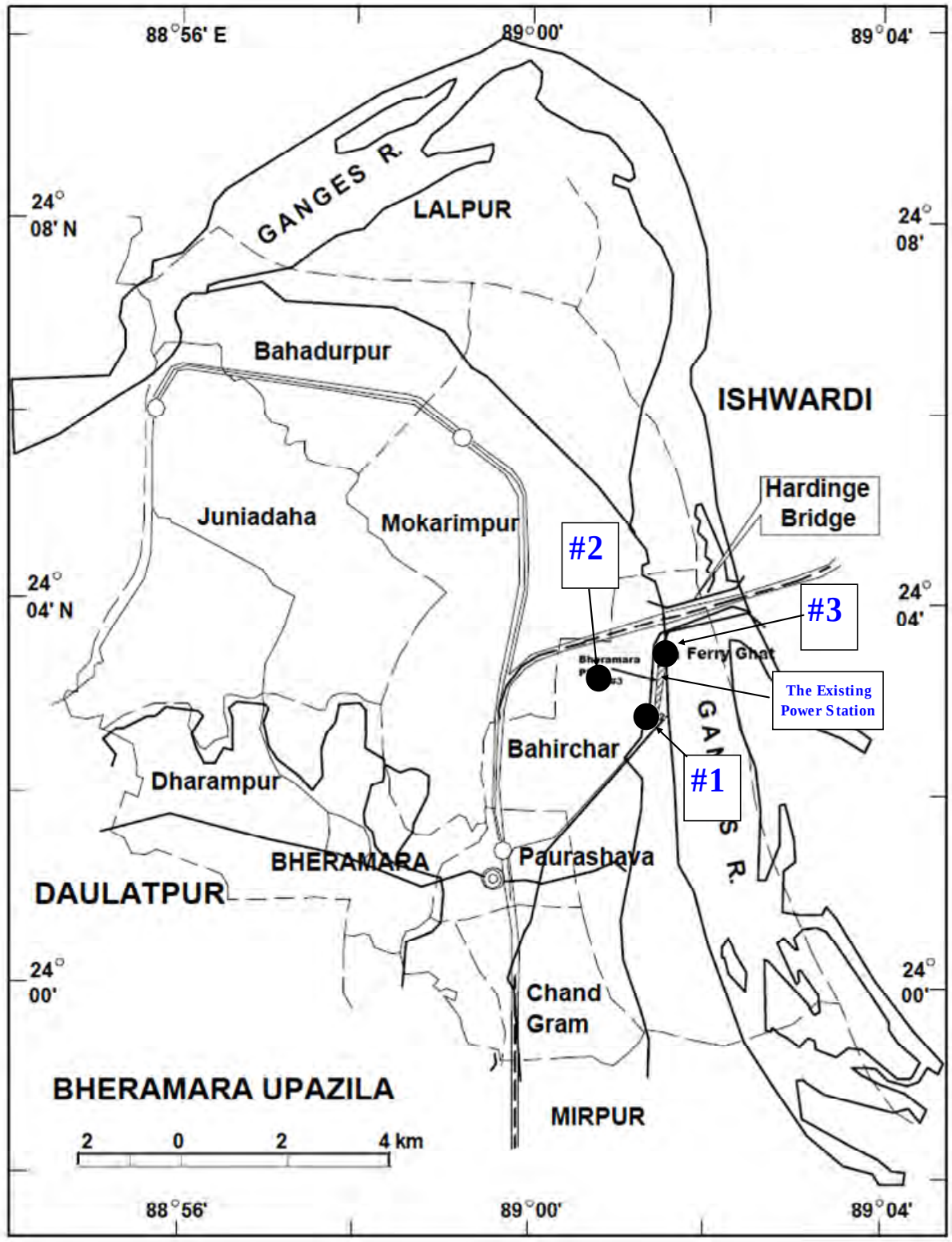


Figure I-7-1-7 Location points of measuring Noise level

Table I-7-1-5 Present condition of the noise levels

St-1 : 1km away from Bheramara Power Station (South Side)

Date	Time zone	Time	Noise Level (dBA)			
			Road Side		Residential Area	
			Maximum	Minimum	Maximum	Minimum
09/06/2008	Day	3:30pm	85	66	48	46
		4:30pm	82	62	50	48
		5:30pm	85	60	51	48
		6:30pm	84	58	47	45
	Night	9.00pm	80	55	42	40
		10.00pm	78	54	40	39

St-2 : 1km away from Bheramara Power Station (West Side)

Date	Time zone	Time	Noise Level (dBA)			
			Road Side		Residential Area	
			Maximum	Minimum	Maximum	Minimum
10/06/2008	Day	6:30am	80	52	37	35
		7:30am	85	55	40	38
		11:30am	87	58	45	40
		12:30pm	86	58	45	40
	Night	10:30pm	78	50	38	37
		11:30pm	77	48	37	35

St-3 : 1km away from Bheramara Power Station (North Side)

Date	Time zone	Time	Noise Level (dBA)			
			Road Side		Residential Area	
			Maximum	Minimum	Maximum	Minimum
11/06/2008	Day	6:30am	84	54	42	40
		7:30am	86	55	44	42
		11:30am	86	56	51	48
		12:30pm	87	60	50	48
	Night	10:30pm	78	60	44	41
		11:30pm	75	58	38	35

Source: Analysed by Department of Environment, Khulna Divisional Office, Boyra, Khulna

c) Water Quality

A total of four sampling points were selected. One point was installed in front of the channel for the GK project along the axis of the flow of the river, one point 1 km upstream thereof, one point 1 km downstream thereof, and one point 2 km downstream thereof (Figure I-7-1-8).

Table I-7-1-6 shows the present situation of the water quality in Padma River at the front of the site. At each sampling point, there was no item that exceeded the ambient water quality standards.

There was no organic contamination such as BOD, COD and DO from both seasons and from each sampling points. SS showed high for the rainy season, although this is assumed to be caused by turbid water from rainfall.

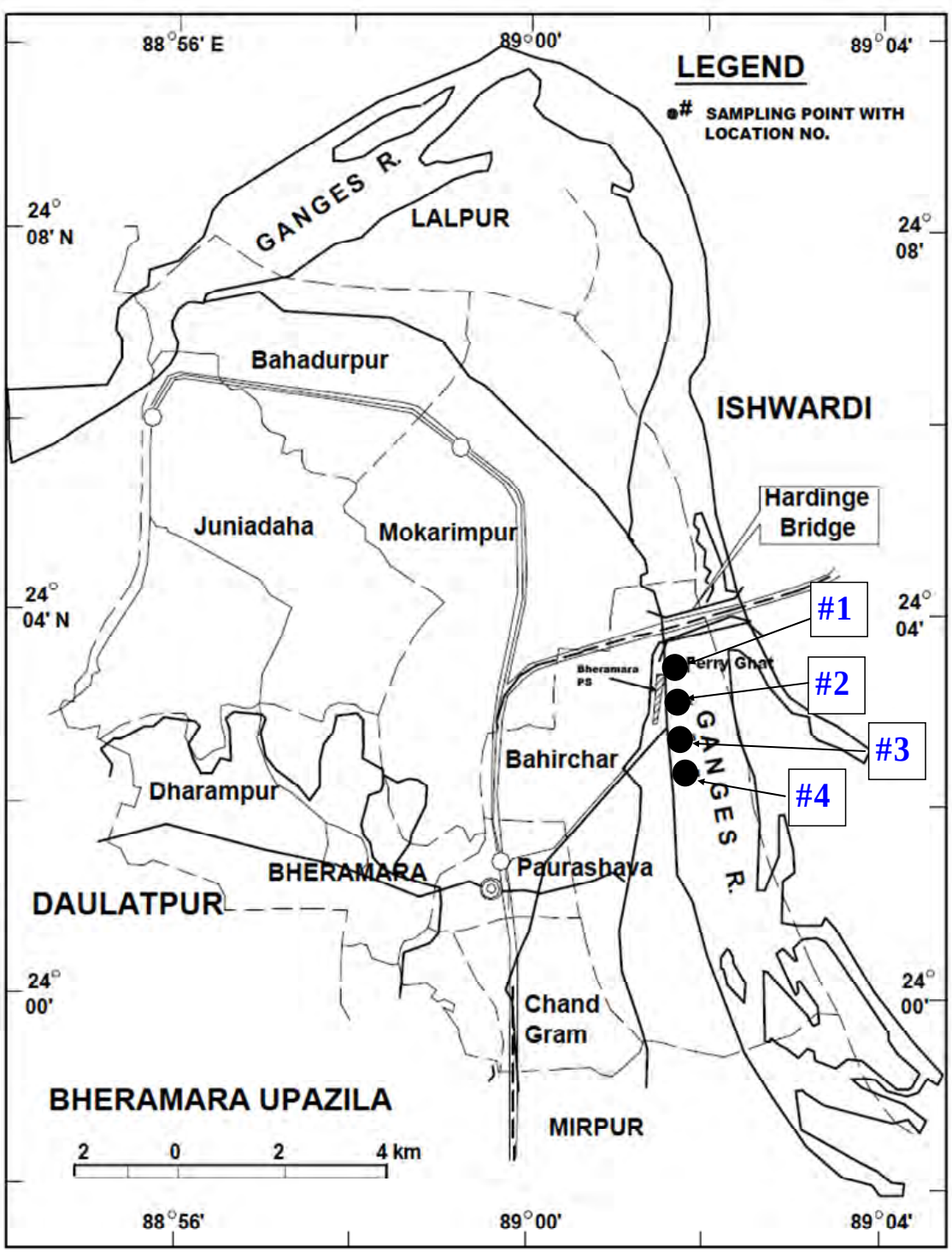


Figure I-7-1-8 Location points of measuring Water quality in river

Table I-7-1-6 (1) Present situation of the water quality (dry season: 2008, June 8th)

Item/Point	Unit	1	2	3	4	Standard Value
		Padma River near Baro Dag Ferrighat, Bheramara, Khushtia	Padma River near GK Pump house,Bheramara, Khushtia	Padma river near Moslempur North para, Bheramara, Khushtia	Padma River near Moslempur South para, Bheramara, Khushtia	
NO_3	mg/l	0.7	0.9	0.8	0.8	< 10
Sulfate	mg/l	16	21	15	18	< 400
Iron	mg/l	0.74	0.42	0.68	0.52	0.1 - 1.0
Ammonium	mg/l	0.067	0.097	0.071	0.068	< 5
BOD	mg/l	0.8	1.1	0.8	0.8	< 6
Cl	mg/l	9.996	9.996	9.996	9.497	< 650
COD	mg/l	20	32	<20	<20	
DO	mg/l	5.6	5.2	5.6	5.4	5 & above
TSS	mg/l	23	22	22	24	
Water Temperature (Surface)	℃	28.5	29.0	28.5	28.5	20-30
Water Temperature (2 m depth)	℃	27.0	27.5	27.0	27.0	
pH (Surface)	-	7.98	8.12	8.06	7.91	6.5 - 8.5
pH (2m depth)	-	8.08	8.21	8.19	7.93	

Source: Analysed by Department of Environment, Khulna Divisional Office, Boyra, Khulna

Table I-7-1-6 (2) Present situation of the water quality (rainy season: 2008, Sep. 8th)

Item/Point	Unit	1	2	3	4	Standard Value
		Padma River near Baro Dag Ferrighat, Bheramara, Khushtia	Padma River near GK Pump house,Bheramara, Khushtia	Padma river near Moslempur North para, Bheramara, Khushtia	Padma River near Moslempur South para, Bheramara, Khushtia	
NO_3	mg/l	0.6	0.6	0.6	0.6	< 10
Sulfate	mg/l	11.0	12.0	11.0	11.0	< 400
Iron	mg/l	0.22	0.24	0.27	0.22	0.1 - 1.0
Ammonium	mg/l	0.08	0.09	0.08	0.08	< 5
BOD	mg/l	0.8	0.9	0.8	0.8	< 6
Cl	mg/l	7.78	7.58	7.67	7.98	< 650
COD	mg/l	20.0	23.0	22.0	21.0	
DO	mg/l	5.6	5.5	5.6	5.6	5 & above
TSS	mg/l	40	40	40	40	
Water Temperature (Surface)	℃	30.5	30.8	30.4	30.2	20-30
Water Temperature (2 m depth)	℃	29.8	29.6	29.4	29.5	
pH (Surface)	-	7.63	7.68	7.62	7.62	6.5 - 8.5
pH (2m depth)	-	7.56	7.62	7.55	7.56	

Source: Analysed by Department of Environment, Khulna Divisional Office, Boyra, Khulna

(4) Ecological situation

a) Terrestrial Ecosystem

1) Terrestrial plants

The site does not include any forests such as a natural forest or secondary forest. Fruit trees or flowers are planted. The survey was conducted at the site and in the surrounding houses, roads, and agricultural lands. 66 species of trees, shrubs, fragrant herbs, and plants have been confirmed. The great majority of vegetation includes fruit trees such as mango, jack fruit and guava, and flowers, and plants for viewing. Table I-7-1-7 shows the list of plants having been found.

Table I-7-1-7 List of plants confirmed in the site

No.	Local Name	English Name	Scientific Name
1	Bokul		
2	Am	Mango	*Mangifera indica* L. (Anacard)
3	Kathal		*Artocarpus heterphyllus* Lamk
4	Pepe	Papaya	*Carica papaya* L (caricaceae)
5	Golap	Rose	*Rosa centifolia* L. (Rosaceae)
6	Chandan	Sandal	*Santalum album* L. (Santalaceae)
7	Mahua		*Madhuca indica* Gmel
8	Beli		*Jasmin sambac* Ait (Olea)
9	Jhau		*Thysanolaena maxima*
10	Narikel	Coconut	*Cocos nucifers* L. (Palmae)
11	Chameli		*Jasminum grandiflorum L.* (Oleace)
12	Patabahar	Patabahar	*Codiaeum variegatum*
13	Rangan		*Ixora coccinea* L. (Rubiaceae)
14	Peyara	Guava	*Psidium guajava* (L) Bat. (Myrtaceae)
15	Kola	Banana	*Musa paradisica*
16	Ipil Ipil	Ipil Ipil	*Leucaena latisiliqua*
17	Patabahar		*Acalypha welkesiana* (Euphorbiaceae)
18	Rangan		*Ixora rosea will* (Rubiceae)
19	Gashpul		*Zephyranthes tubispatha* Herb. (Amaryllidaceae)
20	Sajina		*Moringa oleifera* Lamk. (Moringa)
21	Supari	Betel leaf	
22	Jam		*Syzygium cumini* Skiel. (Myrtaceae)
23	Shimul		*Bombax ceiba* L. (Bombacaceae)
24	Kamranga		*Averrhoa carambola*
25	Jamrul		*Syzygium samraogense* (Bl.)
26	Sofeda		*Manilkara Zapota*
27	Kadbel		*Feronia limonia* (L.)
28	Bel		*Aegle marmelos* (L).
29	Tal		*Borassus flabellifer* L. (Palmae)
30	Krishnachura		*Delonix regia* (Boj.) Raf. (Leguminosae)
31	Radhachura		*Caesalpinia pulcherrima* Sw. (Leguminosae)
32	Bot	Banayan tree	*Ficus benghalensis* L. (Mora)
33	Pakur		*Ficus Infectoria*
34	Madar		*Erythriana variegata* L. var. *orientalis* Merr.
35	Jaba		*Hibiscus rosa sinensis* L. (Malvaceae)
36	Man Kochu		*Alocasia indica*
37	Kachu		*Colocasia esculenta* (L.)
38	Jambura		*Citrus grandis*
39	Dumur		*Ficus hispida*
40	Koroi		*Derris robusta* Benth.
41	Dalim		*Punica granatum* L.
42	Lebo	Lemon	*Citrus aurantifolia*
43	Mehogini		*Swietenia mahagoni*
44	Kowa nim		*Melia sempervirens*
45	Shimul		*Bombax ceiba*
46	Pui Shak		*Basella alba* L.
47	Rain tree		*Samea Samon*
48	Dol Kolme		*Ipomoea fistolosa*
49	Bansh pata		*Podocarpus nerifolia*

No.	Local Name	English Name	Scientific Name
50	Mankata		*Xeromphis spinosa*
51	Babla		*Acacia nilotica*
52	Ulatkambal		*Abroma augusta*
53	Basak		*Adhatoda zeylanica*
54	Muktajhuri		*Abroma augusta*
55	Rashun	Garlic	*Allium sativum*
56	Shatamuli		*Asparagus racemosus*
57	Neem		*Azadirachta indica*
58	Nayantara		*Catharanthus roseus*
59	Thankuni		*Centella asiatica*
60	Kalo Dhutra		*Datura metel*
61	Mehedi		*Lawsonia inermis*
62	Ashoke		*Saraca asoca*
63	Arjun		*Terminalia arjuna*
64	Methi		*Trigonella foenum-graecum*
65	Ashwagondha		*Withania somniferum*
66	Ada		*Zingiber officinale*

2) Terrestrial animals

The animals found 1 km around the site include a total of 46 species - 10 species of mammalian animals, 31 species of birds, two species of reptiles, and 36 species of amphibians. Of these, the animals given on the 2007 Red List of the International Union for Conservation of Nature (IUCN) contain two species of mammalians and two species of birds. All of them fall under the category of Least Concern (LC). Table I-7-1-8 shows the terrestrial animals having been found.

Table I-7-1-8 List of animals found 1 km around the site

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
MAMMALS				
1	Ban biral	Jungle cat	*Felis chaus kutas*	LC
2	Mecho Biral	Fishing cat	*Felis viverrinus*	
3	Biral	Cat	Felis : Catus	
4	Kukur	Dog	*Cannis Familiaris*	
5	Shial	Fox	*Vulpes vulpes*	LC
6	Sagol	Goat	*Capra Hircus*	
7	Bhera	Sheep	Bovidae : Ovis	
8	Goru	Cow		
9	Katbirali	Squirrel	Rodentia : Sciurus	
10	Khorgosh	Rabbit	Leporidae : Cuniculas	
BIRDS				
1	Chorai	Sparrow	*Passer domesticus*	
2	Kak	Crow	*Corvus splendens*	
3	Gang Shalik	Indian mynah	*Acridotheres tristis*	
4	Shalik	Indian mynah		
5	Doyel	MagJettyobin	*Copsychus saularis*	
6	Paira	Pigeon	*Columba livia domestica*	LC
7	Jalali Kobutor			
8	Dahuk			
9	Chil	Pariah Kite	*Milvus migrans*	LC
10	Finge	Black Drongo	*Dicrurus macrocercus*	

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
11	Tia			
12	Bak	Intermediate Egret	*Mesophoyx intermedia*	
13	Bali Hash			
14	Machhranga	Kingfisher	*Halcyn smyrensis*	
15	Bulbuli			
16	Tuntuni	Tailorbird	*Orthotomus sutorius*	
17	Kat Tokra	Woodpecker	*Picoides pubescens*	
18	Babui			
19	Mohan Chura.	Hoopoe	*Upupa epops*	
20	Hottiti			
21	Pan kouri			
22	Ghughu	Spotted dove	*Streptopelia chinesis*	
23	Moutusi	Sunbird	*Nectarinia zeylonica*	
24	Konch Bak.	Pond Heron.	*Ardeola grayii*	
25	Banspaati	Green Bee-eater	*merops orientalis*	
26	Shamuk Khol.	Open Billed Stork	*Anastomus oscitans*	
27	Sipahi Bulbul	Red Whiskered Bulbul	*Pycnonotus jocosus*	
28	Kokil	Asian Koel	*Eudynamys scolopacea*	
29	Rajhaans	Goose		
30	Hash	Duck	Anatidae : Anseriformes	
31	Pecha	Owl	Nocturnalis : Strigiformes	
REPTILE				
1	Tiktiki	Lizard	Sauria : Lacertidae	
2	Bezi			
AMPHIBIA				
1	Geso Beng	Canyon treefrog	*Hyla arenicolor* Cope	
2	Brischik	Scorpion	Archinida1 : Scorpionida	
3	Beng	Frog	Anura : Ranidae	

Note : Category "LC" means "Least Concern Species"

b) Aquatic Ecosystem

1) Aquatic plants

One of the oxeye (Altermanthere philoxeriodes), the swamp cabbage (Ipomoea aquatica), the bush morning glory (Ipomoea fistulosa), one of the southern naiad (Najadaceae), and the common water hyacinth (Eichhomia crassipes) have been observed in the fresh water area around the site. Also, the common duckweed (Lemna minor), the water lettuce (Pistia stratiotes), and Saipus articulatus are commonly observed.

2) Aquatic animals

The Padma River abounds with fishes and crustaceans. They are the target of the fishing industry. The crustaceans include the giant freshwater prawns (Macrobrahcium Rosenbergii), fresh water snails (Charonia Variegate) and mussels (Mytilus Edilis). The Bheramara Upazila Fisheries Department has listed 58 species of aquatic animals considered to inhabit the Padma River close to the project site. Of these, 36 species are regarded as important by the Bheramara Upazila Fisheries Department. Table I-7-1-9 lists the fishes.

Table I-7-1-9 List of fish inhabiting the Padma River

No.	Local (Bangladeshi) Name	Scientific Name	Important Species listed by Bheramara Upazila Fisheries Department
1	Hilsa	*Hilsa hilsa*	
2	Rui	*Labeo rohita*	
3	Katla	*Catla Cattla*	
4	Mrigal	*Cirrhinus mrigala*	
5	Kalibaush (kalbasu)	*Labeo calbasu*	X
6	Air/Aor (Long Whiskered cat fish)	*Aorichthys* (*Mystus*) *aor*	
7	Guijja Air (Giant River Cat Fish)	*Aorichthys* (*Mystus*) *seenghala*	X
8	Tengra (Assamese Batasio)	*Batasio tengana*	X
9	Baghair (Gangetic Goonch)	*Bagarius yanvelliisykes*	X
10	Sisor / Chenua (Sisor cat fish)	*Sisor rhabdophorus*	X
11	Cheka / Chega (Indian Chaca)	*Chaca chaca*	X
12	Ek Thota (Wrestling half beak)	*Dermogenys pusilla*	X
13	Kucha / Kuchia (Gangetic Mud Eel)	*Monopterus cuchia*	X
14	Ritha	*Rita rita*	
15	Bata	*Liza melinoptera*	
16	Khorshola	*Labeo dero*	
17	Raikh bata	*Rhinomugil corsula*	
18	Boal	*Wallago attu*	
19	Shole (snake head)		
20	Gojar/ Gojal (Giant snake head)		X
21	Pungash	*Pangasius pagasius*	X
22	Ghaura (Gaura Bacha)	*Clapisoma gaura*	X
23	Bacha(Batchwa Bacha)	*Eutropicchthys vhacha*	X
24	Shilong (Silondia V cha	*Silonla Silondia*	X
25	Bele	*Awaous grammepomus*	
26	Banshpata	*Damio devario*	
27	Piali	-	
28	Bhagna	-	
29	Golsa/ Golsa Tengra (Gangetic Mistus)	*Mystus cavaslus*	X
30	Kani Pabda / Boali Pabda (Indian Butter cat fish)	*Ompak bimaculatus*	X
31	Pabda (Pabo Cat fish)	*Ompak pabo*	X
32	Chanda / nama chanda (Elongate glass perchlet)	*Chanda nama*	X
33	Ranga Chanda / Lal Chanda (Indian Glassi Fish)	*Pseudembassis ranga*	X
34	Meni / Bheda/ Rayan/ Bheduri (Mottled nandus, mud perch)	*Nandus nandus*	X
35	Napit Koi/ Koi Banedi (Dwarf Chemeleon fish Badis)	*Badis badis*	X
36	Neftani (Indian Paradise Fish)	*Clenops nobolis*	
37	Puti	*Puntius puntio* (Hamilton)	
38	Khalisha	*Colisha faciata*	
39	Chitol (Humped Featherback	*Nototeruse chitala*	X

No.	Local (Bangladeshi) Name	Scientific Name	Important Species listed by Bheramara Upazila Fisheries Department
40	Foli (Grey Featherback)	*Notopterus notopterus*	X
41	Bamos / Baobaim (Indian Long Fin Eel)	*Anguilla bengalensis*	X
42	Elong/Sefatia(Bengal barb)	*Bengala elanga*	X
43	Kash Khaira (Indian Glass barb)	*Chela laubuca*	X
44	Tatkini/Bata/Bangla (Reba carp)	*Cirrhinuss reba*	X
45	Kala Bata (Gan Getic latia)	*Crossocheilus latius*	
46	Bhangon Bata/Bata (Bata labeo)	*Labeo boga*	X
47	Ghonia/Gonainya (Kuria baleo)	*Labeo gonius*	X
48	Nandina / Nandil (Nandi Labeo)	*Labeo nondina*	
49	Dhela/ Dipali/ ketti(Cotio)	*Osteobrama cotio*	X
50	Sarputi / Swarnaputi (Olive barb)	*Puntias sarana*	X
51	Titputi (Ticto barb)	*Puntias ticto*	X
52	Darkina (Gangetic scissortail rasbora)	*Rasbora rasbora*	
53	Rani / Beti (Necktie Loach)	*Batia dario*	X
54	Rani/ Putul /Beti (Y-Loach)	*Botia iohachata chaudhuri*	
55	Kajli / Banshpata (Jamua ailiz)	*Ailia punctata*	X
56	Telo Taki / Rana Cheng/ Ganchua (Asiatic snake head)	*Channa orientalis*	X
57	Tara Baim (One Strip spiny eel)	*Macroganthus aral*	X
58	Shal baim/ Baim /Bam(Tire track spiny eel)	*Mastecembelus armatus*	X

（Source：Bheramara Upazila Fisheries Department）

3) Protected Area, Sensitive Area

Four types of natural protected areas including national parks are stipulated in Bangladesh. There is no nature conservation area, conservation forest, or protected forest, around Bheramara.

4) Rare and Endangered Species

According to Dhaka DOE, rare or endangered species are not stipulated in the laws and regulations of Bangladesh. Some of the terrestrial animals listed in the IUCN red data were observed around the protected site of the power station, but the plants or aqueous animals and plants listed in this data have not been observed.

7.1.3 Outline of the social environment

(1) Overview of Bheramara Upazila

Table I-7-1-10 shows the overview of the socio-economic environment of Bheramara Upazila

Table I-7-1-10 Overview of the socio-economic environment of Bheramara

No.	Description	Total / Quantity
01	Area	153.69 Sq. km.
02	Population	175,480 Nos.
03	Union	6 Nos.
04	Municipality	1 No.
05	Village	84 Nos.
06	Ponds	1430 Nos. (Area 210 Hector)
07	River	3 Nos. (Area 225 Hector)

No.	Description	Total / Quantity
08	Baor / Lake	1 No. (Area 19.25 Hector)
09	Beel	9 Nos. (Area 180 Hector)
10	Canal	02 Nos. (Area 17 Hector)

(Source:Population Census 2001, Kushtia District)

a) Population

Table I-7-1-11 shows the population in each village of Bahirhar Union for 2001. The project site belongs to 12 Dag village.

Table I-7-1-11 Population of each village of Bahirhar Union

(unit: person)

No.	Villages	Male	Female	Total
01.	Chok Bheramara	488	441	929
02.	West Damokdia-1	310	275	585
03.	Char Damokdia	487	449	936
04.	East Damokdia	845	860	1705
05.	West Damokdia-2	222	232	454
06.	Power House Colony – 1	404	383	767
07.	12 Dag	713	707	1420
08.	68 Para	357	337	694
09.	Moshlempur	1227	991	2218
10.	Munshipara	597	577	1174
11.	16 Dag South	1345	1371	2716
12.	16 Dag North	1339	1373	2712
13.	West Bahirchar	2275	2059	4334
14.	Power House Colony – 2	208	145	333
15.	Bangal para	261	240	501
Total		11,078	10,440	21,478

(Source: Population Census 2001, Kushtia District)

b) Local Economy

1) Workforce

Table I-7-1-12 shows the workforce in each age category in Bheramara Union. The chart shows the situation for only men since most of the women are engaged in housework. “Not working” here stands for day workers without regular jobs. Setting aside this “ not working “ category, most of the workers are engaged in agriculture.

Table I-7-1-12 Workforce in each age category in Bheramara Union

(unit: person)

Age Group	Not Working	Agriculture	Industry	Water/Elect/Gas	Construction	TransPort/Comn.	Hotel/Restaurant	Business	Service	Others	Total
10-14	18,989	795	140	3	60	22	25	96	17	980	21,127
15-19	9,946	1,899	260	9	239	146	19	382	28	1,211	14,139
20-24	3,956	3,102	220	22	218	321	23	782	38	1,347	10,029
25-29	2,160	2,932	216	25	200	355	16	1,067	70	1,293	8,334
30-34	1,174	2,837	117	17	181	390	24	1,219	59	1,258	7,276
35-39	959	2,637	96	13	141	313	12	1,196	55	1,188	6,610
40-44	810	2,376	107	19	116	251	9	1,044	49	1,136	5,917
45-49	515	1,739	53	21	67	125	6	675	40	739	3,980
50-54	569	1,589	36	14	38	90	7	483	41	652	3,519
55-59	316	854	16	10	24	27	1	250	23	375	1,896
60-64	732	1,143	28	5	41	28	3	248	18	424	2,670
65-69	366	521	7	5	11	8	0	119	9	213	1,259
70 +	1,833	1,271	17	4	23	14	0	185	20	483	3,850
Total	42,325	23,695	1,313	167	1,359	2,090	145	7,746	467	11,299	90,606

(Source:Population Census 2001, Kushtia)

2) Farming

As table I-7-1-12 shows, that rice has huge share of area under cultivation and crop

prpduction as main agricultural products in Kushtia District. Kushtia is famous for tabacoo which is also one of the main agricultural products.

Table I-7-1-13 Cultivation and crop production for main agricultural products in Kushtia District

（Unit：Area: ha, Production : ton）

Product	Area & Production	2000 – 2001	2001 – 2002	2002 – 2003	2003 – 2004	2004 – 2005	2005 – 2006
Rice	Area	249,000	244,000	242,000	241,000	225,000	233,000
	Production	589,000	577,000	587,000	625,000	602,000	589,000
Wheat	Area	50,663	45,495	42,994	41,424	38,363	34,034
	Production	120,000	104,400	84,670	89,330	53,781	60,296
Ground -nut	Area	83	87	150	166	198	166
	Production	85	110	190	230	305	280
Sum. & Win. Til	Area	223	223	324	368	362	856
	Production	85	85	150	215	200	450
Tobacco	Area	6,880	7,817	8,266	8,571	7,806	8,335
	Production	10,270	11,625	10,375	12,960	13,985	17,505
Fruits							
Banana	Area	1,050	1,896	1,605	2,851	3,310	3,575
	Production	18,455	40,765	32,195	63,575	82,155	115,410
Mango	Area	1,364	1,372	1,378	1,386	2,326	2,401
	Production	5,035	5,050	5,895	5,890	50,790	46,965
Jackfruit	Area	1,348	1,354	1,346	1,356	331	1,157
	Production	20,165	20,185	20,075	20,345	52,795	75,400
Lichi	Area	204	243	247	271	134	137
	Production	730	790	755	705	42,570	3,770
Cocoanut	Area	506	510	514	832	208	191
	Production	2,190	2,195	2,205	3,300	8,950	10,030

Source: Statistical Yearbook of Bangladesh, 2006

3) Fishery

According to Bheramara Upazila Fisheries Department, open season for commercial fishing in Padma River is from Sep. to July. The mainly fishing area in Padma River is around 2 km up and down the streams of Hardinge Bridge. The catch amount from the fishing areas in Padma River are smaller than that of the mainly fishing area.

Riverbank on the side of the power station has an annual fish catch of around 3 tons (2007). However, fish catch is larger at the riverbank on the other side which has annual catch of around 9 tons, making totaled annual catch of 12 tons. The fishing area in the front of the power station is not major since Bheramara Upazila has total of 1300 tons of fish catch in 2007. The main fishing areas in Bheramara Upazila are canals, ponds, and so on.

According to the interview done to the fishermen around the Bheramara site, fish catch reaches the peak in October to November. Fishing methods used are mostly skimming net and trammel net with Hilsa, Rui,Katla, Puti(carp) / Pabda, Taki (catfish) as their main catches.

There are 35 fishermen around the Bheramara site. They have by-business besides fishing, as sand dredging or brick manufacture.

c) Utilization of Underground water

In farm villages, household water and irrigation water are usually supplied from the shallow wells (tube well) of 40 m to 50 m. Shallow wells in Bangladesh have a problem of arsenic contamination of underground water.

Table I-7-1-14 shows conditions of Tube wells in Bheramara Upazila.

In the Bahirchar Union including the project site, about 2000 tube wells are used by about 20,000 people. The underground water of about 95% of the tube wells is below the drinking

water quality standards concentration of arsenic (0.05 mg/L) for drinking water.

Table I-7-1-14 Conditions of arsenic contamination of tube wells in Bheramara Upazila

(unit: number of wells)

No.	Union	Number of Village	Total TW	Number of Arsenic Safe TW	Number of Arsenic Conta. TW	% of TW Conta.
01.	Bahadurpur	12	1831	1252	579	31.62
02.	Bahirhar	11	2002	1917	85	4.25
03.	Chandgram	7	1245	734	511	41.04
04.	Dharampur	12	2006	1293	713	35.54
05.	Juniadaha	15	1933	1517	416	21.52
06.	Mokarimpur	12	2381	1837	544	22.85
07.	Ward No-01	4	1069	848	221	20.67
08.	Ward No-02	2	1001	713	288	28.77
09.	Ward No-03	3	741	281	460	62.08
Upazila summary		78	14209	10392	3817	26.86

(Source:Bangladesh Sanitation Engineer, 2001)

Sanitation Engineering Department at Kushtia carried out water test around the existing power station during the year 2000-2001. Only Chloride, Iron and Arsenic were analyzed The test results are given in Table I-7-1-15. The arsenic value of drinking water standards in Bangladesh is 50 ppb, and underground water in 13 places met the drinking water quality standards.

Table I-7-1-15 Underground water Test Reports for areas around Power Station

Sl. No.	Village	Union	Chloride Mg/Litre	Iron Mg/Litre	Arsenic ppb
1.	Bilshaka	Dharampur	10	4.2	1
2.	Bhabanipur	-do-	5	6.3	2
3.	-do-	-do-	5	7.5	3
4.	-do-	-do-	10	4.7	2
5.	-do-	-do-	5	7.6	4
6.	-do-	-do-	5	3.2	5
7.	Kamirdiar	Mokarimpur	5	5.1	5
8.	Nolua	Juniadah	25	0.7	27
9.	-do-	-do-	24	2.6	14
10.	-do-	-do-	5	5.7	16
11.	-do-	-do-	5	2.6	14
12	-do-	-do-	5	4.9	14
13.	-do-	-do-	10	4.8	11

(Source: Sanitation Engineering Department at Kushtia, 2001)

d) Users of electricity

Table I-7-1-16 shows users of electricity in Bheramara Upazila. PBS means Rural Electrification Association, “Palli Bidyut Samities”.

Table I-7-1-16 Users of electricity in Bheramara Upazila

(unit: number of users)

No.	Consumers	Quantity (Nos.)		
		PBS	BPDB	Total
1.	Domestic	9,356	4,726	14,082
2.	Commercial	633	1238	1,871
3.	Irrigation/Pump	50	7	57
4.	Industry	137	120	257
5.	Mosque/Madrasa/ School /College	168	51	219
6.	HV Industry		4	4
Total		10,344	6,146	16,490

e) Education

In Bangladesh, first through fifth graders attend primary schools corresponding to Japanese elementary schools. Sixth through tenth graders attend secondary schools corresponding to Japanese junior high schools. They can be promoted from primary school to secondary school without qualifications. Further, eleventh and twelfth graders attend colleges corresponding to Japanese senior high schools. After that, they go to universities. However, they are required to pass the SSC examination (Secondary School Certification) at the time of graduating from secondary school, and the HSC (Higher Secondary Certification) at the time of graduating from college. If they fail the examination, they are not regarded as having completed the corresponding course.

Table I-7-1-17 shows rate of school attendance in Bheramara Upazila from 2001 census. Rate of school attendance is higher in the urban area compared to the rural area and the rate is higher for those older than 10 years of age.

Table I-7-1-17 Rate of school attendance in Bheramara area

（Unit：%）

Localoty	5-9 Years		10-14 Years		15-19 Years		20-24 Years		2-24 Years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Upazila	41.7	43.4	61.9	72.6	45.5	44.6	21.8	10.6	44.7	43.6
Urban	45.8	46.9	70.0	75.3	56.5	57.4	34.0	19.3	53.4	50.1
Rural	41.1	42.8	60.4	72.1	43.2	41.7	19.4	8.8	43.1	42.4

(Source: Population Census 2001, Kushtia)

f) Medical Treatment

According to Bheramara Upazila Statistics Office, a total of 17 medical institutions including public institutions, private hospitals, and NGO clinics are found in Bheramara Upazila in March 2008.

g) Heritage

Kushtia District has two cultural heritages, which do not belong to Bheramara Upazila but to other Upazila.

(2) Social environment around the Bheramara site

In the vicinity of the site, the interview survey was conducted to study more detailed social environments. Questionnaires is attached on Appendix-1. This is written in English, although the original ones to be in Bengali.

The area in the vicinity of the site was divided into three categories(Figure I-7-1-9). The following households were assigned for each category.

Category A: All 8 households (workers at the existing power station) in the Bheramara site were assigned
Category B: 72 households to the east of the Bheramara site were assigned
Category C: 130 households in about 300 households to the north of the Bheramara site were assigned.

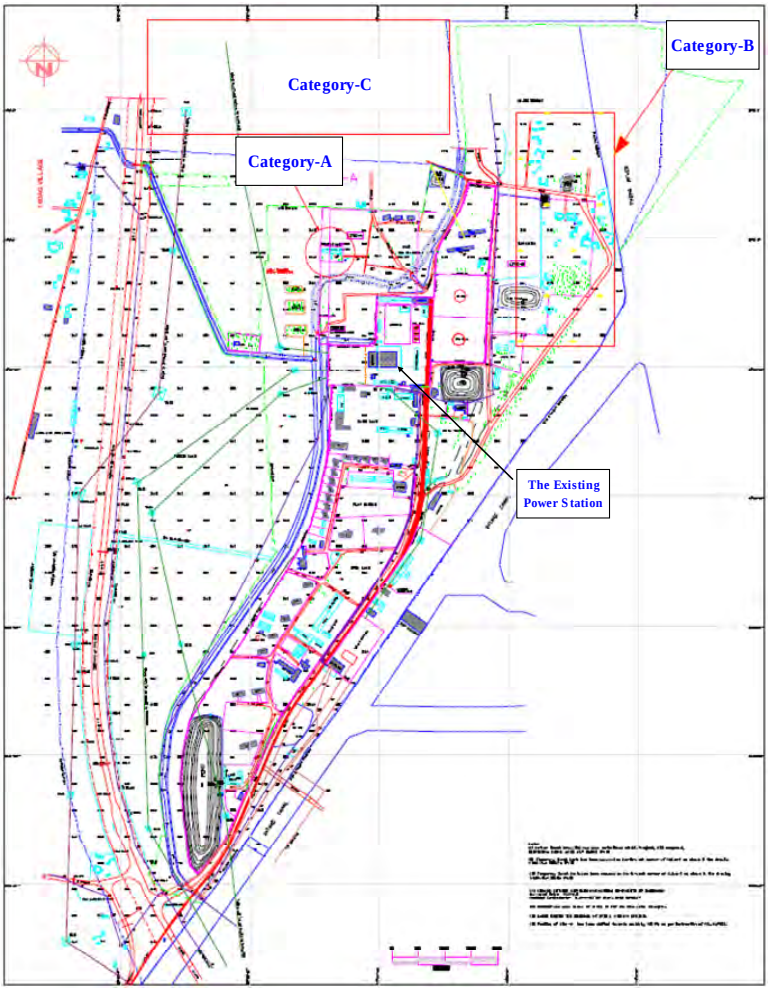


Figure I-7-1-9 Location of interview survey

a) Land utilization and possession

Farm lands and paddy fields lie in the west and north side of the existing power station. The Bheramara site is located to the north of the existing power station, with farmland and government quarters for workers engaged in work at the existing power station.

As shown in photo No.2, Figure I-7-1-10, irrigation channel is connected to the Bheramara site. There is a request from the existing power station for securing this channel. There is a farm road which can be used on foot at the embankment of the channel. The Bheramara site is owned by BPDB. The north side of the site is private land and the area adjacent to the Bheramara site in the west of the site is owned by BWDB. Any land further than that are all private land.

In the vicinity of the site, all 8 households of Category-A do not own land, whereas all 130 households of Category-C own land. Of the 72 households of Category-B, only one person owns land. However, the land which the owner has exists in 16 Dag Villages 500m apart

from the Bheramara site.

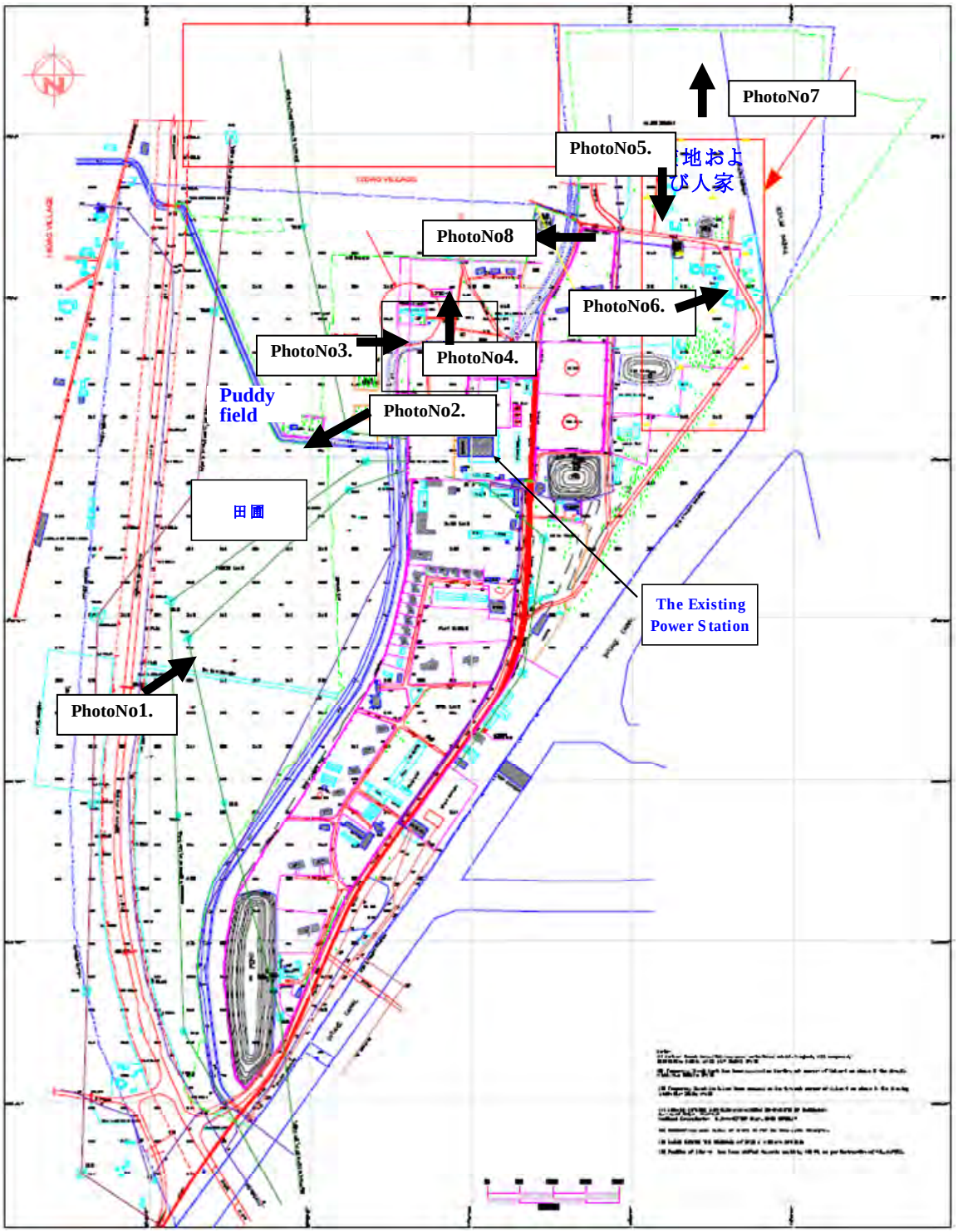


Figure I-7-1-10 Land utilization around the project site

PhotoNo1.

PhotoNo2.

PhotoNo3.

PhotoNo4.

PhotoNo5.

PhotoNo6.

PhotoNo7.

PhotoNo8.

b) Utilization of Under Underground water

5 households in Category-A, 72 households in Category-B and 130 households in Category-C all use tube wells for their drinking water.

Existing tube well survey was conducted in Bahirchar Union.

Following three (3) types of tube wells are running in the Union.

- Hand tube well (HTWs) :
  approx. 0.3 L/sec (0.02m3/min) of discharge rate, 8 - 16 m of depth and for domestic potable water
- Shallow tube well (STWs) :
  approx. 15 L/sec (0.9m3/min) of discharge rate, 40 - 50 m of depth and for irrigation
- Deep tube well (DTWs) :
  approx. 160 m^3/hour of discharge rate, 90 - 100 m of depth and for irrigation

HTWs could not suction more than one atmospheric pressure (10 m water height) in principle and could operate only in suction limit of approximately 7.5 m. As mentioned in Chapter 4.6.5 above, the groundwater level in dry season almost reaches the suction limit of hand tube well. However, no HTWs which could not suction in dry season was found by this survey.

The result of existing tube well survey in Bahirchar Union is shown in Table I-7-1-18 and tube well survey map of Bahirchar Union is shown in Figure I-7-1-11.

Table I-7-1-18 Result of existing tube well survey

No.	Geo Code	Locality	Area (km^2)	House Hold (nos)	Population (2001) (Head)	HTWs	STWs	DTWs	Water Bodies (nos)
30	213	Chak Bheramara	0.81	196	929	151	4	1	11
165	307	Char Mokarimpur	4.04	122	492	79	9		13
168	331	Char Ruppur	1.28	28	346	18	6		17
29	355	Damukdia	2.97	647	3,095	415	8	2	12
		Char Damukdia		181	936	173	3	1	4
		Purba Damukdia		365	1,705	166	3		5
		Paschim Damukdia		101	454	76	2	1	3
166	902	Pashchim Bahirchar	12.88	3,412	16,889	2,077	5	5	53
		Powerhouse Coloney		175	767	28			1
		Bara Dag		279	1,420	277	1	1	4
		68 Para		141	694	109		1	3
		Mo slempur		444	2,218	153	1		3
		Munshi Para		241	1,174	185			4
		Sholadag Dakshinpara		552	2,716	437	1		8
		Sholadag		551	2,712	274			9
		Paschim Bahircar		856	4,334	456	2		13
		Pumphouse Coloney		70	353	112		3	6
		Bengal Para		103	501	46			2

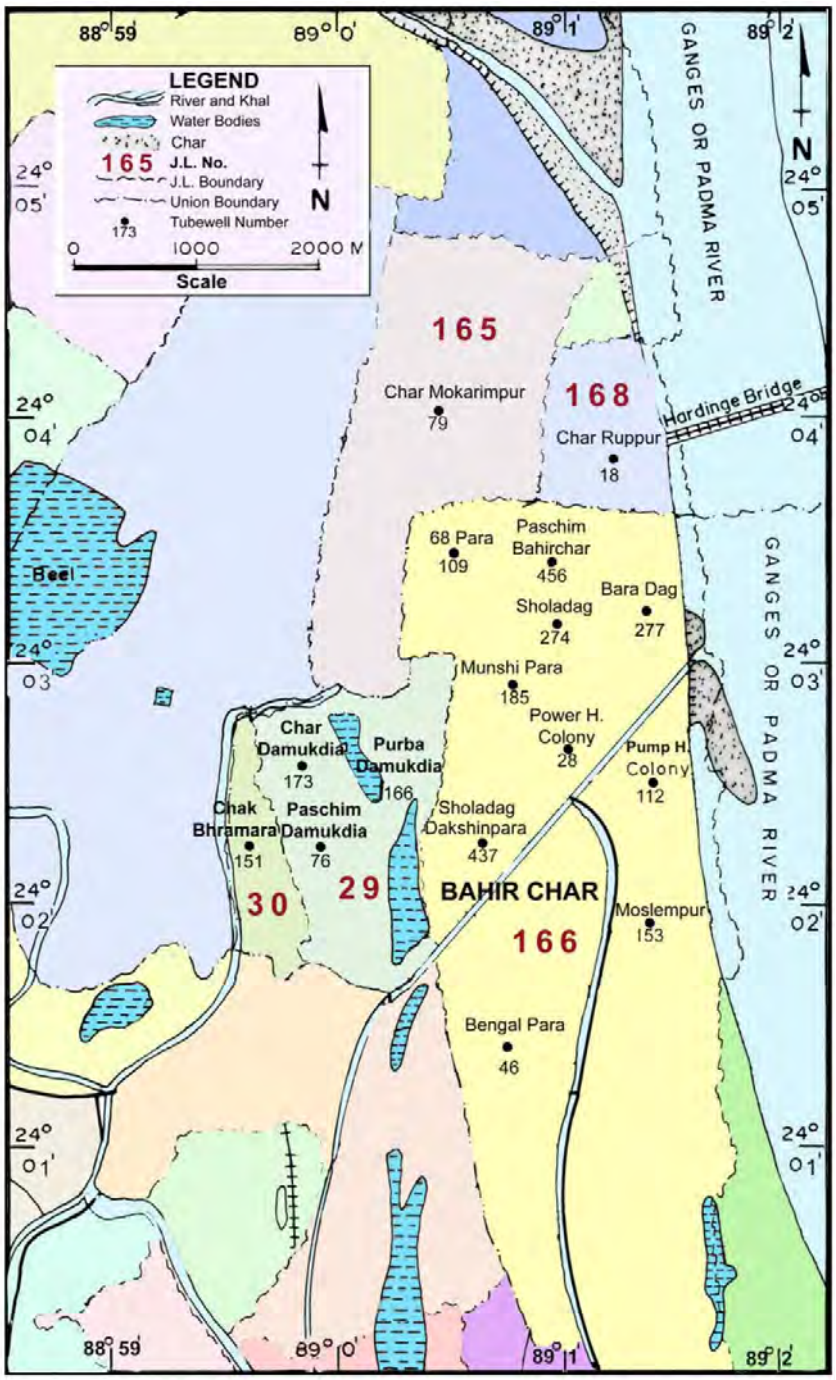


Figure I-7-1-11 Tube well survey map

c) Landscape

As shown previously in photo No.3 and No.4, there are farmlands and houses in the Bheramara site. The houses are included in Category-A. The residents are staff members or their relatives engaged in work related to the existing power station. The new government

quarters for them to reside will be taken care by BPDB.

d) Demographic Characteristics

Table I-7-1-19 shows the members of all the households interviewed in the survey in the vicinity of the site, according to age bracket. In the survey, the age of several persons was not clear.

Table I-7-1-19 Households interviewed in the survey, according to age bracket

(unit: person)

Range	Category-A	Category-B	Category-C
0 – 10	12 (22.2)	51 (16.9)	115 (18.7)
11 – 20	13 (24.1)	86 (28.4)	122 (19.9)
21 – 30	13 (24.1)	49 (16.2)	138 (22.5)
31 – 40	6 (11.1)	55 (18.2)	97 (16.0)
41 – 50	5 (9.2)	31 (10.3)	56 (9.1)
51 – 60	1 (1.9)	17 (5.6)	42 (6.8)
Above 60	4 (7.4)	13 (4.3)	44 (7.2)

Note: ( ) shows % of households of each category

e) Education, Employment and Incomes

1) Education

Table I-7-1-20 shows the education background of the head person of households. Class-I though -V includes people who attended primary school, and Class-VI through -X includes people who attended secondary school without success in passing the SSC test. BA/MA indicates the people graduated from universities.

Table I-7-1-20 Education background of the heads of households

(unit: households)

Class	Category-A	Category-B	Category-C
Illiterate	7 (87.5)	57 (79.2)	44 (33.8)
Class-I to V	1 (12.5)	8 (11.1)	30 (23.1)
Class-VI to X		6 (8.3)	37 (28.5)
SSC/HSC		1 (1.4)	14 (10.8)
BA/MA			5 (3.8)
Total	8	72	130

Note: ( ) shows % of households of each category

2) Employment

Table I-7-1-21 shows the employment of the head person of households. Categories-A

and -B include a higher percentage of daily employees and Category-C includes the greatest number of regular employees. Categories-A and -C include a great number of people engaged in the service business, and Category-C includes many farmers. The 8 households in Category-A are engaged in the service business related to the power station or daily employment. However, the 8 households in Category-A live in the government quarters.

Table I-7-1-21 Employment of the heads of households

(unit: households)

Occupation	Category-A	Category-B	Category-C
Business		9 (12.5)	39 (30.0)
Day Labour	3 (37.5)	41 (56.9)	17 (13.1)
Domestic		1 (1.4)	
Driver		4 (5.6)	2 (1.5)
Farmer			21 (16.2)
House Wife		1 (1.4)	13 (10.0)
Maid Servant		3 (4.2)	
Overseas Job			2 (1.5)
Retired			9 (6.9)
Service	5 (62.5)	1 (1.4)	21 (16.2)
Skill Labour		2 (2.8)	4 (3.1)
Teacher		1 (1.4)	
Unemployed		3 (4.2)	
Van Puller		6 (8.3)	2 (1.5)
Total	8	72	130

Note: ( ) shows % of households of each category

3) Income

Table I-7-1-22 shows the income and expenses of the households. The income is approximately the same as the expenses, however, one of the households in Category-B spends only 50% of its income. Generally, the income of Category-C is the highest, and that of Category-B is the lowest. One of the households in Category-B includes a household without income.

Table I-7-1-22 Monthly income and expenses of each household

(unit: cost(Taka), households)

Range	Category-A		Category-B		Category-C	
	Income	Expenditure	Income	Expenditure	Income	Expenditure
0 – 1999			5 (6.9)	5 (6.9)	1 (0.8)	1 (0.8)
2000 – 3999			19 (26.4)	24 (33.3)	4 (3.1)	7 (5.3)
4000 – 5999	2 (25.0)	2 (25.0)	27 (37.5)	31 (43.1)	5 (3.8)	10 (7.7)
6000 – 7999	1 (12.5)	1 (12.5)	17 (23.6)	10 (13.9)	18 (13.8)	26 (20.0)
8000 – 9999	1 (12.5)	2 (25.0)	2 (2.8)		19 (14.6)	14 (10.8)
10000 – 11999	2 (25.0)	1 (12.5)		1 (1.4)	9 (6.9)	16 (12.3)
12000 – 13999	1 (12.5)	1 (12.5)	1 (1.4)		17 (13.1)	12 (9.2)
14000 – 15999				1 (1.4)	11 (8.5)	8 (6.2)
16000 – 17999					5 (3.8)	9 (6.9)
18000 – 19999	1 (12.5)	1 (12.5)			6 (4.6)	5 (3.8)
20000 – 21999					10 (7.7)	4 (3.1)
22000 – 23999					1 (0.8)	3 (2.3)
24000 – 25999					7 (5.3)	5 (3.8)
26000 – 27999					1 (0.8)	2 (1.5)
28000 – 29999					1 (0.8)	1 (0.8)
30000 – 31999			1 (1.4)		5 (3.8)	2 (1.5)
32000 – 33999						
34000 – 35999						
36000 – 37999					1 (0.8)	2 (1.5)
38000 – 39999						
40000 – 44999					6 (4.6)	
42000 – 43999						1 (0.8)
44000 – 45999					1 (0.8)	
46000 – 47999						1 (0.8)
48000 – 49999						
50000 -					2 (1.5)	1 (0.8)
Monthly Average	9737.50	9687.50	4856.00	4308.00	16317.00	13390.00

Note: ( ) shows % of households of each category

4) Furniture and durable

Table I-7-1-23 shows the main furniture and durable owned by the households .Not all

households owned electrical appliances, especially in Category-B showed very few. Some households owned not only land vehicles but also boats as means of transportation.

Table I-7-1-23 Main Furniture and durable owned by the households

(unit : households)

Furniture and Durable	Category-A	Category-B	Category-C
Radio		14 (19.4)	41 (31.5)
Television	5 (62.5)	7 (9.7)	78 (60.0)
Bi-cycle	1 (12.5)	11 (15.3)	63 (48.5)
Motor cycle		1 (1.4)	17 (13.1)
Sewing machine		1 (1.4)	23 (17.7)
MobilePhone	2 (25.0)	24 (33.3)	82 (63.1)
Land Phone			5 (3.8)
Refrigerator	2 (25.0)	1 (1.4)	15 (11.5)
Truck			5 (3.8)
Rickshaw/van		11 (15.3)	7 (5.4)
Boat		1 (1.4)	17 (13.1)
Clock	6 (75.0)	15 (20.8)	102 (78.5)
Almirah	1 (12.5)	15 (20.8)	100 (78.5)
Cot /bed	8 (100)	72 (100)	130 (100)
Chair/ bench	8 (100)	62 (86.8)	123 (94.6)

Note: ( ) shows % of households of each category

5) Sanitation

a. Health

Table I-7-1-24 shows the type of toilet facilities used by the households. All households in Category-A. 50% of the households in Category-B use Slab Latrin, although it is not the type with tanks but underground seepage type.

Table I-7-1-24 Type of toilet facilities used in each household

(unit : households)

Type	Category-A	Category-B	Category-C
Safety Tank/ Modern Tiolet	8 (100)		68 (52.3)
Slab Latrin		50 (69.4)	44 (33.8)
Open Latrin		18 (25.0)	10 (7.7)
Suspeded Latrin		1 (1.4)	8 (6.2)
Open Yard		3 (4.2)	
Total	8	72	130

Note: ( ) shows % of households of each category

b. Medical institutions

Table I-7-1-25 shows the medical institutions used by the ill residents. Residents of Category-A use public facilities due to their involvement with the power station. Probably because the residents of Category-C have been living there for a long period of time, they appear to have private physicians.

Table I-7-1-25 Medical institutions to be used

(unit: households)

Item	Category-A	Category-B	Category-C
Govt. Hospital	8 (100)	49 (68.1)	48 (37.0)
Private Physician		23 (31.9)	82 (63.0)

Note: ( ) shows % of households of each category

6) Transportation

Table I-7-1-23 shows households with land vehicles (including motor cycles), although only few own them. It can be presumed that the major means of their transportation is either by bicycle or on foot.

7) Others

a. Electrification rate

Table I-7-1-26 shows the electrification rate. All households in Category-A and close to 90% of the households in Category-C have been electrified, whereas only one house in Category-B is electrified.

Table I-7-1-26 Electrification rate of the households

(unit : households)

Item	Category-A	Category-B	Category-C
Electrified	8 (100)	1 (1.4)	114 (87.7)
Non-electrified		71 (98.6)	16 (12.3)

Note: ( ) shows % of households of each category

b. House building materials

Table I-7-1-27 shows house building materials for each household. Bricks are used in Category-A since they are government quarters. Many houses in Category-C use bricks, however, houses for Category-B are much more simple with tin or bamboo roofs and clay floors.

Table I-7-1-27 House building materials for each households.

(unit:households)

Homestead	Category-A	Category-B	Category-C
Roof			
Tin	8 (100)	72 (100)	121 (93.1)
Other			9 (6.9)
Total	8	72	130
Wall			
Brick	8 (100)	20 (27.8)	97 (74.6)
Tin		24 (33.3)	10 (7.7)
Bamboo and jute stick		12 (16.7)	10 (7.7)
Leaves		3 (4.2)	
Clay		4 (5.6)	13 (10.0)
Jute Stick		9 (12.5)	
Total	8	72	130
Floor			
Concrete	8 (100)	4 (5.6)	85 (65.4)
Clay		68 (94.4)	45 (34.6)
Total	8	72	130

Note: () shows % of households of each category

c. Fuel

Table I-7-1-28 shows fuels used for cooking in households. Since several types of

fuels are used, answers are multiple.

Main fuels are wood and crops waste, although, only few households in Category-B use wood.

Table I-7-1-28 Fuel used for cooking

(unit : households)

Cooking Fuel	Category-A	Category-B	Category-C
Wood	8 (100)	32 (44.4)	126 (96.9)
Crops Waste	8 (100)	71 (98.6)	123 (94.6)
Cow Dung	7 (87.5)	15 (20.8)	73 (56.2)
LPG			1 (0.8)
Electric Heater	1 (12.5)		
Kerosine			3 (2.3)

Note: ( ) shows % of households of each category

d. Change of address

A survey was conducted to check for previous changes in address. The members of all 8 households of Category-A and 119 households of Category-C have long been living at the present address, whereas the members of 72 households of Category-B have changed their addresses. This is because 42 households lost their previous land for some reason and 25 households lost their residents due to the flood of other places in the Padma River. However, currently they live here without having any periodical changes in their addresses. Category-B has no family members and relatives who come to live with (e.g. to use the place as shelter during the rainy season) them periodically.

There are also no family members moving to the Bheramara site other than the current residents.

The local government will take responsibility in the care of the refugees of flood, for example, and therefore BPDB has no intention to acquire a site for potential refugees. However, BPDB is willing to cooperate fully with the local government if required.

7.2 EIA related Laws and Regulations

Followings are national strategy, policy, ordinance and regulation in Bangladesh.

1) Environment Pollution Control Ordinance, 1977
2) Environmental Standards in Bangladedsh1991
3) National Conservation Strategy (NCS), 1992
4) Environmental Policy, 1992

5) National Environmental Management Action Plan “NEMAP”, 1995
6) Environmental Conservation Act, 1995
7) Environmental Conservation Rules, 1997

The basis for the Environmental impact Assessment related laws and regulations is the Environmental Policy which is the major outline of the policy, stating the environmental policy, framework and system of laws in 15 fields. It also stipulates implementation of policy by the National Environment Committee and legal status of the Department of Environment （DOE） which implements EIA.
Bangladesh also has joined, ratified and signed for major international agreement, treaty, and protocol regarding environmental protection and conservation of natural resources.

1) Rio Declaration, 1992
2) Convention on Biological Diversity, Rio de Janeiro, 1992
3) Convention on Wetland of International Importance Especially as Waterfowl Habitat, 1972
4) United Nations Convention on the Law of the sea, Montego Bay, 1982
5) Convention relative to the Preservation of Fauna and Flora in their Natural State, 1933
6) International Convention for the Protection of Birds, 1950
7) International Plant Protection Convention, 1951

7.2.1 EIA Regulations and procedures

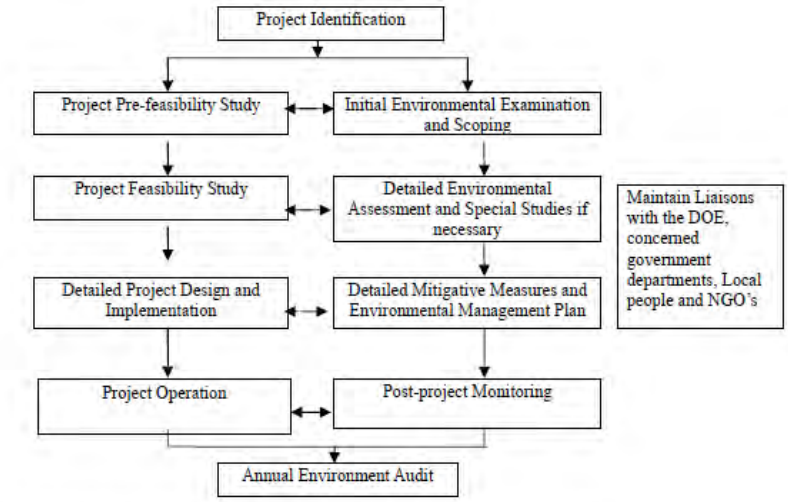
The procedures and requirements for the power station division indicated by EIA is to adopt the Environmental Conservation Act, 1995, which stipulates the requirement of advance approval by the Environmental Agency against all “industrial facilities or project”. Under the Environmental Conservation Act, Department of Environment divides the intended projects for screening into 4 categories (Green, Amber-A, Amber-B, Red).
The construction of the power station is categorized as Red which automatically requires IEE and subsequently, the comprehensive EIA. Based on the assumption that sufficient review on Environmental Assessment has been done, approval for the implementation of the project will be issued.
EMP is the main requirements by EIA on projects categorized as Amber-B and Red. The role of EMP is to give explanation to the Department of Environment on ways of businesses to carry on the environmental performance assessed by EIA. EMP must state detailed scope of responsibility of the organization and the management, on how the mitigation measures to be implemented and on how the monitoring to be implemented. Even after obtaining approval from the Department of Environment, businesses are required compliance with the environmental regulations.
Projects categorized as Red need to implement IEE. The procedures are as follows.

1) Collect baseline information on the project itself and environment of the project and its site.
2) Specify important items on IEE
3) Suggest mitigation measures based on EIA, EMP, and alternative land and points of improvement on other projects.
4) TOR (Terms of Reference) by EIA

After completing the IEE report, businesses need to apply for Site Clearance to the Department of Environment for approval. Construction can start after obtaining this approval.
Further more, attachment of the followings are required for procedures of submission and approval of EIA report.

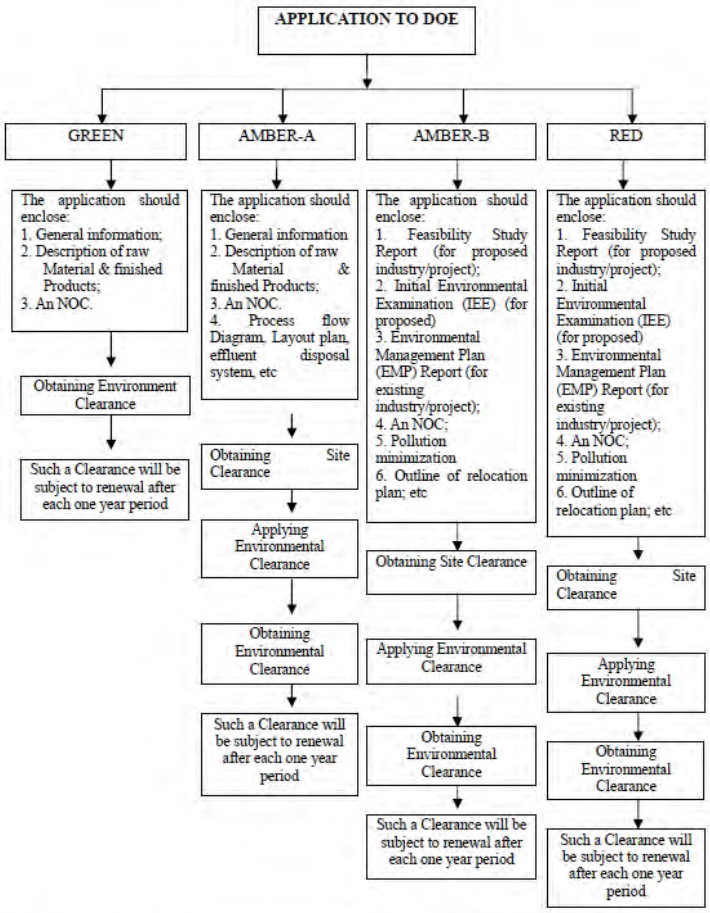
- FS survey report on the feasibility of the project
- EIA report
- NOC (No Objection Certificate) from the local government
- Management plan including emergency response plan for suppressing harmful impact on the environment
- If relevant, outline of resident relocation plan
- Other information judged necessary

After obtaining approval on EIA report, permit approval on ECC “Environmental Clearance Certificate” is necessary in order to gain final Environmental Clearance before commencement of commercial operation. As stated earlier, the environment clearance is renewed every year as part of the procedure. Conditions for renewal are to meet the standards required by DOE at the time of the initial approval and to pass DOE inspection every year.
Figure I-7-2-1 and Figure I-7-2-2 are flow charts showing the procedures.



出典："EIA Process ", EIA Guidelines for Industries, Department of Environment, 1997

Figure I-7-2-1 Flow chart for EIA implementation process



出典："EIA Flow Chart", EIA Guidelines for Industries, Department of Environment, 1997

Figure I-7-2-2 Flow chart for procedures on each category

7.2.2 EIA related organizations

The main government agency for administration on the environment of Bangladesh is MoEF, handling all issues related to policies and regulations on domestic environment. In response to this gain of significance on environmental issues, MoEF has been established in 1989 to replace the Forestry Agency. It is now a permanent member of executive committee for National Economic Council. This group is a major decision making body for economic policy issues with responsibility to approve government funded projects.

- Department of Environment (DoE)
- Department of Forestry (DoF)
- Forest Industries Development Corporation (FIDC)

The government has formulated Environmental Pollution Control Act, 1977, in order to expand the scope and to enforce implementation on environmental management. Based on this act, plan to build Environmental Pollution Control Board was suggested. The aim of this board is to suggest policy decision and implementation measures.
In 1982, the board name has been changed to Department of Environmental Pollution Control (DEPC). Division offices were established in 6 areas which are Dhaka, Chittagong, Khulna, Barisal, Sylhet, and Rajshahi.
The name has been changed to Department of Environment (DOE) from DEPC under special order by the minister and went under the jurisdiction of MoEF in 1989.
DOE is a department of Environment and Forestry Ministry, represented by Director General (DG). DG is the head of DOE.
Followings are prerogatives of DG which is stipulated by law.

- DG hold prerogatives to cease any activities deemed to have harmful affect to human lives or to the environment. Business operators have the right to appeal. Procedures for doing so is stipulated, although, there is no opportunity for appealing unless the urgency is admitted.
- DG has the prerogatives to declare contaminated district as natural life preservation district. Environmental Agency manages the activities and schedules in those districts.
- Upon development of new project, obtaining Environmental Clearance is necessary. The procedures of obtaining those permits are previously noted.

If failed to comply with ECA, 1995, maximum of 5 years in prison or/and maximum of 10 million Taka as a penalty will be imposed.
Forest Agency under Environment and Forestry Ministry hold responsibility to protect and manage all protected national forests. The staff members of the Agency are spread widely in districts and unions which possess protected forests. Agro forestry program has just recently

started. Board members of the Forestry Agency are responsible for protection of wildlife within the forests.
Other organizations relating to the environmental roles are:

- Ministry of Land : Land Reform and Land Acquisition Directorate
- Bangladesh Water Development Board (BWDB)
- Ministry of Fisheries and Livestock : Directorate of Fisheries

There will be no private land acquisition since the suggested Bheramara site for the power station is owned by BPDB and BWDB. Although, acquisition of small agricultural land (private land) in order to install transmission line and gas pipeline is necessary. For these land acquisition, under the following laws and regulations, the above noted Ministry of Land is to compensate instead of the business operators in Bangladesh.

・The land acquisition act,1894
・The acquisition and requisition of immovable property ordinance, 1982
・ The acquisition of immovable property rules, 1982
・ The electricity act, 1910

According to the electricity act, 1910, compensation could be made for the standing crops only not for land of transmission line laying.
NWGPCL, therefore, dose not intend to compensate for land acquisition of transmission line. However, JICA study team recommends NWGGCL that compensation for land acquisition of transmission line should be made taking account of global environmental and social situation.
These laws stipulate that the amount of compensation for land acquisition by public project except a transmission line accounts for 1.5 times higher than the price of registered land at the local land office.
If the compensation price is lower than the market price, it does not constitute a reacquisition price.
The compensation should therefore be equivalent to the reacquisition price.
The price of registered farmland in the vicinity of the project site at the Bheramara land registration office is 2,950Tk. /decimal, and the calculated compensation price is 4,425 Tk. /decimal. The market price may be approximately 4,000Tk /decimal, according to the information around the site, as there is no real estate business in Bheramara and Kushitia.
Therefore, it is concluded that reacquisition of land is feasible at the legal compensation price.

However, in order to ensure the compensation with reacquisition price under the limited information on land market price, NWPGCL plans to proceed the acquisition of land with the process similar to the one used in the nearby ADB gas pipeline project. In the process for this gas pipeline project , the legal compensation price and reacquisition price are calculated, and if the latter is more expensive than the former, the balance is to be paid by the project operator.

The calculation is conducted by the team consisted of business operator, local administrator, and NGOs, including invited local residents.

The acquired land will be restored entirely to the former condition except the footholds of the transmission line. Care will be taken so that the land will be reused for agriculture after completion of the project, which will minimize the interruption of agricultural activity only to the construction period.
The loss of agricultural crops caused by the construction activity will be compensated only for one time, and the decrease of income and livelihood due to the land acquisition and other project activity will be well considered. In Bheramara site, the land is still used by local people for agricultural activity, although it is owned by BPDB or BWDB. Here, the one-time compensation for the loss of crops is to be applied also in this case.

The decreased income of the local people who had been interrupted their agricultural activity by the construction is to be compensated by employment by priority on the construction site. The project site covers approximately 1ha, and the major crop of the area is rice. The loss of crops will amount to approximately 62,500TK per year※. There are 44 local residents cultivating the land used for project site, and the loss of crops per person will amount to 1,420TK per year on an average.
The average income of a day worker for dredged sand operation around the Bheramara site is 250TK/day. Assuming that the construction workers on the power generation site earn the similar amount, working one week for the construction activity will well compensate the loss of agricultural product for one year. Therefore, the employment by priority will result in increased income, in place of decreased income.
The number of owners of land for transmission line and gas pipeline, and households engaged in farming affected by the land acquisition, the dimension of the project site are described in Table 1-7-2-1, the location thereof is shown in Figure 1-7-2-3 (Annex 7-2).

※ Compensation fee for land required for transmission line is calculated on the basis of same method applied for compensation for land required for gas pipeline though it is not necessary to compensate for land acquisition of transmission line due to the electricity act..

Table I-7-2-1 Numbers of affected households and Acquired area

Type of effect	Ownership of land	Type of usage	Household	Acquired area	Compensation
Land acquisition	Private land	Transmission line	2	27.2 Decimal (1,102m^2)	120,360 TK (4,425TK/decimal × 27.2desimal)
		Gas pipeline	1	43.8 Decimal (1,773m^2)	193,815 TK (4,425 TK/decimal × 43.8desimal)
	BWDB	Transmission line, Gas pipeline,. Transformer station etc	BWDB	2,381 Decimal (9.6ha)	—
Cultivation in the site	BWDB	Transformer station	44	Cultivated area : 247Decimal (1ha)	Employment in priority. No additional compensation

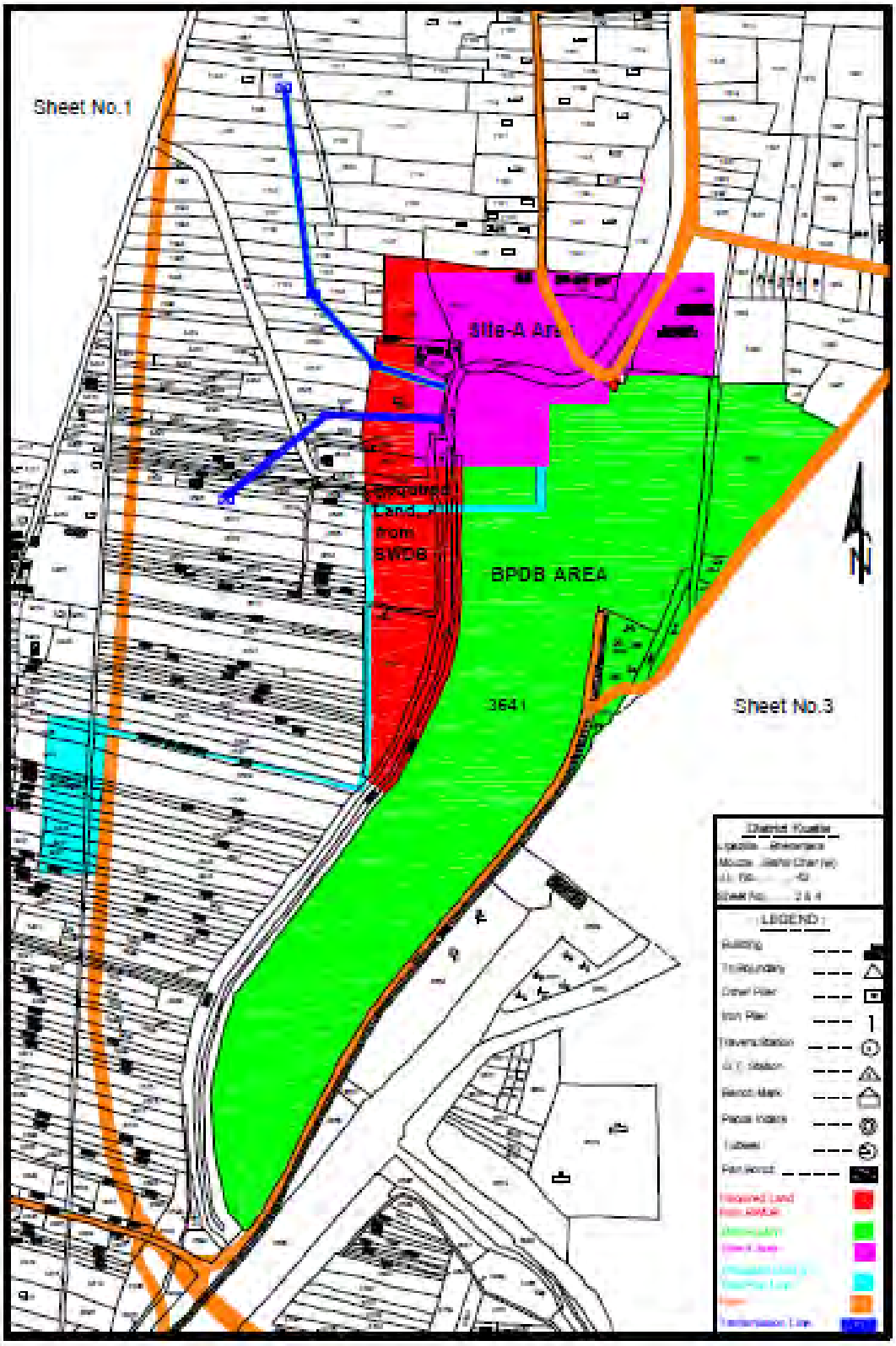


Figure I-7-2-3 Mouja Map for Land acquisition

7.2.3 Relation with the project

Project for the gas-fired power station is categorized as Red. This category requires obtainment of Site Clearance and Environmental Clearance. Site Clearance is for construction and Environmental Clearance is for operation. Environmental Clearance is renewed every year. Figure I-7-2-2 shows necessary paper and materials in Red category. Site Clearance needs abridged edition of F/S report, IEE check list, and its attached material and IEE report. Environmental Clearance needs F/S report, EIA report, and EMP. No Objection Certificate （NOC） from the local government is also required.

Gas pipeline and transmission line relating to the project are categorized as Red category. Therefore, the same procedure is necessary with the power station.

7.2.4 EIA Schedule

Figure I-7-2-3 shows procedures and schedules for EIA relating to the project. Procedure for permit approval has two stages. As previously noted, the first stage is site clearance which is submission of IEE for obtaining approval. Maximum of 60 business days are necessary. Following this, the construction will be able to start.

The second stage is submission of EIA for obtaining approval. Maximum of 60 business days are also necessary. Then comes the Environmental Clearance, including ECC “Environmental Clearance Certificate” to be handled before the operation which needs maximum of 30 business days. Following this, the operation will be able to start.

Application form for IEE is already submitted including the construction plan for gas pipeline, transmission lines, and unloading jetty. EIA is planned to be submitted in November.

DOE has pointed out that a formal document is required indicating the approval of BWDB for the transition of ownership of the land for the power plant from BWDB to BPDB. The document has not been approved as of the mid-December, as BPDB claimed that more time is needed for preparation.

This is an approval document issued by BWDB General Director to BPDB Project Director. The document has not been approved as of the end of December, nor is it approved by IEE.

The document will be immediately approved once it is submitted, as there is no problematic issue in the contents of IEE. EIA report is complete with the collaboration of BPDB, and is to be submitted immediately after the IEE approval.

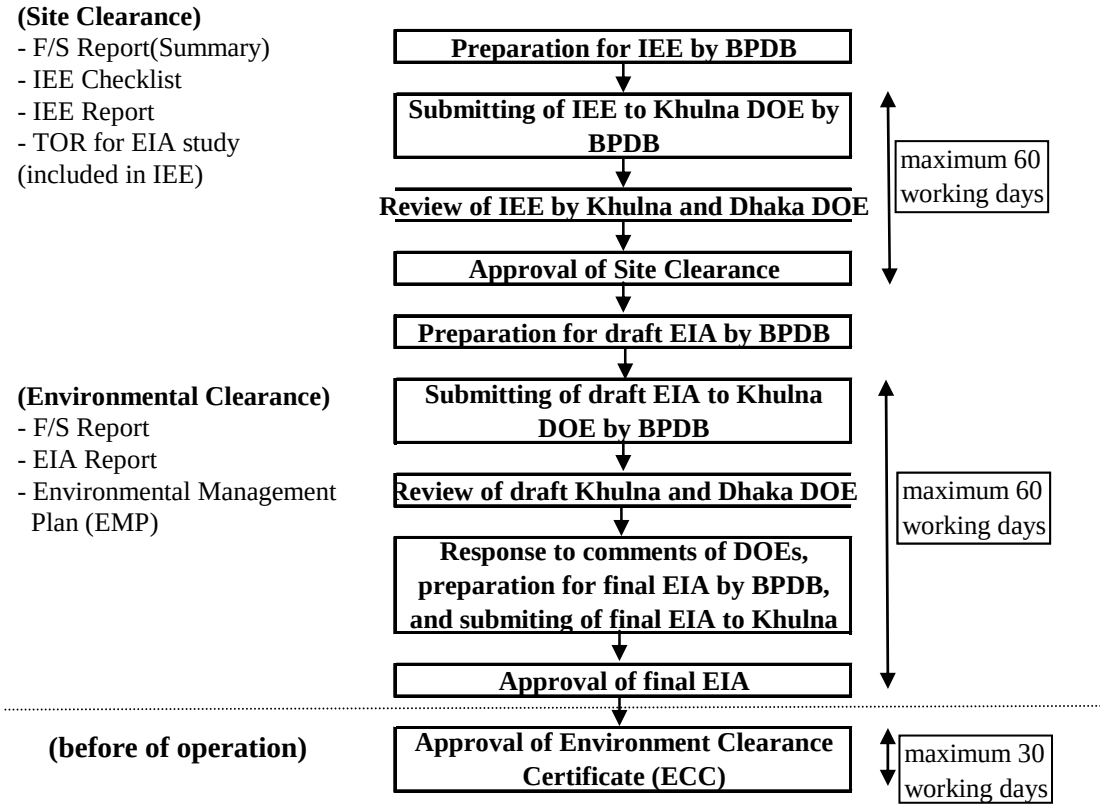


Figure I-7-2-3 Flow chart approved by EIA on the project

7.3 Environment impact assessment and measures for avoiding or mitigating the impact

7.3.1 Environment impact assessment for selected method

(1) Selection of assessment items

The Bheramara combined cycle power station (hereinafter referred to as "Bheramara CCPP) is planning to install a F class combined cycle power plant in the Bheramara site to the north of the existing power station. As shown in Chapter 4.6.3, this project will select a site where there is no need for relocation of the residents, adopt a cooling tower as the cooling system and use underground water as make-up water or the like. Underground water is also used as service water for construction work.

In association with construction of the power station, the gas pipeline and the transmission lines will also be built. Since river traffic is used for the transportation of heavy equipments, an unloading jetty will be built in the left side bank of Padma River in the storage yard, and an access road will be built to connect between the jetty of the storage yard and Bheramara site.

Pump houses for getting underground water will built in the left side bank of Padma River as

well as the storage yard.

Impact assessment was implemented by picking up the factors affecting the environment at the time of construction and operation for all the related facilities.

For the impact assessment, reference has been made of the guidelines of Bangladesh and international organizations:

- EIA Guideline for Industries (DOE, 1997)
- JICA Guideline for Environmental and Social Considerations (JICA, 2004)
- JBIC Guideline for Confirmation of Environmental and Social Consideration (JBIC, 2004) [&]
- Pollution Prevention and Abatement Handbook (1999)

To implement impact assessment, the impacts anticipated from various projected activities were picked up, and measures for avoiding or alleviating such impacts were studied. The impacts assumed to be particularly serious were estimated on a quantitative basis whereby impact assessment was performed.

Whenever required, further measures for mitigating the impact were studied. Consideration was also given to the comments and views on the Bheramara CCPP presented by the residents in the survey on the surrounding community and environment and at the stakeholders' meeting.

Table I-7-3-1 shows the overview of the selected assessment items. The details are given in article (2) and (3).

[&] The ODA department of JBIC has been integrated with JICA since 2008. The guideline used here is the previous one before integration.

Table I-7-3-1 (1) Overview of the selected assessment items (Construction period)

	No.		Overall Rating	Construction Phase						
					Power Plant					
				Temporary impact by undertaking construction	Land formation of Earth work	Operatin of construction machinery	Carrying construction materials in and out	Gas Pipeline	Transmission line	Jetty and Pump house
Environmental contamination	1	Air pollution	B			B	B			
	2	Water pollution	B		B	B				B
	3	Solid waste	B	B		B				
	4	Noise/Vibration	A		A	A	B			
	5	Odor	B	B						
Natural environment	6	Climate								
	7	Hydrology								
	8	Flood								
	9	Underground water	B	B		B				
	10	Ground subsidence	B	B						
	11	Soil erosion	B		B					B
	12	Sanctuary								
	13	Terrestrial ecosystem	B		B			B	B	B
	14	River ecosystem	B			B				B
	15	Precious species	B		B			B	B	B
	16	Global warming								
Social environment	17	Involuntary resident resettlement								
	18	Employment /Livelihood	A	B	A			B	B	B
	19	Local economy	A	B	A		B	B	B	B
	20	Land utilization	A		A			B	B	B
	21	Social infrastructure/service facillities	B	B	B					
	22	River traffic	B				B			B
	23	Land traffic	B	B			B			
	24	Sanitation	B	B						
	25	Risks for infectious diseases such as (HIV/AIDS)	B	B						
	26	Local custom								
	27	Burden on vulnerable groups(women,children, aged,impoverished, minorities,indegenous people and such)	B	B				B	B	B
	28	Uneven distribution of benefit and loss(damage)	B	B				B	B	B
	29	Utilization/Right of water, including underground water	B	B		B				
	30	Cultural heritage								
	31	Landscape	B	B				B	B	B
	32	Accident	B	B	B	B	B			

A: Serious impact is expected.

B: Some impact is expected.

No mark: No impact

Table I-7-3-1 (2) Overview of the selected assessment items (Operation period)

	No.		Overall Rating	Operation Phase								
				Power Plant						Gas Pipeline	Transmission line	Jetty and Pump house
				Operation of Facilities				Carrying materials/stuff in and out	Solid waste			
				Intake of cooling water	Gas emissions	Waste water	Others					
Environmental contamination	1	Air pollution	A		A							
	2	Water pollution	B			B						
	3	Solid waste	B						B			
	4	Noise/Vibration	A				A	B				
	5	Odor	B						B			
Natural environment	6	Climate										
	7	Hydrology										
	8	Flood										
	9	Underground water	A	A		B						
	10	Ground subsidence	B	B								
	11	Soil erosion										
	12	Sanctuary										
	13	Terrestrial ecosystem										
	14	River ecosystem	B			B						
	15	Precious species	B			B						
	16	Global warming	B		B							
Social environment	17	Involuntary resident resettlement										
	18	Employment /Livelihood	B				B					
	19	Local economy	B				B					
	20	Land utilization										
	21	Social infrastructure/service facillities	B				B					
	22	River traffic	B									B
	23	Land traffic	B					B				
	24	Sanitation	B				B					
	25	Risks for infectious diseases such as (HIV/AIDS)	B				B					
	26	Local custom										
	27	Burden on vulnerable groups(women,children, aged,impoverished, minorities,indegenous people and such)	B				B					
	28	Uneven distribution of benefit and loss(damage)	B				B					
	29	Utilization/Right of water, including underground water	A	A								
	30	Cultural heritage										
	31	Landscape	B				B					B
	32	Accident	B				B	B			B	B

A: Serious impact is expected.
B: Some impact is expected.
No mark: No impact

7.3.2 Impact assessment and measures for avoiding or mitigating the impact

Impact assessment has been made by studying the measures for avoiding or mitigating the impact with respect to various forms of environmental items. The measures for avoiding or mitigating the impact are shown in the environment management plan of Chapter 7.4.

(1) Construction phase

The gas pipeline, the transmission line, the unloading jetty and the pump houses to be constructed are not very large in size and, the construction work will be carried out adjacent to the plant. Thus, the impact is small in almost all items, and a big problem will not be raised in terms of the total construction work.

Some of the items where the need for impact assessment by construction work is assumed are separately described.

a) Environmental pollution

1) Air pollution

With the progress of construction work, SOx, NOx, and soot and dust will be generated from the construction machinery and transportation vehicles and earth, sand and dust particles will be scattered. This may cause air pollution.

Periodic inspection and maintenance control will be conducted to reduce exhaust discharged from construction machines and vehicles. To minimize scattering of earth, sand and dust particles, protective covers will be provided, and washing of the vehicles and cleaning of the surrounding roads will be performed on a periodic basis, whereby impact of air pollution is reduced.

2) Water pollution

Drainage caused by rainfall, effluent resulting from washing the equipment, and domestic wastewater will be generated during the work. Wastes will also be produced.

If they are inadequately handled, river water and underground water will be contaminated.

To prevent the soil from flowing out due to rainfall, a fence against earth and sand deposition will be installed around the site where excavation is performed. For the drainage, a settling tank will be installed on a temporary basis, whereby the supernatant will be removed.

To effluent resulting from washing the equipment, a tank will be installed on a temporary basis because chemicals may be used at the time of washing the boiler. For domestic wastewater, septic tanks will be installed Then these waste water will be discharged after having been adequately handled.

The waste generated with the progress of the construction work will be adequately

handled according to the procedures shown in the following item.

Contamination will occur during the unloading jetty construction work. This may cause river pollution.

In the dredging work for the construction of the unloading jetty, vertical pile method will be adopted for the unloading jetty contracture and the size of the dredging area will be minimized wherever possible. The work will be conducted in the dry season of the year to mitigate the impact.

These measures will minimize the impact of contamination of river water and underground water.

3) Solid Waste

Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping ground of the workers includes cans, bottles and food remnants. If they are inadequately handled, underground water and river water will be contaminated, and sanitation problems will arise.

For metal chips, waste plastic, wood shavings, waste glass and waste oil, basically, a waste management program including the plan for reduction in the amount of waste, reuse and recycling of waste will be worked out. Measures taken include adequate classification of waste and adequate disposal at the disposal site for each type of waste.

To reduce the amount of solid waste discharged from the workers during the construction work, efforts will be taken to employ the local workers wherever possible, so that the amount of household solid waste will be minimized.

The aforementioned measures will be taken to ensure that water pollution or sanitary problems resulting from waste do not arise.

4) Noise and vibration

With the progress of construction work, noise will be generated from the construction machinery and transportation vehicles.

Noise problem of the existing power station has been taken up by the residents of the surrounding area. Sufficient consideration must be given to minimizing noise impact.

Bheramara CCPP is responsible for the following major construction work:

- Installation of power generate facilities within Bheramara site
- Installation of gas pipeline
- Installation of transmission line
- Installation of unloading jetty
- Installation of pump houses

Of these work items, installation of gas pipeline and transmission line is characterized

by shorter distance and smaller amount of work. Further, the size of the unloading jetty and the pump houses are smaller. Thus, the following describes the impact of the construction work involved in the installation of the power generate facilities within the Bheramara site:

The level of the noise resulting from the operation of the construction machinery was simulated using the following estimation model.

Noise level estimation model

Estimation was made according to the following theoretical formula where each construction machine was assumed as a noise source:

[Formula]

$$L_{PA} = L_{WA} - 201og_{10}r - 8 - A_{\gamma} - A_{E}$$

[Symbol]

L_{PA}: Noise level at the estimated site (dB)
L_{WA}: A-characteristic correction power level (dB) of noise source
r: Distance from noise source to estimation site
A_{γ}: Amount of attenuation by partition wall (dB) (= 0)
A_{E}: Amount of attenuation by air suction (dB)

Noise level data of noise source

The major construction machinery used in the construction work includes a dump truck, bulldozer and back hoe for excavation, a hydraulic hammer used for pile driving, a truck crane for transportation of the equipment and material, and a mixer for producing concrete.

Table I-7-3-2 shows the noise level of the construction machinery and the number of machines.

Table I-7-3-2 Noise level of major construction machinery

Machine type	Standards	Noise source level (dB)	Number of machines	Operation position (Fugure 7.3.1)
Truck crane (hydraulic)	50 t	116	4	No.
Dump truck	11 t	113	4	No.
Back hoe	0.6 m^3	110	2	No. 4, 5
Bulldozer	11 t	99	1	No. 1
Earth auger	25 t	98	1	No. 1
Hydraulic hammer	4.5 t	95	1	No. 1
Vibro-hammer	-	80	1	No. 4
Concrete pumping car	65 - 85 m^3/h	113	2	No. 1, 2
Concrete mixer	4.5 m^3	105	4	No. 1, 2
Air compressor	10.5 - 11.0 m^3/min	105	5	No. 1, 2, 3, 5, 6

Note: Noise source level has been calculated from the A-characteristic correction value at a distance of 7 meters from the construction machinery.

Calculation conditions

All the aforementioned machines are assumed to be operating simultaneously. The operation position of the construction machinery is as shown in Table I-7-3-1.

In actual practice, excavation and pile driving work are performed sequentially according to the work schedule, so simultaneous operation of all the aforementioned machines is not frequent.

Estimation was performed at 15 points on the boundary of the site, and at one point 200 m away to the north, east and west from the site to the residential area.

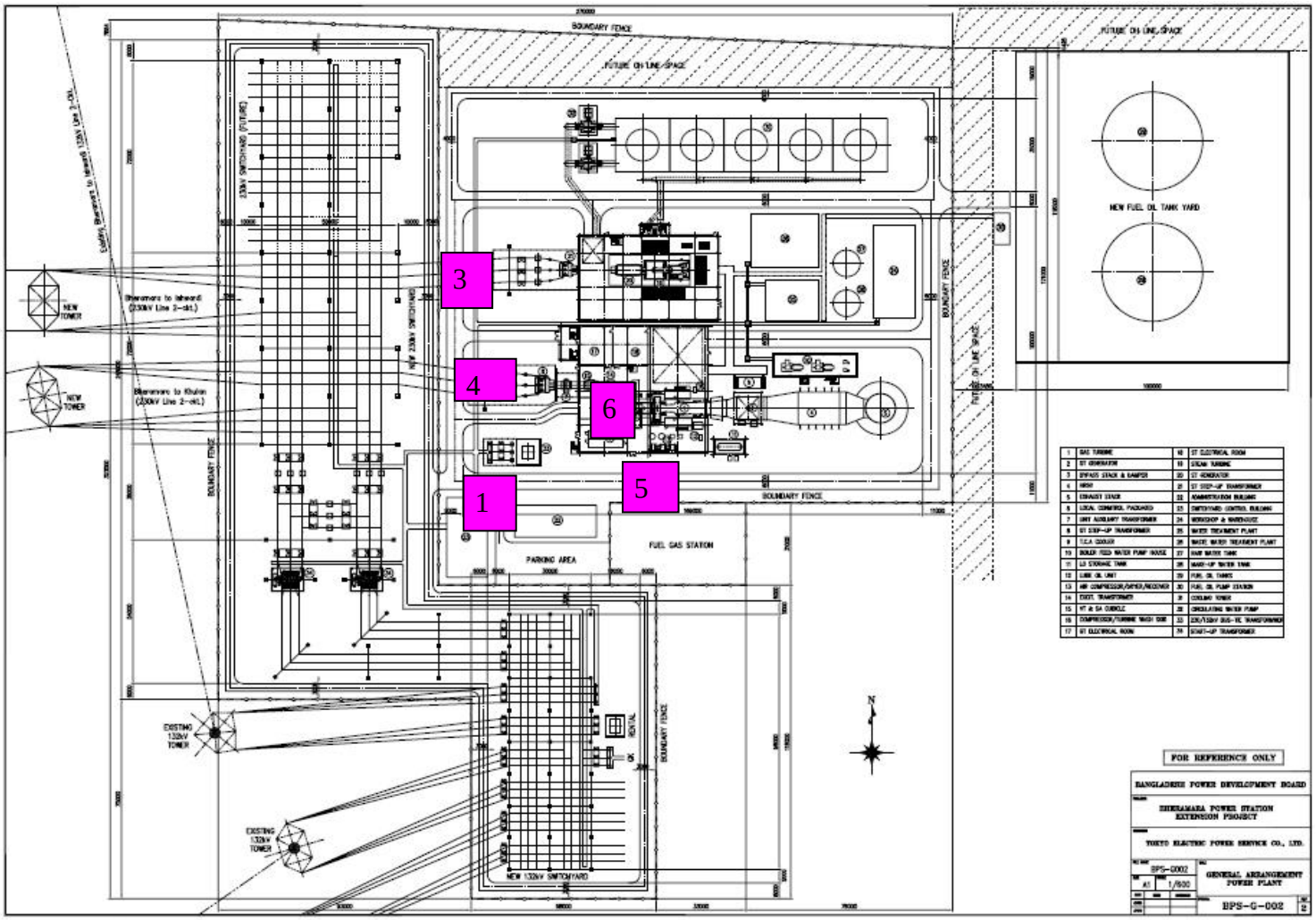


Figure I-7-3-1 Construction machinery noise level

Result of estimation

Table I-7-3-3 shows the result of estimating the noise for each estimation point during the operation of the construction machinery. Figure I-7-3-2 shows the distribution of noise levels.

The noise level resulting from the operation of the construction machinery is 62.4 through 74.6 dBA on the boundary of the site, and 26.5 dBA through 55.1 dBA in the residential area.

The estimated value for the site boundary partly exceeds 70 dBA stipulated in the noise standards in industrial zone of Bangladesh. In most positions, the noise standards have been met.

Further, all the estimated values at three points on the residential zone are below the level of 55 dBA, which is the noise standards (during the daytime) in the residential zone.

In the actual construction work, the schedule management will be performed to ensure leveling of the amount of construction work wherever possible, and the state-of-the-art low-noise equipment will be introduced. Thus, efforts will be made to minimize the noise impact.

Table I-7-3-3 Result of simulating the diffusion of noise produced from the machines used in construction work

	Site boundary 1	**Site boundary 2**	**Site boundary 3**	**Site boundary 4**	**Site boundary 5**	**Site boundary 6**	**Site boundary 7**	**Site boundary 8**	**Site boundary 9**
Estimated noise level: dBA	66.4	63.6	69.4	66.6	65.7	59.9	61.4	68.6	74.6
	Site boundary 10	**Site boundary 11**	**Site boundary 12**	**Site boundary 13**	**Site boundary 14**	**Site boundary 15**	**200 m to the west**	**200 m to the north**	**200 m to the east**
	70.7	71.8	62.8	62.4	67.0	63.3	54.0	55.0	51.9

(Standards of Noise- dBA)

DOE limit standards value			**Guideline value of IFC/World Bank (PPAH)**		
Item	**Day**	**Night**	**Item**	**Day**	**Night**
Industrial Zone	70	70	Industrial Zone	70	70
Residential Zone	55	45	Residential Zone	50	45

Materials and equipments transportation vehicles will be placed under the schedule management to ensure that the amount of the construction work will be leveled. Measures for reducing generation of noise such as requirements for installation of mufflers and speed reduction in the residential area will be taken wherever possible,

whereby vehicle noise impact will be minimized.

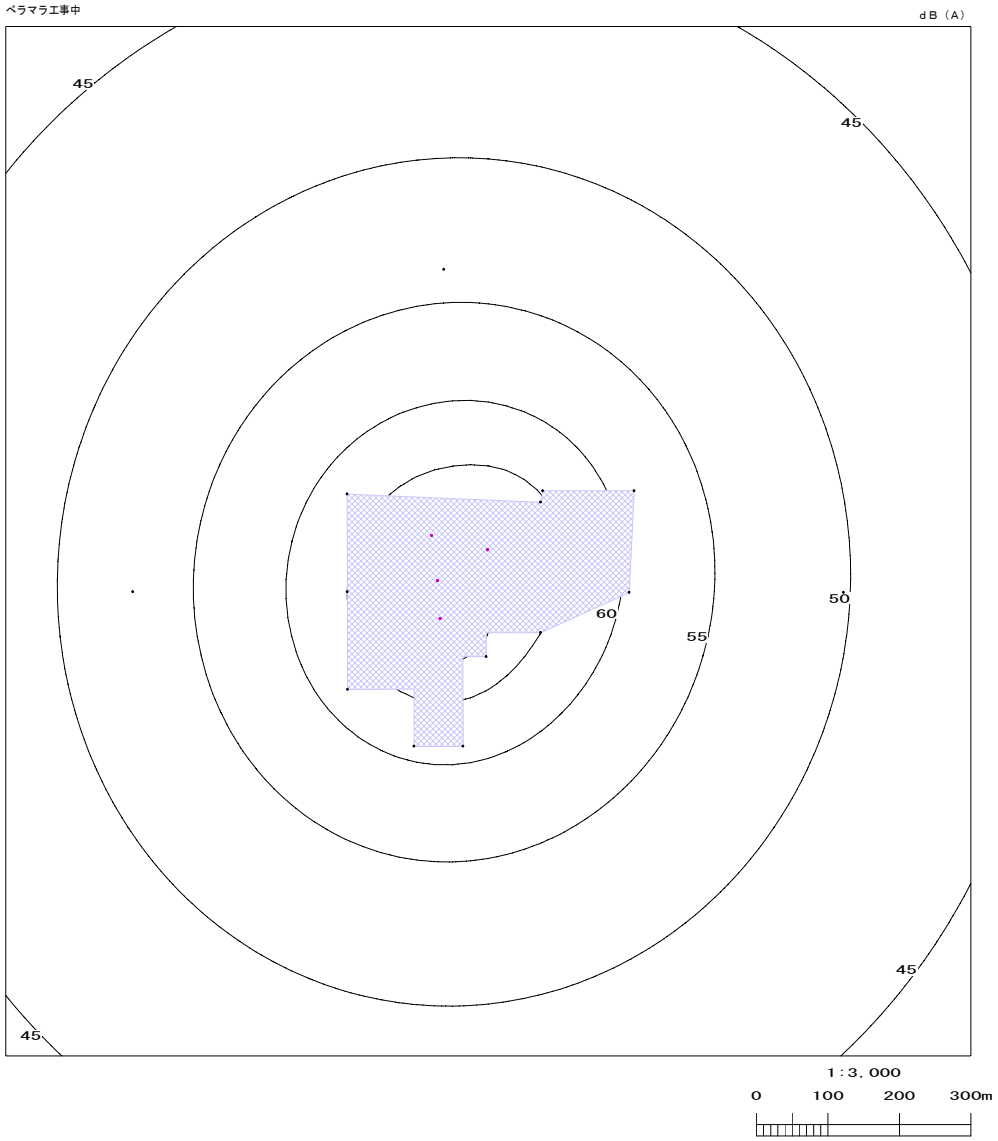


Figure I-7-3-2 Result of simulating the diffusion of noise produced from the machines used in construction work

5) Odor

The amount of domestic waste will increase due to inflow of a great number of workers. If such waste is inadequately handled, odor may be produced by putrefaction.

Before starting the construction work, the workers will be instructed to classify and collect garbage. Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction. These measures will be taken to minimize generation of odor.

b) Natural environment

1) Underground water

The surrounding wells may be affected by reduction of underground water level resulting from underground water intake during the construction work.

For construction work, the maximum amount of the water taken is estimated at 2,000 m3/day. This amount is very small, and is about 1/15 as much as the amount of water

taken for the cooling tower during the operation.
As is shown in Chapter 7.3.2.(3).b).1), it is estimated that groundwater can be taken without any substantial decrease of the water level even in the period of high water intake during operation.
For this reason, it is presumed that no significant decline of groundwater level at surrounding wells can be occurred due to water intake used for construction. Monitoring of groundwater levels of the wells for residential use will be conducted for confirmation.

2) Ground subsidence
If there is a considerable reduction of underground water level resulting from underground water intake during the construction work, ground subsidence may occur.
As described above, there will be no substantial reduction in the underground water level of the surrounding wells as a result of underground water intake during the construction work. This indicates that there will be no ground subsidence as a result of underground water intake.

3) Soil erosion
With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall.
Measures will be taken to avoid outflow of the earth and sand where a fence is installed against subsidence of earth and sand.
The unloading jetty will be built on the side of the river, and earth and sand may flow out at the time of rainfall.
As a mitigation measure, the actual construction will be implemented during dry seasons.

4) Terrestrial ecosystem
With the progress of excavation work, the habitat of the plants and animals will disappear.
The Bheramara site and its surrounding areas have already been converted into the agricultural land and are used for artificial purposes. There is no natural forest in these areas. The plants are restricted to fruit trees and ornamental plants.
The area to be modified by installation of the transmission lines, the gas pipeline and the unloading jetty is small, and there will be not much impact on plants and animals.

5) River ecosystem
With the progress of construction work, water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.
Contamination will occur due to Jetty construction work. This may have an adverse effect on many forms of life in the river.
The measures indicated in the description of "Water pollution" will be taken against the river water pollution resulting from drainage during the construction work and installation of the unloading jetty, whereby the impact on the river plants and animals will be minimized.

6) Precious species
With the progress of excavation work, the habitat of the plants and animals will disappear. The life of the precious species, if any, may be endangered.
Around the Bheramara site, there are four species falling under the category of the Least Concern Species (LC) of the IUCN red list. They are a jungle cat, fox, pigeon and kite.

They are all characterized by a high degree of mobility. The agricultural area is not their major habitat for building nests, for example. Accordingly, they will not be much affected by the construction work.

With construction work, water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.

The Padma River is inhabited by fishes as precious species of Bheramara Upazila. The impact of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

c) Social environment

1) Employment and livelihood

The construction work requires a great number of workers. There are a high percentage of day labor around the Bheramara site. They want to be hired on a steady basis as regular employees.

Before starting the construction work, priority will be given to employment of the local residents.

It is assumed that the residents around the site are deficiency in technique level applied to the construction work. Measures are taken that prospective indigenous workers can acquire relevant skills for construction through preliminary education and training program in cooperation with local authorities from an early stage of construction, so that local people are prioritized at employment opportunity.

In addition, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure.

The Bheramara site is the landed property of the BPDB and BWDB, but there are farmers working within the land site and their revenue will be reduced.

The residents harvesting the agricultural products in the power station site owned by the BPDB and BWDB.

The aforementioned priority employment policy will be implemented to ensure that their livelihood will not be affected by the reduced income (Appendix-2).

When the Padma River will be used to transport heavy equipments, activities of fishermen may be interfered.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishing activities.

There will be a need for land expropriation to acquire the required land for installation of the gas pipeline and the transmission line. During the construction work, suspension of farming is anticipated.

For the gas pipeline installation work, compensation for land acquisition will be given to the people according to the laws and regulations of Bangladesh. The construction work will be performed during the agricultural off-season wherever possible, so that there will be suspension of farming (Appendix-2). As for compensation of land acquisition for transmission line, the Study Team recommends NWPGCL that such compensation should be made.

During the construction work of the unloading jetty and the pump houses in the storage yard, suspension of the work of the sand dredging worker and the sand sellers are anticipated. In that case, it is influence to the shop intended for them.

The scope and processes of the construction work is informed to the sand dredging workers and the sand seller, and arranged so that they can relocate the work site quickly in order for their work not to be interrupted.

2) Local economy

As is shown in "Employment and livelihood", before starting the construction work, priority will be given to employment of the local residents. Cleaning and catering services as well as materials will be provided by the local company

In addition, compensation for land acquisition will be conducted complying with relevant laws of Bangladesh, in parallel with the mitigation measures so that income levels of local farmers, fishermen, and dredging workers will not be declined.

Moreover, it is important to corporate for the fostering of new local industries through consultation of local municipality.

The potential increase in income of residents and local companies owing to this project may be contributed to local economic revitalization.

3) Land utilization

As is shown in “Employment and Livelihood”, mitigation measures will be taken so that no significant change will be occurred in agriculture and land use of dredging workers, etc.

4) Social infrastructure and service facilities

Local workers will be hired wherever possible, so construction of new infrastructure facilities will be unnecessary.

An increase in the number of vehicles for construction work may affect the access of the residents to the infrastructure and service facilities of the community.

Regarding material installation and staff mobilization vehicles due to the construction work, measures will be taken as is shown in “Land traffic” described below.

The local residents desire new medical facilities to be built so that the current poor medical facility will be improved. Efforts are made to ensure that the medical facilities for the workers can be used by other than the workers.

The existing farm roads and the channels within the Bheramara site will disappear as a result of construction work. These farm roads and channels will be formed to detour around the site.

5) River traffic

Since Padma River will be used to transport heavy equipments, river traffic may be affected.

For the transportation of large-sized heavy equipments by ship, an adequate and safe traffic schedule will be worked out through consultation with Bangladesh Inland Water Transport Authority (BIWTA) as an organization having jurisdiction over river traffic.

During the construction work of the unloading jetty, river traffic may be affected.

As a mitigation measure, the actual construction will be implemented during dry seasons that the volume of traffic is relatively low.

6) Land traffic

Priority will be given to employment of the local residents. There will be no much number of vehicles for workers from the outside. But some increase in the number of vehicles for construction work may affect land traffic in the surrounding area.

For the vehicles used to transport materials and equipments required for the construction work and to carry the workers, measures will be taken to use of bass , to ensure reduction of vehicle speed, installation of traffic signs and marks, and education on safe-driving practices in the school-commuting roads and residential areas.

7) Sanitation

Priority will be given to employment of the local residents. There will be no much

inflow of workers from the outside. Most of the local residents use underground seepage type toilet facilities, and this may be unsanitary.
During the construction work, workers will be engaged in the work within the Bheramara site, and lack of hygiene may be further aggravated.
These measures include the installation of the night soil treatment system and an education and training course on sanitation management.

8) Risk for infectious disease
Priority will be given to employment of the local residents, so there will be no spread of infectious disease by the increase in the number of outside workers. However, the engineers coming from the outside area may carry infectious disease.
The following measures will be taken against infectious disease:

- Installation of medical facilities and periodic medical checkup
- Education and training for sanitation management of the workers
- Protection of construction workers against HIV/AID, dengue fever, malaria, and hepatitis A,

9) Burden on vulnerable groups
As is shown in “Employment and Livelihood”, employment opportunity for construction activities will be prioritized to local people. And compensation for land acquisition for gas pipeline will be conducted in accordance with relevant national laws (as for compensation of land acquisition for transmission line, the Study Team recommends NWPGCL that such compensation should be made.), in parallel with the mitigation measures so that income levels of local farmers, fishermen, and dredging workers will not be declined, in order not to have a burden to vulnerable groups.

10) Uneven distribution of benefit and loss
Local people are prioritized at employment opportunity during construction as is mentioned. Regarding this as a mitigation measure, the guideline for employment will be developed so as to assure fair opportunity and to avoid unequal distribution of benefit.

11) Utilization and Right of water (including underground water)
There is a possibility to have a negative effect to fishery activities in the river due to water pollution caused by inappropriate waste water disposal generated by construction activities. Furthermore, turbidity generated by the construction of the unloading jetty also may cause an adverse effect to the fishery activities in the river.
These possible causes of water pollution (waste water disposal and the construction of Jetty) will be reduced through the mitigation measures indicated in the article of “Water Pollution”.
Regarding the effect of water use at surrounding wells due to groundwater level decrease, although it is presumed that no significant decline of the water level can be occurred as is shown in “Underground water” of “Natural environment”, monitoring of the water levels at residential wells will be conducted for confirmation.

12) Landscape
Fences will be installed around the site on a temporary basis during the period of construction work.
The construction work period is limited, and impact on landscape will be small.

13) Accident

Inadequate construction work will cause an accident. The percentage of traffic accident will be raised by an increase in the number of vehicles.

During the construction work, a safety management program setup regulation will be worked out, and various forms of safety measures will be implemented based on this regulation. To ensure traffic safety, various forms of measures will be taken, as exemplified by inspection of traffic rules, installation of traffic signs and markings, education on safety driving, reduction of the vehicle speed in the school-commuting roads and residential areas, and avoidance of driving during the school commuting time zone.

(2) Operation phase

a) Environmental pollution

1) Air pollution

Natural gas will be used as the fuel for operation. Diesel oil (HSD) will also be used on the temporary basis. The exhaust gas due to combustion of gas from a gas turbine during the operation may lead to air pollution by NOx.

The amount of exhaust gas from a power station into the atmosphere is greater than that in other industries. In the conventional environmental impact assessment, a detailed study on air pollution has been carried out without fail. The Bheramara CCPP is required to make a careful verification to avoid air pollution.

During the operation, there is estimated to be impact on air quality by exhaust from the gas turbine. Natural gas is mainly used as fuel.

The current air quality is below the limit of the ambient air quality standards of Bangladesh. Appropriate measures must be taken to ensure that the standards will be met in future as well.

In the study of these measures, consideration was given to the diffusion under the special conditions leading to high concentration, in addition to the general diffusion. The concentration of exhaust in the atmosphere has been estimated using the simulation method.

(Inversion layer)

· If there is an inversion layer above a stack, the discharged gas will remain below the Inversion Layer of temperature and the degree of concentration may increase.

(Down draft)

· At the time of strong wind, a downward flow will be formed by entrainment on the leeward side under the influence of the adjacent buildings. Soot and dust from the smokestack will be lowered in the vicinity of the ground, whereby the degree of concentration increases. This is called the "down draft". When 2.5 times the height of a building is greater than the height of the smokestack, the building may be affected by the down draft. The down draft is generally said to occur when the exhaust speed is equal to or less than 1.5 times the wind speed, also under the influence of entrainment by the smokestack itself at the time of strong wind. This phenomenon is called the down wash.

Environment conciliatory measure as a prerequisite for estimation

· Fuels used

The Bheramara CCPP adopts the method of using natural gas for combustion of the gas turbine.

Basically, this method reduces the load on the environment as follows

- Sulfur content and ash are not included in the natural gas
- Basically, complete combustion of the fuel occurs in the gas turbine. Almost no CO or SPM is produced.
- A low-NOx burner is used to minimize generation of NO_2.

The exhaust concentration will be kept below 40 ppm and below the emission standards of Bangladesh. This value is sufficiently below the World Bank guideline value.

Table I-7-3-4 NOx emission concentration

Item	New installation (natural gas)	Emission standard of Bangladesh	IFC/World Bank guideline (PPAH)
NOx emission concentration	< 40 ppm	40 ppm	165 mg/m^3 (80 ppm)

A stack having a height of 60 meters is adopted to minimize the impact of the major building within the aforementioned site.
Further, to minimize the chance of the building affecting diffusion, arrangement is so configured that high buildings will not be located to the leeward in the north and south as the main wind direction.
To put it more specifically, arrangement was made to the west of the boilers of the gas turbine building and (30 m high) and heat recovery steam generator (HRSG) (35 m high).

Atmospheric diffusion estimation model

Using the following different Gaussian diffusion model, 24-hour value estimation was conducted according to the time scale in conformity to the ambient air quality standards of Bangladesh.

· **Normal conditions**

$$C = \frac{Q_p}{2\pi\ \sigma_y \sigma_z u} \cdot \exp(-2\frac{y_2}{2\sigma_{y}{}^2}) \exp\left\{-\frac{(z-He)^2}{2\,\sigma_z{}^2}\right\} + \exp\left\{-\frac{(z+He)^2}{2\,\sigma_z{}^2}\right\}$$

[Symbol]

C: Above-ground concentration at a leeward distance R (m)
Q_p: Emission volume
σ_y: Parameter in the horizontal direction (m)
σ_z: Parameter in the vertical direction (m)
u: Wind speed (m/s)
R: Horizontal distance between smoke source and calculated point (m)
z: Above-ground height
He: Effective smokestack height (m)
He = H + ΔH
H: Smokestack height (m)
ΔH: Smokestack elevation height (m)

Special conditions

- **Inversion layer**

$$C(x) = \frac{Q_p}{2\pi \cdot \sigma_y \cdot \sigma_z \cdot u} \cdot \sum_{n=-3}^{3} \left[\exp\left\{ -\frac{(He + 2n \cdot L)^2}{2\sigma_z^2} \right\} + \exp\left\{ -\frac{(-He + 2n \cdot L)^2}{2\sigma_z^2} \right\} \right]$$

[Symbol]

Q_p: Emission volume
σ_y: Parameter in the horizontal direction (m)
σ_z: Parameter in the vertical direction (m)
u: Wind speed (m/s)
He: Effective smokestack height (m)
L: Mixed layer altitude (m)
(L = He as the worst condition)
n: Number of reflections (assumed as being equal to ±3)

- **Down draft and down wash**

The diffusion formula is the same as the aforementioned average conditions. The diffusion parameters (m) in the horizontal and vertical directions have been corrected in conformity to the height and width of the building. They are the improved versions of the ISC-ST3 model of the EPA (U.S.A.).

The effective smokestack height is based on the formula under the average conditions where the reduced amount is taken into account, as shown below:

$He = Ho + \Delta H + \Delta H' + \Delta H''$

[Symbol]

He: Effective stack height (m)
Ho: Actual stack height (m)
ΔH: Elevation height (m)
ΔH': Reduction of the main shaft of the plume with consideration given to stack impact
ΔH": Reduction of the main shaft of the plume with consideration given to building impact

Estimation conditions

Table I-7-3-4 shows the exhaust gas volume, temperature, velocity, and emissions of the NOx, and soot and dust.

The emissions of the existing contaminated substances have not yet monitored. The values for the existing materials were used for setting. Data for the soot and dust is not sufficient, and is not included in the calculation.

The emission specifications of the newly installed facility when HSD is used are also shown as reference.

When HSD is used, there is a great deal of the emission of SO_2 and NO_2, as compared to the case where natural gas is used. The Bheramara CCPP does not use HSD except in case of emergency when the supply of natural gas is suspended due to an accident. The maximum period of emergency is about one week.

Table I-7-3-5 Emission specifications

Item	Unit	Newly installed facility	Existing (units 1 through 3)	Newly installed facility (Reference)
		Natural gas	HSD	HSD
Emission volume (wet)	Nm^3/h	$2,287\times10^3$	296×10^3	$2,298\times10^3$
Exhaust temperature	ºC	94	510	159
Exhaust speed	m/s	19.2	5.5	19.2
Actual smokestack height	M	60	10	60
Sulfur oxide emission	kg/h	-	396.9	1971.8
Nitrogen oxide emission	kg/h	188.8	364.8	471.9
Emission of soot and dust	kg/h	22.8	N/A	23.0

Notes:
1. The value indicates the value under the maximum continuous load
2. Three existing units are adjacent with one another. The case of the emissions for all three units collectively is assumed in the calculation of diffusion. In calculation, the average values are used for the amount of the exhaust, temperature of exhaust, the speed of exhaust and actual height of the smokestack, and the total value is used for the emission of the contaminated substance.

- **Meteorological conditions**

Normal conditions

The concentration of the smoke and soot discharged from the smokestack having reached the ground by dispersion heavily depends on the diffusion parameter for each of the wind speed and atmospheric stability, as shown in the aforementioned calculation formula.

Calculation is simulation under the conditions shown in Table I-7-3-6, based on the stability and wind speed indicated in the atmospheric stability classification of Pasquill.

The atmospheric stability A indicated in the atmospheric stability category of Pasquill can be applied to the emission source near the ground. However, this is excluded because the instability comparable to that on the ground is not encountered at a height of 60 meters.

Table I-7-3-6 Setting conditions for stability and wind speed

Stability		Wind speed conditions at ground level (m/s)
Unstable	B	1.0, 2.0, 3.0, 3.9
Neutral	C	2.0, 4.0, 5.0, 5.9
	D	1.0, 2.0, 3.0, 4.0, 5.0, 10.0
Stable	E	2.0, 2.9
	F	1.0, 1.9

Pasquill stability categories

Wind speed at ground level U (ms^{-1})	Daytime				Nighttime (rate of solar radiation = 0)
	Rate of solar radiation Q (unit 0.01 kWm^{-2})				
	60 < Q	30 - 59	15 - 29	1 - 14	
U < 2.0	A	A-B	B	D	F
2.0 - 2.9	A-B	B	C	D	E
3.0 - 3.9	B	B-C	C	D	D
4.0 - 5.9	C	C-D	D	D	D
6.0 < U	C	D	D	D	D

Special conditions

Inversion layer

The inversion layer has been calculated from the result of the general diffusion using the atmospheric stability B and wind speed of 3.9 m/s at ground level where the concentration is the highest under impact.

Down draft and down wash

The exhaust of the stack is discharged from the height of 60 meters. The buildings 2.5 times the height of which exceeds the height of the stack where the phenomenon of down draft occurs includes the gas turbine building (30 m high) located to the west of the stack, the heat recovery steam generator (HRSG) (35 m high) and the steam turbine building (30 m high) to the northwest of the stack. These buildings are used in the calculation.

For the calculation of down draft, the wind speed shown in Table I-7-3-7 is selected in conformity to the general diffusion conditions.

The estimated values of stabilities E and F are low under the general diffusion conditions, and are not used for calculation.

Table I-7-3-7 Setting conditions for stability and wind speed

Stability		Wind speed conditions at ground level (m/s)
Unstable	B	1.0, 2.0, 3.0, 3.9
Neutral	C	2.0, 4.0, 5.0, 5.9
	D	1.0, 2.0, 3.0, 4.0, 5.0, 10.0

The winds from the east and southeast where impact is encountered are used, with consideration given to the arrangement of the aforementioned building.

In this project, the speed of the exhaust is as high as 19.2 m/s, and the wind speed where the impact of down wash is encountered must be about 30 m/s. Such a condition cannot be assumed, and is therefore not taken in account in the study.

Result of estimation

Newly installed facility

Normal condition

Nitrogen oxides (NOx)

Table I-7-3-8 and Figure I-7-3-3 show the result of estimation of NOx concentration according to stability. The maximum ground-level concentration of NOx is the highest when the atmospheric stability is B, and the wind speed is 3.9 m/s. The concentration is 7.91 μg/m^3, which does not exceed 1/10 of the ambient air quality standards of Bangladesh.
According to the current survey result in the dry and rainy seasons around the power station, the highest concentration is recorded at the survey point on the north in the dry season when the existing power station is operating. This concentration as the current concentration is added to the estimated value to assume the future concentration.
The future concentration is 30.16 μg/m^3. This value is sufficiently lower than the ambient air quality standards of Bangladesh. Further, it is sufficiently lower than the value of the World Bank guideline.

Suspended particulate matter (SPM)
The estimation result of the suspended particulate matter according to stability is given in Table I-7-3-8. The ground-level concentration of the suspended particulate matter is high when the atmospheric stability is B, and the wind speed is 3.9 m/s. The concentration is 0.96 μg/m^3, and does not exceed 1/200 of the ambient air quality standards of Bangladesh.
According to the current survey result in the dry and rainy seasons around the power station, the highest concentration is recorded at the survey point on the north in the dry season when the existing power station is operating. This concentration as the current concentration is added to the estimated value to assume the future concentration.
The future concentration is 113.51 μg/m^3. This value is sufficiently lower than the ambient air quality standards of Bangladesh. Further, it is sufficiently lower than the value of the World Bank guideline.

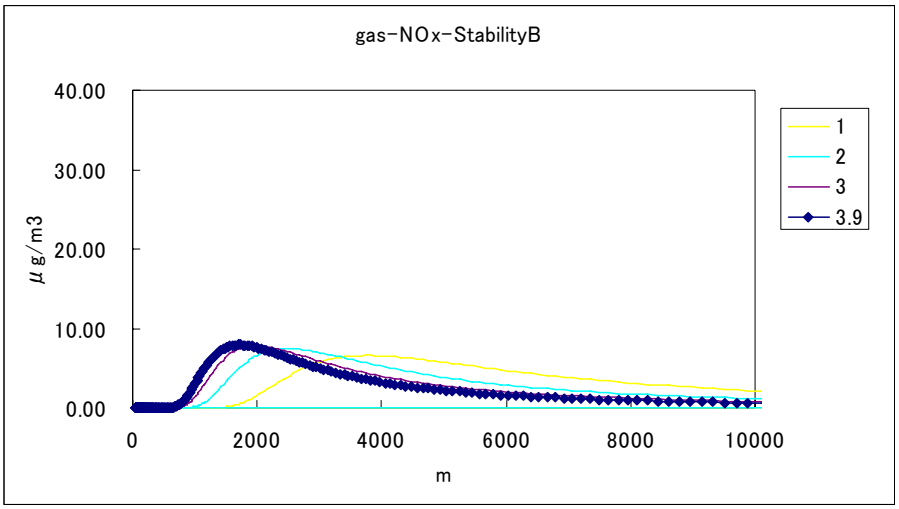
Table I-7-3-8 Estimation result of the maximum future concentration under normal conditions using a new facility (24-hour value)

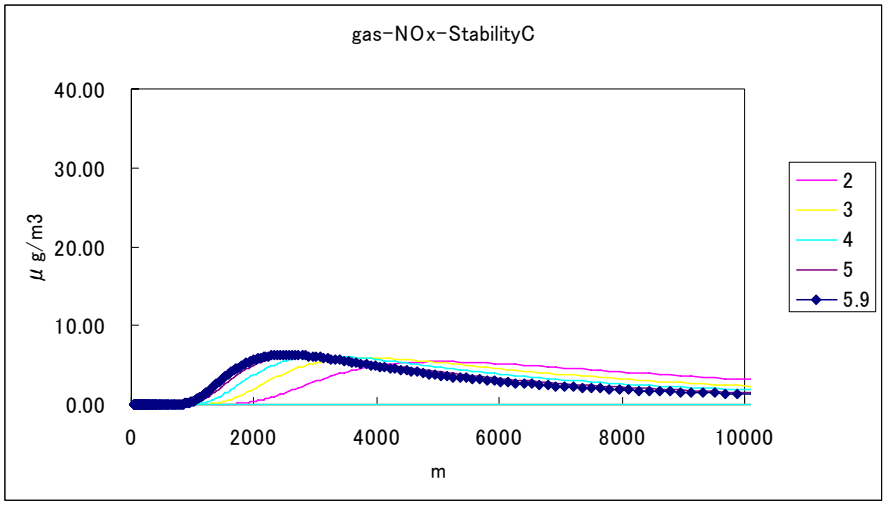
Item	Atmospheric conditions (stability)	Maximum ground-level concentration a (μg/m^3)	Maximum ground-level concentration distance (m)	Current concentration b (μg/m^3)	Maximum future concentration a + b (μg/m^3)	Environmental reference value of Bangladesh (inhabited area) (μg/m^3)	Guideline value of IFC/World Bank (PPAH) (μg/m^3)
NOx	B	7.91 (Wind speed 3.9 m/s)	1,731	22.25	30.16	80	150
	C	6.31 (Wind speed 5.9 m/s)	2,522		28.56		
	D	3.01 (Wind speed 10 m/s)	5,794		25.26		
	E	0.79 (Wind speed 2.9 m/s)	53,239		23.04		

	F	0.13 (Wind speed 1.9 m/s)	608,207		22.38		
SPM	B	0.96 (Wind speed 3.9 m/s)	1,731	112.55	113.51	200	150
	C	0.77 (Wind speed 3.9 m/s)	2,522		113.32		
	D	0.37 (Wind speed 10 m/s)	5,794		112.92		
	E	0.09 (Wind speed 2.9 m/s)	53,239		112.64		
	F	0.02 (Wind speed 1.9 m/s)	608,207		112.57		

Notes:

1. The maximum ground-level concentration denotes the maximum of the estimated values for all the wind speeds according to stability.
2. The current concentration indicates the data of the dry season to the north of the power station where the air quality value is the highest.





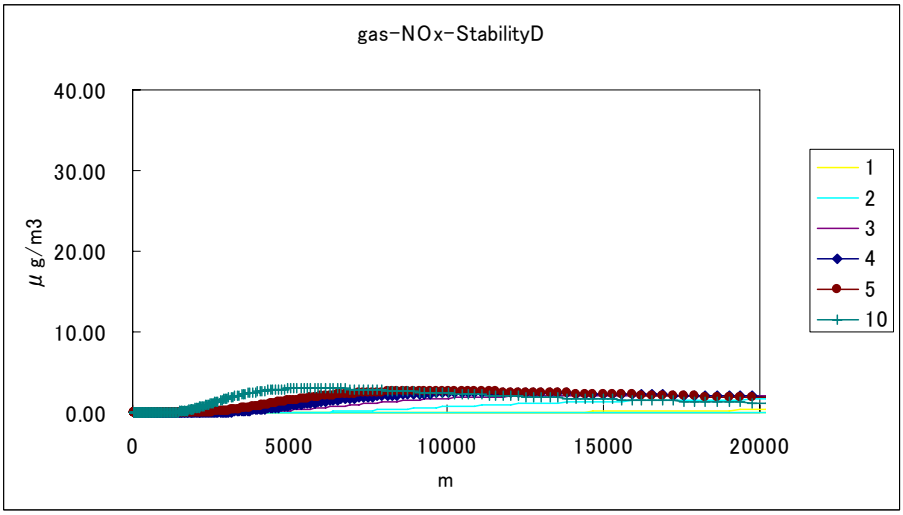


Figure I-7-3-3 Estimation result of the maximum ground-level concentration of NOx under normal conditions, using a new facility (24-hour value)

Special conditions

Table I-7-3-9 and Figure I-7-3-4 show the estimation result of NOx under special conditions. The maximum ground-level concentration of NOx is the highest when the concentration at the time of occurrence of the inversion layer is 13.2 μg/m^3. But this value does not exceed 1/5 of the ambient air quality standards of Bangladesh.

According to the current survey result in the dry and rainy seasons around the power station, the highest concentration is recorded at the survey point on the north in the dry season when the existing power station is operating. This concentration as the current concentration is added to the estimated value to assume the future concentration.

The future concentration is 35.45 μg/m^3. This value is sufficiently lower than the ambient air quality standards of Bangladesh. Further, it is sufficiently lower than the value of the World Bank guideline.

The maximum ground-level concentration at the time of occurrence of the down draft is on the same level as the estimated value under the general conditions. Since the height of the stack has been increased up to 60 meters, there is almost no impact of the building.

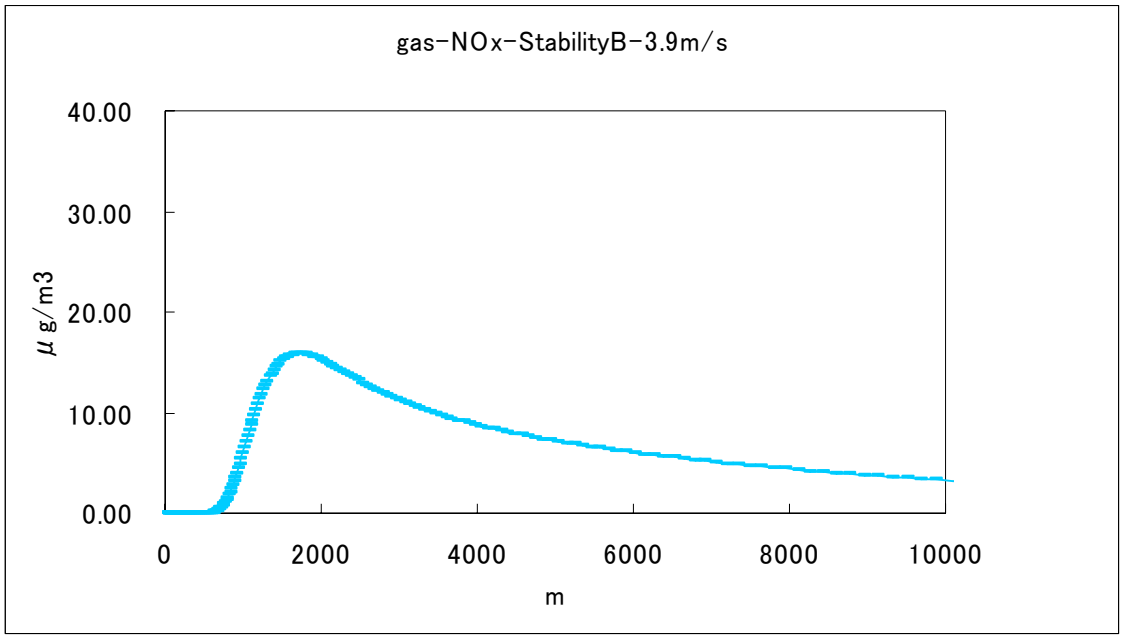
Table I-7-3-9 Estimation result of the maximum future concentration by new installation under special conditions

	Item	Atmospheric conditions (stability)	Maximum ground-level concentration a ($\mu g/m^3$)	Maximum ground-level concentration distance (m)	Current concentration b ($\mu g/m^3$)	Maximum future concentration a + b ($\mu g/m^3$)	Environmental reference value of Bangladesh (inhabited area) ($\mu g/m^3$)	Guideline value of IFC/World Bank (PPAH) ($\mu g/m^3$)
NOx	Inversion layer	B	15.9 (Wind speed 3.9 m/s)	1,731	22.25	38.15	80	150
	Down draft	B (East wind)	8.34 (Wind speed 3.9 m/s)	1,.850		30.59		
		B (Southeast wind)	8.34 (Wind speed 3.9 m/s)	2,491		30.59		

Notes:

1. The maximum ground-level concentration of the down draft denotes the maximum of the estimated values for all the wind speeds according to stability.
2. The current concentration indicates the data of the dry season to the north of the power station where the air quality value is the highest.

(Inversion layer)



(Down draft)

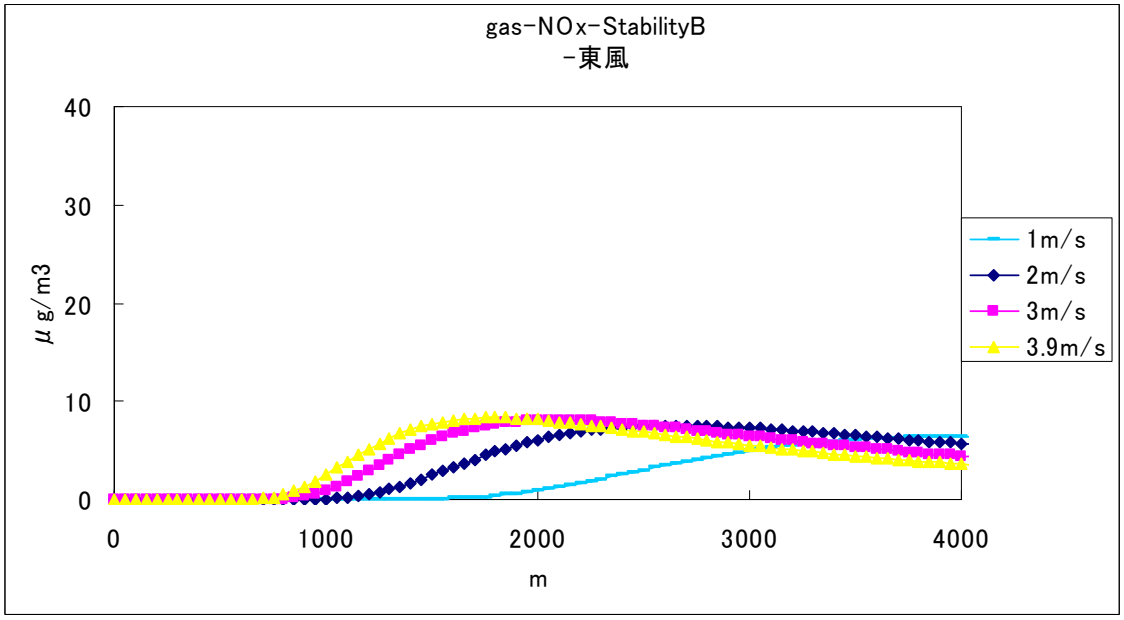


Figure I-7-3-4 Estimation result of the maximum future ground-level concentration of NOx under special conditions using a new facility (24-hour value)

Overlap with the existing facility

Table I-7-3-10 and Figure I-7-3-5 show the estimation result of NOx according to stability when the existing and newly installed facilities are put into full operation. The maximum ground-level concentration of the nitrogen oxides is the highest when atmospheric stability is B and wind speed is 3.9 m/s. The concentration is 32.6 μg/m^3. This value does not exceed 1/10 of the ambient air quality standards of Bangladesh.

At the time of surveying the current situation around the power station, the existing power station is in the process of operation. The concentration 1 km to the south where there is not much impact of the existing facility is added to the estimated value as the current concentration which constitutes the background.

The future concentration is 46.35 μg/m^3. This value is sufficiently lower than the ambient air quality standards of Bangladesh. Further, it is sufficiently lower than the value of the World Bank guideline.

Table I-7-3-10 Estimation result of the maximum future concentration under normal conditions including new facilities (24-hour value)

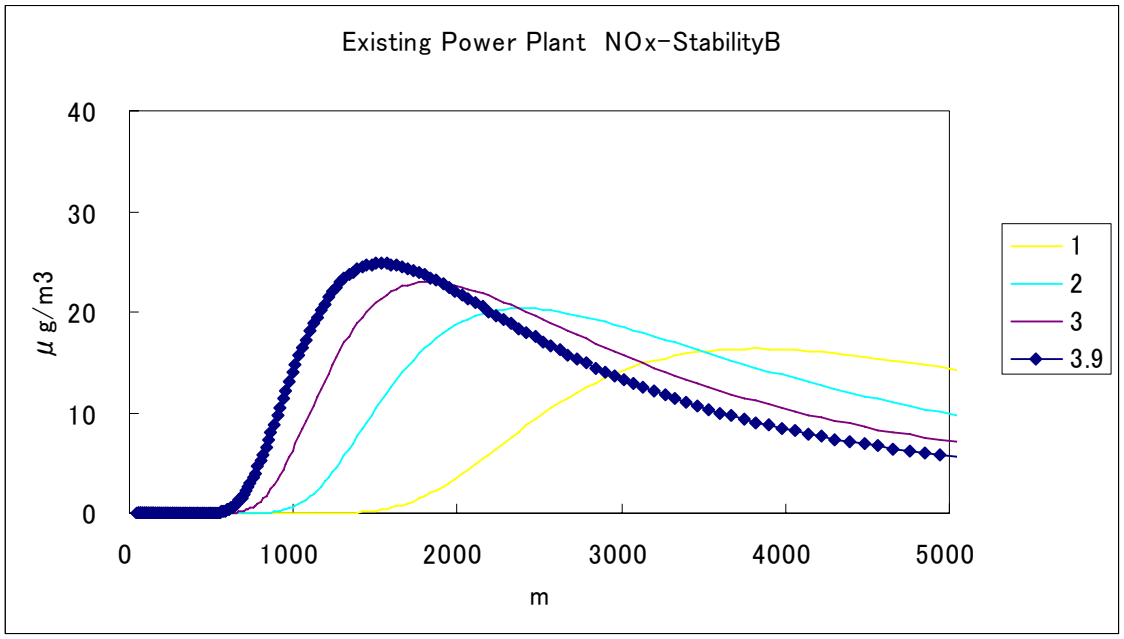
Item	Atmospheric conditions (stability)	Maximum ground-level concentration a (μg/m^3)	Maximum ground-level concentration distance (m)	Current concentration b (μg/m^3)	Maximum future concentration a + b (μg/m^3)	Environmental reference value of Bangladesh (inhabited area) (μg/m^3)	Guideline value of IFC/World Bank (PPAH) (μg/m^3)
NOx	B	32.6 (Wind speed 3.9 m/s)	1,568	13.75	46.35	80	150
	C	29.0 Wind speed 5.9 m/s)	2,285		42.75		
	D	17.7 (Wind speed 10 m/s)	4,479		31.45		

Notes:

1. The maximum ground-level concentration denotes the maximum of the estimated values for all the wind speeds according to stability.
2. The current concentration indicates the data in the dry season 1 km to the south where this is no much impact of the existing facility.

Thus, the impact on air pollution can be reduced by properly taking the currently planned conciliatory measures. Further, the exhaust after operation and contaminated substances in the atmosphere will be monitored.

(Existing facility)



(Existing facility + new facility)

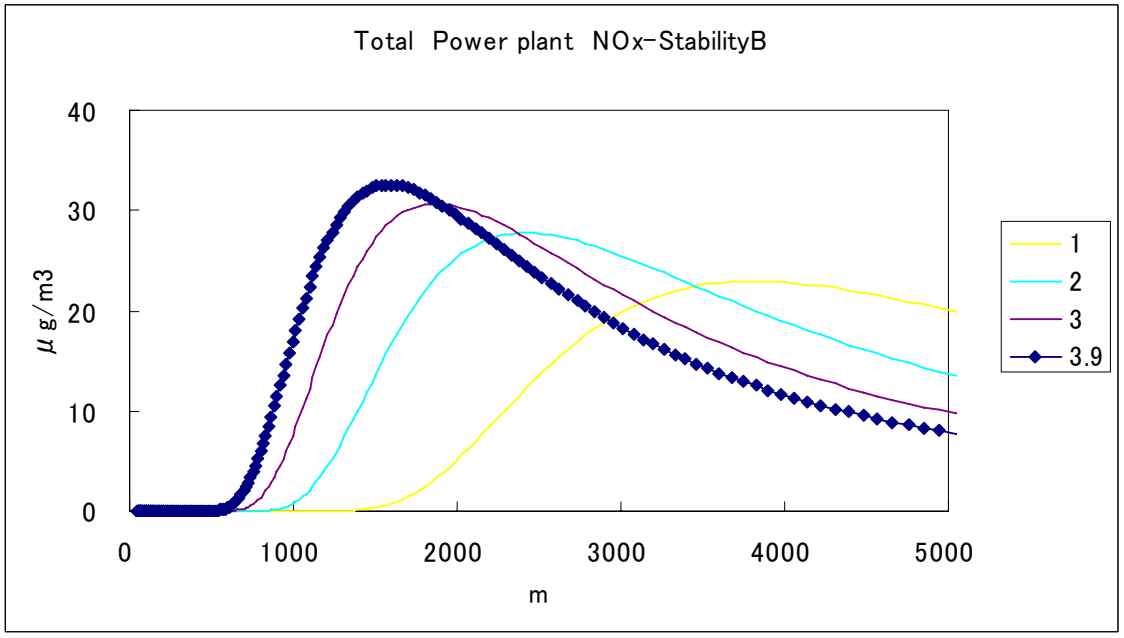
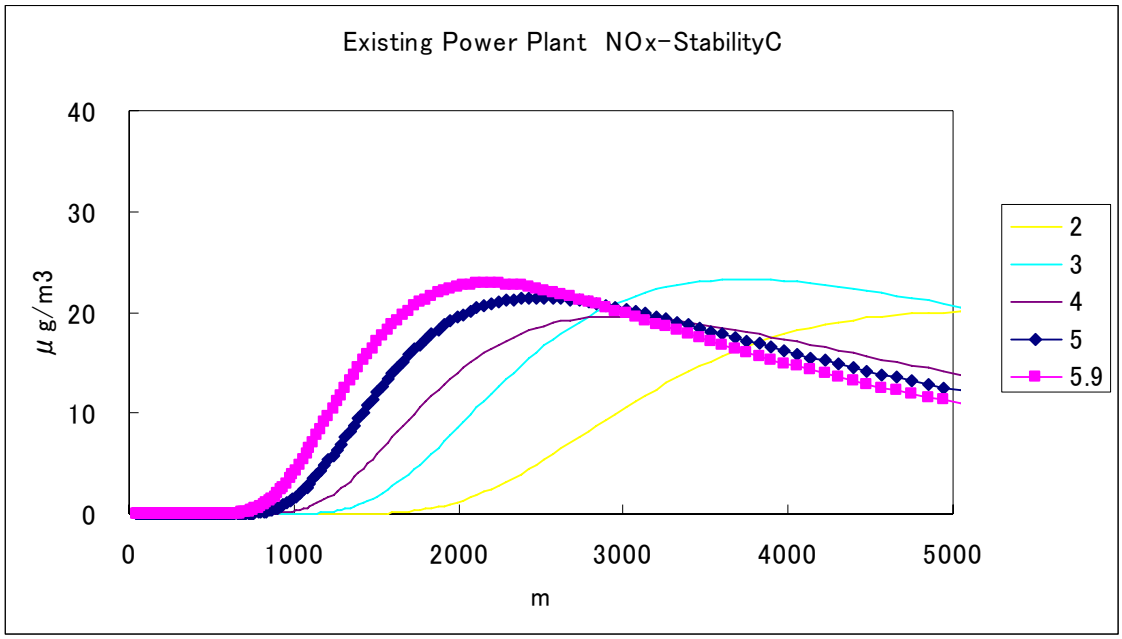


Figure I-7-3-5 (1) Estimation result of the maximum future ground-level concentration of NOx including existing facilities (24-hour value with stability B)

(Existing facility)



(Existing facility + new facility)

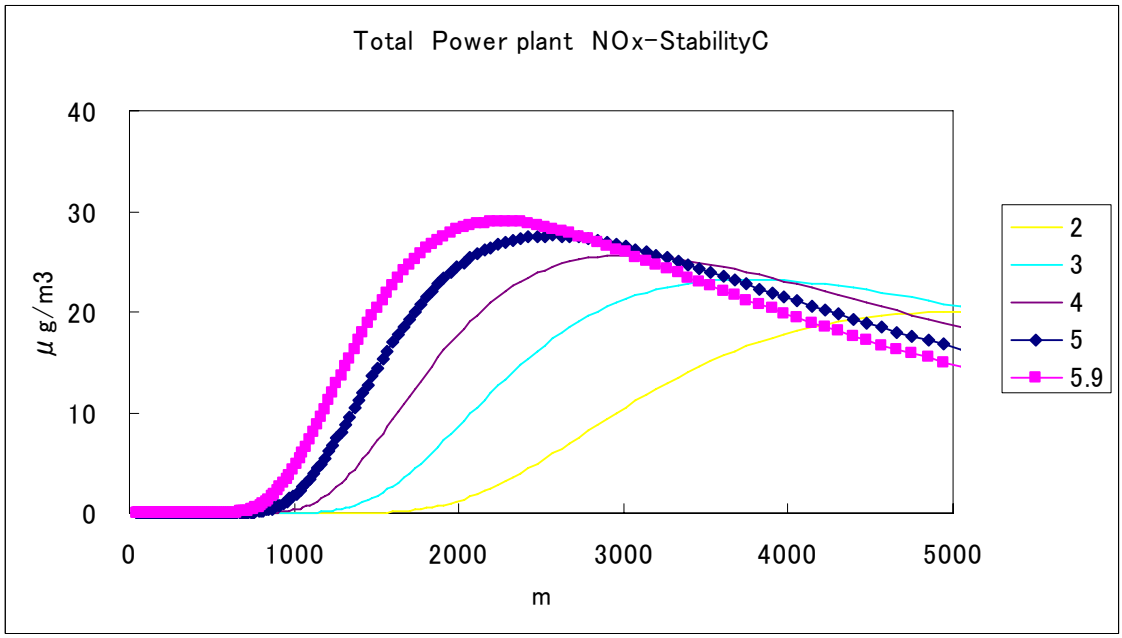


Figure I-7-3-5 (2) Estimation result of the maximum concentration of NOx for future including existing facilities (24-hour value with stability B)

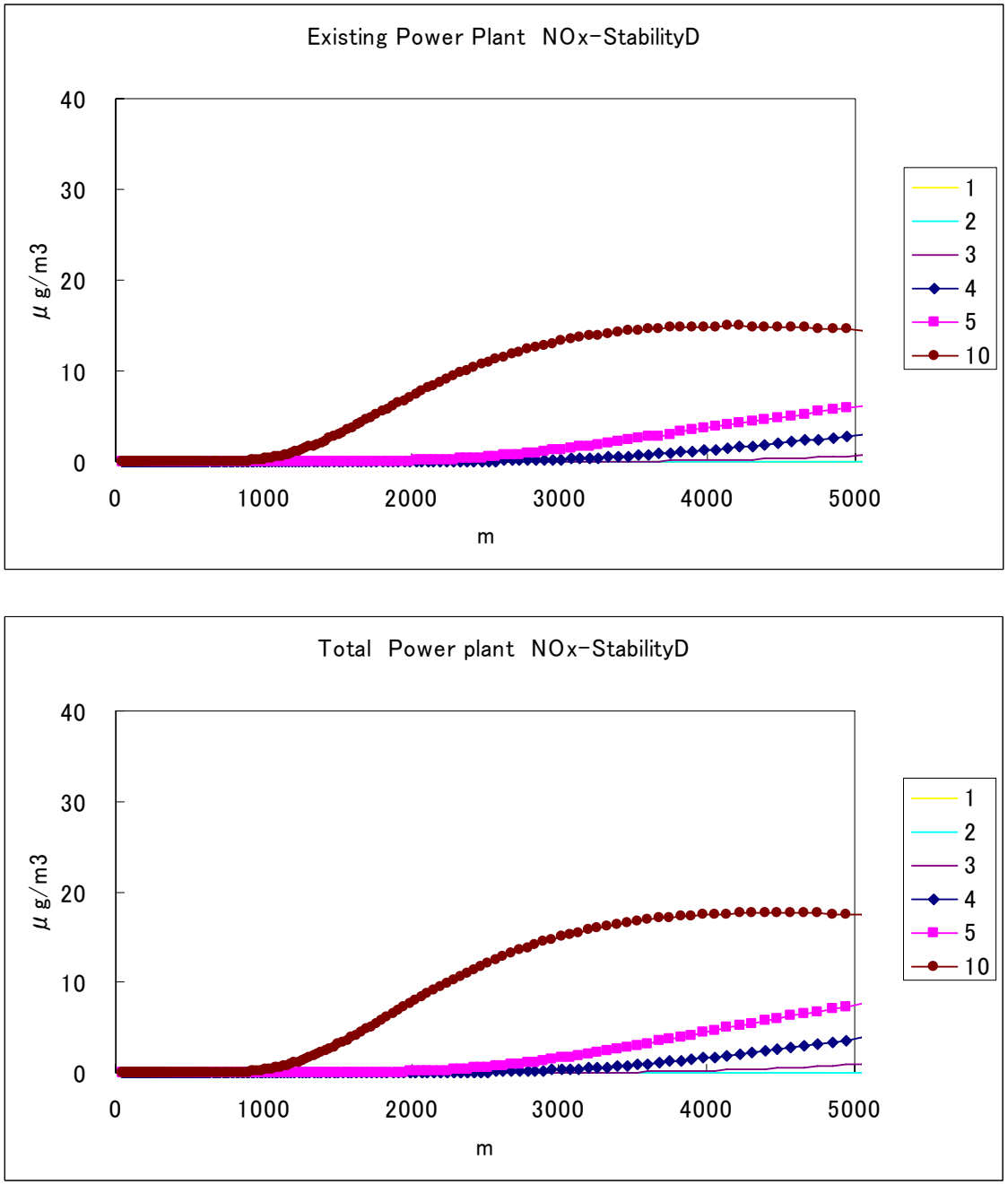


Figure I-7-3-5 (3) Estimation result of the maximum ground-level concentration of NOx for future including existing facilities (24-hour value with stability D)

2) Water pollution

A cooling tower is used in the cooling system, and no thermal discharge will be produced. However, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, river water and underground water will be contaminated.

To dispose of the waste water produced by operation of the power station, waste water treatment facilities capable of precipitation by condensation, neutralization and oil separation and household waste water treatment facilities will be installed, then the waste water will be discharged to Padma River. The waste water level will not exceed

the waste water discharge standards of Bangladesh.
The blow wastewater from the cooling tower will be subject to dilution or other cooling measure, or will be naturally cooled by heat radiation before reaching Padma River.
All waste water will be treated to meet the waste water discharge standards of Bangladesh before discharge. As described in Table I-7-3-11, the predicted water quality of blow wastewater from cooling tower will meet the waste water discharge standards even before being treated by the above-described mitigation measure.

Table I-7-3-11 The predicted blow wastewater quality

Parameter	Unit	Concentration of waste water	Waste water standards
Chloride	mg/l	30	600
Iron (Fe)	mg/l	0.25	2
Manganese (Mn)	mg/l	1.5	5
Nitrate (N molecule)	mg/l	1.0	10.00
Fluoride (F)	mg/l	1.5	7
Arsenic (As)	mg/l	＜0.005	0.2
Total Dissolved solid	mg/l	750	2,100
Total Suspended Solid (TSS)	mg/l	15	150
Temperature	℃	39.8	Summer :40 Winter :45

Notes: the concentration of waste water is predicted considering condensation estimated from the water quality survey of the groundwater used and the water amount balance.

Further, leakage of HSD as a preliminary fuel can be assumed. The bottom surface of the tank in the current power station is lined with concrete. The newly installed tank will be provided with measures to protect underground water against contamination by HSD.

3) Solid Waste
The industrial waste produced during the operation includes the waste oil and sludge from the wastewater treatment system. Further, the domestic solid waste such as cans, bottles and food remnants discarded by employees is also generated.
If they are inadequately handled, river water and underground water will be contaminated, and sanitation problems will arise. For the waste produced in the process of operation of the power station, the waste management program including the reduction, reuse and recycling of the waste will be worked out. To put it more specifically, the measures to be taken includes systematic solid waste collection at the worksite, prohibition of dumping contaminated substances, appropriate classification, and disposal at the disposal site determined for each class of waste.

4) Noise and vibration
The noise generation source during the operation includes workers' commutation, traffic of vehicles for carrying the periodic inspection materials and operation of the power generation facilities.
Noise problem has been taken up by the residents of the surrounding area. Noise of the power generation facilities is produced even the during the nighttime, so sufficient consideration must be given to the impact of noise and vibration.
The following describes the major sources of generating noise during the operation.

- Operators' commutation, traffic of vehicles for carrying the periodic inspection

materials and traffic of workers' vehicle
- Noise and vibration produced from power generation facility

To solve the problem involved in the traffic of vehicles, the workers commutating from a distant place will use the special-purpose buses of the power station. Further, not a great number of vehicles will be required to carry the materials for periodic inspection.
Thus, the study is restricted to the noise produced by the operation of the power generation facility.

Noise level estimation mode

Noise level has been estimated according to the following theoretical formula, assuming that noise is produced from the power generation facilities:

[Formula]

$$L_{PA} = L_{WA} - 201og_{10}r - 8 - A_{\gamma} - A_{E}$$

[Symbol]

L_{PA}: Noise level at the estimation point (dB)
L_{WA}: A-characteristic correction power level at noise source (dB)
r: Distance from noise source to estimation point
A_{γ}: Amount of attenuation by partition wall (dB)
A_{E}: Amount of attenuation by air suction (dB)

Noise level data at the noise source

The great noise source include the turbine, pumps, air compressors, transformer and cooling tower. The noise source level generated from the power generation facility is shown in Table I-7-3-12.

Conditions for calculation

Estimation was performed at 15 points on the boundary of the site, at one point 200 m away to the north, east and west from the site to the inhabited area, and at one point 400 m away to the west.
Further, calculation is based on the assumption that a soundproofing wall having a height of approximately 5 m will be installed along the site of the power station.

Table I-7-3-12 Noise level of power generation facility

Machine type	Noise source power level	1/1 octave band center frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Waste heat collection boiler	84	79	81	77	57	43	39	35	29
Water supply pump	94	74	80	93	81	83	81	81	76
Cooling tower fan	95	74	84	87	90	90	83	79	73
Cooling tower (louver)	84	57	69	70	76	78	75	78	77
Main transformer for gas turbine	85	54	80	79	79	77	66	56	44
Main transformer for steam turbine	85	54	80	79	79	77	66	56	44
Circulation water pump	109	95	95	98	101	104	102	99	96
Station air compressor	86	55	69	76	83	82	72	68	66
Gas turbine	105	74	87	93	96	98	102	97	80
Steam turbine	99	70	83	84	93	91	96	88	68

Machine type	Noise source power level	1/1 octave band center frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Gas compressor	109	86	96	102	103	105	103	96	87
Condensate pump	101	59	73	83	93	95	96	94	83

Notes:
1. The noise source level has been calculated from the sound pressure level A-characteristic value at the point 1 meter away from the noise source.
2. The values for the gas compressor and gas turbine are the values when they are provided with soundproofing covers.

Estimation result

Table I-7-3-13 shows the estimation result of the noise produced in the process of power generation facility operation for each point. Figure I-7-3-6 shows the distribution of the noise level.

The noise level produced in the process of power generation facility operation is 40.6 through 64.9 dBA on the boundary of the site, 46.6 dBA through 51.7 dBA at a point 200 m away in the direction of the inhabited area, and 44 dBA at a point 400 m away.

The estimation value on the boundary of the site does not exceed the level of 70 dBA which is the noise standards for the industrial zone in Bangladesh.

Further, at a place 400 m away and close to the nearest residential zone, the value does not exceed the noise standards of the residential zone in day and night.

In the field of more detailed designing for future, efforts must be made to achieve the estimated noise level resulting from the operation of the power generation facility, for example, by introduction of the state-of-the-art low-noise equipment.

Table I-7-3-13 Result of diffusion simulation of the noise generated from the power generation facility

	Site boun-dary 1	Site boun-dary 2	Site boun-dary 3	Site boun-dary 4	Site boun-dary 5	Site boun-dary 6	Site boun-dary 7	Site boun-dary 8	Site boun-dary 9	Site boun-dary 10
Estimated noise level: dBA	40.6	45.5	52.5	52.4	53.2	40.2	52.1	63.2	58.5	64.9
	Site boun-dary 11	**Site boun-dary 12**	**Site boun-dary 13**	**Site boun-dary 14**	**Site boun-dary 15**	**200 m to the west**	**200 m to the north**	**200 m to the east**	**400 m to the west**	
	63.0	62.1	55.7	57.7	54.3	46.6	51.7	50.2	44.2	

(Standards of Noise : dBA)

DOE limit standards value			Guideline value of IFC/World Bank (PPAH)		
Item	Day	Night	Item	Day	Night
Industrial Zone	70	70	Industrial Zone	70	70
Residential Zone	55	45	Residential Zone	50	45

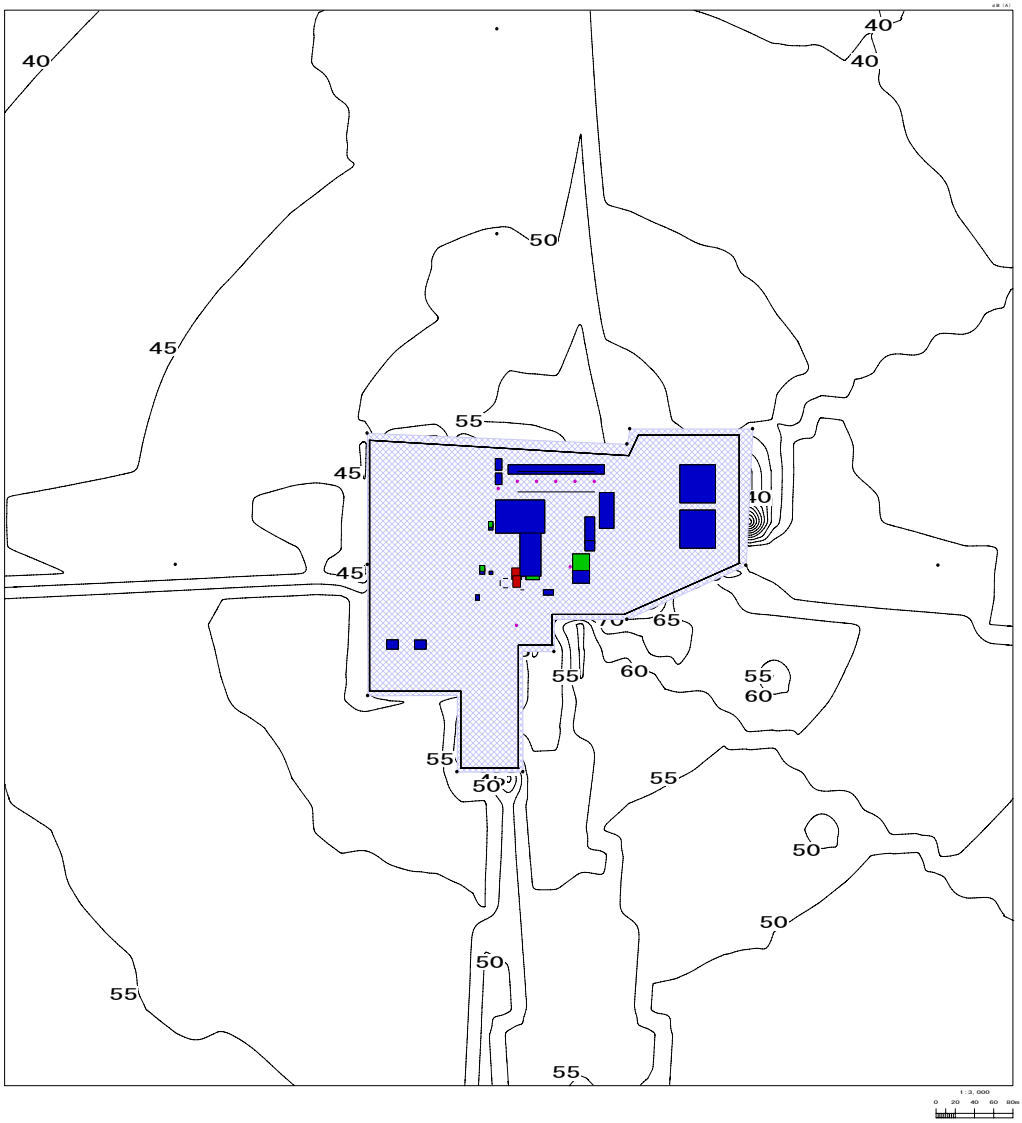


Figure I-7-3-6 Result of diffusion simulation of the noise generated from the power generation facility

5) Odor

Facilities or equipment that produce odor are not introduced into power generation facilities.

The domestic solid waste of the employees will be produced. If such waste is

inadequately handled, odor may be produced by putrefaction.
Garbage will be subjected to separate collection, and garbage will be disposed on a periodic basis to make sure that odor by putrefaction will not be produced.

b) Natural environment

1) Underground water

The cooling tower system uses 1,300 m^3 per hour of underground water as cooling tower make-up water and station service water. This may cause reduction of the underground water level.
As is shown Chapter 4.6.5.(2), pumping test of groundwater was conducted, the level of groundwater was estimated if it is the case that the water pumping in dry seasons (in May) is conducted for 20 consecutive years.
In dry season (May), the lowering of groundwater level is 2m at the maximum, and therefore the pumping of groundwater will be conducted without causing serious lowering of groundwater level.
However, the existing less deep wells, the pumping may be interrupted in the dry season. To prevent this, the groundwater level must be monitored. The wells that fail to supply a sufficient amount of groundwater will be subjected to additional excavation by NWPGCL.

2) Ground subsidence

If there is a considerable reduction of underground water level resulting from underground water intake, ground subsidence may occur.
It is estimated that there will be no substantial reduction in the underground water level in the surrounding area by the underground water intake.

3) Terrestrial ecosystem

The Bheramara site and its surrounding areas have already been changed into the agricultural land and are used for artificial purposes. There is no natural forest in these areas. The plants are restricted to fruit trees and ornamental plants.
The area to be used in Bheramara CCPP and the unloading jetty is comparatively small and will have little impact on plants and animals. However, the buffer zone will be planted with trees.
Further, after the gas pipeline has been laid, the site will be backfilled, and the transmission line except for the scaffolding will be put back to the current state. There will be almost no impact on the terrestrial ecosystem.

4) River ecosystem

Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.
As is shown "Water pollution", measures will be taken to prevent water pollution in the river so that the impact on the plants and animals living in the river will be minimized.

5) Precious species

For the precious land species having been verified around the Bheramara site, the agricultural area is not their major habitat for building nests, unlike the case in the Bheramara site before modification. Accordingly, impact on these species will be very small. However, the buffer zone will be planted with trees.
Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.
The Padma River is inhabited by fishes as precious species of this Upazila. The impact

of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

6) Global warming

CO_2 as a greenhouse gas will be discharged from the power station. About 888,000 tons of CO_2 as a greenhouse gas is estimated to be discharged from the Bheramara CCPP every year.

The present project uses a combined cycle power plant characterized by high efficiency and a reduced amount of CO_2 produced per unit of electricity produced. Further, as is shown Chapter 4.7.2, the gas turbine type to be used is characterized by a further reduced amount of CO_2 produced per unit of electricity produced.

c) Social environment

1) Employment and livelihood

There are a high percentage of day labors around the Bheramara site. They want to be hired not only during the period of construction work but also during the operation of the Bheramara CCPP.

The Bheramara site is the landed property of the BPDB and BWDB, but there are farmers working within the land site and their revenue will be reduced.

It is assumed that the residents around the site are very deficiency in high technique level applied to the operation work. Measures are taken that prospective indigenous workers can acquire relevant high skills for operation through preliminary education and training program in cooperation with local municipalities from an early stage , so that hiring is conducted within local area as many as possible.

In addition to this, local people (especially farmers cultivating within the site) are prioritized at employment opportunity in simple work like cleaning.

Moreover, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure.

After the gas pipeline has been laid, the site will be backfilled, and the transmission line except for the scaffolding will be put back to the current state. There will be no impact on the livelihood of the farmers.

When large-sized heavy equipments will be transported for maintenance and management by ship, activities of fishery may be interfered.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishing activities.

Materials may be unloaded at the time of maintenance and management and this may require suspension of the work of the sand dredging workers.

After consultation with the sand dredging workers, such measures as temporary relocation of the sand storage yard or adjustment of the process will be taken to ensure that these workers will not be inconvenienced.

2) Local economy

As is shown "Employment and livelihood", even in the operational phase, local residents will be prioritized at employment as many as possible.

Cleaning and catering services as well as materials will be provided by the local company.

In addition, compensation for land acquisition will be conducted complying with relevant laws of Bangladesh, in parallel with the mitigation measures so that income levels of local farmers, fishermen, and dredging workers will not be declined.

Moreover, it is important to corporate for the fostering of new local industries through consultation of local municipality.

The potential increase in income of residents and local companies owing to this project may be contributed to local economic revitalization.

3) Land utilization

After the gas pipeline has been laid, the site will be backfilled, and the transmission line except for the scaffolding will be put back to the current state. There will be no impact on the use of land.

4) Social infrastructure and service facilities

Staffs are planned to settle initially around Bheramara during operation, and there is no need to construct new facilities such as roads and schools for them and their families.

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

Regarding commuting vehicles, measures will be taken as is shown in '6) Land traffic' described below.

The local residents desire new medical facilities to be built so that the current poor medical facilities will be improved.

The medical facilities installed for the construction work will be used on a continuous basis by the local residents.

The existing farm roads and the channels within the Bheramara site will disappear as a result of construction work. These farm roads and channels will be formed to detour around the site.

5) River traffic

Large-sized heavy equipment will be transported for maintenance and management by ship. Transportation will be carried out in the rainy season when a sufficient water depth is ensured. In the rainy season, the river width will increase and there will be little impact on the river traffic of the local residents.

6) Land traffic

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

Measures such as use of bass, inspection of the traffic rules, introduction of the traffic signs and markings and education on safe driving will be taken to alleviate the impact.

7) Sanitation

About 300 employees will be engaged in the operation of the power station. There may be a shortage of sanitary facilities such as toilet facilities

These measures include the installation of a human-waste treatment plant conforming to the number of employees and an education and training course on sanitation management.

8) Risk for infectious disease

The engineers coming from the outside area may carry infectious disease.

The engineering workers coming from the outside area receives health checkup before being employed. Further, the following measures are taken:

- Installation of medical facilities and periodic health checkup
- Education and training of workers on sanitation management

9) Burden on vulnerable groups

As is shown in ”Employment and Livelihood”, employment opportunity for operation will be prioritized to local people as many as possible and the mitigation measures will be conducted so that income levels of local farmers, fishermen, and dredging workers will not be declined, and that vulnerable groups will not have a burden.

10) Uneven distribution of benefit and loss

Measures will be taken to ensure that unfair distribution of profits will not occur as described with reference to "Load on the socially handicapped".

11) Utilization and right of water (including underground water)

Since underground water is used as cooling water, surrounding wells may be adversely affected.

As is shown in "Underground water", the cooling water (1,300 m3/hour) can be supplied sufficiently without the underground water level being substantially reduced. However, in the wells close to the power station, the underground water level may be reduced in the dry season. To check this possibility, monitoring will be performed. The wells that fail to supply a sufficient amount of underground water will be subjected to additional excavation by NWPGCL.

12) Landscape

The building of the power station is higher than the surrounding structures, and this may affect the landscape.

The power generation facility contains a smokestack having a height of 60 meters, a turbine building having a height of 35 m and an HRSG having a height of about 35 m. The area of the Bheramara site is limited and there will be little impact on landscape.

13) Accident

Possible accident will include leakage of light oil as a standby fuel or breakage of the gas pipeline in terms of equipment. Further, various forms of operation or maneuvering errors may occur during the operation.

Possible accident will be breakage of the transmission line due to cyclone and others.

Collapse of the unloading jetty due to flood or the like may occur.

The following measures are taken against possible accident:

- Creating and implementing a sanitation and safety education program
- Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities
- Working out a management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program
- Installation of fire prevention equipments and facilities at proper positions inside the power station.
- Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning facilities and emergency exit.
- Working out safety regulations.

7.4 Environmental Management Plan and Monitoring Plan

7.4.1 The objective of the environmental management plan

The main objective of the environmental management plan (EMP) and environmental monitoring plan is to ensure implementation of the mitigation measures planned to reduce the environmental impact by the implementation of the power station project, and to verify and record the environmental impact.
The EMP and monitoring plan are worked out based on the following.

- Reduce the environmental impact to the permissible level by the mitigation measures during the period of construction and operation, so that a hazardous impact will not occur.
- Configure a responsible organization for the implementation of the mitigation measures.
- Implement the EMP and monitoring plan adequately during the period of construction and operation.

The permissible level mentioned above is determined based on the environmental standards of Bangladesh listed below

(1) Air Quality

a) Ambient environment

Table I-7-4-1 shows the ambient air quality standards. In Bangladesh, although strategic area including industrial area and school and hospital are designated, the classification of other lands, either "commercial" or "residential", is determined by DOE in charge according to the situation.
The project site is classified as "residential area" by Khulna DOE.

Table I-7-4-1 Ambient Air quality standard

(Unit: $\mu g/m^3$)

Sl. No.	Area	Suspended Particulate Matter (SPM)	Sulfur Dioxide	Carbon monoxide	Nitrogen oxides
a)	Industrial & mixed	500	120	5000	100
b)	Commercial & mixed	400	100	5000	100
c)	Residential & Rural	200	80	2000	80
d)	Sensitive	100	30	1000	30

Note :1) National monuments. Health-center/Hospital, Archeological site. Educational Institute and area declared by Government (if applicable) are included under Sensitive Area.
2) Industrial units not located in designated industrial area shall not discharge or emit any pollutant which may deteriorate the air quality in the areas (c) & (d) of above Table.
3) Suspended Particulate Matter (SPM) means airborne particles of diameter of 10 microns of less.

b) Gas emissions

The emission standards regarding the operation of the power station is shown in Table I-7-4-2. Natural gas is used for fuel in the power station and SOx and particulate matter are not emitted: NOx is the only concern. The emission standard of NOx for Bheramara CCPP is 40ppm.
HSD is used in case of emergency, and the regulation value for dust emission is 150 mg/Nm3. Regarding SOx, regulation for emission amount applies as well as concentration. The regulation applies only to coal-fired power station.

Table I-7-4-2 Gas emission standard for industrial facilities

No.	Parameter	Unit	Standard Limit
1.	Particulates		
	a) Electric Power Station of 200 Megawatts and above	mg/Nm^3	150
	b) Electric Power Station less than 200 Megawatts	mg/Nm^3	350
2.	Chlorine	mg/Nm^3	150
3.	Hydrochloric Acid gas & mist	mg/Nm^3	350
4.	Total Fluoride (F)	mg/Nm^3	25
5.	Sulfuric Acid mist	mg/Nm^3	50
6.	Lead particle	mg/Nm^3	10
7.	Mercury particle	mg/Nm^3	0.2
8.	Sulfur Dioxide		
	a) Sulfuric Acid manufacture (DCDA process)	kg/ton	4
	b) Sulfuric Acid manufacture (SCSA process) Minimum Stack height for Sulfuric Acid emission	kg/ton	10
	Lowest height of stack for dispersion of sulfuric acid a) Coal Fired Electric Power Station		
	i) 500 Megawatts & above	m	275
	ii) 200-500 Megawatts	m	220
	iii) Below 200 Megawatts	m	$14\ (Q)^{0.3}$
	b) Boiler		
	i) For Steam up to 15 tons/hour	m	11
	ii) For steam above 15 tons/hour	m	$14\ (Q)^{0.3}$
9.	Nitrogen Oxides		
	a) Nitric Acid manufacture	kg/ton	3
	b) Gas Fired Electric Power Station		
	i) 500 Megawatts & above	ppm	50
	ii) 200-500 Megawatts	ppm	40
	iii) Less than 200 Megawatts	ppm	30
	c) Metal Treatment Furnace	ppm	200
10.	Soot & Dust Particles		
	a) Air Ventilated Furnace	mg/Nm^3	500
	b) Brick-field		1000
	c) Cooking Furnace		500
	d) Limestone Furnace		250

Note:$Q=SO_2$ emission in kg/hour

Water quality

a) Ambient water quality

The classification of water area is determined by the DOE in charge, as in the case of air quality. Padma River flowing near the project site is classified as “water used for pisciculture” by Khulna DOE. For other parameters, the water quality standards for drinking water applies.

Table I-7-4-3 Ambient water quality standard (inland surface water)

Sl. No.	Best Practice based classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable Water Source supply after bacteria freeing only	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation purpose	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable Water Source Supply after conventional processing	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisciculture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

Note :1) Maximum amount of ammonia presence in water are 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.

2) For water used in irrigation Electrical Conductivity-2250 microh mho/cm (at $25^{o}C$). Sodium less than 26 mg/l* Boron less than 2 mg/l*

Table I-7-4-4 Environmental water quality standard (drinking water)

Sl. No.	Parameter	Unit	Standard limit
1.	Aluminium	mg/l	0.2
2.	Ammonia (NH_3)	”	0.5
3.	Arsenic	”	0.05
4.	Barium	”	0.01
5.	Benzene	”	0.01
6.	BOD_5 $20^{O}C$	”	0.2
7.	Boron	”	1.0
8.	Cadmium	”	0.005
9.	Calcium	”	75
10	Chloride	”	150-600 **
11	Chlorinated Alkanes	”	
	Carbon tetrachloride		0.01
	1.1 Dichloroethylene	”	0.001
	1.2 Dichloroethylene	”	0.03
	Tetrachloroethylene	”	0.03
	Trichloroethylene	”	0.09
12.	Chlorinated phenols	“	
	Pentachlorophenol		0.03
	2.4.6 Trichlorophenol	”	0.03
13.	Chlorine (residual)	”	0.2
14.	Chloroform	”	0.09
15.	Chromium (hexavalent)	”	
16.	Chromium (total)	”	
17.	COD	”	
18.	Coliform (fecal)	n/100 ml	0
19.	Coliform (total)	”	0
20.	Color	Huyghens unit	15
21.	Copper	mg/l	1
22.	Cyanide	”	0.1
23.	Detergents	”	0.2

Sl. No.	Parameter	Unit	Standard limit
24.	DO	"	6
25.	Fluoride	"	1
26	Alkalinity (as $CaCO_3$)	"	200-500
27.	Iron	"	0.3
28.	Nitrogen (Total)	"	1
29	Lead	"	0.05
30.	Magnesium	"	30-35
31.	Manganese	"	0.1
32.	Mercury	"	0.001
33.	Nickel	"	0.1
34.	Nitrate	"	10
35.	Nitrite	"	Less than 1
36.	Odor	"	Odorless
37.	Oil & Grease	"	0.01
38.	pH	"	6.5-8.5
39.	Phenolic compounds	"	0.002
40.	Phosphate	"	6
41.	Phosphorus	"	0
42.	Potassium	"	12
43.	Radioactive Materials total alpha radiation	Bq/l	0.01
44.	Radioactive Materials total beta radiation	"	0.1
45.	Selenium	mg/l	0.01
46.	Silver	"	0.02
47.	Sodium	"	200
48.	Suspended solid particles	mg/l	10
49.	Sulfide	"	0
50.	Sulfate	"	400
51.	Total soluble matter	"	1000
52.	Temperature	0C	20-30
53.	Tin	mg/l	2
54.	Turbidity	J.T.U	10
55.	Zinc	mg/l	5

Note : ** In coastal Aera 1000

b) Waste water

Table I-7-4-5 shows waste water discharge standards. As waste water treated within the power station is discharged into Padma River, the standards value for "Inland Surface Water" applies.

Table I-7-4-5 Waste water discharge standards

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
1.	Ammoniacal Nitrogen (N molecule)	mg/l	50	75	75
2.	Ammonia (free ammonia)	mg/l	5	5	15
3.	Arsenic (As)	mg/l	0.2	0.05	0.2
4.	BOD_5 20°C	mg/l	50	250	100
5.	Boron	mg/l	2	2	2

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
6.	Cadmium (Cd)	mg/l	0.05	0.5	0.5
7.	Chloride	mg/l	600	600	600
8.	Chromium (total Cr)	mg/l	0.5	1.0	1.0
9.	COD	mg/l	200	400	400
10.	Chromium (hexavalent Cr)	mg/l	0.1	1.0	1.0
11.	Copper (Cu)	mg/l	0.5	3.0	3.0
12.	Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13.	Electrical Conductivity	micro mho/cm	1200	1200	1200
14.	Total Dissolved Solids (TDS)	mg/l	2,100	2,100	2,100
15.	Fluoride (F)	mg/l	7	15	10
16.	Sulfide (S)	mg/l	1	2	2
17.	Iron (Fe)	mg/l	2	2	2
18.	Total Kjeldahl Nitrogen (N)	mg/l	100	100	100
19.	Lead (Pb)	mg/l	0.1	1.0	0.1
20.	Mangaense (Mn)	mg/l	5	5	5
21.	Mercury (Hg)	mg/l	0.01	0.01	0.01
22.	Nickel (Ni)	mg/l	1.0	2.0	1.0
23.	Nitrate (N molecule)	mg/l	10.00	Undetermined	10.0
24.	Oil & grease	mg/l	10	20	10
25.	Phenol compounds(C_6H_5OH)	mg/l	1.0	5	1
26.	Dissolved Phosphorus (P)	mg/l	8	8	10
27.	Radioactive Materials.	As determined by Bangladesh Atomic Energy Commission			
28.	pH		6-9	6-9	
29.	Selenium	mg/l	0.05	0.05	0.05
30.	Zn (Zn)	mg/l	5.0	10.0	10.0
31.	Total Dissolved solid	mg/l	2,100	2,100	2,100
32.	Temperature	Centigrade			
	Summer		40	40	40
	Winter		45	45	45
33.	Total Suspended Solid (TSS)	mg/1	150	500	200
34.	Cyanide (CN)	mg/1	0.1	2.0	0.2

Note :1) These standards shall be applicable to industrial units or projects other than those given under Quality Standards for Classified Industries (Schedule 12).

2) These quality standards must be ensured at the moment of going into trial production for industrial units and at the moment of going into trial production for industrial units and at the moment of going into operation for other projects.

3) The value must not exceed the quality standard during spot check at any time ; if required, the quality standards may be more strict to meet the environment terms in certain areas.

4) Inland Surface Water shall mean drain, pond, tank, water body or water hole, canal, river, spring and estuary.

5) Public sewer shall mean sewer connected with fully combined processing plant including primary and secondary treatment.

6) Irrigated land shall mean appropriately irrigated plantation area of specified crops based on quantity and quality of waste water.

7) Inland Surface Quality Standards (Schedule 13) shall be applicable for any discharge taking place in public sewer or land not defined in Notes 5

(2) Noise level

The applicable category of zone and noise standard for noise level are determined by the DOE in charge. The Khulna DOE determined the noise standard in the surrounding area of the power station as follows: along the vehicle road, 70 dBA in daytime and 60 dBA in nighttime; in the residential area, 55 dBA in daytime and 45 dBA in nighttime.

Table I-7-4-6 Noise standard

Sl. No.	Zone Class	Limits in dBa	
		Day	Night
a)	Silent Zone	45	35
b)	Residential Zone	50	40
c)	Mixed Zone (this area is used combined as residential, commercial and industrial purposes)	60	50
d)	Commercial Zone	70	60
e)	Industrial Zone	70	70

Note :1) The day time is considered from 6 a.m. to 9 p.m. The night time is considered from 9 p.m. to 6 a.m
2) From 9 at night to 6 morning is considered night time.
3) Area within 100 meters of hospital or education institution or educational institution or government designated / to be designated / specific institution / establishment are considered Silent Zones. Use of motor vehicle horn or other signals and loudspeaker are forbidden in Silent Zone.

7.4.2 Work Plans and Schedules

(1) Construction phase

Before starting the construction work, the project manager (PD) of the BPDB or NWPGCL is required to give sufficient consideration to the details of the construction work, and to make sure that the required EMP and monitoring plans are thoroughly understood by the contractor. Thus, the project manager (PD) of the BPDB is required to form the required organization.

Especially, there is an active inflow of the workers and many construction-related vehicles during the construction. The details of the construction work, schedule and mitigation measures should be sufficiently explained to the communities in the surrounding area. The countermeasures should be altered as appropriate, based on the correct understanding of the views of the residents.

The administrative role of the project will be sequentially transferred from BPDB to NWPGCL following the split of the Project Company, and sufficient consultation and negotiation prior to the transfer is essential.

The following are the major environmental impacts during the construction work.

- Inflow of workers and an increase in the number of construction-related vehicles
- Generation of construction wastes
- Generation of dust particles, and gas emission from vehicles and machinery
- Generation of noise from vehicles and machinery
- Occurrence of muddy water in the excavation area

Employing workers from local areas during the construction phase will have a favorable impact on the local economy. Sufficient consideration must be given to the local employment, including implementation of the preliminary education and training program of the workers.

Table I-7-4-7 shows the basic information of the EMP during the construction phase, and Chapter 7.4.9 describes the environmental monitoring plan.

The EMP and monitoring plan should be worked out by sufficient discussions between the BPDB and the contractor. To confirm the implementation plan and to study further measures, a report schedule should be worked out in such a way that the contractor will report

the current situation of implementation in the form of a written statement. This report should be submitted to the Khulna DOE for further discussion.

Table I-7-4-7 Major environmental impacts and mitigation measures using the construction phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Inflow of workers	Generation of sewage and refuse	- Installation of sewage treatment facilities - Can and bottle refuse is classified and are supplied to a third party for reuse - Disposal at a predetermined disposal site.	Contractor (BPDB or NWPGCL)
	Outbreak of diseases	- Installation of sewage treatment facilities - Installation of medical facilities and implementation of periodic health checkups - Education and training on health management of the workers - Prevention of epidemics among workers (HIV/AID, dengue fever, malaria, hepatitis A) - Elimination of potential breeding site for harmful insects, provision of preventive medicine as necessary	
	Safety, accident prevention, land traffic	Use of Bas for worker - Avoidance of the time when students travel between school and home - Reduction of vehicle speed in resident areas and close to schools	
		- Observation of traffic regulations, installation of traffic signs, and education on driving safety - Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	
	Employment, income, livelihood, vulnerable groups, uneven distribution of benefit	- Priority of employment for local residents, development of employment standard - Utilization of local service (cleaning, catering, materials) - Implementation of the preliminary education and training programs with local authority	
	infrastructure	- Installation of medical facilities	
Installation of construction equipment	- Safety, accident prevention, land traffic	- Avoidance of the school commuting time - Reduction of vehicle speed in resident areas and close to schools - Observation of traffic regulations, installation of traffic signs, and education on driving safety - Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	Contractor (BPDB or NWPGCL)
	Noise	- No traffic at night	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	- Gas emission, flying sand and dust particles from vehicles	- Periodic inspection and maintenance management - Periodic check of the concentration of vehicle emissions based on laws and regulations - Stop the engine when idling - Use of a cover to protect against dust, and periodic washing of vehicles -Periodic cleaning of the surrounding roads - Monitoring of resident areas	
	- River traffic	- BIWTA will be consulted to determine appropriate safety and/or scheduling standards to be followed.	
Excavating work and operation of construction equipment	- Emission gas from machinery/sand and dust dispersion	- Periodic watering of sediment disposition site and such - Monitoring in residensial area	Contractor (BPDB or NWPGCL)
	- Noise	- Operation in daytime only in principle - Use of low-noise machinery (silencer, muffler) - Construction of temporary fence around Bheramara site - Restriction of worker's prolonged exposure to noise - Use of Personal Protective Equipment (PPE)	
	Construction debris	- Waste management program consisting of reduction, reuse, and recycling of materials. - Prohibition on dumping of any contaminating material - Appropriate segregation of waste and disposal into designated disposal site	Contractor (BPDB or NWPGCL)
	Soil runoff, turbid water, waste water from equipment cleaning	- Installation of temporary settling tanks and sediment fencing - Water used for equipment cleaning is collected in the temporary tank and treated before discharge - Monitoring at the water outlet	
	Leakage of harmful substances	- Mitigation measures to prevent leakage, installation of cleaning facility	
	Loss of habitat of flora and fauna	- Installation of green buffer	
	Income, livelihood, vulnerable group	- The agricultural products growing on the site is compensated according to the Bangladesh regulation. - Explanation of the construction extent and procedure in the early stage. - Preferentially employ local people predicting decrease in income.	
	Safety, accident prevention, land traffic, infrastructure	- Develop a safety management plan and rules - Swift transport to medical facility - Observation of traffic regulations, installation of traffic signs, and education on driving safety - Reduction of vehicle speed in resident areas and close to schools - Installation of bypass for farm road and waterway within the site	
Water intake	Lowering of underground water	- Monitoring of underground water level in the	Contractor

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	level	surrounding wells - Dig deeper wells as necessary	(BPDB or NWPGCL)
	Ground subsidence	- Monitoring of underground water level in the surrounding wells	
Installation of gas pipeline and transmission line	Loss of farm land	- Compensation of the expropriated land according to the national regulation	Contractor (BPDB or NWPGCL)
	Livelihood	- Construction conducted during agricultural off-season.	
Jetty construction	Sediment outflow, turbid water	- Construction of jetty will adopt vertical piles type to minimize the dredging area - Dredging activities will occur during dry season when water levels and flow are the lowest. - Adoption of dredging method that minimizes environmental effect - Use of the floating siltation curtains where appropriate. - Dredged materials will be landed and dried on-site. - Installation of sediment fencing	Contractor (BPDB or NWPGCL)
	River traffic	- Conduct dredging activity during dry season with less traffic	
	Income and Livelihood	- Minimization of jetty construction area - Explanation of the construction extent and procedure in the early stage.	
Pump house construction	Income and Livelihood	- Explanation of the construction extent and procedure to the sand dredging workers in the early stage.	Contractor (BPDB or NWPGCL)

(2) Operation phase

During the operation phase, the NWPGCL is responsible to form a required organization for environmental management. This organization is responsible for receiving the complaints from the residents of the surrounding area during the operation phase and to take appropriate measures, so that the complaints of the residents will be correctly understood and necessary measures will be taken.

The basic idea is to establish a relationship with the local communities. It is important to sufficiently explain the environmental management procedures taken at the power station. It is also important to invite the residents and school children to observe the power station.

The following describes the major environmental impacts during the operation phase.

- Generation of gas emissions and waste water
- Generation of noise from operating machinery
- Generation of solid waste from operation

The operation workers are required to have specialized knowledge. It will be difficult to hire workers from the local area. However, employing local workers will have a favorable impact on the local economy. For the comparatively easy work, sufficient consideration must be given to local employment, including implementation of the preliminary education and training programs for workers.

Table I-7-4-8 shows the basic information on the EMP during the operation phase, and Chapter 7.4.10 describes the environmental monitoring plan.

NWPGCL should prepare a report on the implementation of the EMP and monitoring plan

and should submit it to the Khulna DOE and related organizations for further discussion.

Table I-7-4-8 Major environmental impacts and mitigation measures during the operation phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Power generation	Generation of gas emissions	- Adoption of a high stack - Installation of a continuous monitoring system for gas emissions - Adoption of pre-mixing method and a low-NOx combustor - Monitoring of atmospheric air - Periodic maintenance and management	NWPGCL
	Generation of waste water	- Installation of a wastewater treatment system capable of coagulation sedimentation, neutralization, and oil separation - Monitoring of waste water - Monitoring of the river or local water - Blow-off water from cooling tower is cooled by dilution	
	Generation of noise and vibration	- Planting trees around the power station - Adoption of low-noise type machinery and installation of soundproofing covers - Installation of low-vibration type machinery and the use of rigid foundations - Periodic maintenance and management - Monitoring around the border of the site and residential area - Distribution of ear protectors to employees	
Water intake	Lowering of Underground water level Ground subsidence	- Monitoring the underground water level in the surrounding wells - Did wells of appropriate deepness as necessary	NWPGCL
Generation of waste	Generation of sludge from the wastewater treatment system Generation of waste oil Generation of domestic waste	- Waste management program consisting of reduction, reuse, and recycling of materials. - Systematic collection and protected-storage on-site - Prohibition on dumping of any contaminating material - Waste away from the site and their appropriate disposal in a designated municipal dumping site.	NWPGCL
Presence of power station, inflow of workers	Loss of habitat of flora and fauna	- Provision of vegetated buffer - Preferential employment of local people	NWPGCL
	Employment, livelihood, vulnerable people, uneven distribution	- Utilization of local service (cleaning, catering) and materials - Implementation of the preliminary education and training programs	
	Land traffic	- Use of Bas for worker - Observation of traffic regulations, installation of traffic signs, and education on driving safety - Speed limit in residential- and school area	
	Social foundation Diseases	- Provision of emergency medical facility - Medical facility and periodical health checkup - Education and training on health management of the workers	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	Accident and safety management	- Tank storage areas will be equipped with oil spill bank and countermeasure for underground oil seepage and designed as physical containment area. - Implement gas leakage prevention procedures and have available on-site all preventive equipment and materials as part of the process of developing emergency plan. - Fire protection equipment and facilities shall be made available at suitable locations in power station including fixed fire protection system, fire hydrants, portable fire fighting equipment, fire vents, alarm system, fire compartments and fire exit signs. Preparation of safety standard.	
presence of gas pipeline and transmission line	Land e acquisition	- Guarantee for the continuance of agricultural activity after construction.	NWPGCL
Presence of jetty	River traffic, land utilization, livelihood	- Develop an appropriate maintenance and management schedule	NWPGCL

7.4.3 Environmental Implementation and Training

During operation phase, NWPGCL is responsible for the system organization of environmental management of the power station and its implementation. The environmental manager, who is a senior environmental engineer, should take charge of the management of the system to ensure environmental management and monitoring described hereinafter.
The environmental manager should be responsible for reporting the planning and implementation of environmental management plan and environmental monitoring plan to the manager of the power station through all the phases of the project, and the director should take the final responsibility.
The environmental manager provides preliminary training on environmental management to the staffs prior to the beginning of the operation. The environmental manager should also provide appropriate updated training all through the operation phase.
The environmental manager is also responsible for reporting about the negotiation with local residents and issues of environmental management and monitoring and training to Khulna DOE, JICA and relevant organization.

7.4.4 Environmental Monitoring Plan

(1) Monitoring Parameters
a) Construction Phase
Table I-7-4-9 shows the monitoring condition during the construction phase.

- Air quality monitoring: SPM, SO_2, and NO_2 are used as parameters for the measurement.
  Air quality is monitored in the residential areas in principle. If there are any places susceptible to impact such as schools, select those places as the target of the measurement.

- Waste water monitoring: TSS is used as a parameter for the measurement.
  Waste water is monitored at the outlet from the settling tank.
- Noise monitoring: Noise level is used as the parameter for the measurement.
  Noise is monitored in the residential areas in principle. If there are any places susceptible to impact such as schools, select those places as the target of the measurement.
- Underground water monitoring: The underground water level , Water temperature, and precious metals（As, etc） is used as the parameter for the measurement. Underground water is monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

b) Operation Phase

Table I-7-4-10 shows the monitoring condition during the operation phase.

- Gas emission monitoring: SPM, SO_2, and NO_2 are used as parameters for the measurement.
  Gas emissions are monitored in the flue.
- Air quality monitoring: SPM, SO_2, and NO_2 are used as parameters for the measurement.
  Air quality is monitored in the residential areas in principle. If there are any places susceptible to impact such as schools, select those place as the target of measurement.
- Waste water monitoring: Water temperature, DO, SS, oil, BOD, and precious metals are used as parameters for the measurement.
  Waste water is monitored at the outlet where the waste water is discharged from treatment plant.
- Water quality monitoring: Water temperature, DO, SS, oil, BOD, and precious metals are used as parameters for the measurement.
  Water quality is monitored at river or local.
- Noise monitoring: Noise level is used as the parameter for the measurement.
  Noise is monitored on the boundary of the site and in the residential areas in principle. If there are any places susceptible to impact such as schools, select those places as the target of the measurement.
  It is preferable that the monitoring point is set to the nearest location to the power plant site within the residential area, considering the residents' complaints for noise of the existing power station.
- Underground water monitoring: The underground water level , Water temperature, and precious metals （As, etc） is used as the parameter for the measurement.
  Underground water is monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

(2) Monitoring schedule

Tables I-7-4-9 and I-7-4-10 show the monitoring schedule during the construction and operation phases.

Table I-7-4-9 Monitoring schedule during the construction phase

Item	Parameter	Place	Frequency
Air quality	SPM, SO_2, NO_2	Residential areas and schools	Monitor SPM every two weeks, and SO_2 and NO_2 every two months.
Water quality	TSS	Drain outlet	Every month
Noise	Noise level	Residential areas and schools	Every week when the amount of construction work is maximized
Underground water	Underground water level Water temperature, heavy metals（As, etc）	Residential area	Twice/year (dry season and rainy season)

Table I-7-4-10 Monitoring schedule during the operation phase

Item	Parameter	Place	Frequency
Gas emission	SPM, SO_2, NO_2	Flue	Monitor SO_2 and NO_2 on a continuous basis (by a continuous monitoring system), and SPM every month.
Air quality	SPM、SO_2, NO_2	Residential areas and schools	Monitor SO_2 and NO_2 every month, and SPM every two months.
Waste water	Water temperature, DO, SS, oil, BOD, and heavy metals	Drain outlet	Every two months
Water quality	Water temperature, DO, SS, oil, BOD, and precious metals	River or Canal	Twice a year (dry and rainy seasons)
Noise	Noise level	On the border of the site and in the residential areas	Twice a year
Underground water	Underground water level Water temperature, heavy metals（As, etc）	Residential areas	Twice a year (dry and rainy seasons)

7.5 Stakeholder consultation (explanation to local residents)

7.5.1 Purposes

Stakeholder meeting is aimed at hearing the opinions of individuals and organizations having stake in the implementation of the project and appropriately reflecting them to the decision making. The administrative organizations and power generation companies are headquartered in Dhaka. Since exchange of options can be made in a workshop, stakeholder consultation will be made mainly with the local government and residents.
The surrounding area of the Bheramara site is mainly farm land and vacant ground. In the north side of the site (Category-C) a village is located with approximately 300 households; the north-east side (Category-B) includes a community of 72 “illegal” households. Approximately 300m west to the Bheramara site runs a highway, and the environmental impact to the residential area in the western side of the road is the traffic of vehicles transporting materials during construction phase.

7.5.2 Implementation

The contents of the stakeholder consultations are as follows.
The first stakeholder meeting was held with the local organizations only, since the details of

projects such as the site and equipment overviews were not yet determined. The second and third meetings were held with local residents and NGOs in addition to the local organizations. The content of the meetings is shown in Table I-7-5-1.

Table I-7-5-1 Contents of the stakeholder consultations

Item	1st meeting	2nd meeting	3rd meeting
Planned agenda	Explanation of the project overview Explanation of scoping Explanation of the survey objective, background, contents, and schedule Views and comments on the project	Explanation of summary of facility Explanation about method of environmental impact assessment Explanation of basic policy of environmental management plan Views and comments on environmental management	Explanation of the environmental impact assessment result Explanation of the environmental management plan and monitoring plan Reply to the views and comments
Relevant organizations	Local Administrative organization, etc.	NGO, residents and fishers around the project site, local administration, local people and stakeholders of the land acquisition for transmission line and gas pipeline.	
Place of meeting	Around the existing power station	Around the existing power station	
Notification of the time of opening the meeting	Notification letter was sent 1~2 weeks before to the related organizations and the director of the existing power plant.	Notification letter was sent 1~2 weeks before to the related organizations and the director of the existing power plant, and handed directly to the leader and sub-leader of the local village 1 week before, asking notification to the village people.	
Method of disclosing the Minutes of the Meeting	Copies are sent to the related organizations.	Copies are sent to the related organizations and NGOs. Copies will be kept at the existing power station and the leader and sub-leader of the village for public access.	

7.5.3 Result of the consultations

(1) The First stakeholder consultation

The attendance sheet, the explanatory material, and the minutes of the First stakeholder consultation is shown in Appendix-3. An English PowerPoint document was used for explanation at the meeting and the copy thereof was distributed to all the attendants.

The 1st stakeholder consultation
Date: 10:00 to 12:00, June 16
Meeting place: School inside the existing power station
Attendants: Touhidul Islam Alam (Bheramara Municipality Chairman), Abu Bakkar (Union chairman), Sadam Md. Abu Salek (Secondary education office), Nripendra Nath Biswas (Upzila fishier office) and others: 64 persons in total

Proceedings:
- Opening address: (Md. Tahir Mian, Manager of power station, BPDB)
- Objective and necessity of the project (Zahid Hasan, BPDB)
- Overview of power generation facilities (OkawaOkana, Leader of JICA team)
- Environmental and social considerations (Fukazawa, a member of JICA team)
- Questions-and-answers session
- Closing address

<< Major questions and answers >>
- Are there any impacts on fishes by the warm waste water discharged from the power station?
  -> Waste water discharged does not exceed the waste water standards.
- Is the school not affected by noise?
  -> The power generation facilities are provided with sufficient measures against noise so that the noise does not exceed the noise standard level.

(2) The second stakeholder consultation

The attendance sheet, the explanatory material, and the minutes of the second stakeholder consultation is shown in Appendix-4. On the first day, an English PowerPoint document was used for explanation at the meeting and the copy thereof was distributed to all the attendants. On the second day, the PowerPoint document translated in Bengali was used and the copy thereof was distributed to all the attendants.

The second stakeholder consultation
The first day
Date: 10:00 to 13:00, September 21
Meeting place: School inside the existing power station
Attendants: Dr. Md. Ashfaqul Islam Babul (UNO, Bheramara), Md. Anwar Hassin (Bheramara Municipality Chairman) and others: 75 persons in total
Proceedings:
- Opening address : Md. Tahir Mian, Manager of power station, BPDB
- Overview of power generation facilities (hereinafter explained by Zahid Hasan, BPDB)
- Overview of the survey result
- Predicted environmental impacts
- Overview of the environmental management plan and environmental monitoring plan
- Questions-and-answers session
- Closing address

<< Major questions and answers >>
- Is there a possibility that the existing wells become unusable due to utilization of underground water? Is there any countermeasures?
  -> The underground water survey is undergoing to understand the behavior of the underground water and predict the environmental impact. The result and possible countermeasures will be reported in the EIA.
- Will the waste water discharged from the power station have environmental impact?
  -> The water emission standard will be followed. Countermeasures will be taken such as the delusion of thermal water over 40℃ with other cool waste water.

<< Major opinions >>
- Local residents are expecting to be employed not only in the construction phase but also in the operation phase.
- Plantation of fruit trees for greening would benefit the local residents' life.
- The installation of medical facility for construction workers is expected.

The second day
Date: 10:00 to 12:00, September 22
Meeting place: School inside the existing power station
Attendants: local residents: 96 persons
Proceedings:
- Opening address : Md. Tahir Mian, Manager of power station, BPDB
- Overview of power generation facilities (hereinafter explained by Zahid Hasan, BPDB)

- Predicted environmental impacts
- Overview of the environmental management plan
- Group discussion (8 groups: opinion exchange, requirements)
- Closing address

<< Major opinions >>

- There was a demand for alternative land for expropriated land, while some demanded for compensation payment to buy new land
- There is complaint from the local residents about the noise from the operation of the existing power station.

(3) The third stakeholder consultation

The attendance sheet, the explanatory material, and the minutes of the third stakeholder consultation is shown in Appendix-5. On the first day, an English PowerPoint document was used for explanation at the meeting and the copy thereof was distributed to all the attendants. On the second day, the PowerPoint document translated in Bengali was used and the copy thereof was distributed to all the attendants.

The first day

Date: 11:15 to 14:30, November 30
Meeting place: School inside the existing power station
Attendants: Dr. Md. Ashfaqul Islam Babul (UNO, Bheramara), Shariful Islam (WZPDCO DGM) and others: 66 persons in total
Proceedings:

- Opening address (Md. Shahjahan, Manager-in-charge, Bheramara Power Station)
- Opinions of the 1st and 2nd stakeholder meeting and explanation of correspondence of initiator (Zahid Hasan, BPDB)
- Overview of the project (Okano, Leader of JICA team)
- Explanation of results of the survey, procedure of environmental permission, EIA and mitigation measures, and monitoring plan (Zahid Hasan, BPDB)
- Questions-and-answers session
- Closing address

<< Major questions and answers >>

- Is there a possibility that the existing wells become unusable due to utilization of underground water? Is there any countermeasures?
  -> After 20 years of operation, the groundwater level lowered only 2m at the maximum. In the event of trouble in using well, a pump will be provided.
- The impact of noise from the power plant should be prevented throughout the operational phase.
  -> The noise level meets the noise standard. Further noise reduction will be realized by planting trees surrounding the power plant site.
- Is there the possibility of acid rain resulting from the exhaust gas from the power plant, and the impact on agriculture?
  -> The predicted gas dispersion level is well below the emission standards, and far from the level to cause acid rain.

The second day

Date: 10:45 to 14:00, December 01
Meeting place: School inside the existing power station
Attendants: local residents: 92 persons
Proceedings:

- Opening address (Md. Shahjahan, Manager-in-charge, Bheramara Power Station)

- Opinions of the 1st and 2nd stakeholder meeting and explanation of correspondence of initiator (hereinafter explained by Zahid Hasan, BPDB)
- Overview of the project, explanation of results of the survey, procedure of environmental permission, EIA and mitigation measures, and monitoring plan
- - Group discussion (6 groups: opinion exchange, requirements)
- Questions-and-answers session
- Closing address

<< Major questions and answers >>

- Is no relocation of the local residents necessary?
  ->No relocation of the residents is necessary.
- Will the land expropriated for installation of transmission line compensated?
  -> The expropriated land will be compensated according to the law[1].
- The residents of 12 Dags and 16 Dags villages near the power plant will be impacted. Will they receive any benefit from the implementation of the project?
  -> The local residents will be, after job training, employed by priority as plant workers, except the plant operators.

7.5.4 The Focus Group Discussions

The Focus Group Discussions were held four times for Category-B area and the areas inside and outside the projected site, with the male members and female members separated into different groups. Separation of the male members and female members into different groups was intended to make sure that female members' views and comments would be made more explicit and more clearly understood.

Table I-7-5-2 shows the contents of the Focus Group Discussions.

There were no views or comments which were strongly against the project. They took an affirmative attitude to the construction of the power station if there will be appropriate compensation for the land expropriation.

They expected new employment to be created by the construction of the power station.

[1] Compensation for land required for transmission line is not made due to the law. The Study team recommends NWPGCL that compensation for land required for gas pipeline should be made taking account of global environmental and social situation.

Table I-7-5-2 Contents of the Focus Group Discussions

Item	1st	2nd	3rd	4th
Time	June 15, 2008	June 15, 2008	June 21, 2008	June 13, 2008
Place	Main house of the residents	Main house of the residents	- Main house of the residents	Main house of the residents
Attendants	Inside the projected site; males	Inside the projected site; females	- Inside the projected site; males	Inside the projected site; females
Number	12	8	7	8
Predominant comment	- Construction of a power station is welcomed. - Improve the situation of the power crisis. - Having relocated to the current location due to the erosion of the Padma River. - Concerned about relocation of the residents. - Prepared for the relocation of the residents. - Compensation is essential. - Lose job during every rainy season. - Currently supplied with food from the Government.	- Expect more employment to be created by construction of the power station. - Prepared for the relocation of the residents. - Compensation is essential. - Blackout problems will be solved.	- Willing to cooperate to offer the land required for the construction of a power station if there is compensation. - Expect more employment to be created by construction of the power station. - Received no compensation when the Hardinge Bridge (Lalon Shah Bridge) was built. Hope this will not occur again. - Noise level should be reduced. - Construction of a power station is essential for the nation in the final analysis.	- Power supply is insufficient. - Willing to cooperate to offer the land required for the installation of the transmission line or pipeline if there is compensation. - Construction of a power station is essential for the nation in the final analysis.

7.5.5 Opinions from the local residents at social environmental survey

In the social environmental survey conducted in June 2008, the overview of the power station construction project, including the undetermined Bheramara site and the cooling system, was explained to the interviewed residents and their opinions were collected.
The result is shown in Table I-7-5-3 (including multiple answers).
The attitude of the residents toward the project is generally affirmative, with large expectation for improvement of the electricity crisis, and also for regional benefit and improved employment.
On the other hand, negative opinion includes the big concern for the loss of residence in Category-B, and some concern for noise in Category-C.

Table I-7-5-3 Opinions from local residents at the social environmental survey

(unit : family)

Opinion	Category-A	Category-B	Category-C
Electric crisis will be mitigated	7	26	99
Benefit for the local area			20
Improvement in service for local residents			5
Promotion of job opportunity		6	8
Electricity shortage in the local area will be solved.			1
Concern for loss of residence		41	
Concern for bad effect on plantation and fish			1
Concern for environmental impact			1
Noise			6
No comment	1	5	7

Chapter 8 Project Cost and Economic and Financial Analyses

8.1 Operational Condition of the Bheramara CCPP

The output and thermal efficiency of the power plant must be assumed for economic and financial analysis. There is a slight difference according to the supplier of the power plant. Purchase of the power plant is commonly carried out based on the EPC contract and the EPC contractor is selected through the international competitive bidding. In this case, the bid price is evaluated with consideration given to the difference in the proposed specifications, and the difference in performances including output and thermal efficiency. Accordingly, the bidder of the lowest price does not always win the contract.
Thus, in this Chapter, the SCC5-4000F of Siemens whose price is expected to be the middle out of the four models of F-class CCPP shown in Table I-4-7-8.
Table I-8-1-1 shows the technical assumption under the site condition of the Bheramara CCPP by Siemens SCC5-4000F used for the economic and financial analyses. Estimated power output and thermal efficiency described in Sub-Section 5.2.1 is used for this analyses. 42 months is applied for construction period from the recommendation described in Sub-Section 4.9. Because the Bheramara CCPP is planned as the major power source in the western region of Bangladesh and would have highly efficient, it is assumed to be operated as base load plant. Therefore the base case annual load factor was assumed as 70% which is set up as an operational indicator in Sub-Section 8.6. As for project period, 30 years is applied based on the plant life required in Sub-Section 5.2.

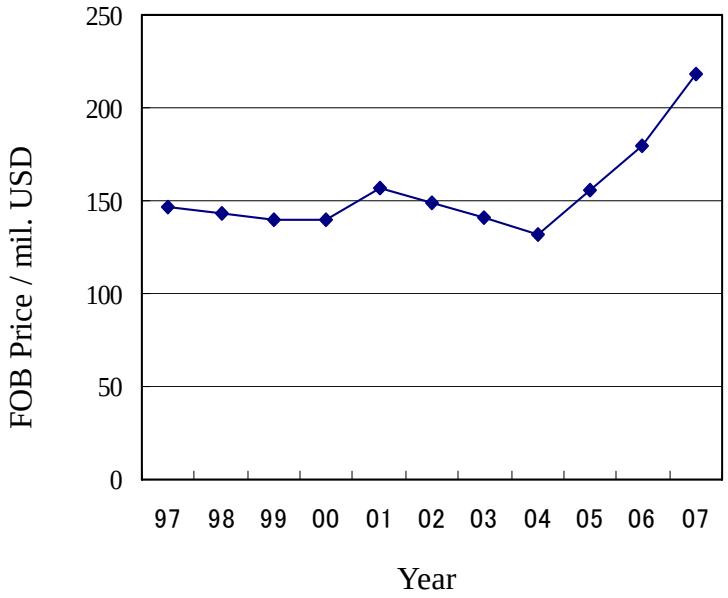
Table I-8-1-1 Technical Assumption of Bheramara CCPP

C/C Model	Siemens SCC5-4000F
Gross Power Output @35^{o}C,1013hPa, RH60%	365,600 kW
Net Power Output @35^{o}C,1013hPa, RH60%	355,100 KW
Net Thermal Efficiency (LHV)	54.2%
Net Heat Rate (LHV)	6642 kJ/KWhr
Construction Period	42 months
Plant Load Factor	70 %
Project Period	30 years

8.2 Project Cost

8.2.1 Trend of FOB price for F-class CCPP

Hot parts of the gas turbine (hereinafter referred to as "GT") of which major component is mainly made of rare metals such as nickel, chromium, and cobalt. Therefore there has been a drastic increase in the production cost due to an increase in the price of rare metals and other steel materials in recent years. Further, because of a steep rise in energy price, a demand for highly efficient CCPP has increased over the supply and this is regarded as one of the causes for a steep rise in the price of CCPP.
The following shows the average FOB price of the F class 1 on 1 CCPP of four F-class gas turbine manufacturers. The price started to rise steeply in about 2004 and has been rising about 1.66 times (about 18%/yr) in the following three years. In 2008, the price has raised more steeply and it is expected to reach 300 million USD in June 2008.



(source) Gas Turbine World GTW Handbook
Note: Since data in 1998, 2000, and 2005 is not available, the averages of the values in the previous and subsequent years are used.

Figure I-8-2-1 Trend of FOB price of the F class 1 on 1 CCPP

In the World Bank's report "Study of Equipment Price in the Energy Sector" established in June 2008, it is also described that above mentioned dramatic increase in energy price and raw material price and market situation where demand for power plant equipment and services is higher than manufacturing firm capacity lead to steep increase of power plant. However, this report indicates that the projected escalation rates are lower than the past three years due to the slowdown in the U.S. economy. As mentioned bellow, CCPP market situation is going to be changed and the price of CCPP is expected to be moderated.

- As of October 2008, the WTI crude oil price is going down almost a half of the highest price 147 USD/barrel.
- The material price is going down to moderate price (Nickel is almost a half of the peak price.)
- It is expected the CCPP market will is shrunk by financial difficulties for CCPP projects affected by the worldwide financial crisis in September 2008. For example, an IPP in the

Middle East faces financial difficulties and such situation would be realized in other project.

8.2.2 Contract Records of F-class CCPP

Table I-8-2-1 shows contract records of F-class CCPP for the last one year according to the data acquired from the home page of each of the GT manufacturers.
The contract records in the table shows the CCPP made up of one through three F-class gas turbines. It included the CCPP consisted from one to three GTs, the EPC price have been converted into that of the 1 on 1 CCPP, and the average value has been calculated. From the following the table, Alstom registers an average of 427 million USD in terms of the EPC cost without a long-term service agreement (LTSA), while Siemens records an average of 425 million USD in terms of the EPC cost with LTSA during the period of 10 to 25 years. This suggests that Alstom's product is more expensive.
The EPC cost is consisted of FOB cost, transportation cost, construction / erection cost, commissioning cost, and insurance fees. In the case of a standard plant configuration, the EPC cost other than the FOB cost is normally 30% of the FOB cost. However, as shown in the following table, when the KA26-1 of Alstom is studied, the assumed FOB cost is 220.7 million USD (refer to Table I-4-7-4 of Section 4.7.2) and in generally, EPC cost is assumed as 287 million USD (1.3 times of 220.7 million USD). However the average EPC cost is 427 million USD and it is about 1.9 times of said assumed FOB cost. This can be seen as an abnormally steep rise in the EPC cost caused by the overheated market of the CCPP.

Table I-8-2-1 Contract records of F-class CCPP for 2007-2008

Date	GT manufacturer	Country	C/C Model	No. of GTs	Output /MW	EPC Price /mil. EUR	EPC Price /mil.USD *1	EPC Price 1 on 1 C/C /mil. USD	Note
2008.7	Alstom	Tunisia	KA26-1	1	400	335	529	N/A	incl. 12 yrs LTSA
2008.6	Alstom	Netherland	KA26-1 x 3	3	1,280	1,000	1,580	N/A	incl. LTSA
2008.3	Alstom	France	KA26-1	1	420	270	427	427	
2008.1	Alstom	Netherland	KA26-1 x 2	2	870	400	632	(316) *2	First GT26 C/C in Netherland
2007.12	Alstom	Algeria	KA26-1 x 3	3	1,200	800	1,264	433	
2007.7	Alstom	Ireland	KA26-1	1	430	275	435	435	
2007.6	Alstom	India	KA26-1	1	370	175	277	(277) *2	First GT26 C/C in India
Average EPC Price w/o LTSA of Alstom F-class 1 on 1 CCPP								**427**	Excluding *2 marked Price
2008.3	Siemens	Portugal	SCC5-4000F	2	830	600	948	474	incl. 25 yrs LTSA
2007.8	Siemens	Singapore	SCC5-4000F	2	800	520	822	411	incl. 10 yrs LTSA
2007.7	Siemens	Singapore	SCC5-4000F	2	785	480	758	379	incl. 12 yrs LTSA
2007.3	Siemens	Netherland	SCC5-4000F	2	870	550	869	435	incl. 15 yrs LTSA
Average EPC Price with LTSA of Simens F-class 1 on 1 CCPP								**425**	
2008.3	GE	Romania	S209FB	2	860	400	632	**379**	

(source) Homepage of each manufacturer etc.

Note) *1 Exchange Rate 1 EUR = 1.58 USD as of July 1st, 2008

8.2.3 Estimation of Project Cost

The project cost includes the EPC cost, consultant fee, contingency, various taxes and duties, interest rate during construction and direct administrative expenses incurred on the BPDB. Of these costs, the EPC cost, consultant fee, contingency and others as of June 2008 are shown in Table I-8-2-1.

Based on the price record in Table I-8-2-1, a price hike for the latest several months was taken into account to get the costs given in Table I-8-2-2 considering the price escalation rate of this year is around 20 to 40%.

The physical contingency was considered as 5% of the total EPC cost.

The price contingency for local portion was estimated considering that the local price escalation would be 5.4%/yr which is the average CPI from 1998 to 2007. On the other hand, the price contingency for foreign portion was estimated as 4.1% / yr which is the average FOB increase rate for the F-class CCPP form 1997-2007 considering the moderate CCPP market situation described in the section 8.2.1.

Cost estimation was also made for the LTSA for the hot parts of the gas turbine that is required periodic inspection, repair and replacement. The contract period will be 6 years considering the time for the first major inspection. The LTSA cost was estimated with sufficient consideration given to the recent steep rise of the steel and rare metal prices.

The Project cost was estimated at June 2008 when world market of raw material like iron was very high. As described Sub-section 8.2.2, since world economy is facing crisis, it seems that the project cost may decrease in near future.

Table I-8-2-2 Estimated Project Cost for Bheramara CCPP (as of June 2008)

Category	Local Portion		Foreign Portion	Total	
	MTk	Eqv. MJPY	MJPY	MJPY	Eqv. MTk
A. Power Plant Construction and Associated Works	4,331	6,713	36,445	43,158	27,844
A1. Power Plant					
(1) FOB Price of Imported Equipement	-	-	31,457	31,457	20,295
(2) Marine, Freight and Insurance	-	-	790	790	510
(3) Inland Transportation and Insurance	255	395	-	395	255
(4) Construction, Erection, Commissioning and Insurance	3,821	5,922	1,974	7,896	5,094
A2. Fuel gas brunch pipeline	5	7	43	50	32
A3. 230kV Substation	138	214	1,517	1,731	1,117
A4. 132kV Substation (Replace)	111	172	601	773	499
A5. Transmission line (230kV main T/L to 230kV S/S)	2	3	64	67	43
B. Consulting Services					
incl. Price Escalation and Physical Contingency	197	305	1,911	2,216	1,429
C. Contingency					
C1. Physical Contingency on A (5% of A)	217	336	1,822	2,158	1,392
C2. Price Contingency on A (Foreign:4.1%/yr, Local: 5.4%/yr)	1,216	1,884	7,560	9,444	6,093
D. Custom Duties, Tax, and VAT					
D1. Custom Duties (15% of Foreign portion of A and C1)	3,703	5,740		5,740	3,703
D2. VAT (15% of A and C1)	4,385	6,797		6,797	4,385
D3. Income Tax (4%) and VAT (4.5%) for B	121	188		188	121
		-			
E. Interest During Construction on A	132	205	2,420	2,624	1,693
A-E. Sub-Total (Construction Portion)	14,302	22,168	50,157	72,326	46,662
F. 6-year LTSA Cost for Gas Turbine	-	-	6,807	6,807	4,392
F1. Initial Spare Parts for LTSA	-	-	2,397	2,397	1,546
F2. Maintenance Fee	-	-	4,410	4,410	2,845
G. Contingency					
G1. Physical Contingency on F (5% of F)	-	-	340	340	220
G2. Price Contingency on F (Foreign:4.1%/yr, Local: 5.4%/yr)	-	-	2,844	2,844	1,835
H. Customs Duty, Tax, and VAT					
H1. Custom Duties (15% of Foreign portion of F and G1)	692	1,072		1,072	692
H2. VAT (15% of F and G1)	692	1,072		1,072	692
				-	-
I. Interest During Construction on F			27.30	27.30	17.61
F-H. Sub-Total (LTSA Portion)	1,383	2,144	10,018	12,162	7,847

8.2.4 Justification of the Project Cost Estimation

For justification of the project cost estimation, the comparative study with the expected cost for a project, the bid of which was opened in July 2008, was conducted and the result was shown in Table I-8-2-3. Furthermore the budget of Haripur 360MW CCPP is shown just for reference and is not used for the comparative study because it was estimated in 2007 and it is difficult to compare cost with that of Bheramra CCPP directly.

(1) Direct Cost

Project A will be implemented using Siemens' E class CCPP (SCC5-2000E 2 x1). FOB price of this model is expected 223.2 million USD in 2007 price and Siemens' F class CCPP (SCC5-4000F) is expected 216.9 million USD in 2007 price, that is both models are almost same price (refer to Table I-4-7-10, I-4-7-11). The FOB bid price of Project A in 2008 is expected around 300 million USD which is about 34% increase comparing that of in 2007. Therefore 294 million USD for the FOB price is feasible estimation.

As for transportation, insurance, construction and commissioning cost, such cost of the Project A is double compared to Bheramara Project and assumed to be included risk premium. Sub-Total of Direct Cost is almost same level.

(2) Indirect Cost

Project A is exempted form custom duties, tax and VAT as IPP project. On the other hand, Bheramara CCPP requires 136 million USD for custom duties, tax and VAT and such difference affects on total project cost.

It is evaluated that the substantial project cost is almost at the same level compared to Project A, although there is difference in direct cost components. Therefore, it is concluded that the estimated project cost of the Bheramara Project is feasible.

Table I-8-2-3 Comparison with other project cost

Unit: Million USD

		360 MW Bheramra CCPP (Cost estimation as of June 2008)	450 MW A CCPP Project (Expected Cost as of July 2008)	360MW B CCPP Project (Budget as of 2007)	Remarks
A	**Direct Cost**				
A1	FOB cost	294	300	193	FOB Price in 2007(GTW2007-8) Siemens E-CCPP : 223 MUSD Siemens F-CCPP : 217 MUSD
A2	Transportation, Insulance, Construction and Comissioning	85	165	77	Including Risk premium for Project A
A3	Related facilities (T/L, S/S, gas pipeline etc.)	24	40	17	
A4	Consulting Service	13	N/A	13	
	Sub-Total (Sum of A)	416 (1,155 $/kW)	505 (1,122 $/kW)	299 (831 $/kW)	
B	**Indirect Cost (1)**				
	IDC / Financial Charge	61	143	34	
C	**Indirect Cost (2)**				
	Custom Duty, Tax, VAT	136	N/A	93	
D	**Contingency**				
D1	Physical Contingency on A	24	N/A	17	Bheramara CCPP: 5% of A
D2	Price Contingency on A	91	N/A	20	Bheramara CCPP: Foreign:4.1%/yr, Local: 5.4%/yr
	Sub-Total (Sum of D)	115	N/A	37	
E	**LTSA Cost**	64	N/A	15.7	Bheramara CCPP: 6yrs B CCPP Project: 3yrs
	Total Project Cost (A+B)	477 (1,325 $/kW)	648 (1,440 $/kW)	333 (925 $/kW)	
	Total Project Cost (A+B+C+D+E)	791	648	478	

8.3 The Basis of Economic and Financial Analyses

For conducting the economic and financial analyses, we are to construct the economic and financial analysis models which will be composed of the cost that will be input to the project and the benefit to accrue from the project. The economic evaluation of the project is similar to the financial evaluation in the sense that both deals with the cost and benefit of the project but is different from each other as the economic benefit to be assessed is different from the financial benefit and so is the cost of the project. Whereas the financial analysis is to estimate and evaluate the benefit which will accrue to the executing agency and/or the stakeholders financially, the economic analysis is to estimate, quantify and evaluate the benefit that will accrue to the national economy as a whole. The basic conditions and presumptions of the project for conducting the economic and financial analyses are laid out and stated hereunder.

(1) Commissioning Date and Useful Life of the Project

The project is planned to start its construction in 2010, to be completed and commissioned in October 2014. The project will continue its commercial operation for 30 years till 2044. For the sake of analytical convenience, the economic and financial analyses assume the project to be completed in June 2014 and start its commercial operation at July 1, 2014. All the costs and benefits to be evaluated are to be expressed in terms of the constant price as of the end of June 2014. Should it happen that any data to be evaluated is captured prior to the end of June 2014, such data is to be converted to the constant price of 2014 by using the inflation indexes of the mother countries of such data, i.e. Taka (Tk) from Bangladesh, Japanese Yen (JPY) for Japan and U.S. Dollar (US $) from the U.S.A.

(2) Inflation

As stated earlier, the wholesale price index is of no practical use because of its belated capturing and announcement and the inflation of the country is predominantly discussed by using CPI. We therefore use, primarily, CPI for Bangladesh and for the other countries too to make our analysis comparable with Bangladesh. The following table lists up the CPIs of the three countries of our concern. The average rates of inflation during past 10 years are seen to be 4.63% in Bangladesh, -0.9% in Japan and 2.54% in U.S.A. In estimating the future rates of inflation, we are to assume the rates of inflation in Bangladesh and U.S.A will keep the past trends to continue during the years to come. The inflation in Bangladesh for 2008-09 is, however, assumed to be 7.0% on the point-to-point basis and 8.50% on the average of the year taking into consideration of the actual record of inflation between July and October 2008 which stands at 7.26% on the point-to-point basis and 9.80% on the average basis for 12 months as of the end of October 2008[1], Meanwhile the past rate in Japan is deemed distorted due to the deflation in the country and will not hold true in future. Rather, we are to assume the future rate based on the inflation in the country of immediate preceding months and assume an annual average rate of 1.0% for the future. Those assumed rates of inflation are indicated in the ATTACHMENT 6.1, Economic Assumptions.

[1] Bangladesh Bank, “Major Economic Indicators; Monthly Update”, November 2008

Table I-8-3-1 Inflation Rates

July of Previous Year to June	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave.
Bangladesh	7.06	2.79	1.94	2.79	4.38	5.83	6.49	7.16	7.20	9.94	4.63
Japan	-3.6	1.1	-2.0	-5.4	-1.8	-0.1	2.6	-1.3	0.7	0.8	-0.9
U.S.A.	2.59	3.81	3.01	2.19	2.20	1.78	3.43	2.88	1.73	1.78	2.54

(note) The fiscal years are; Bangladesh: July of preceding year to June, Japan: April to March next year, U.S.A: January to December

(source) Bangladesh: Bangladesh Bureau of Statistics
Japan: Cabinet Office, "Consumer Price Index Statistics"
U.S.A.: InflationData.com

(3) Foreign Exchange Rate

The statistics of foreign exchange in Bangladesh is available at Bangladesh Bank. The following table shows the historical records of the foreign exchange rates in Bangladesh for 10 years since the fiscal year of 1999.

Table I-8-3-2 Foreign Exchange Rates

Fiscal Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave.
Taka/US$	48.06	50.31	53.96	57.43	57.90	58.94	61.39	67.08	69.03	68.60	59.27
(% change)	5.7%	4.7%	7.3%	6.4%	0.8%	1.8%	4.2%	9.3%	2.9%	4.3	4.3
Taka/JPY	0.39	0.47	0.47	0.46	0.48	0.53	0.57	0.59	0.58	0.52	0.52
(% change)	8.3%	20.5%	0.0%	-2.1%	4.3%	10.4%	7.5%	3.5%	-1.7%	5.68	5.68

(source) Bangladesh Bank

A classic theory of economics tells that the exchange rate between two countries fluctuate in reflection of the interest differential between the two countries whereas the actual fluctuations are observed in defiance of such classic theory. Based on such empirical learning, the analyses adopt the assumption that the exchange rates will take the pattern of its historical trend in its direction and magnitude. Having the historical data as given above, we are to obtain the past trend lines for the two key rates; US$ vs Taka; and JPY vs Taka as follows;

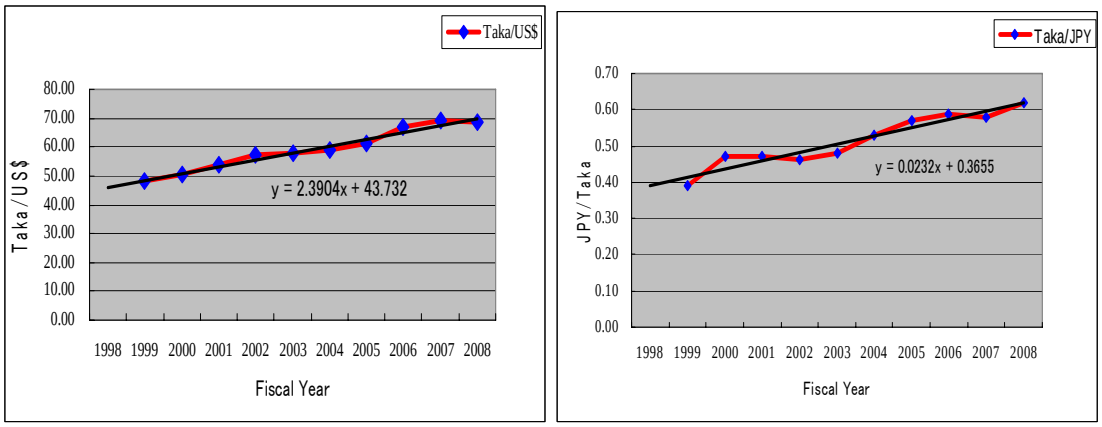


Figure I-8-3-1 Exchange Rates and Trend Lines

It is learnt from the above that the exchange rate between US Dollar and Bangladesh Taka is expressed by the linear function of Y=2.3906X + 43.732 and the one for Japanese Yen and

Taka is Y=0.023X + 0.3655, whereas Y represents the exchange rate and X represents the number of years starting 1998=0. By using the functions, we are to assume the exchange rates for the future years to come. The outputs of the assumed foreign exchange rates appear in the ATTACHMENT 6.1, Economic Assumptions.

(4) Fund Raising

The government controlled entities that belong to the power sector in Bangladesh with exception of a few cases are suffering from the poor business performance carrying a large amount of the accumulated deficits and are not strong enough to raise the funds either from the financial market or from financial institutions. The exceptional cases are acknowledged at DESCO (Dhaka Electricity Supply Co., Ltd.) and PGCB (Power Grid Company of Bangladesh) who are listed in Dhaka and Chittagong Stock Exchanges by offering 25% each of the companies' shares. The entities other than those two basically rely on the bilateral as well as the international donor agencies for raising the funds necessary for implementing the capital investments. In addition, the entities are normally supported by the government through injection of equity capital, long term loans for capital investment and short term loans for working capital which may or may not bear interest depending upon the circumstances.

This analysis makes the assumption that the project will utilize the ODA Yen Loan from Japan and the equity together with loan from the government of Bangladesh. The ODA Yen Loan from the government of Japan will be lent to the government of Bangladesh (Ministry of Finance) and on-lent to the executing agency, NWPGCL, for the project directly or indirectly through BPDB. The standard terms and conditions of ODA Yen Loan to Bangladesh are, as of present, with the rate of interest at 0.01% p.a., for the repayment period of 40 years including the grace period of 10 years. The ODA Loan can cover up to 100% of the total project cost while some of the cost items including, cost of land acquisition, taxes and fiscal levies are not eligible for the Loan. The ceiling limit of the ODA Yen Loan is the total cost of the project less the amount of the non-eligible items. The standard terms and conditions of on-lending within Bangladesh is indicated in the Guideline issued by the Ministry of Finance[2] which prescribes that the funds shall be provided in the combination of the equity and debt=60:40; the terms of the loan is 25 years including 5 years of grace period; the rate of interest to be 4.0% p.a. for the foreign currency and 3.0% p.a. for the domestic currency. The actual conditions of the terms of loans and equity are not strictly standardized but will be determined depending upon the nature of the project[3]. The analysis assumes that ODA Loan from Japan covers 80% of the total project cost, though the actual ceiling amount of the ODA will be determined by deducting the non-eligible items from the total estimated cost. The remaining gap of 20% is assumed to be financed by the government through equity (60%) and loan (40%) as is tabulated in the following table;.

[2] Ministry of Finance, "Lending and Relending Terms of Local Currency and Foreign Loans", March 7, 2004

[3] In normal practice, the DPP (Detailed Project Proforma) to be prepared by the executing agency shall contain the terms and conditions of the loans and apply ECNEC (Executive Committee of the National Economic Council) for approval.

Table I-8-3-3 Terms and Conditions of Loans

	Funds to be Provided	Currency	Rate of Interest	Repayment Period	Out of which Grace Period
ODA Loan from Japan	80%	JPY	4.00%	25 years	5years
GOB Loan	8% (=20%X40%)	Taka	3.00%	25 years	5 years
GOB Equity	12% (=20%X60%)	Taka	—	—	—

(source) Ministry of Finance, "Lending and Relending Terms of Local Currency and Foreign Loans", March 7, 2004

The ultimate combination of the equity and loan will be 12% in equity and 88% in loan. As of present, a separate project is being undertaken at Power Cell of MPEMR under the assistance of the World Bank named, "Power Sector Financial Restructuring and Recovery Plan (FRRP)" to help the government to reinforce the financial strength of power sector entities. The project is recommending in its conclusion that the debt equity ratio of power entities shall not be lower than 60:40[4]. Notwithstanding such has been recommended by World Bank study, we adopt the ratio of 88:12. The reason behind our approach is that the ODA Yen Loan from Japan is of the condition that is extremely soft and concessionary and should be utilized to its fullest extent possible for the benefit of the national economy, while the precious funds of the government shall be utilized for other investment opportunities.

(5) Debt Service

The repayment of the funds borrowed is assumed to be made in accordance with the normal practices of financing. The principal of the loan after elapsing the grace period shall be repaid in equal installments semi-annually at the ends of June and December of each year. The interest on loans shall be calculated on the outstanding balance of the loan and be paid at the ends of June and December each year. The interest accruing prior to the commissioning of the project shall be capitalized at the time of transfer of the asset from capital work in progress to the fixed asset. The detailed schedule of debt services is exhibited in the ATTACHMENT 6.5, Capital & Operational Cost (FIRR).

(6) Electricity Tariff

The electricity tariff is determined by Bangladesh Energy Regulatory Commission (BERC) through approval of the application to be submitted by the power sector entities who shall compile the application based on the actual cost of supplying the electricity. The prevailing electricity tariff has been in force since March 1, 2007. BPDB has filed an application for the revision of the tariff to BERC in June 2008. BERC has approved the wholesale part of the application on September 29, 2008 in such manner that the wholesale tariff is increased by 16% to be immediately effective. Following the approval of revision of the wholesale tariff, the distribution companies including BPDB themselves may take actions of submitting their application for the revision of the retail tariff in due course. Despite the latest increase, the tariff still remains at a low level which barely covers the supply cost of the electricity. In particular, the power generating entities under the umbrella of BPDB are forced to operate in the environment where the average billing rate undermines the average supply cost. In the financial analysis, we are to adopt the actual level of tariff that BERC approves whereas in the economic analysis, the prices shall be replaced by the economic price of electricity using

[4] Power Cell, Ministry of Power and Mineral Resources, "Power Sector Restructuring and Recover Plan", August 2006

the quantified level of the willingness-to-pay which will be rational in view of the international environment of fuel prices.

(7) Useful Life and Depreciation

In Bangladesh, the depreciation is generally treated in a flexible manner. In particular, a preferential treatment is given to the foreign investor. The power entities are allowed to select the straight line or the declining balance method. The analysis assumes to adopt the straight line depreciation while setting up the residual value of 10% and useful life of 30 years. The residual value shall be recognized as the benefit of the project at the final end year of project life. The details of depreciation and residual value are tabulated in ATTACHMENT 6.5.

(8) Interest during Construction

For calculating the interest on the loan during the construction period, the rates specified in the item (4) above shall be adopted and used. The interest accrued during construction shall be booked into the account of capital project in progress and shall be capitalized at the time of account transfer to the fixed assets. The calculation of interest during construction is made in ATTACHMENTES 6.3, Capital Cost and 6.4, Capital Cost (2014 constant price). The interest during construction, however, shall be excluded from the project cost when analyzing the FIRR as such is true for the interest to be paid during the operational period.

(9) Contingencies

The project cost presented before contains both the physical and the price contingencies. The economic as well financial analyses are to be carried out based on the constant price as of the end of June 2014, based on which the adaptation of the concept of the price contingency shall not be justified in theory. The price contingency mentioned in the project cost explanation shall be disregarded from the economic and financial analyses. On the other hand, the physical contingency is included in the project cost because the physical contingency is to cover any of the shortcomings of the project plan that has to be complemented with additional material, parts or works before the project could be completed as has been designed. Such parts of the project are found to be vital and indispensable to the project and, therefore, should be incorporated as an integral part of the project when conducting the economic and financial analyses. Details should be referred to ATTACHMENTES 6.3 and 6.4.

8.4 Financial Evaluation

8.4.1 Method of Evaluation and the Basic Parameters

Within the perspective of the executing agency, the study will evaluate the viability of the project in the financial aspect. The purpose of the analysis is to check and verify that the project would be financially sustainable under the framework constructed. The method of the evaluation is to compare the financial cost (expenditure) against the financial benefit (revenue) of the project by calculating the financial internal rate of return (FIRR). The FIRR calculated shall be checked against the weighted average of the capital cost (WACC) mobilized for the project. When FIRR is found to undermine the WACC of the project, it is suggested that the cash flow output of the project falls insufficient for the executing agency to collect the reasonable return for the funds mobilized in the form of either equity or loan. The cost and benefit used for the analysis is expressed in the constant price of June 2014 when the project will commence its commercial operation. Though constituting a part of the total cost, the items such as the interest paid or taxes paid shall be disregarded from the calculation of financial cost as those cost components are deemed as the transfer of the capital from the payer to the receiver.

8.4.2 Financial Cost

(1) Scope of the Project

The project is to construct a combined cycle gas turbine power generation plant in Bheramara Thana of Kushtia Zilla. The plant is planned to operate as the base load supplier. The construction site of the plant is the property owned by BPDB for its existing Bheramara Power Plant. The fuel gas is to be supplied by Petrobangla through the Bheramara-Khulna trunk pipeline which is being constructed by Petrobangla. A branch pipeline is to be constructed to receive the gas from the trunk pipeline whose cost is to be born partially by NWPGCL. For transmission of the power, the project is to utilize the existing transmission line which will deliver the power generated by the project to the power grid for sale to the single buyer BPDB.

(2) Project Cost

The cost of the project has been presented in the section 8.2. The cost presented is compiled based on the cost estimated in the constant price of June 2008. In order to create the basis which is fit for the financial analysis, all the estimated costs are converted into the constant price as of June 2014. The analysis is estimating the inflation toward the future years and is to apply its result for the price conversion. The project cost based on the 2014 constant price is now presented in the following table. One may note that the LTSA cost that has been included in the cost estimate in 8.2 above but the economic and financial analyses deal with the cost as a part of O&M costs. For detail, please refer to ATTACHMENT 6.4, Capital Cost (2014 Constant Price).

Table I-8-4-1 Project Cost for Economic and Financial Analyses (2014 constant price)

	Cost		
	Foreign currency (JPY Million)	Local currency (Tk million)	Total（Tk million）*1
A. Power Plant Construction			
A1. Power Plant			
FOB Price of Imported Equipment	33,392	0	22,513
Marine, Freight & Insurance	839	0	565
Inland Transportation & Insurance	0	342	342
Construction, Erection, Commissioning & Insurance	2,095	5,129	6,542
A2. Fuel Gas Brunch Pipeline	0	7	7
A3. 230kV Substation	1,610	185	1,271
A4. 132kV Substation	638	157	587
A5. Transmission Line	68	3	48
A1-5 Sub-total for EPC Contract	38,688	5,823	31,907
B. Consulting Services	1,634	313	1,414
C. Contingencies			
C1. Physical Contingencies	1,934	291	1,595
C2. Price Contingencies *2	8,801	849	6,872
D. Custom Duties, Taxes & VAT			
D1. Custom Duties	0	9,100	9,100
D2. Corporate Tax		495	495

	Cost		
	Foreign currency (JPY Million)	Local currency (Tk million)	Total (Tk million) *1
D3. VAT	0	231	231
E. Interest during Construction (IDC) *2			
E1. IDC (Foreign Loan)	1,135		1,694
E2. IDC (Local Loan)	0	72	72
Total Cost	51,935	19,078	54,170

(note) *1: JPY 1 = 0.67Taka (estimated for 2014)

*2: Price contingency and IDC are to be excluded from the total cost used for the economic and financial analyses.

(source) JICA Study Team

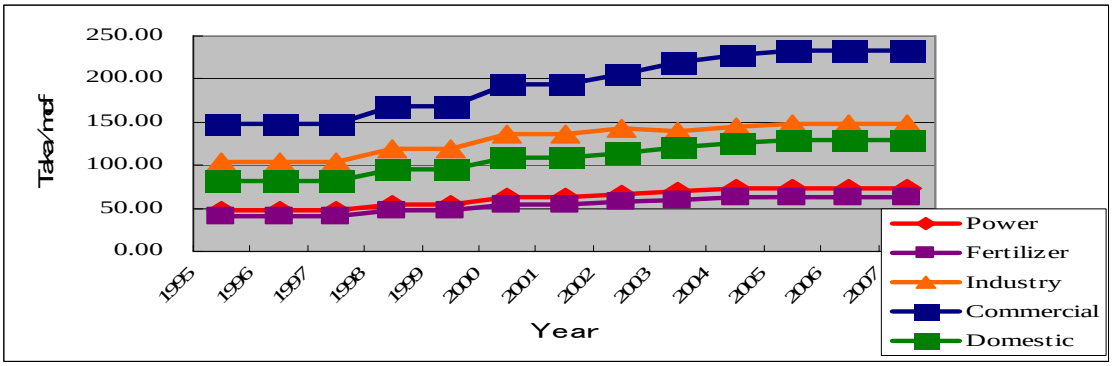
(3) Fuel Price

The development, production and marketing of gas in Bangladesh rest within the responsibility of Bangladesh Oil, Gas & Mineral Corporation (PETROBANGLA). The price of gas is subject to the approval of BERC being similar to the electricity tariff. But unlike the electricity, different tariffs are set separately for each of the usage. The prevailing tariff is the one revised as of January 1, 2005. The level of gas prices are extremely low ranging at about 10-20% of the international price. The tariff of gas for the electricity is set at Taka 73.91/mcf[5] which is the second lowest after the fertilizer (Taka 63.41/mcf).

Table I-8-4-2 Domestic Gas Price

	Electricity	Fertilizer	Industrial	Commercial	Households
Price of Natural Gas (Taka/mcf)	73.91	63.41	148.13	233.12	130.00

(source) PETROBANGLA



(source) PETROBANGLA

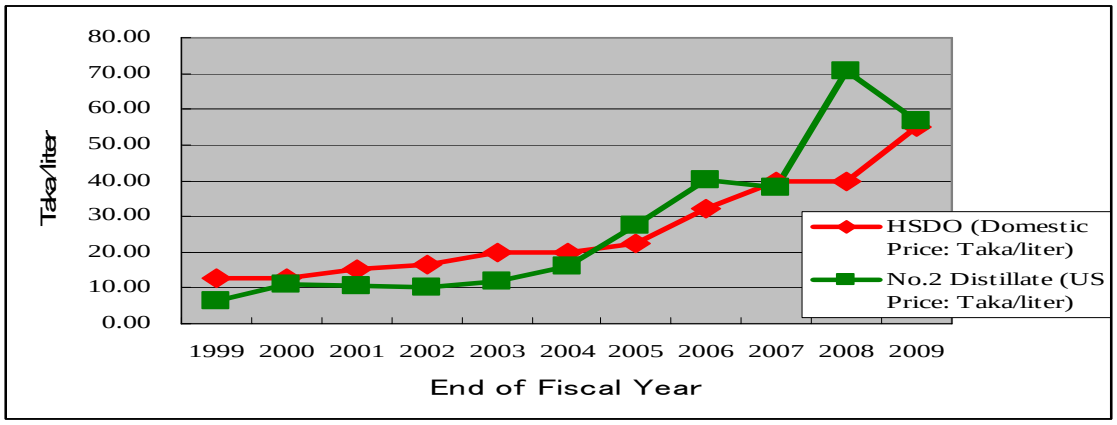
Figure I-8-4-1 Historical Trend of Gas Prices

According to the information obtained in Bangladesh, Petrobangla reportedly filed its application for the revision of the gas tariff. Similar to the proceedings taken for the power tariff, BERC invited the public hearing on September 24, 2008 and the final decision was to

[5] Mcf stands for 1,000 cubic feet.

to be announced on November 30, 2008. The appraisal at BERC will see the public hearing conducted within 60 days of the official receipt by BERC of the application and the final decision shall be made and announced within 90 days of the receipt of the application. The revision of gas tariff will affect the cost of generation for which the generating entities may reasonably take actions for another round of the tariff revision. Based on the actual price during the fiscal year 2008, this analysis estimates the price of gas in 2014 by applying the inflation factor.

In addition to the tariffs of power and gas, attention should be given to the tariff of the petroleum products, in particular, high speed diesel oil (HSDO). Bangladesh produces no crude oil but imports all of its petroleum consumption. The import and marketing of petroleum products in the country is handled by Bangladesh Petroleum Corporation (BPC). The tariff matter is understood to be within the jurisdiction of BERC. Nevertheless, the government has been by-passing BERC in determining and announcing the tariff of petroleum products. The prices are kept under frequent revision, once every year lately, and the level of the tariff are treading the international prices closely. The tariff of the high speed diesel oil (HSDO) used to be Taka 40.00/liter since April 2007 and was raised to Taka 55.00/liter on September 1, 2008. The increase was partially reversed by the cutting down to Taka 46.61/liter on October 27, 2008. A widely understood forecast is that the price will decrease one more time in a few months to come.



(note) 2009 is as of September 1, 2008
(source) Domestic Price: BPDB, US Price: Energy Information Administration, U.S. Department of Energy.

Figure 8-4-2 Domestic and International Prices of Diesel Oil

In conducting the economic analysis, the fuel cost shall be adjusted to meet the international level of price with the aim at conducting the analysis based on the economically rational costs and benefits. The financial analysis, on the other hand, is to use the prevailing gas prices. For both economic and financial analyses, the above prices that are effective now are to be converted to the 2014 constant price.

(4) Operation and Maintenance Cost

With respect to the maintenance of the plant which is adopting a sophisticated technology, the project plans to hire a specialized service provider by entering into a long term service agreement which is to cover the initial six years (2015 – 2020) after commissioning. Beyond the expiry of the long term service agreement, NWPGCL will take over the maintenance jobs on its own. The cost required for the two phases of maintenance operation is estimated and converted into the 2014 constant price as enumerated in the following table;

Table I-8-4-3 Maintenance Cost (2014 constant price)

	Foreign/Local Currency	Years 2015－2020	Beyond the year 2021
Maintenance through LTSA			
LTSA, Initial Spare Parts incl. contingency	Foreign	JPY 2,672million (Tk 1,790 million)	
LTSA, Maintenance incl. Contingency	Foreign	JPY 819million/yr(Tk 549 million/yr)	
LTSA Total incl. contingency		JPY 7,586 million	
Maintenance by NWPGCL			
NWPGCL Maintenance Fixed Cost (US$8.80/kW/year)	Foreign	n.a.	n.a.
	Local	Tk 604/kW/yr	Tk604/kW/yr
	Sub-total	Tk 604/kW/yr	Tk 604/kW/yr
NWPGCL Maintenance Variable Cost （=US$4.00/MWh）			
	Foreign	Tk 270/MWh	Tk 270/MWh
	Local	Tk 27/MWh	Tk 27/MWh
	Sub-total	Tk 297/MWh	Tk 297/MWh
Adjustment for LTSA		-Tk 549 million/year	

(note 1) The inflation rates used for conversion to 2014 price are that of Japan for foreign portion and Bangladesh for local portion.
(note 2) In addition to the above, custom duties and VAT (30%) are assumed to be levied for imports and VAT (15%) for labor.
(source) JICA Study Team

(5) Fiscal Levies

The fiscal levies including the taxes and custom duties that are levied upon the judicial person are listed in the following table;

Table I-8-4-4 Fiscal Levies

Fiscal Levies	Subject for Levy	Exempted Items	Levying Rate
Income Tax		・Expenses incurred for business purposes ・Bad debts ・Interest payment ・Depreciation（accelerated depreciation allowed depending upon the company）	・40% (non publicly traded companies) ・30%publicly traded companies）
Import Duties	Ad valorem tax on imported goods	・Concessional rates apply to a wide range of capital equipment, spare parts, etc.	・4 tariffs (0%、5%、12%、25%）
Value Added Tax	Invoice method VAT applied to manufacturers, importers and selected wholesale and retailers	・VAT is levied on the base inclusive of custom duties. ・Exports are zero rated. ・Electricity for agriculture	・15%all imports） ・5.0025%(electricity consumption)
Insurance Tax	Tax on premium paid for general insurance policies		15%
Withholding Tax	Salary		10%
	Interest on bank deposits		10%
	Contractors, suppliers		1-4%
	Importers		5%

Fiscal Levies	Subject for Levy	Exempted Items	Levying Rate
	Professional/technical services		5%
	L/C commission		5%
	Compensation against acquisition of properties		5%

(source) IMF, "Bangladesh: Statistical Appendix", June 2007

The taxes and fiscal levies are deemed as the domestic unrequited transfer of revenue that plays no contributory function in the project and are disregarded in conducting the economic analysis. In the financial analysis, on the other hand, they represent legitimate expenditure for the project. The custom duties, the value added taxes and the income taxes are counted as a part of the project cost.

(6) Weighted Average of Capital Cost (WACC)

Once the FIRR is calculated, the rate obtained is to be compared with the weighted average of capital cost to verify if the FIRR calculated is sufficiently covering the cost of the funds including the equity and borrowed funds. WACC is calculated by using the following equation formula;

WACC (before tax) = [Equity Cost (after tax)／(1 - corporate tax rate)
X Equity／(Equity + Debt)] + [Debt Cost X Debt／(Equity + Debt)]
Or,
WACC (after tax) = [Equity Cost (after tax) X Equity／(Equity + Debt)]
+ [Debt Cost X (1 - corporate tax rate) X Debt／(Equity + Debt)]

Depending upon the cases of WACC to be taken before the tax or after the tax, either one of the above formulae shall be applied for calculation. The FIRR, the tool for the financial analysis is to be calculated on the basis of the cost and benefit after incorporating the taxes into the benefit and cost stream. We therefore use the WACC (after tax) for the analysis.

The followings are the assumptions that are laid down for the project;

Equity Cost = 15% p.a. (before tax)
Equity／(Equity + Debt) = 12%
Debt Cost (from Yen Loan) = 4.0% p.a.
Debt Cost (from government loan) = 3.0% p.a.
Debt／(Equity + Debt)（from Yen Loan） = 80%
Debt／(Equity + Debt)（from government loan） = 8%
Corporate Tax Rate = 40%

Those assumptive figures are inserted into the formulae to draw the output rates for WACC (before tax) and WACC (after tax) as follows;

WACC (before tax) = 5.24% and WACC (after tax) = 3.11%

What is learnt from the above exercise, the weighted average of capital costs are 5.24% on the basis of before tax and 3.11% on the after tax basis. We conclude this section by confirming that the project is to be deemed viable when FIRR will be found at above the WACC (after tax) of 3.11%.

On the other hand, the economic analysis is conducted on the basis of evaluating the project on the perspective of national economy and, therefore, the criteria of viability for the

economic feasibility rests upon whether the EIRR clears the opportunity cost of capital in the country. The opportunity cost of capital is normally represented by the yields of the short term treasury bills and/or of the foreign currency denominated bonds issued by the country and floated in the international markets. The yields of the short term treasury bills (3-6 months of maturity) in Bangladesh is captured as is seen in the following table. While there exists neither Bangladesh bonds floated in the international markets nor the official indicator announced by the government for the opportunity cost of capital, we adopt the average yield of the treasury bills as the opportunity cost of capital for the project to clear.

Table I-8-4-5 Yields of the Treasury Bills in 2008

(Unit : %)

	January	February	March	April	May	June	July	August	September	Average
90 days	7.63	7.64	7.67	7.71	7.72	7.73	7.78	No issue	7.78	7.71
180 days	7.95	7.96	7.96	7.96	7.96	7.96	8.0	No issue	8.05	7.98

(source) Bangladesh Bank

The above table indicates that the opportunity cost of capital in Bangladesh is, in general, 8%. The international donor agencies are observed to be setting the level of the opportunity cost of capital at 10-12% which is higher than the one adapted above for Bangladesh, though such setting of rates accompany no supporting data. The Planning Commission of Bangladesh is instructing the agencies concerned of preparing the DPPs to adopt the discount factor of 15% in calculating the cost/benefit ratio and net present value of the project. The fact that the government requires any projects to satisfy the discount rate of 15% before being proved as feasible implies that EIRRs of any projects are expected to be above the discount rate.

8.4.3 Financial Benefit

(1) Definition of Financial Benefit

The financial benefit is defined here as the revenue to be raised through the sale of electricity. The exact price of the electricity shall be determined by the appraisal of BERC of the application to be submitted by NWPGCL before starting its commercial operation. For the purpose of conducting the financial analysis, the study assumes the existing tariff will prevail and tests the financial sustainability based on such electricity tariff. Should it happen to be the cases in which the electricity tariff will be determined in a different level from the current one or any of the key parameters of the plant may change from the original assumption, one will be able to learn the impact of the differences in major parameters including tariff upon the financial viability by resorting to the result of the sensitivity analysis that the study will conduct later.

(2) Electricity Tariff

NWPGCL is supposed to sell all of the electricity generated to the single buyer, BPDB who also purchases the electricity generated for IPPs and, in turn, sell the powers to the distribution companies including REB while BPDB itself is selling a part of the electricity to the end users. The price for BPDB's sale shall be approved by BERC. The policy adopted by BERC for determining the electricity tariff is reported to be the one which aims at recovering the cost incurred for supplying the energy plus a reasonable margin to secure the sustainability of the power entity and assuring the investors to invest in the power sector. In the grim reality, the tariff has been suppressed by the government for a long time and power entities has been placed in the environment in which the selling prices undermine the cost of supply. The following table illustrates the environment BPDB has been placed in respect of the selling price and supply costs of power during recent several years;

Table I-8-4-6 Electricity Selling Price and Supply Cost

FY	2002	2003	2004	2005	2006	2007
Average Selling Price (Tk/kWh)	2.31	2.45	2.40	2.27	2.19	2.26
Average Supply Cost (Tk/kWh)	2.47	2.47	2.54	2.62	2.70	2.77
Average Margin (Tk/kWh)	-0.16	-0.02	-0.14	-0.35	-0.51	-0.51
Tariff for High Voltage (132kV) Wholesale (Tk/kWh)			2.12 (2004.4.1)			2.34 (2007.1.1)

(source) BPDB, Annual Reports

The retail tariff which is prevailing now is the one that has been revised as of March 1, 2007 and the wholesale tariff has been revised by 16% on September 29, 2008. The revision allowed BPDB to wholesale the power at the prices of; 1) high voltage (132kV): Tk 2.34/kWh, 2) medium voltage (33kV): Tk 2.39/kWh, and 3) medium voltage for REB (33kV): Tk 2.05/kWh. The appraisal for the revision conducted by BERC has been based on the actual cost incurred during the fiscal year of 2007-08, based on which BERC has come up with the wholesale price level which would have been sufficient enough to cover the actual cost incurred but to allow no return of equity. The average of the wholesale tariff approved by BERC stands at Taka 2.37/kWh which is construed as the price that would have been the break-even price for the fiscal year of 2007-08. The revision will subsequently invoke the distribution companies including BPDB, itself, to apply for the revision of the retail tariff. The electricity generated by this project shall be sold to the single buyer at the high and ultra high voltage of 230 kV and 132 kV. The actual record of the wholesale price in 2006/07 of Tk 2.04/kWh which is applied for estimating the base tariff for the analysis by multiplying 16% to reach Taka 2.37 as the estimated price for 2007/08. The price thus calculated is converted into the constant price of 2014 by using the inflation index between 2007/08 and 2013/14. The unit price for the year is obtained as Taka 3.22/kWh. The estimated revenue expressed in 2014 constant price is exhibited in ATTACHMENT 6.5, Capital & Operational Cost (FIRR).

8.4.4 Financial Analysis

(1) Financial Internal Rate of Return (FIRR)

Based on the assumptions stated above, the analysis has constructed an analytical model for obtaining FIRR. The model appears in the ATTACHMENTES 6.5 and 6.6, Financial Rate of Return (FIRR). The analytical model culminates in producing the cost versus benefit table as appearing hereunder.

Table I-8-4-7 Financial Internal Rate of Return（FIRR）

(Taka Million)

Fiscal Year	Financial Cost (A)			Financial Benefit (B)	(B) - (A)
	Capital	O&M	Total Cost		
2010	331		331		-331
2011	13,323		13,323		-13,323
2012	8,910		8,910		-8,910
2013	8,910		8,910		-8,910
2014	13,489		13,489		-13,489
2015		4,953	4,953	7,009	2,055
2016		2,876	2,876	7,009	4,133
2017		3,212	3,212	7,009	3,796
2018		3,212	3,212	7,009	3,796
2019		3,212	3,212	7,009	3,796
2020		3,228	3,228	7,009	3,781
2021		3,308	3,308	7,009	3,700
2022		3,339	3,339	7,009	3,669
2023		3,370	3,370	7,009	3,638
2024		3,401	3,401	7,009	3,608
2025		3,432	3,432	7,009	3,577
2026		3,463	3,463	7,009	3,546
2027		3,494	3,494	7,009	3,515
2028		3,525	3,525	7,009	3,484
2029		3,556	3,556	7,009	3,453
2030		3,587	3,587	7,009	3,422
2031		3,618	3,618	7,009	3,391
2032		3,648	3,648	7,009	3,360
2033		3,679	3,679	7,009	3,329
2034		3,710	3,710	7,009	3,298
2035		3,741	3,741	7,009	3,267
2036		3,772	3,772	7,009	3,236
2037		3,803	3,803	7,009	3,205
2038		3,834	3,834	7,009	3,174
2039		3,865	3,865	7,009	3,144
2040		3,880	3,880	7,009	3,128
2041		3,880	3,880	7,009	3,128
2042		3,880	3,880	7,009	3,128
2043		3,880	3,880	7,009	3,128
2044		3,880	3,880	11,505	7,624
Total	44,962	108,241	153,203	214,752	61,549
FIRR	**5.88%**				

FIRR is calculated as 5.88%. The WACC (after tax) we discussed before stands at 3.11% and we hereby conclude that the project is financially viable. There exist important points to note in taking the result of financial viability. The points are; 1) the project assumes the rate of return on the equity at 15% before tax; 2) the on-lending rate of interest of ODA Yen Loan at 4.0% p.a.; 3) the government imposes the project, despite being the one to be implemented by a government controlled agency the custom duties (15%), the value added tax (15%) and income taxes (40%).

Generally speaking, it is legitimate for the government to require the return of investment at the prevailing level of the opportunity cost of capital. Should we assume the project be invested by a private investor, the return on investment shall reasonably include a certain amount of the risk premium on to the opportunity cost of capital. The government investment should be different in counting the risk premium which should not be equal to the one of the private investor. The project undertaken by the government is not for the purpose of profit,

besides the government is in the position to control and/or mitigate the risks involved with the execution of the project. The return on investment that should be rewarded needs to discount such factors that are not bestowed at the private sector investment.

The second point is concerned with the terms and conditions of the on-lending of the ODA Loan to be provided by the government of Japan. The original loan from government of Japan is to be provided at the concessionary rate of 0.01% p.a. for the repayment term of 40 years including 10 years of grace period. The on-lending terms and conditions will be at 4.0% p.a. of interest for the repayment terms of 25 years including 5 years of grace period. The government is to take the interest margin of 3.99%, while the on-lending will be made in the currency of Japanese Yen in transferring the exchange rate risk onto the executing agency. The on-lending terms and conditions should legitimately established within the limits that would not infringe upon the profitability of the project.

Next is on the fiscal levies. According to the government policy of IPP promotion, IPPs are given the preferential treatment of exempting the custom duties and the value added taxes on the initial construction of the project. In addition, IPPs are also exempted from the income tax for the first 15 years of operation and from the custom duties and the value added taxes for the imports of its spare parts during the initial period of 12 years with the maximum ceiling of 10% of the initial total investment[6]. These are the factors contributing to the higher cost of generation at the government controlled power plants in comparison with the IPPs. For sake of comparison, we are testing the financial model for the assumed case of the fiscal levies being exempted, i.e. exemption from the custom duties and the value added taxes for the initial construction, the income tax for the initial 15 years, the custom duties and the value added taxes on the maintenance activities for the first 12 years. The FIRR is calculated as 9.46% under the condition which culminates the improvement of the rate by 3.58%. We hereby urge that a level playing field should be developed in order to promote the competitive environment of the power sector that is deemed imperative for the improvement of the efficiency.

(2) Profit and Loss Analysis

The financial analysis model enables us to review the profit and loss conditions of the project. To begin with, we have to make one reservation that the analyses conducted here in this item (2) through item (5) ratio analysis is carried out by utilization of the model developed for FIRR and therefore does not take into the account of the price contingency while the tariff of the electricity generated is assumed to be sold to BPDB at the bulk selling rate of BPDB. Given the background as such, it happen that the capital cost of the project exceed what we have assumed by converting the current price to 2014 constant price or the selling rate of electricity from NWPGCL to single buyer BPDB be set at a lower level than the bulk selling rate of BPDB, the following analyses have to be re-tried by adjusting the financial model. The details of the profit and loss are displayed in ATTACHMENT 6.7, Financial Statements of which some of the points are to be noted as stated hereunder. The revenue of the project is calculated based on the tariff effected on September 2008 converted into the 2014 constant price. The fuel price considered the prevailing gas tariff of Petrobangla. The gas tariff of Petrobangla is under the appraisal of BERC for its upward revision. The potential increase of the tariff will invoke the subsequent revision of power tariff that might maintain at least the present cost benefit relationship. The model analysis indicates that the earnings before interest and tax (EBIT) are shown to be positive from the very first year of operation through the end of the project. For the net profit after tax, the project will take the deficit on the first

[6] Ministry of Power, Energy and Mineral Resources, “Private Sector Power Generation Policy of Bangladesh”, October 1996 Revised November 2004.

year but will turn to be positive on the second year (FY 2016) and will keep going through the final end of the project. To be also learnt from the model, the project will have profits from the second year of operation and thus will be subject to the income tax. The model analysis also indicates that the level of the profit after tax may be sufficient enough to declare the dividend of 9% (equals to 15% before tax) from the second year till the end of the project.

(3) Cash Flow Analysis

Similarly, the financial analysis model can produce the estimate in cash flow whose details are shown in ATTACHMENT 6.8, Cash Flow Statement and Key Performance Indicators. The major stream of the cash flow is seen to be; 1) cash is constantly generated through the daily operation; 2) expenditures for the operation and maintenance are paid out of the cash flow; 3) the cash flow covers payment of principal and interest of the loan; 4) cash flow remaining after 1) through 3) will be declared and paid as the dividend. The prominent feature of the cash flow is that the free cash flow generated through the operation sufficiently covers the operational expenses, debt service and the return on the equity. The profits after tax are added by the depreciation to produce the significant amount of the free cash flow. The annual cash flow appears to be negative, though in small amounts, in the first year and 6 consecutive years starting from 2020 the repayment of loans commence. The setbacks in the cash flow will be in minimal amount and will be accommodated by the accumulation of cash from during prior years. The free cash flow which is defined as the cash flow from operating activities less the cash flow from investment activities maintains the comfortably positive level supported by the constant cash flow generated from operating activities, as the project anticipates no investment during its life with exception of maintenance. There will be neither shortfall nor insufficiency of funds for the financial operation of the project including the payment of principals and interest of the loans, payment of fiscal levies as well as the declaration of dividend.

(4) Debt Service

The net cash flow from operating activities starts the first year with a negative amount, but generates surplus of Taka 2,000 million or above in the second year and steadily increases to stay at Tk 2-3,000 million till the end of the project. The repayment of the principal of the loan will commence in the 6th year (FY 2020) and will be over in FY 2039. The interest is kept paid out of the cash flow for the two loans, one from ODA Loan from Japan and the other loan provided by the government of Bangladesh. The debt service is sufficiently incorporated into the cash flow and the analysis acknowledges no problem in proceeding with the cash flow as estimated. The details of the debt service are exhibited in ATTACHMENTES 6.5 and 6.8.

(5) Ratio Analysis

The outcome of the ratio analysis is shown in ATTACHMENT 6.8. The debt service coverage ratio starts the project at a high level till the commencement of the repayment of loans with exception of the first year but takes a plunge when the repayments of loans commence. The ratio goes below the level of 1.0 to say nothing of the standard norm of 1.3. This is due to the fact that the project takes the debt as much as 88% of the total cost including 80% of the ODA Loan from Japan and 8% from the government of Bangladesh. The large amount of the repayment falling due after the grace period pushes down the ratio during most of the repayment period. The ratio comes back to the level of 1.3 in the 19th year of operation which is in the fiscal year of 2038, leaving most of the repayment period in a warning track as far as the ratio is concerned.

With respect to the return on assets, the ratio starts the project at the level of 2.9% and increases gradually to reach 8% which is the opportunity cost of the capital for the project in

2034. The ratio takes a sharp rise toward the end of the project as the accumulated depreciation makes the denominator amount smaller year after year and finally reaches the level of 39%. Meanwhile, the return on equity starts the project at a very high level of 23% in the second year and thence to climb to 33% in the final year surpassing the opportunity cost of capital by a significant margin. This is nothing but the high leverage effect which the project is designed with the small equity and large borrowed funds.

The debt equity ratio starts the project at the level of 90% and lowers gradually. It will be in the fiscal year 2030 when the project will satisfy the debt equity ratio of 60% or lower which is the level solicited by the FRRP Project implemented by Power Cell and sponsored by the World Bank. This is also due to the design of the project with small equity and large debt.

The ratios of the current ratio and the quick ratio are the ones intended to measure the solvency of the project. The ratios appear to be quite healthy for the project. In despite, what has been learnt from the empirical lessons includes that the accounts receivable took the balloon like swelling stemming from the delays of payment inflated the total amount of assets that have caused the superficial appearance of the ratios improve. However, the fact is to the detriment of the company as the overwhelming part of such accounts receivable turned to be uncollectable. The sponsor of the project needs to use the caution and establish the measures to keep the current assets under a healthy and solvent condition.

8.4.5 Sensitivity Test

The analysis moves to the next task that, should any of the basic assumptions adopted for the project happen to change to a significant extent, what extent of impact to be felt by FIRR, is to be examined. The factors considered here are; 1) construction cost; 2) fuel cost; 3) billing rate of electricity; 4) operation and maintenance cost; and 5) plant factor. The following table summarizes the different pictures of FIRRs depending upon the fluctuations of those parameters;

Table I-8-4-8 Sensitivity Test of FIRR

Parameter	Deviation	FIRR	Parameter	Deviation	FIRR
Construction Cost	▲20%	7.25%	Fuel Cost	▲20%	6.29%
	▲10%	6.51%		▲10%	6.08%
	+10%	5.34%		+10%	5.67%
	+20%	4.86%		+20%	5.46%
O&M Cost	▲20%	6.24%	Billing Rate of Electricity	▲20%	3.68%
	▲10%	6.06%		▲10%	4.84%
	+10%	5.69%		+10%	6.82%
	+20%	5.49%		+20%	7.68%
Plant Factor (Base Case =70%)	▲20%(PF=56%)	4.46%			
	▲10%(PF=63%)	5.21%			
	+10%(PF=77%)	6.51%			
	+20%(PF=84%)	7.11%			

Among the 5 parameters selected for the analysis, there is no one whose change deprives the project of its financial viability, so long as the changes remain within 20% of the base case condition. Nevertheless, it is observed for some of the parameters to cause their FIRRs undermining the WACC (before tax) and coming close to the viability threshold. Namely, the cases under which the capital cost increases by 20%, the plant factor and the selling price of electricity deteriorate by 10% are the ones that we see FIRRs moving close to the threshold. The cases where the O&M cost or fuel price increases by 20%, FIRRs goes below 6% but never erodes the WACC (before tax). To the contrary, should the O&M cost or fuel cost decrease by 20%, FIRRs improve and go beyond 7%. Out of the 5 factors the one that impacts most on the FIRR is the billing rate of electricity whose fluctuation of ±20% swings FIRRs with the range

of 4.0%. The one that impacts least is the O&M cost whose fluctuation of ±20% causes FIRRs to move within the range of 0.8%.

From what has been seen above, we have noted three cases in which FIRR moves lower than WACC (before tax) and closer to WACC (after tax). Hereunder is the brief insight into the probability of the factors to realize as a precaution. The billing rate of the electricity is estimated based on the wholesale tariff approved by BERC in September 2008. The rate calculated as Taka 2.37/kWh as of 2007/08 is converted to the 2014 constant price of Taka 3.22/kWh. The gap between the 2008 price and 2014 price is 36% which is equal to the annual average of 6%. The revision that has been approved by BERC in 2008 was for 16% in two years since March 2007. The annual rate of increase for the latest revision is 8%. In comparison with the latest tariff increase, the increase of 6% on an annual average appears to be probable and the deterioration of the selling price of electricity is out of the practical consideration. The plant factor is the second item for consideration. The sensitivity test reveals that should the parameter deteriorate by 20%, FIRR decreases to 4.46%. As has been stated earlier, Bheramara CCGT is designed for the base load operation under which the plant remains operative at any time with exception of the scheduled maintenance period. While the demand supply condition of the country's electricity remains very tight and is suffering from the severe shortage of supply, the project is expected to operate at higher plant factor than at lower rate. Unless an event of fatal accident takes place at the plant, 70% of the plant factor is of high probability. The last of the parameters is the capital cost of the project. The capital cost, to the most extent, depends upon the price of the plant that cannot be pre-determined. The plant cost has been in a sharp rising trend stemming from the upsurge of the prices of the natural resources and of the international commodities. At the time of the year 2008, the international economy is seen to be turning around toward recession that is sending the prices of international commodities downward from the level of what has been seen in late 2007 through the first half of 2008[7]. By using the model, we have explored the extent of the change of the capital cost allowable without eroding the viability line and found that the increase of 70% is the threshold line. The project will not loose its financial viability so long as the increase in the capital cost remains within 70% of the base case. We can hereby safely conclude that the project has no problem in terms of its financial viability.

The cases of the sensitivity tests are visualized in the following graph;

[7] As the typical example of such move, the forward rate of crude oil at New York Commodity Exchange recorded the historical high price of WTI crude oil at US$147/bbl and is on a downward trend ever since. The latest price quoted in the market is at US$ 70/bbl as of October 16, 2008.

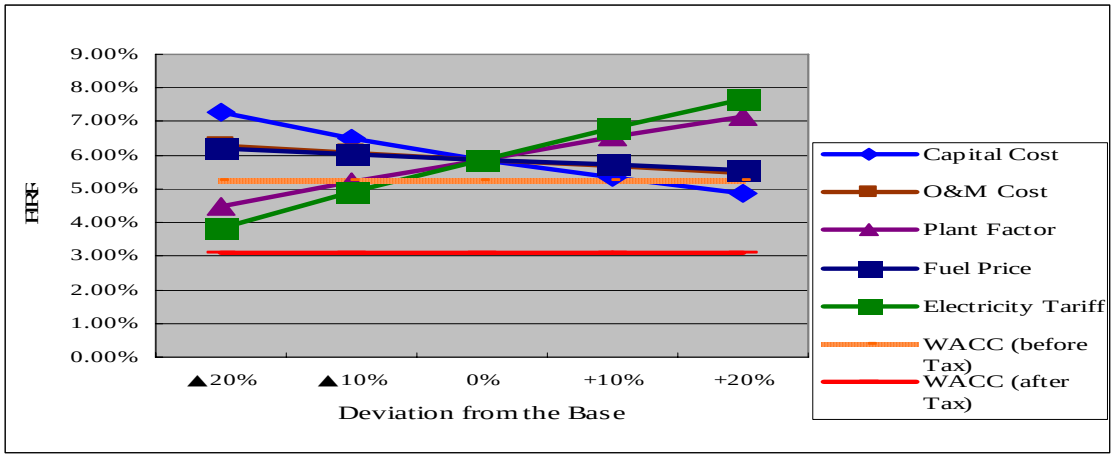


Figure I-8-4-3 Sensitivity Test of FIRR

One may notice that the red horizontal lines inserted in the graph represent the WACC (before tax: 5.24%) and WACC (after tax: 3.11%) for the project. The crossing point of other curves represents the FIRR for the base case (=5.88%). The positions of the 5 curves vis-à-vis the WACC lines are demonstrating the general tendency of FIRRs and the financial viability for the possible deviation of the parameters from the base case. It is noted that all the points dotted for the changes of the parameters are staying above the WACC (after tax) line and conclude that the project is financially viable.

8.5 Economic Evaluation

8.5.1 Methodology of Evaluation and Basic Assumptions

Whereas the financial analysis has focused on the viability of the project from the standpoint of the sponsor of the project, the economic analysis considers and evaluates the optimal and/or efficient allocation of the resources utilized for the sake of the national economy. The methodology of evaluation is to compare the economic benefits that will be produced from the resources input for the project under the environment of "With Project" and that of "Without Project" through which the economic internal rate of return (EIRR) is to be drawn out. The analysis verifies whether the EIRR is sufficient in covering the opportunity cost of the capital mobilized. The costs and benefits to be compared need to be expressed in terms of 2014 constant price. The interest for loan and taxes are deemed as the domestic transfer and therefore shall be excluded from the cost.

8.5.2 Economic Cost

(1) Capital Cost

The cost of the project has been examined in the section 8.2. The sub-section 8.4.2 has dealt with the conversion of the project cost to the constant price of 2014 to formulate the basis of the economic and the financial analysis. The economic analysis uses the same output of the project cost expressed in 2014 constant price shown in the Table 8-4-1 and prepares the spread sheet of the economic cost and the benefit for 30 years of project life. For detail, please refer to ATTACHMENT 6.9, Capital & Operational Cost (EIRR).

(2) Fuel Cost

The economic analysis is carried out with a view to the optimal allocation of resources and, therefore, due consideration of scarcity and/or opportunity value has to be given in assessing

the true economic value of the cost and the benefit. The gas price in Bangladesh has been kept at a low price for a long time in comparison with the international standard price and is in no way economically rational. The fuel gas and electricity are the two most predominant factors whose prices are artificially suppressed by the government and are way out of the rational pricing. We are in need of adjusting the prices into the economically rational ones so that they will be aligned for the economic analysis.

With respect to the international prices of various energies, Energy Information Administration (EIA) of Department of Energy in U.S.A. is making an extensive survey and analysis and is releasing the demand and supply conditions, actual prices through its Natural Gas Monthly and future demand and price outlook every year through its Annual Energy Outlook (AEO). The former reports the prices of natural gas traded at US$ 9.56/mcf in March 2008 and the average price during January through March 2008 as US$ 8.96/mcf. It is a matter of coincidence that the average price of imported crude oil in U.S.A. reached US$ 100/bbl. The price of crude oil skyrocketed in July before calming down at below US$ 100 level in October 2008. The AEO 2008 published lately describes the gas in stating that the price of natural gas is already at a very high level from the historical view point. The price is estimated to soften starting from now toward the future as the present high price will curve the increase of demand while it will stimulate the production. The price is represented by the Henry Hub Spot Indicator which is estimated by AEO to increase from US$ 6.73/MMBTU in 2006 to US$ 6.90/MMBTU in 2010. It will take a downturn to US$ 5.87/MMBTU in 2015 (2006 constant price), then turning its move upward in reaching to US$ 7.22/MMBTU in 2030. During such period of span, AEO estimates the average annual rate of increase of gas price at 0.3% p.a. The following table gives the actual and estimated price of natural gas;

Table I-8-5-1 Estimate of International Gas Price

Calendar Year	2006 Actual	2007 Actual	2008	2014	2015	2020	2025	2030	Average Annual Rate of Increase
AEO 2007: Henry Hub Spot (US$/MMBTU) *1	6.73				5.87	5.95	6.39	7.22	0.3%
Natural Gas Monthly (US$/mcf) *2	7.09	7.56	8.94 *3	9.10 *4					

(note) *1: 2006 constant price
*2:: Price of Natural Gas for Power Generation in U.S.A.(2008 constant price)
*3 : Average Price for January though March 2008 (2008 constant price)
*4 : Price estimated from the 2008 price at an average annual rate of increase at 0.3%.(2008 constant price)

(source) Energy Information Administration, US Department of Energy, “Annual Energy Outlook 2008”, June 2008
Ditto, “Natural Gas Monthly”, August 2008

The analysis adopts the actual average prices of natural gas between January and March 2008 recognized as US$ 8.96/mcf which is converted into 2014 price compounded by the annual rate of increase at 0.3% p.a. The outcome obtained is US$ 9.10/mcf which is equivalent to US$ 10.58 in terms of GJ[8] and after conversion to 2014 constant price. The international gas

[8] The equation for conversion is: 1 mcf=0.950MMBTU and 1 BTU=1.055KJ.

price which is indicated in ATTACHMENT 6.1 is adopted from the above.

(3) Operation and Maintenance Cost

The operation and maintenance cost that has been used in the financial analysis is utilized again for economic analysis by excluding the taxes and fiscal levies.

(4) Standard Conversion Factor and Shadow Exchange Rate

The economic analysis requires that the annual cost and benefit shall be recognized for their market value and compiled into the annual cash inflow and outflow. The market structure and condition in developing countries are characterized in general that; 1) the prices of goods and services are distorted by the existence and application of custom duties, import quota, exchange regulations, subsidy and/or other policies of government even though the foreign exchange market is operating based on the commercial principle; 2) due to the fact that the foreign exchange rates are artificially kept apart from the market level, the goods and services expressed in the domestic price do not reflect the market value of those subject items. The tools for making adjustment of those distorted cases are found in the standard conversion factor for the former case and the foreign exchange shadow price for the latter.

Take for example the Project Proforma prepared by BPDB in October 2000 for this Bheramara Power Station Project. The Project Proforma is exercising the analysis of the project utilizing the basic numbers laid down by the Planning Commission. In the analysis, the border price is obtained by multiplying 0.82 to the raw cost of labor as its border price is assessed cheaper, for fuel price, the border price is obtained by multiplying 1.08 and for the foreign exchange, the border price is obtained by dividing the foreign currency denominated price by 0.778. In addition to the above co-efficient, the Planning Commission instructs the sponsors of the project to obtain the economic benefit by multiplying 1.33 onto the financial benefit. Those co-efficients are the ones officially adopted by the Planning Commission and are notified to the agencies concerned by issuing a revised edition of the manual[9].

Bangladesh has liberalized the foreign exchange market and instituted the free floating market system under which all the current transactions are free without restrictions. The foreign exchange rates are reflecting the market price. Based on such state of conditions, we deem the foreign exchange shadow price has no validity as of date.

On the other hand, the distortion between the domestic price and the border price is the subject to be adjusted by applying the standard conversion factor which is calculated by the following formula[10];

$$SCF = [\text{Imports (CIF)} + \text{Exports (FOB)}] / [(\text{Imports} + \text{Import Tax}) + (\text{Exports} + \text{Export Taxes} - \text{Export Subsidy})]$$

For the fiscal years whose statistics available (FY 2002 – FY 2004)[11], we made a trial calculation of SCF and obtained the factors average as SCF=0.91. The SCF is understood as being not a single value which is applicable to any goods and services but varying by a wide margin depending upon the category/kind of goods and services and extent of quality. If the factor is not correctly identified to represent the distortion and if the factor is not used in the right item and in the right extent, what can probably happen is the factor might end up with

[9] Planning Division, Ministry of Planning, " Government Development Projects, Preparation, Processing, Approval and Recast Processing", May 2008

[10] Asian Development Bank, "ERD Technical Note Series No. 11: Shadow Exchange Rates for Project Economic Analysis", February, 2004

[11] International Monetary Fund, "International Financial Statistics"及び"Government Finance Statistics"各年度版

aggravating the distortion. In addition, the fact that the cost and benefit of the project we are dealing with being composed of the gas and electricity is letting us refrain from applying the SCF because the economic cost is taken from the international price that needs not be adjusted whereas the electricity is defined domestic service which should be adjusted by SCF. The treatment of gas and electricity will be distorted if SCF is applied only to the price of electricity, while the major cost ingredient of electricity is the gas which is free from SCF adjustment. We conclude that SCF does not fit to our analysis and we forego with applying SCF.

8.5.3 Economic Benefit

(1) Definition of Economic Benefit

The economic analysis compares the economic cost and benefit in comparison with the environments of "With Project" versus "Without Project". The parties to receive the benefit of the project are defined as; 1) those who are not connected to electricity now will become the user of electricity owing to the implementation of the project; 2) those who are connected to electricity but is not able to use the power as much as they need due to the constraint of supply will become possible to expand their consumption. The benefit of the project will be composed of the incremental volume of power supplied to those beneficiaries.

The contemporary method of economic appraisal is to define and directly quantify in monetary terms and evaluate the benefits arising from the project which is compared against the economic cost of the project in obtaining the economic internal rate of return. In the instances where the measurement and quantification of benefits are difficult, the analysis assumes an alternative project which might generate the same quality and amount of the benefit but could be constructed at the least cost next to the project for appraisal. The economic analysis compares the cost of such least cost alternative project against the project for appraisal quantifying the saving of cost as the benefit of the project. Traditionally in the power sector, the least cost alternative method used to be the predominant methodology but has changed during the past decade to adopt the method of directly quantifying the benefits in monetary terms. For the quantification of the benefit, the contemporary method resorts to the measurement of the Willingness-to-Pay of the consumers for the purchase of electricity.

Before entering into the analytical work, the study team has delved into the pros and cons of the different methodologies to adopt. After deliberation of the different methodologies, we have concluded to adopt the direct quantification method. The elements considered for the selection of the methodology is as tabulated in the following table;

Table I-8-5-2 Comparison of the Methodologies for Economic Analysis

	Direct Quantification (Willingness-to-Pay) Method	Least Cost Alternative (LCA) Method
Methodology		
[Outline of the method]	Many of the electricity consumers are resorting to the captive diesel generation to back up the load shedding. Despite the sharp increase of the diesel oil, consumers are expressing their willingness to pay for the cost of fuel through actual spending for the captive generation.	The generation plants of BPDB are consisted of gas fired generation in 80% of the total. Bheramara CCGT is designed to be a combined cycle which is energy efficient and therefore can save the consumption of its fuel, natural gas. LCA method assumes a part of the existing gas fired plants of BPDB having the same capacity with Bheramara as the Virtual Bheramara Alternative Project. The method calculates the

	Direct Quantification (Willingness-to-Pay) Method	Least Cost Alternative (LCA) Method
		capital invested and operational expenses for the virtual project. With the project of Bheramara CCGT, the cost recognized for the virtual project can be avoided and is regarded as the benefit of Bheramara Project.
[Benefit]	Quantification of WTP needs to identify 1) WTP minimum that is represented by the prevailing average billing rate of electricity, and 2) WTP maximum that the consumers are willing to pay for the purchase of electricity. The area to be formed between WTP minimum and maximum is called as the consumer surplus. WTP is calculated as the total of the WTP minimum plus the consumer surplus. WTP for each year is recognized as the benefit of the project.	Out of the total gas fired power stations of BPDB, the method identifies; 1) the amount of the total net fixed assets (after depreciation) of the virtual project that aggregates the total capacity which is same with Bheramara CCGT; 2) the amount of operational expense other than the fuel to be expended by the virtual project; 3) the amount of natural gas required for running the virtual project based on the actual fuel efficiency per unit generation of the virtual project. The method calculates the total cost of the fuel using the international unit price.
[Cost]	The method calculates annual amounts of; 1) capital investment; 2) operational expenses including the fuel for each year. Taxes, interest and price contingencies are excluded from the calculation.	Same with the left box.
Data collection		
[Benefit]	1) WTP minimum is represented by the average billing rate of electricity at BPDB. The prevailing tariff of Taka 2.26/kWh is brought to 2008 price by multiplying the rate of tariff increase approved in September 2008. The price obtained Taka 2.37/kWh is converted to 2014 price using the inflation index. 2) WTP maximum is represented by the amount of the international price of diesel oil whose volume is calculated to be sufficient to generate the volume of electricity equal to Bheramara Project. Conversion to 2014 price uses the estimate of future price of diesel oil by a reputable international institution (EIA of U.S. DOE) and inflation index. 3) Based on the above, the method calculates WTP Unit Price per kWh of generation; WTP Unit Price = WTP Minimum + 1/3	1) The method calculates the net fixed assets of gas fired power stations held by BPDB using its annual report. 2) It then calculates the operational cost of the virtual project excluding the fuel cost. 3) The fuel cost is derived from the fuel efficiency of the virtual project per kWh of generation for the volume of natural gas which is sufficient to generate the volume of electricity same with Bheramara CCGT. The fuel cost is calculated by using the international price of natural gas. 4) The amounts derived above are converted in to 2014 price whose aggregate is regarded as the economic benefit of the project.

	Direct Quantification (Willingness-to-Pay) Method	Least Cost Alternative (LCA) Method
	(WTP Maximum – WTP Minimum)	
[Cost]	1) Capital cost of the project excluding interest, taxes and price contingencies, 2) Operational cost other than fuel, 3) Fuel cost is derived first by calculating the volume of natural gas required for the generation of the pre-determined volume of electricity and is converted into 2014 price using the international estimate of gas price and inflation index.	Same with the left box
Basis of Data		
[Benefit]	1) The average wholesale price of electricity is taken from the tariff approved by BERC in September 2008 as the base tariff for 2007/08. 2) The actual international price of diesel oil is taken from Petroleum Marketing Monthly issued by EIA, U.S. Department of Energy.	Refer to the above
[Cost]	1) The international price of natural gas is taken from Natural Gas Monthly of the same issuer as above.	Same with the left box.
Pros and Cons		
[Pros]	1) WTP method enables the analyst to measure and quantify the benefit and, therefore, to directly compare the benefit against the cost of the project. 2) The value of the benefit is the monetary valuation of the output of the project that objectively quantifies the benefit and avoids the subjectivity in assessing the benefit.	1) The method enables the analyst to evaluate the project whose benefit is difficult to measure and quantify. 2) The method can stay away from measuring and quantifying the abstract benefit but recognizes the monetary valuation of the alternative project that is easier to measure and quantify.
[Cons]	1) The method adopting the average billing rate of electricity is adhered to by most of the analysts and is subject to no dissenting opinion on the methodology. Meanwhile the method to recognize the WTP maximum meets frequent arguments as the method would be able to identify the actual level at which the consumers are paying but unable to ascertain if such price is the potential maximum. The potential maximum may lie at the level which exceeds the actual level of payment. The method is unable to exactly identify the maximum limit of the	1) There exists no tool to prove that the alternative project adopted is the “least cost alternative” of the project to be evaluated. 2) Alternative project may be brought in subjectively by the analyst. The project cannot avoid the analyst bringing in intentionally an alternative project which is of higher cost. To make the story worse, the alternative project of high cost produces higher value of benefit and EIRR. 3) As the method foregoes valuation of the output, one may not be able to check what would

Direct Quantification (Willingness-to-Pay) Method	Least Cost Alternative (LCA) Method
readiness and willingness of the consumers.	be the effects that the project might have in the pricing of the output commodity, i.e. electricity. It may also be difficult to know whether the project will affect the demand curve to shift upward or downward and therefore be difficult to achieve the equilibrium between the supply and demand after the completion of the project.

(2) Willingness to Pay (WTP)

Willingness-to-Pay (WTP) is the maximum amount consumers are prepared to pay for a good or services. WTP represents the economic value that consumers assess in their consumption pattern. The following figure illustrates WTP in relation with the demand and supply curve;

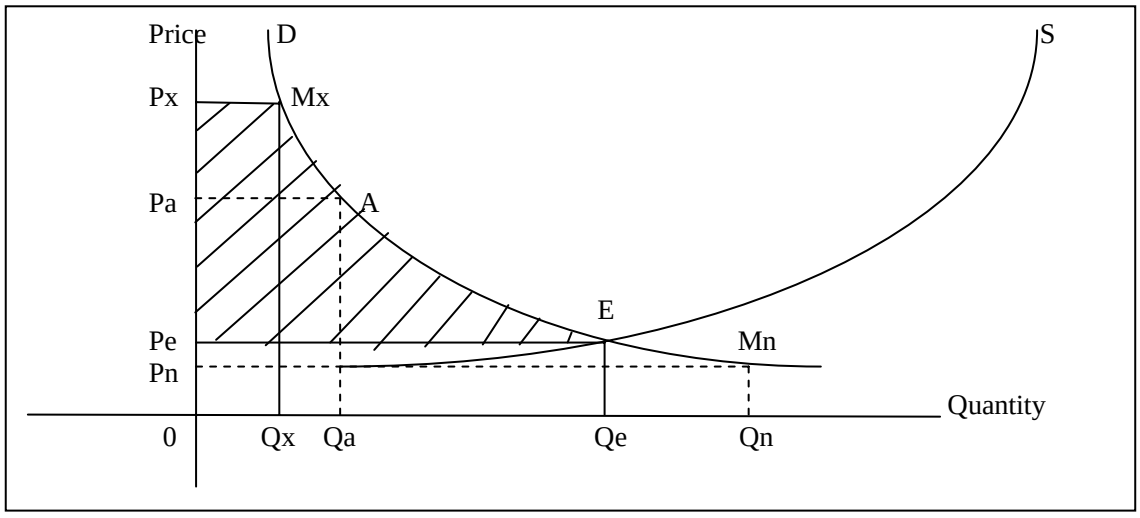


Figure I-8-5-1 Willingness to Pay

In the above graph, the curve D represents the demand curve and curve S the supply curve. The crossing point of both curves, E, is the equilibrium where the supply and demand balances and Pe represents the level of electricity price that is currently paid, as the average billing price. The maximum price that consumers are willing to pay is represented by Px which should match with the long run marginal cost in the country. The area below the demand curve D and the line Px-Mx and above the line Pe-E represents the range which consumers are willing to pay in excess of the prevailing tariff and is called "consumer surplus". WTP is the aggregate of the total amounts that are currently paid by the consumers and the consumer surplus. In the above graph, the area depicted by the points; 0, Px, Mx, E, Qe is the WTP notionally conceived. WTP can be calculated by using the following formula. The curvature of the demand curve is found varying among different analysts and there is no standard number which is theoretically established. General observation witnesses the curvature varying between 1/2 – 1/3. Our analysis adopts the curvature which is the elasticity of demand as 1/3.

WTP = WTP minimum + 1／3 X (WTP maximum – WTP minimum)

There exist different methodologies for calculating the maximum and minimum of WTP. With respect to the minimum value, most analysts rely on the average billing rate of electricity. We, too, follow and adopt the methodology as our own. The average billing rate is the price the consumers are actually paying for the electricity and is obvious that the average consumers are agreeing to pay. The rectangular depicted by the points; 0, Pe, E, Qe represents the aggregate amount consumers are paying at present. Should the price fall below Pe to Pn for example, the demand expands so far as to Qn which the supply cannot meet and no equilibrium is to be reached. For our analysis, the average wholesale rate of BPDB in 2007/08 which is known to be Tk 2.77/kWh is to be converted in 2014 constant price. Out of such efforts, Tk 3.22/kWh is obtained which is the price including the mixture of generation, transmission and distribution. The total sales of BPDB are composed of 77% wholesale of energy to other electricity entities and 23% retail to the end users[12]. There is a study conducted for Power Cell, MPEMR by the consultant, Nexant, which analyzes the cost structure of the power sector in Bangladesh revealing that the total cost is composed of 71.5% of generation, 8.6% of transmission and 19.9% of distribution[13]. Based on such composition, the cost of generation that occupies the total cost of BPDB expressed in 2014 constant price, Tk 3.22/kWh is derived to be Tk 3.01/kWh. We adopt the result as our minimum of WTP.

Table I-8-5-3 Calculation of WTP Minimum

Item	Price or %	Particulars
1) Average electricity price at BPDB (2009)	Tk 2.37/kWh	After the revision of 2008
2) Estimated price of electricity in 2014	Tk 3.22/kWh	Conversion using inflation index
3) Percentage of the generation cost among the total retail price	71.5%	Study conducted by Nexant
4) Composition of sales at BPDB	Wholesale: 77% Retail: 23%	BPDB, Annual Report 2005-06
5) Percentage of the generation cost among the selling sales of electricity at BPDB	Wholesale: Tk 3.22/kWh Retail: Tk 2.30/kWh	Wholesale price assumed to contains no transmission and distribution cost whereas the retail price contains such cost by 28.5%.
6) Aggregate generation cost in 2014 (=WTP Minimum)	Tk 3.01/kWh	Tk 3.22X77% + Tk2.30X23%

On the contrary to the above, there exist a variety of methodologies for obtaining the maximum of WTP. The most solid but conservative approach is found to pick up the highest tariff to the consumers that is applied by any of the electricity providers at retail level. The price to be found is the amount that is actually accepted by the consumers and is deemed to be solid and reliable indicator although the methodology shall not be able to deny the probable existence of the higher level of WTP. In the above graph, the point Pa typically represents such level. Pa is located at higher level than Pe but consumers evidently expressing their readiness to pay through the actual purchasing of the electricity. Other consumers are demonstrating their willingness to pay for the electricity at much higher level such as Px by running the captive diesel generation at much higher cost than the price of electricity at Pa.

[12] Power Cell, MPEMR, "Bangladesh Power Sector Data Book 2006" June 2006
[13] ADB, "Power Sector Development Program II", June 2006, by Nexant

The second method of obtaining the WTP maximum comes from such social phenomenon. There exists many consumers that resorts to the diesel generation as the remedy to tide over the powerless life by paying a higher cost.

The first of the methodologies can be exercised through the following steps of calculation. The prevailing tariff is setting the rate for each category of consumers and for the volume of consumption and for the time zone of usages with exception of the agricultural pumping which is covered by a single flat rate. Out of the tariff table, the highest rates for each category of consumers are taken and weighted average of those highest tariffs is derived. The result obtained through the steps can be treated as the maximum WTP. The following table shows the category-wise consumption, composition, highest rates and weighted average of the highest rates;

Table I-8-5-4 The Highest Tariff for Category of Consumers

	Volume Consumed (MkWh)	Composition (%)	Highest Rate for Category (Tk/kWh)	Weighted Average (Tk/kWh)
Domestic	7,070	42.4	5.25	2.23
Commercial	1,274	7.6	8.20	0.62
Agricultural	674	4.0	-	--
Industrial	7,287	43,7	5.62	2.46
Others	385	2.3	6.73	0.15
Total	16,690	100.0		
Total（excl. Agri.）	(excl. Agri. 16,016)	(excl. Agri. 96.0)		5.69

(note) The agricultural pumping is covered by a single flat rate and has no rate appropriate to be defined as "maximum" and is excluded from the analysis.

(source) Power Cell MPEMR, "Bangladesh Power Sector Databook 2006", June 2006

Thus, the average of the highest tariffs which has been accepted by the consumers is calculated to be Tk 5.69/kWh. The price calculated is of the one for retail to the consumers which therefore is at the level of the distribution out of which we need to know the price at the level of generation. By applying the cost composition mentioned above[14], the price at the level of generation out of the above obtained 5.69/kWh is found to be Tk 4.07/kWh. The price obtained here is as of January 1, 2007 and is converted to the 2104 constant price. The final result is obtained to be Tk 6.06/kWh. The price obtained here represents the average of the highest brackets of tariff and, without doubt, demonstrates the level which consumers are willing to pay. But at the same time, there is no assurance that this represents the level beyond which consumers will not pay. Instead, this is something that keeps implying that the demand exists beyond such level and so is the maximum amount of WTP.

The second of the methods to calculate WTP maximum from the consumers operating the captive diesel generation is as follows; The consumers who fail to obtain sufficient volume of electricity turn to the captive diesel generation. The consumers are paying for the capital cost, operating expenses as well as the fuel cost for such operation. Consumers are found to be paying for such which evidently demonstrates the willingness to pay. The cost of the diesel generation can be obtained from the experience of BPDB at its power station, i.e. Bhola Power Station.

[14] ADB, "Power Sector Development Program II", June 2006, by Nexant

Table I-8-5-5 Diesel Generation Cost at Bhola Power Station of BPDB

	2005-06 actual	Estimate for 2013-14
Installed Capacity（MW）	8.36	Unchanged
Net Volume of Generation（kWh）	5,412,616	Unchanged
Fuel Consumption per kWh (liter/kWh)	0.427liter/kWh	Unchanged
Cost of Fuel（Taka/kWh）	9.27 (62.1%)	15.72 (66.9%) *1
Operational Expense other than Fuel （Taka/kWh）	1.91 (12.8%)	2.90 (12.3%) *2
Fixed Expense（Taka/kWh）	1.45 (9.7%)	2,20 (9.4%) *2
Administrative Expense incl. Depreciation （Taka/kWh）	2.30 (15.4%)	2.67 (11.4%) *3
Overall Generation Cost (Taka/kWh)	14.93 (100%)	23.49 (100%)

(note) *:1: Actual and estimate by EIA, US Department of Energy
*2: Inflation rate estimated by the Study Team
*3: Depreciation and interest assumed to be fixed. Other expenses are adjusted by the inflation index.
（source）BPDB, “Annual Report 2005-06”

The predominant part of the generation cost of diesel generation is composed of the fuel cost occupying approximately 2/3rds of the total cost. The analysis takes the fuel cost only disregarding the capital cost and other expenses for the calculation of WTP maximum because of the following background and conditions;

1) Many of the consumers are acknowledged to own diesel generators for a considerable time prior to the present. The capital costs of the diesel generators vary depending upon the timing and scale of the investment;
2) Consumers might have made investment decision based on the cheaper fuel and intend to operate the equipment while paying for the higher cost of fuel but have no intention to renew such investment; and
3) Other expenses such as the administrative expense come arise at the large institution like BPDB but do not come arise at the small scale of diesel generation.

Based on the above, the analysis treats the investment cost as the sunk cost and assumes the expenses other than fuel as zero. WTP counts the fuel cost only and is captured as in the following table;

Table I-8-5-6 Calculation of WTP Maximum

Item		Particulars
1) Aggregate Volume of Diesel Generation at BPDB in 2006/07	234.4 GWh	BPDB Statistics
2) Total Volume of Diesel Oil Consumed by BPDB in 2006/07	100.2 million liter	ditto
3) Volume of Diesel Fuel Consumed for Unit kWh of Generation	0.427 liter/kWh	ditto
4) International Price of Diesel Oil (March 2008)	Tk 60.40/liter	US DOE, Petroleum Marketing Monthly (March 2008 is when the crude oil price has recorded US$ 100/bbl)
5) Estimate of the Price of Diesel Oil in 2014	Tk 63.60	Applies the growth rate indicated by AEO 2008 of U.S. Department of Energy
6) Price of Diesel Oil per kWh of Generation in 2014 (=WTP Maximum)	Taka 27.16/kWh	6) = 3) X 5)

Heretofore, both of WTP minimum and WTP maximum has been solidly established and we now turn to calculate WTP by using the formula defined before.

WTP = Taka 3.01/kWh + 1/3 X (Taka 27.16/kWh – Taka 3.01/kWh) = Taka 11.06/kWh

We have now obtained WTP 11.06/kWh in our hands. Using the figure obtained as the unit price of the economic benefit and multiplying the total volume of generation can quantify the value of the generated electricity. The quantified benefits are compared to the capital cost and the operational cost calculated by the international price of natural gas for our ultimate purpose of calculation of EIRR.

8.5.4 Economic Evaluation

(1) Economic Internal Rate of Return (EIRR)

In utilization of the basic assumptions that we have so far made and economic costs and benefits, we have deployed the streams of economic cash inflow and outflow in constructing the EIRR analysis model through which we obtain the EIRR, the ultimate products of the analytical work. The details of the model appear in ATTACHMENT 6.9, Capital & Operational Cost (EIRR).

Table I-8-5-7 Economic Internal Rate of Return EIRR) ＜Base Case＞

(Taka Million)

Fiscal Year	Economic Cost (A)			Economic Benefit (B)	(B) - (A)
	Capital	O&M	Total Cost		
2010	284		284		-284
2011	10,359		10,359		-10,359
2012	6,930		6,930		-6,930
2013	6,930		6,930		-6,930
2014	10,501		10,501		-10,501
2015		15,680	15,680	24,076	8,396
2016		13,879	13,879	24,076	10,197
2017		13,879	13,879	24,076	10,197
2018		13,879	13,879	24,076	10,197
2019		13,879	13,879	24,076	10,197
2020		13,879	13,879	24,076	10,197
2021		13,879	13,879	24,076	10,197
2022		13,879	13,879	24,076	10,197
2023		13,879	13,879	24,076	10,197
2024		13,879	13,879	24,076	10,197
2025		13,879	13,879	24,076	10,197
2026		13,879	13,879	24,076	10,197
2027		13,879	13,879	24,076	10,197
2028		13,879	13,879	24,076	10,197
2029		13,879	13,879	24,076	10,197
2030		13,879	13,879	24,076	10,197
2031		13,879	13,879	24,076	10,197
2032		13,879	13,879	24,076	10,197
2033		13,879	13,879	24,076	10,197
2034		13,879	13,879	24,076	10,197
2035		13,879	13,879	24,076	10,197
2036		13,879	13,879	24,076	10,197
2037		13,879	13,879	24,076	10,197
2038		13,879	13,879	24,076	10,197
2039		13,879	13,879	24,076	10,197
2040		13,879	13,879	24,076	10,197
2041		13,879	13,879	24,076	10,197
2042		13,879	13,879	24,076	10,197
2043		13,879	13,879	24,076	10,197
2044		13,879	13,879	27,576	13,697
Total	35,003	418,171	453,174	725,778	272,603
EIRR	**20.64%**				

The above table shows the EIRR at 20.64%. The output obtained is exceeding the opportunity cost of capital we have defined before (=8.0%) and is surpassing the threshold of 10-12% which international donor institutions generally conceive as the feasibility line. It also goes beyond the discount rate of 15% which the government of Bangladesh instructs its agencies for preparation of capital projects. We now conclude that there is no doubt existing as to the economic viability of the project.

8.5.5 Sensitivity Test

The analysis moves to the next task that, should any of the basic assumptions adopted for the project happen to change to a significant extent, what extent of impact is to be felt by EIRR, is examined. The factors considered here are; 1) construction cost; 2) fuel cost; 3) price of electricity (=WTP); 4) operation and maintenance cost; and 5) plant factor. The following table summarizes the impact on EIRR;

Table I-8-5-8 Sensitivity Test of EIRR

Parameter	Deviation	EIRR	Parameter	Deviation	EIRR
Construction Cost	▲20%	24.36%	Fuel Cost	▲20%	24.54%
	▲10%	22.34%		▲10%	22.65%
	+10%	19.18%		+10%	18.53%
	+20%	17.92%		+20%	16.29%
O&M Cost	▲20%	21.05%	Willingness -to-Pay	▲20%	11.92%
	▲10%	20.85%		▲10%	16.60%
	+10%	20.44%		+10%	24.28%
	+20%	20.24%		+20%	27.62%
Plant Factor (Base Case =70%)	▲20%(PF=56%)	17.14%		+30%	
	▲10%(PF=63%)	18.94%			
	+10%(PF=77%)	22.27%			
	+20%(PF=84%)	23.84%			

Among the 5 parameters selected for the analysis, there is no one whose change deprives the project of its economic viability, so long as the changes remain within 20% of the base case condition. Among the 5 parameters, the fluctuation in WTP swings the EIRR to the most extent. The deterioration of WTP by 20% lowers EIRR to 11% way down from the other parameters. To the contrary, should it improve by 20%, EIRR jumps to the high of 27%. The fluctuation of ±20% of the parameter gives its impact upon EIRRs with the swing of 15%. Next to WTP, the fluctuation of the fuel cost affects EIRR. Should it increase by 20%, its EIRR goes down to 16%. The deterioration of the capital cost and the plant factor lowers their EIRRs to 17%. The impact is found to be least from the fluctuation of O&M coat. Its changes of ±20% affects EIRRs only with the small margin of 0.8%. The movement of the parameters and resultant EIRRs are shown in the following figure for easy reference;

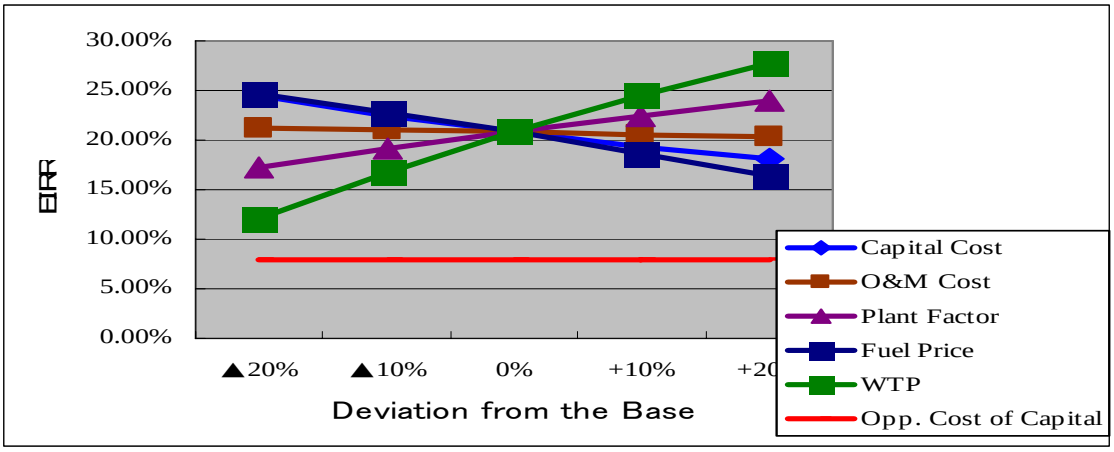


Figure 8-5-2 Sensitivity Test of EIRR

The sensitivity test has been conducted for the cases in which the important parameters of construction cost, operation and maintenance cost, plant factor, fuel cost and WTP for the deviation of 20% positive and negative. The red line inserted indicates the opportunity cost of capital (=8.0%). It is evident that besides the crossing of the lines which represent the EIRR of base case, all of the cases of the sensitivity test stay way up above the opportunity cost threshold that confirms the abundant level of economic viability of the project.

8.6 Key Performance Indicators

Operational and Effect Indicators

The following operational and effect indicators shall be set for monitoring the power plant performance, supervising the management of operation and maintenance and confirming the effect of the Bheramara CCPP.

Operational Indicators

- Maximum Output
- Plant Load Factor
- Availability Factor
- Gross Thermal Efficiency
- Outages Hours by Human Errors
- Outages Hours by Machine Errors
- Planning Outages Hours

Effect Indicators

- Maximum Output
- Net Efficiency Energy Production

The target of each indicator is set based on international experience of this JICA Team. The targets shall be initially set at the lowest levels possible. They will be checked periodically and reviewed yearly for setting and achieving higher targets toward final targets.
Each target shall be checked and reviewed based on Table attached herewith. The indicators above are set based on “Operational and Effect Indicators Reference, 2nd Edition, established by JBIC, October 2002”.

Table I-8-6-1 Operational and Effect Indicators

Name of Indicator	Target	Check Interval*1	Review Interval*1	Comments
Operational Indicator				
Maximum Output*2	360MW	Monthly	Yearly	The Maximum Output shall be evaluated on the terms and conditions, based on manufacturer's evaluation guideline, taking the result of the commissioning into consideration. GT output will be in decline because of the degradation so that CCPP also will be in decline in the future. Therefore this is a significant indicator for check and review.
Plant Load Factor*3	70%	Monthly	Yearly	= Annual Amount of Gross Generated Output / (Rated Output x 24 x 365) x 100 Assumed base load operation case. This might be decreased in case of partial load operation. The maintenance period greatly influences the plant load factor. Its period shall be carefully considered when setting the target. Based on "Power System Master Plan", basic plan in Bangladesh has a plan to introduce 450MW class new power plant until 2016 and 700MW class new power plant after that. Therefore Bheramara CCPP shall be utilized as base load operation at the first term, middle load operation at the second term and peak load operation at the third term because of the change of operation style by load dispatch center. Also It is possible that supply power shall be shifted from gas power plant to coal power plant due to the rising price of gas in the future. As the result Plant Load Factor shall be approximately 80% at the first term, 70% at the second term and 60% at the third term. Plant Load Factor shall be 70% for 30 years of project term.

Name of Indicator	Target	Check Interval*1	Review Interval*1	Comments
Availability Factor*3	90%	Monthly	Yearly	= Annual Operation Hours / (24 x 365) x 100 Assumed base load operation case. This might be decreased in case of partial load operation. The maintenance period greatly influences the availability factor. Its period shall be carefully considered when setting the target. Annual outage is set for 36.5 days for Bheramara CCPP. This is assumed combustor inspection year. 8 days outage is necessary for combustor inspection. Also outages days by machine errors are assumed for 18 days. Therefore annual planning outage except combustor inspection and outage by machine error are assumed for 10.5 days. Condenser inspection and GT inlet filter exchange are included in this term. Actual availability factor was 95.96% in Hapipur 360MW CCPP in 2007. The capacity is as same as Bheramara CCPP however Haripur CCPP is managed by Pendekar Energy, IPP. For that reason, 90% is proper target for Bheramara CCPP.
Gross Thermal Efficiency*2	54%	Monthly	Yearly	= (Annual Amount of Gross Generated Output x 860) / (Annual Amount of Fuel Consumption x Fuel Lower Heating Value) x 100 The gross thermal efficiency shall be evaluated on the terms and conditions, based on manufacturer's evaluation guideline, taking the result of the commissioning into consideration.
Outages Hours by Human Errors	0	Yearly	Yearly	
Outages Hours by Machine Errors	438	Yearly	Yearly	Outage days by machine errors are assumed for 18 days. Unforeseen outage by machine errors is unavoidable because of the operation records of CCPP. 5% per year is set for outage days by machine errors for Bheramara CCPP.

Name of Indicator	Target	Check Interval*1	Review Interval*1	Comments
Planning Outages Hours	192	Yearly	Yearly	Assumed Combustor Inspection year. Combustor Inspection: 192 hour x 4 time / 6 year, Hot Gas Path Inspection: 360 hour / year, Major Inspection: 720 hour / year
Effect Indicator				
Maximum Output *2	360MW	Monthly	Yearly	The Maximum Output shall be evaluated on the terms and conditions, based on manufacturer's evaluation guideline, taking the result of the commissioning into consideration. GT output will be in decline because of the degradation so that CCPP also will be in decline in the future. Therefore this is a significant indicator for check and review.
Net Electric Power Production*2	2,141 GWh	Monthly	Yearly	The maintenance period greatly influences the net electric . Its period shall be carefully considered when setting the target. The target of net electric energy production is calculated as follows. 360MW x 8760 hour x 0.70 x (1 – Auxiliary power ratio: 0.03)

1) The target of each indicator shall be checked based on the "check interval" above, and reviewed based on the "review interval" above.
2) The target of the "maximum output", "gross thermal efficiency" and "net electric energy production" specified above shall be set based on the guaranteed specifications of an EPC contractor.
3) The "plant load factor" and "availability factor" specified above are subject to operation order from the Bangladesh dispatch center.