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バラウニ超臨界圧石炭火力発電所
建設事業準備調査

ファイナルレポート（4/4）

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ANNEXURE - III

ESIA report (Draft)

Environmental and Social Impact Assessment (ESIA) of 1x660 MW Coal Based Power Project (Unit # 10): *Barauni, Begusarai District, Bihar State, India*

Kyushu Electric Power Co., INC, Japan (KEPCO)

Draft Report

February 2016

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ABBREVIATIONS

AMSL	Above Mean Sea Level
AQCS	Air Quality Control System
As	Arsenic
As	Arsenic
B	Boron
BA	Bottom Ash
Ba	Barium
BHEL	Bharat Heavy Electricals Ltd
BMCR	Boiler Maximum Continuous Rating
BOBRN	Bogie Open Bottom Rapid Discharge Type
BSEB	Bihar State Electricity Board
BSPCB	Bihar State Pollution Control Board
BSPGCL	Bihar State Power Generation Company Limited
BSPTCL	Bihar State Power Transmission Company Limited
BTG	Boiler Turbine Generator
BTPS	Barauni Thermal Power Station
CCW	Closed Cooling Water
Cd	Cadmium
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CHP	Coal Handling Plant
CO	Carbon Monoxide
CO	Carbon Monoxide
COC	Cycle of Concentration
CPCB	Central Pollution Control Board
Cr	Chromium
Cu	Cupper
CWC	Central Water Commission
DG	Diesel Generator
DM	Demineralization
DPR	Detailed Project Report
EC	Environment Clearance
ECL	Eastern Coalfield Limited
EIA	Environmental Impact Assessment
EMP	Environment Management Plan
ESIA	Environmental and Social Impact Assessment
ESP	Electrostatic Precipitators
ETP	Effluent Treatment Plant
FA	Fly ash
FD	Force Draft
FGD	Flue Gas De-Sulphurisation
FOHS	Fuel Oil Handling System
GCV	Gross Calorific Value
GoI	Government of India

HCSD	High Concentrated Slurry Disposal
HDPE	High Density Polyethylene
Hg	Mercury
Hg	Mercury
HP	High Pressure
ID	Induce Draft
IDCT	Induced Draft Cooling Towers
IFC	International Finance Corporation
IP	Intermediate Pressure
JICA	Japan International Cooperation Agency
KEPCO	Kyushu Electric Power Co., INC
KLPH	Kilo Litre per Hour
KVA	Kilovolt-ampere
LDO	Light Diesel Oil
LP	Low Pressure
LSD	Lean Slurry Disposal
MoEF&CC	Ministry of Environment, Forests and Climate Change
MTPA	Million Tons per Annum
MW	Mega Watt
NH	National Highway
NO2	Nitrogen di-oxide
NTPC	National Thermal Power Corporation
ODA	Official Development Assistance
OSHA	Occupational Safety and Health Administration
PA	Primary Air
PLF	Power Load Factor
PM	Particulate Matter
PWS	Plant Water System
QB	Quartzoid Bulb
R&M/LE	Renovation & Modernisation / Life Extension
R&R	Resettlement and Rehabilitation
ROW	Right of Way
SC	Super Critical
SO2	Sulphur Dioxide
SPCB	State Pollution Control Board
SPM	Suspended Particulate Matters
SSF	Side Stream Filtration
STG	Steam Turbine and Generator
STP	Sewage Treatment Plant
TPD	Tons per Day
TPH	Tons per Hour
TPP	Thermal Power Plant
VOC	Volatile Organic Compounds
WRD	Water Resources Department
WTP	Water Treatment Plant
ZLD	Zero Liquid Discharge

1 INTRODUCTION

1.1 BACKGROUND

Bihar State Power Generation Company Limited (BSPGCL) is planning to develop a 1 x 660 MW Super Critical Thermal Power Plant within its existing Barauni Thermal Power Station (BTPS) in Begusarai district of Bihar.

BTPS is having 9 units of coal fired sub-critical technology based plants installed in different phases commencing from 1963. The first 3 units, each with a capacity of 15 MW, namely Unit No. 1, 2 and 3, started the commercial production during 1963-66 and presently all these units are not operational. The Unit No. 4 & 5, each with a capacity of 50 MW started its commercial production during 1969 and 1971 respectively; however, both the units were shut-down due to an environmental pollution problem in 1996 and 1995 respectively.

Unit 6 & 7 each with a capacity of 110 MW started its commercial production during 1984 and 1985 respectively; however, both these units are presently non-operational. Renovation & Modernization and Life Extension work is going on, and these units will again come under production. Unit no. 8 & 9 each with a capacity of 250 MW are presently under construction. It is planned to commission these units during end 2015 and early 2016. On the whole, presently total installed capacity at BTPS is 720 MW comprising of 4 units (2 x 110 MW + 2 x 250 MW).

With the advancement in technology and increasing confidence in power generating units utilizing supercritical steam parameters in the country, BSPGCL proposes to expand and develop 1 x 660 MW plant (i.e. Unit No. 10 within BTPS complex. The Unit would be brown-field, river water based, domestic coal-fired thermal power project with ultra-supercritical technology.

The design consultant for the Project is Kyushu Electric Power Co., INC, Japan (hereinafter referred to as "KEPCO"). ERM India Private Limited (herein after referred to as "ERM") has been appointed by KEPCO to undertake the Environmental and Social Impact Assessment (ESIA) for the Project and also to support in regulatory approval from Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India (GoI).

1.2 NEED OF THE PROJECT AND ITS IMPORTANCE TO THE COUNTRY, REGION

The basic objective of the planned development in power sector in the country is to outpace the rapid rise in power demand with reasonable level of reliability to ensure faster economic growth. Rapid industrialization induced by the ongoing liberalization of the country's economic policy, continued stress on rural electrification with larger use of water pumps for irrigation purposes and increase in electricity utilization for transportation and household purposes have all contributed to the rise in the growth rate for demand of power.

The power generation capacity in State of Bihar has been adversely affected with the creation of Jharkhand State. The major power generating stations under the state sector at Patratu (840 MW units), Tenughat (420 MW units) and Sikidri (130 MW Hydel) are now located in the state of Jharkhand. 70% of the generation capacity of erstwhile Bihar has been shifted to the jurisdiction of State of Jharkhand. Bihar is left with two old thermal power stations having a total generating capacity of 440 MW viz. Barauni (220 MW) & Muzaffarpur (220 MW). Bihar has installed hydel power generating capacity of about 44 MW.

The gap between demand and supply of power was highest during 2009-10 at 32.9 percent (720 MW). This gap has reduced in the year 2011-12 to 15.5% owing to the allocations from the central sector. This situation of low capacity and inadequate generation has led to large dependence of the State for power purchase from Central Sector to meet the requirements.

New projects will take time to come up and as a result the State of Bihar will be depending mainly on the Central Sector Power allocation in coming years. Keeping in view of the projected power demand and the need to achieve self-sufficiency for fulfilment of its energy requirements, BSPGCL proposes to extend the capacity of Barauni Thermal Power Station by adding 2X 250 MW coal based units. And now BSPGCL proposed to expand the capacity by setting up 660 MW coal based unit at Barauni Thermal Power Station.

The GoI has planned a mission "POWER TO ALL BY 2019". Growth in economy and population has resulted in rise in the growth rate for demand of power. 90% of total power generated in the State of Bihar is fossil fuel based thermal power. Present power shortage in Bihar State is anticipated to the tune of 15.3% in terms of energy for the year 2014-15 as per "Load Generation Balance Report 2015-16" published by CEA and therefore Bihar Government has planned a massive capacity addition to cater for increase in demand.

The GoI, through the Ministry of Power and Bihar state, is targeting to secure a supply capacity of about 5,243 MW until 2015-2016, to achieve its declared mission of 'power to all' and annual growth rate as of 9-10%. In order to reduce the duration for setting up of the new power station, Bihar State Power Generation Company Ltd. (BSPGCL) has planned the extension of existing Barauni Thermal Power Station. Accordingly, BSPGCL has proposed to augment the power generating capacity of Barauni Thermal Power Station where 2 x 110 MW & 2 x 250 MW units is in R&M/LE and installation stage, respectively.

BSPGCL had taken up the development of new power plants and hence construction of 2 x 250 MW rating units of sub-critical parameters due to retirement of old Units No. 1, 2 & 3 (3 x 15 MW) under the 12th Five Year Plan at Barauni site. The GoI has requested to check the feasibility to set up 1 x 660 MW unit with increased confidence in power generating set and advancement in using supercritical technology. Thus, the net capacity addition from this project will be 620 MW approximately (i.e. exported power to grid after taking account of auxiliary power consumption from gross power.

Further, environmental consideration also leads to introduction of a highly efficient power generating machine, the supercritical coal fired thermal power plant of 1 x 660 MW supercritical unit instead of original envisaged subcritical unit.

For the main power block, 660 MW set with SC parameters is favoured because of followings major advantages:

- Superior thermal efficiency;
- Better heat rate, low fuel consumption, even though fragmentally high initial cost;
- Commendable performance record of the above sets in India & abroad; and
- Reduction in emission like, CO_2, SOx, NOx, SPM with application of supercritical technology.

1.3 PROJECT & PROJECT PROPONENT

Bihar State Electricity Board (BSEB) was constituted under section 5 of the Electricity Supply Act, 1948 vide Bihar Government's Notification No. 2884 -A/AI-121/57 dated 25th March, 1958 with effect from 1st April, 1958. The Board was given the responsibility of promoting coordinated development of Generation, Transmission and Distribution of Electricity in the State in an efficient and economic manner.

Under the new 'Bihar State Electricity Reforms Transfer Scheme 2012', the BSEB has been unbundled into five companies: Bihar State Power (Holding) Company Limited (Holding company), Bihar State Power Transmission Company, Bihar State Power Generation Company, South Bihar Power Distribution Company and North Bihar Power Distribution Company with effect from 1st November' 2012 vide notification no PR/Board Punar no-31/2008 (Vol-I) 17 dated 30.10.2012. Accordingly, all the generation activities of the erstwhile BSEB have been transferred to Bihar State Power Generation Company Limited (BSPGCL). Following are the major functions and duties of BSPGCL:

- To undertake planning, establishment, construction, operate, maintain, renovate, modernize activities in regard to generating stations;
- To explore, prospect, exploit, operate, control the mining activities; and
- To enter into joint ventures for construction of power projects

1.4 *REQUIREMENT OF ESIA STUDY FOR THE PROJECT*

The proposed project activity falls under the Project Category (1d) thermal power plant and due to capacity more than 500 MW (coal/ lignite/ naphta & gas based), it has been categorized as Category 'A' vide the Notification dated 14th September, 2006, and is required to obtain environment clearance from the MoEF&CC.

BSPGCL has approached Japan International Cooperation Agency (JICA) for the loan to develop this project. In order to justify the loan to the planned construction of the Project, JICA has initiated a preparatory study, which includes the detailed feasibility study of the power plant and is currently being developed by KEPCO. In order to understand the environmental and social consideration of the planned project, JICA has also proposed to conduct an ESIA study in order to proceed as Japanese official development assistance (ODA) project as well as to meet the regulatory requirements of the MoEF&CC. This Environment & Social Impact Assessment (ESIA) study report is prepared to meet the JICA's requirement.

1.5 *PURPOSE OF THE ESIA STUDY*

The power plant construction project is categorised as "Category A" as it falls under "thermal power plant (including geothermal power plant) sector (which has characteristics likely causing certain impact or in the vulnerable area where it to susceptible to external disturbances[1]" according to JICA's Environmental and Social Guideline (enacted on April 2010).

As per the Indian regulations, the proposed project falls under category A, item 1(d) of Schedule to the EIA notification, 2006 as amended till date as per the notification issued by MoEF&CC and would require prior Environmental Clearance (EC).

The overall objectives of the ESIA study will be as follows:

- Establish the prevailing baseline environmental and socioeconomic condition of the project site and its surroundings;
- Assess environmental, socioeconomic and health impacts arising out of the construction and operation of proposed power plant and associated activities like construction of ash pond and its operation, river water intake facility and pipeline, transportation and handling of coal, etc.;
- Recommend appropriate preventive and mitigation measures to minimize pollution, environmental and social disturbances during the life-cycle of the project;

[1] Japan International Cooperation Agency (JICA), Guidelines for Environmental and Social Considerations

- Integrate mitigation measures with existing BSPGCL's program so that they can be implemented, monitored and suitable corrective action can be taken in case of deviations; and
- Identify residual and cumulative impacts that may arise from the project and suggest suitable measures to minimize them.

1.6 LAYOUT OF THE REPORT

This ESIA report is prepared on the basis of MoEF&CC guidelines and has been divided into 11 sections as briefly described in ***Table 1.1.***

Table 1.1 Layout of the Report

Section No.	Section	Description
0	Executive Summary	This section includes Introduction about the site and Project, requirement of EIA, summary compilation of Project description, baseline conditions, impact assessment & mitigation measures proposed and EMP and conclusion.
1	Introduction	This section includes the purpose of the report, identification of project & project proponent, brief description of nature, size, location of the project and its importance to the country, region, scope and limitations of the study.
2	Project Description	This section presents a concise description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details provided to give clear picture of the type of project, need for the project, location, size or magnitude of operation, technology and process details & description of mitigation measures incorporated into the project to meet environmental standards.
3	Policy and Administrative Framework	This section covers the regulatory framework and describes legislations applicable to the proposed project.[1]
4	Environmental Baseline Status	This section provides a description of the environmental baseline status of the study area within 10 km radius from the project site.
5	Impact Assessment	This section includes details of identified environmental impacts and associated risks due to project activities, assessment of significance of impacts and presents mitigation measures for minimizing and /or offsetting adverse impacts identified.
6	Analysis of Alternatives	This section covers a description of the reason for selection of the adopted alternative for proposed power plant.
7	Environmental Monitoring Programme	The section describes monitoring program and reporting requirements for effective implementation of the EMP.
8	Environmental Management Plan	This section describes the environmental Management plan including EMP budget.
9	Summery & Conclusion	Explanation of how, adverse effects have been mitigated. Overall justification for implementation of the project.

[1] Policy and Administrative Framework is not required as Reporting Structure given in EIA Notification 2006.

1.7 SCOPE OF THE ESIA STUDY

As discussed in *Section 1.1*, presently BTPS has two existing unit (2 x 110 MW), which is under maintenance modernisation and two under construction unit (2 x 250 MW). The proposed expansion unit (1 x 660 MW) will be constructed adjacent to 2 x 250 MW plant site. The common facility and new facility for proposed expansion unit is given in Table 1.2.

Table 1.2 Common Facilities for Proposed Expansion Unit

Sl. No.	Facilities	Units
1.	Ash Pond	Common facilities with Unit No. 6, 7, 8 and 9
2.	Water Intake Facility	Common facilities with Unit No. 6, 7, 8 and 9
3.	Residential Area	Common facilities with Unit No. 6, 7, 8 and 9
4.	Railway Siding	Common facilities with Unit No. 8 and 9
5.	Coal Storage	New facility

The basic scope for this study involves:

- Two season (pre-monsoon and post monsoon) baseline environment study to understand the environmental and social baseline of the study area,
- Assess the project level impacts (land use, soil quality, water quality, biological environment and socio-economic environment) and cumulative impacts (air quality, water resource);
- Carry out stakeholder analysis and public consultation;
- Reviewing of DPR and related study; and
- Formulate the EMP in line of EMP proposed for 1 x 660 MW power project.

1.8 LIMITATIONS

This report is based on certain scientific principles and professional judgement to certain facts with resultant subjective interpretation. Professional judgement expressed herein is based on the available data and information.

ERM is not engaged in the impact assessment and reporting for the purposes of advertising, sales promotion, or endorsement of any client's interests, or other publicity purposes. The client acknowledges that any report prepared by ERM is for the exclusive use of the client and agrees that ERM's report or correspondence will not be used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular. The client also agrees that none of its advertising, sales promotion, or other publicity matter containing information obtained from these reports will make reference to ERM's name.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The project involves commissioning and operation of 1 x 660 MW unit, Turbine Generator together with other auxiliaries viz. Coal Handling Plant, Ash Handling Plant, Ash Pond, Plant Water System, Fuel Oil Handling System, Ventilation & Air Conditioning System, Fire Protection System etc. The details regarding project location and settings, description of main plant unit and auxiliaries, resource requirements etc., have been discussed in the subsequent sections.

2.2 DESCRIPTION OF PROJECT SITE

2.2.1 Site Location

The project primarily has three components (a) Main Plant site for power generation system, coal handing unit, power evacuation system, (b) ash pond, (c) water intake facility. The locations & area occupied by each of these components are as follows:

Main Plant Site

The main plant and ancillary facilities like railway siding for coal, coal handling unit, raw water reservoir and switchyard is located in Malhipur village, Begusarai district, Bihar. The main plant is located in the Survey of India's Topo- Sheet No. 45 O3. The geographical location of the proposed plant site is provided at the ***Table 2.1*** below.

Table 2.1 Coordinates of the Main Plant

Point	Latitude	Longitude
A	25°23'57.30"N	86°00'59.86"E
B	25°23'43.60"N	86°01'45.88"E
C	25°23'31.40"N	86°01'46.33"E
D	25°23'14.04"N	86°01'42.74"E
E	25°23'19.91"N	86°00'53.46"E
F	25°23'23.41"N	86°00'57.91"E

Ash Pond

The proposed Ash Pond is located in Kasaha Diyara – Maranchi Diyara, Patna District, which is at 2.7 km (approx.) from main plant site towards south-east, and will be connected through ash slurry pipeline. The ash pond is located in the Survey of India's Topo- Sheet No. 45 O3The coordinates of the proposed ash pond is provided at the **Table 2.2** below

Table 2.2 Coordinates of Ash Pond

Point	Latitude	Longitude
G	25°22'27.49"N	86°02'34.86"E
H	25°22'29.88"N	86°03'06.20"E
I	25°21'42.29"N	86°03'27.80"E
J	25°21'42.04"N	86°02'21.16"E

Water Intake Facility

The water intake point is located in the Ganga River near Simariya Ghat and water intake facility will be located in the Simariya Village, Begusarai district, Bihar, approximately 3.5 km from main plant towards south-west. The water intake pump will be connected through 3.5 km pipeline, mostly passing along the ROW of existing road. The residential colony (existing) is located adjacent to main plant, on the north-eastern side of the main plant.

The Regional Setting Map of the project site is presented in Figure 2.1**.** The location of main plant, ash pond and water intake facility on Toposheet and Satellite Imagery is presented in Figure 2.2 and Figure 2.3, respectively.

2.2.2 *Accessibility*

The main plant site is accessible by National Highway-31 (NH-31) from Begusari and traverses the major urban and industrial area of Barauni. The NH-31 then continues west towards Rajendra Road & Railway Bridge over River Ganga to Mokama –other industrial area on western side of the Ganga River. The main plant is located adjacent to NH-31.

The proposed ash pond lies at a radial distance of approximately 3.0 km from Simariya Junction on NH-31 and is approachable by 3-4m wide road originating from the aforesaid junction near Simariya Ghat. The approach road will be utilised for movement of construction machineries/equipment. This road is a village road and belongs to Government of Bihar.

The major railway link to the site is Simaria Station located on the East Central Railway (ECR) line at a radial distance of approx. 1.8 km south-west. In addition to Rajendra Railway Station, the BTPS has railway siding within the plant. A separate railway siding will be constructed within the proposed plant for 2 x 250 MW and 1 x 660 MW units.

The nearest airport to the site is Patna Airport at distance of approx. 110km. Nearest port is Kolkata Port which is approximately 430 km from site. The accessibility map of site is presented in Figure 2.4.

Figure 2.1 Regional Setting Map of the Site

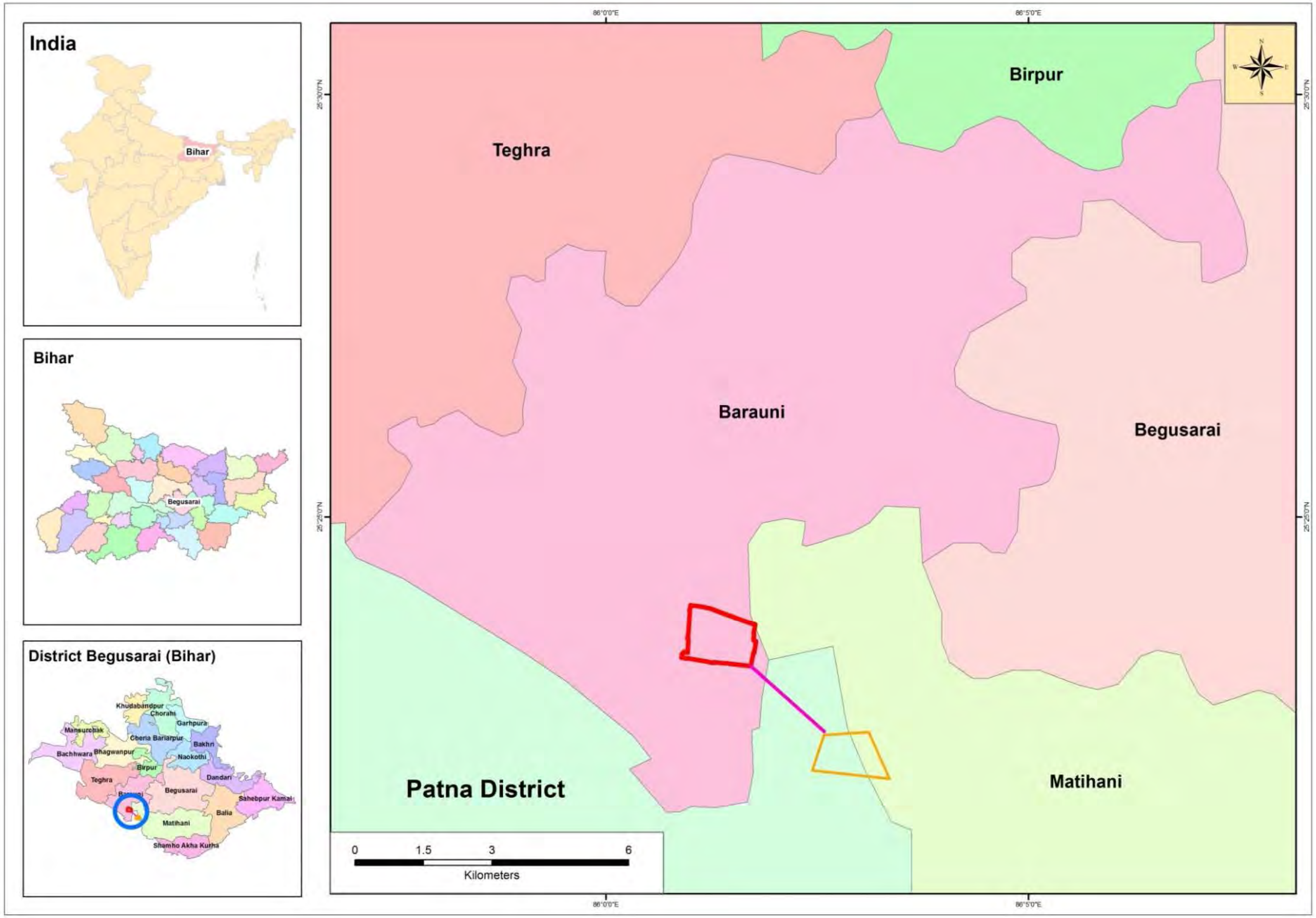


Figure 2.2 Plant Location on Toposheet

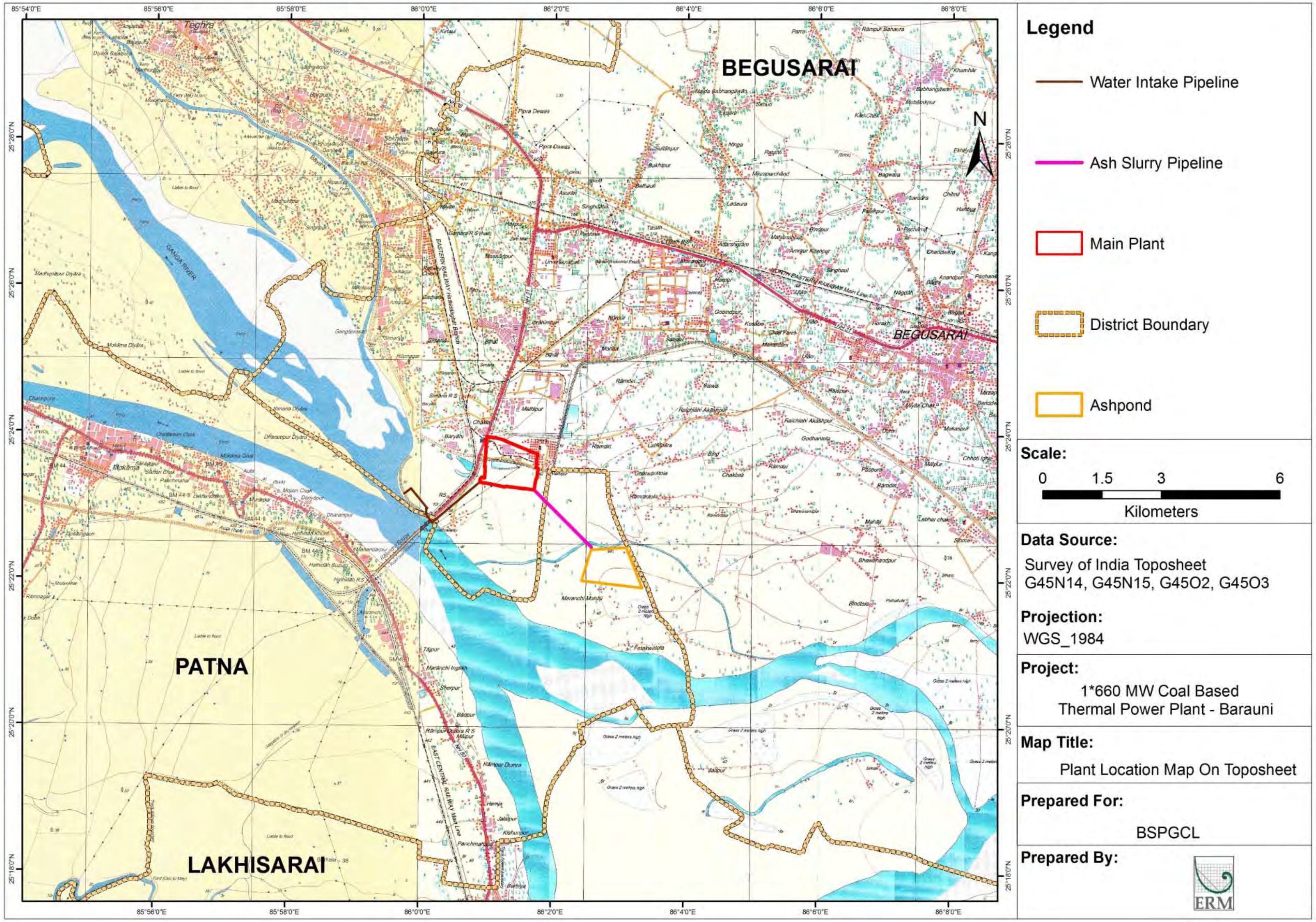
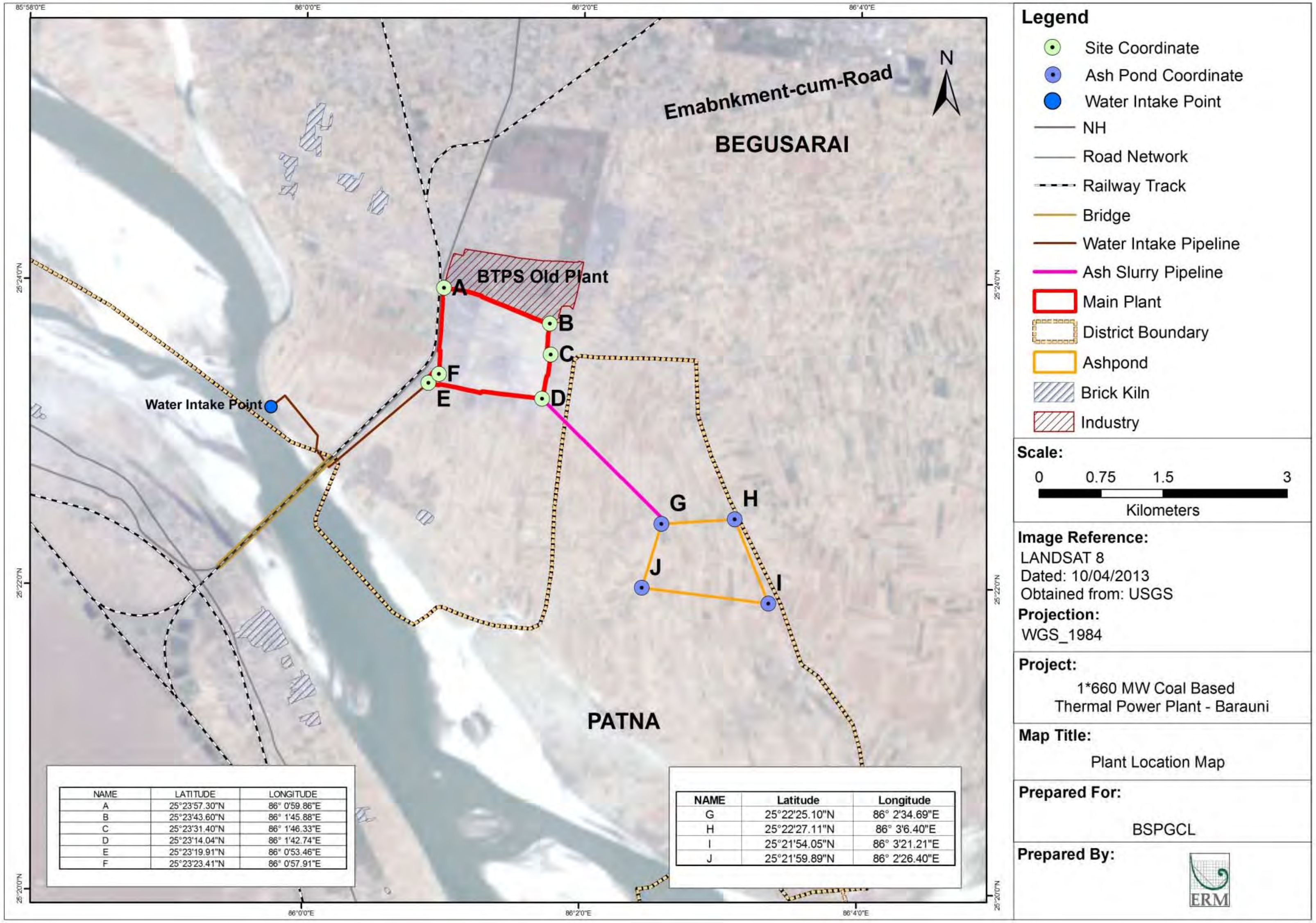


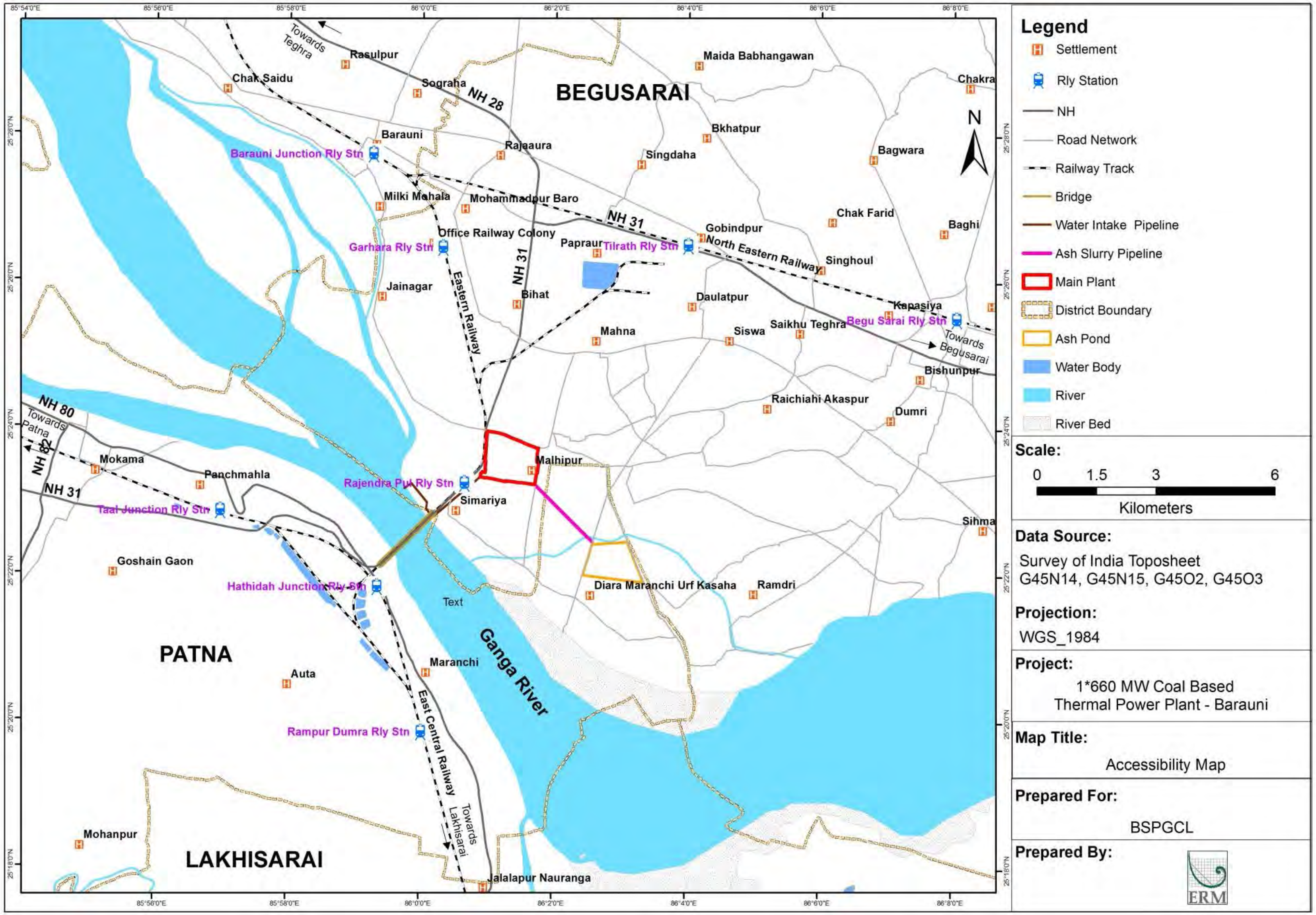
Figure 2.3 Plant Location on Satellite Imagery



NAME	LATITUDE	LONGITUDE
A	25°23'57.30"N	86° 0'59.86"E
B	25°23'43.60"N	86° 1'45.88"E
C	25°23'31.40"N	86° 1'46.33"E
D	25°23'14.04"N	86° 1'42.74"E
E	25°23'19.91"N	86° 0'53.46"E
F	25°23'23.41"N	86° 0'57.91"E

NAME	Latitude	Longitude
G	25°22'25.10"N	86° 2'34.69"E
H	25°22'27.11"N	86° 3'6.40"E
I	25°21'54.05"N	86° 3'21.21"E
J	25°21'59.89"N	86° 2'26.40"E

Figure 2.4 Accessibility Map of the Site



2.2.3 *Environmental Setting*

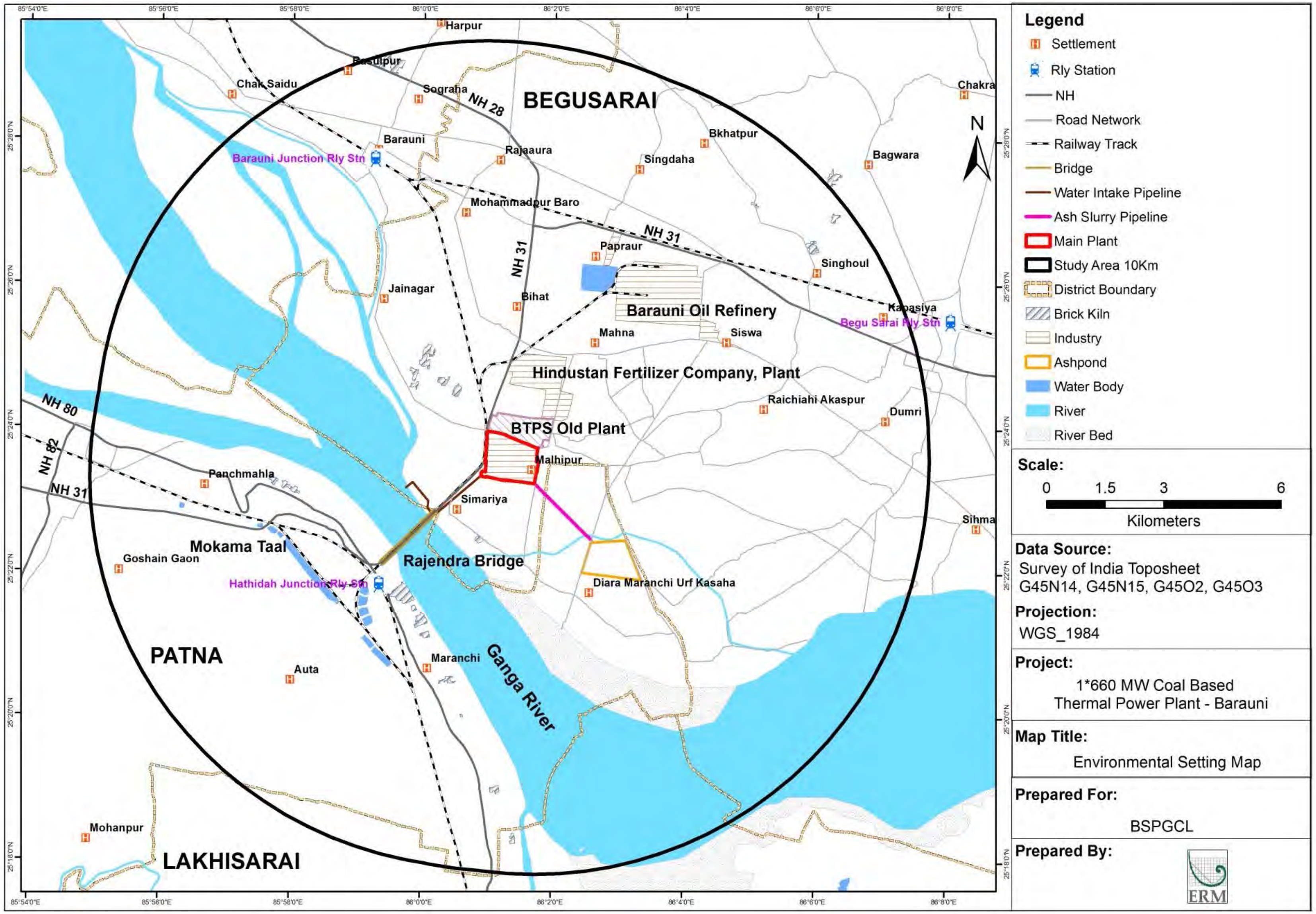
The selected project site is at Barauni and this area is in the Middle Ganga Plain. This area is almost flat and having no undulation. BTPS is located about 3.5 kms from the left bank of the Ganga River.

BTPS is located on eastern side of the NH-31. Embankment come flood protection bund has divided the site into two parts, which is passing west to east. The existing units (Unit No. # 1 to 7) is located on north-western part and residential colony on south-western part. The existing units and residential colony is located within the flood projection band. The old ash pond is located on southern part of the site, outside the food protection bund, which was reclaimed and has been utilized for construction of 2 x 250 MW units. The main plant of the proposed expansion unit will be construed on the reclaimed ash pond land. The environmental setting of the site is as follows:

North	Immediately abutting the site northern boundary lies a flood protection bund. Beyond the bund the BTPS old plant (having all the seven units, railway siding, residential area) is located. Further north, Hindustan Fertilizer Plant with township, which is closed. Barauni Oil Refinery is located at radial distance of 4.5 km towards north east.
South	Immediately abutting the site southern boundary monocrop agricultural land is located. Simariya village is located at distance of 1.0 km towards south-west; Simariya Ghat is located at a distance of 1.7 km. Diara Maranchi Urf Kasaha village is located at a distance of 2.7 km, which is adjacent to proposed ash pond. River Ganga is located at a distance of 1.7 km towards south-west. Mokama Taal IBA is located 3.2 km on south.
East	Immediately abutting the site eastern boundary Malhipur village is located. Ralchlahi Akashpur village along with agricultural land is located 1.8 km.
West	Immediately abutting the site western boundary lies NH-31, beyond that East Central Railway line. Bariyahi and Kasaha villages is located north-western side.

The environmental setting map is presented in Figure 2.5.

Figure 2.5 Environmental Setting Map



2.2.4 *Existing Facility*

Thermal Power Units

There have been 7 numbers of coal fired sub-critical type of units installed in different phases commencing from 1963. The first 3 units, each with a capacity of 15 MW, namely unit no. 1, 2 and 3, started the commercial production during 1963-66; presently all these units are not operational.

The unit 4 & 5, each with a capacity of 50 MW started its commercial production during 1969 and 1971 respectively; however, both the units are shut-down due to an environmental pollution problem on 1996 and 1995 respectively.

Unit 6 & 7 each with a capacity of 110 MW started its commercial production during 1984 and 1985 respectively; however, both these units are presently non-operational. Renovation & Modernization and Life Extension work is going on, and these units will again come under operation.

In addition, Unit no. 8 & 9 each with a capacity of 250 MW are under construction. It is planned to commission during end 2015 and early 2016. On the whole, presently total installed capacity at Barauni Thermal Power Plant is 720 MW comprising of 4 units (2 x 110 MW + 2 x 250 MW).

As discussed, Unit No. 6 & 7 (2 x 110 MW) was come under commercial operation prior to EIA Notification 1994. Therefore, environmental clearance is not applicable for these units. Unit no. 6 & 7 has been taken under renovation & modernisation / life extension (R&M/LE. On the proposal of Govt. of Bihar for R&M/LE, a five party memorandum of understanding was signed amongst Ministry of Power (Govt. of India), NTPC, BHEL and BSEB on 29.05.2006.

BSPGCL has taken environment clearance (EC) from MoEF for construction of 2 x 250 MW (Unit No. 8 & 9) vide letter No. J-13012/143/2008-IA.II(T) dated 8th May 2014 (Annexure 2.1).

Railway Siding, Coal Storage Yard & Coal Handling Plant

BTPS is currently having a railway network inside power plant premises for receiving coal and unloading of the same by use of railway wagons. The existing coal storage facility is also under renovation. The upgraded facility will be utilised for unit No. 6 & 7. It is proposed to construct new Railway siding and coal storage facility for Unit. No. 8 & 9 and will be utilised for proposed expansion unit (i.e. Unit No. 10).

Township

Barauni Thermal Power Station has its own residential area on north-eastern side the plant. The township has all necessary amenities and infrastructure like water supply, health facility, school, etc. The same facility will be used for existing and proposed expansion unit. The residential colony needs some modernisation and renovation. This will cater plant residential facility for all the existing and proposed expansion unit.

Ash Pond

BTPS had an ash disposal area on southern side of the old plant, spread over 336 acres of land. The ash pond was exhausted and same area was now utilised for construction for 2 x 250 MW (Unit No. 8 & 9) and proposed expansion unit 1 x 660 MW (Unit No. 10). BTPS has proposed to construct a new ash pond for existing and proposed expansion units, details are provided in following section. It has been planned that BTPS will utilise Hindustan Fertiliser Plant's ash pond on temporary basis before construction of ash pond for Unit. No. 6, 7, 8 and 9.

2.3 PROJECT RESOURCE REQUIREMENTS – OPERATIONAL PHASE

2.3.1 Land

The land requirement for the proposed 1 x 660 MW expansion unit No. 10 can broadly be classified under the following major heads:

a. Main Plant Area
b. Ash Dyke / Pond & Slurry Pipelines
c. Residential Township
d. Greenbelt
e. Other land area requirements for infrastructure facilities such as rail access, river water intake system, intake water piping corridor, evacuation corridor, etc.

Main Plant

Barauni Thermal Power Plant, presently implementing the unit No. 8 and 9. Unit No. 8 and 9 has been constructed over reclaimed ash pond area of BTPS. The main plant of proposed expansion unit (Unit No. 10) will be constructed on the plant area of Unit No. 8 & 9. The total area available for main plant of Unit No. 8, 9 and 10 is 370 acres. For the main plant area (370 acres), the Unit No. 10 plant area required is 84 acres and remaining land (286 acres) is used for the existing 2 x 250 MW (i.e. Unit No. 8 & 9) main plant area. The component wise land requirement for different unit is given in table below.

Ash Pond

Ash disposal will be in common ash dyke of Unit No. 6 to 10. For this purpose, sufficient ash dyke area will be required for the unit no. 6 to 9 including Unit No. 10 throughout the operational life of 30 years with 100% fly ash utilization after 4th year of plant operation as per MoEF requirements, including 30% area required for green belt, protection bund and peripheral road around the ash dyke.

The proposed 290 acres of ash pond, which is located at a distance of approximately 2.7 kms south east from the plant area of BTPS, will be used to dispose-off ash generated from the Unit No. 10. The ash pond will be shared among Unit No. 6 to 10. It is expected that available ash dyke land of 290 acre is sufficient for 16 years from the commencement of the project assuming 80% ash utilization, hence additional land will be secured before the ash pond.

Ash Slurry pipelines will be installed within a land secured by BSPGCL for Unit No. 8 & 9. This 50 m of Right of Way (ROW) acquired for Unit No. 8 & 9 project will also be used for the installation of ash slurry pipelines for Unit No. 10.

Residential Township

It is expected that the plant personnel's and outstation required staff (including specialized resources) will be suitably accommodated in the existing residential colony. The existing residential colony of BTPS having 139.184 acres of land is located on the north eastern side. The existing residential colony will be upgraded without acquiring additional land for all the units 6 to 10.

Greenbelt

BTPS will develop a greenbelt around the main plant site and around the ash pond area. As per CPCB/MoEF&CC guidelines greenbelt for thermal power unit should 33% of the total area. BTPS has proposed to develop 104 acres of greenbelt in the main plant and 27.6 acres of greenbelt around the ash pond area. Therefore, total greenbelt will be 131.6 acres, which is approximately 20% of the total plant area.

Other Facility

Water will be sources from River Ganga for existing and proposed expansion units. Water intake facility will be constructed, which includes River Water Sedimentation / Settling Basin and River Intake pipeline. Water intake facility would require 20 acres of land.

Land Availability

A total of 680 acres of land will be required for the proposed project to be implemented under BTPS expansion unit. Necessary consideration have been made by BSPGCL during the project design and planning stage in consistent with Central Electricity Authority (CEA) Guidelines on[1] "Land Requirement

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[1] Standard Design Criteria/ Guidelines for Balance of Plant of 2 X (500 MW or above), CEA, 2010

for Thermal Power Plants" to optimize land requirement for the project to the extent possible.

As per CEA Guidelines 2009, land required for pit head station using Indian coal for 2 x 500 MW, for main plant including greenbelt is 600 acres, ash pond including greenbelt is 500 acres, land for other facilities outside plant area (raw water pump house and de-siltation basin) is 10 acres and township is 100 acres. Total land requirement for such types of plant is 1240 acres, i.e. 1.42 acres/ MW.

The proposed expansion unit will be constructed on land under construction Unit No. 8 & 9 (2 x 250 MW). Therefore, 1160 MW power plant unit will be constructed on 370 acres of land; i.e. 0.32 acres/ MW. The proposed ash pond area will be common for Unit No. 6 to 10 (2 x 110 MW + 2 x 250 MW + 1 x 660 MW = 1320 MW) and area of proposed ash pond is 290 acres. The land for other facility is 20 acres and for township is approx. 139 acres. Therefore total land available is 819 acres including township. Therefore land requirement is 0.71 acres/ MW as compared to 1.42 acres/MW of CEA guidelines.

The Plant layout is presented in Figure 2.6. The detailed land requirement breakup has been provided in the Table 2.3.

Table 2.3 *Land Requirement for Proposed Unit No. 10*

Sl. No.	Description	Area (Acre)	CEA Guidelines (Acres)
A.	Main Plant Area	370	600
A.1	Proposed 1 x 600 MW Plant area		
A.1.1	Main power plant including transformer yard	15	
A.1.2	Coal Silos & Handling systems	25	
A.1.3	Water System and related equipment	19	
A.1.4	Cooling Tower Area	10	
A.1.5	Switchyard (400 kV)	5	
A.1.6	Miscellaneous Plant facilities	5	
A.1.7	Road & Drains	5	
	Total for A.1	***84***	
A.2	Existing 2 x 250 MW plant area	***166***	
A.3	Outside Plant		
A.3.1	Green area and laydown area	104	
A.3.2	Rail track area	16	
	Total for A.3	***120***	
B.	Ash pond and slurry pipelines	290	500
C.	Water Intake Facility	**20**	**220**
C.1	River Water Sedimentation / Settling Basin	10	
C.2	River Intake pipeline	10	
	Total for C	**20**	
	Grand Total (A + B + C)	**680**	

(*Source: Project Feasibility Report*)

Of the total land required for the project, 370 acres of main plant land is under the possession of BSPGCL. The land (290 acres) identified for proposed ash pond is Government land under Land and Revenue Department. This land will be alienated to BSPGCL for construction of ash pond. However the entire land is used for agriculture purposes. Presently, land transfer is under progress. The land identified for water intake facility is also Government land under Railway and same will be transferred to BSPGCL for construction of water intake facility.

Figure 2.6 Proposed Plant Layout

2.3.2 *Fuel*

Coal

Coal Requirement

The plant has been envisaged as a coal fired Thermal Power Plant. The type of fuel envisaged for the Unit No. 6 to 10 is domestic coal. Although the plant is based on domestic coal, in accordance with CEA technical guideline[1], up to 30 % of imported coal blending (i.e. 70 % Domestic & 30 % Imported) will be taken into main plant design.

The estimated coal requirement for the Unit No. 10 would be approximately 11,200 TPD considering worst coal at Boiler Maximum Continuous Rating (BMCR). The annual coal requirement at PLF of 85 % (2 years average) would be about 3.5 MTPA with the gross calorific value (GCV) of 3,100 kcal/kg based on worst coal.

Similarly, annual coal requirement for the Unit No. 10 has been assessed as 2.8 MTPA based on blended GCV of 3,855 kcal/kg with imported coal GCV of 5,617 kcal/kg & domestic coal GCV of 3,100 kcal/kg, unit heat rate 2,042 kcal/kWh & PLF of 85 %.

Table 2.4 Annual Coal Requirement

Sl. No.	Description	Units	Value
1	Unit heat rate for 660 MW	kcal/kWhr.	2,050
2	Gross calorific value of the worst coal	kcal/kg	3,100
3	Daily Coal requirement @ BMCR	TPD	11,200
4	Annual Coal requirement @ 85% PLF	MTPA	3.5

[Source: DPR]

Sourcing of Coal

For Unit No. 8 &9, Eastern Coalfield Limited (ECL) has already issued Letter of Assurance to BSPGCL for supply of 1.53 MTPA of coal in GCV grade of G10 and above on tapering basis from its basket of mines, and Badam Coal Block having minerals reserves of 90.5 million tonnes of coal, which is scheduled to supply the coal from 2019.

The coal will be sourced either from the coal blocks or the coal linkage which will be allocated by the GoI. There is no coal linkage for the proposed expansion unit 1 x 660 MW (Unit No. 10) at present, however, BSPGCL will take coal linkage before operation of the plant.

Coal Physicochemical Characteristics

The specification of design coal is considered of Class / Grade "G14" domestic coal, i.e. Gross Calorific Value (GCV), Ash & Sulfur contents respectively as

[1] Standard Design Criteria/ Guidelines for Balance of Plant of 2 X (500 MW or above), CEA, 2010

3,300 kcal/kg, 44.6 % & 0.3 % for design coal and 3,100 kcal/kg, 40 % & 0 % for worst coal.

Table 2.5 *Coal Characteristics (Design & Worst Coal)*

Item		Unit	Design	Worst	Remark
Gross Calorific Value		Kcal/kg	3,300	3,100	As received
Proximate Analysis	Fixed carbon	%	29.7	29.4	As received
	Volatile matter	%	17.7	20.6	
	Ash	%	44.6	40.0	
	Total Combined Moisture	%	8.0	10.0	
Ultimate Analysis	Carbon	%	34.69	34.66	
	Hydrogen	%	2.43	2.26	
	Sulphur	%	0.3	0.00	
	Oxygen	%	9.27	12.33	
	Nitrogen		0.71	0.75	

[Source: DPR]

As per amended rules (GSR. 02 (E) Dated 2nd January 2014), regarding supply and use of coal with ash content not exceeding 34% to coal based Thermal Power Plants. The rule is applicable for (i) standalone power plant of any capacity, located beyond 500 km from pit-head or (ii) in urban area or in ecologically sensitive area or critically polluted area irrespective of any distance from pit-head.

The proposed BTPS is standalone unit having capacity of 660 MW and TPP will operate with indigenous coal mine, however, presently have no coal mine. For 2x250 MW, the coal mine is located in Karanpura area of Jharkand, which is approximately 100 km. The power plant is not located in urban area, or ecologically sensitive area, or critically polluted area. As per feasibility report, BSPGCL is considering the mine located within 500 km. Therefore it is not applicable for the proposed expansion unit.

Coal Transportation

For domestic coal, coal would be transported by the Indian Railway System in bottom opening coal wagons (BOBRN – Bogie Open Bottom Rapid Discharge Type) up to the BTPS site for the Unit No. 10.

Light Diesel Oil

Light Diesel Oil (LDO) will be used to serve as an auxiliary fuel for the project for boiler start up and flame stabilization of the turbine generator units. Depending on the daily plant load factor, grid stability, quantity of coal etc, the requirement of LDO for the 1 x 600 MW unit has been estimated to about 18 kilo litre per hour (KLPH). The use of LDO will assist in improving the operational efficiency of the power plant through increased energy conservation and reduction in cost incurred for additional pollution abatement and maintenance due to its low viscosity, sulphur (1.8%) and carbon residue (1.5%) content.

Table 2.6 LDO Characteristics

Characteristics	Unit	Value
Acidity, Inorganic	-	Nil
Ash content (max.)	% by mass	0.02
Carbon residue (Rams bottom) on whole sample (max.)	% by mass	1.5
Pour Point (max.)		
a) Winter	^oC	12
b) Summer	^oC	18
Flash point (Pensky Martens) (min.)	^oC	66
Kinematic Viscosity at 38 ^oC	cSt	2.5 to 15.7
Sediment (max.)	% by mass	0.1
Water Content (max.)	% by volume	0.25
Total Sulphur Content (max.)	% by mass	1.8
GCV (Approximate)	kcal/kg	10,000
Density at 15 ^oC	kg/m^3	850

[Source: Draft Feasibility Study Repot, 1 x 660 MW BTPS Unit 10 Expansion Project, 2015]

LDO will be sourced from the nearest depots of the Government Agencies and supplied to BTPS site either by road tankers or rail tankers. A new LDO storage tank of capacity 2,500 kL will be envisaged along with the transportation facilities by rail tankers within the main plant. This new tank together with existing 2 x 250 kL tanks will be adequate to unload one (1) complete rake of LDO wagons. The unloading of LDO through an existing unloading and storage fuel oil facility of Unit No. 8 & 9 inside the BTPS site will be further modified to meet the future requirements of the Unit No. 10. Necessary provisions/arrangement will be made during pumping and storage of LDO to prevent any possible overheating and accidental spillages.

2.3.3 *Water*

The water to meet the operational phase demand viz. for cooling water system, heat cycle make up, etc for the proposed project will be sourced from Ganga River near Simariya village upstream of Simariya Ghat, which is at a distance of 3.5 km from the main plant.

Water Requirement

The estimate water requirement for the proposed expansion unit (1 x 660 MW) is about 2140 m^3/ hr (21 cusec[1]). Water conservation will be achieved for the proposed project through recycled use of cooling tower blow down (248 m3/hr) for dust suppression/dust extraction in coal handling plant (CHP), preparation of high concentrated ash slurry for disposal etc. The remaining of the cooling tower blow down water will be collected in guard pond along with other waste effluents and utilized in landscaping and ventilation system following adequate treatment. The water requirement break up for the proposed project is represented in Figure 2.7.

[1] 1 cusec = 101.94 m3/hr.

Water Availability

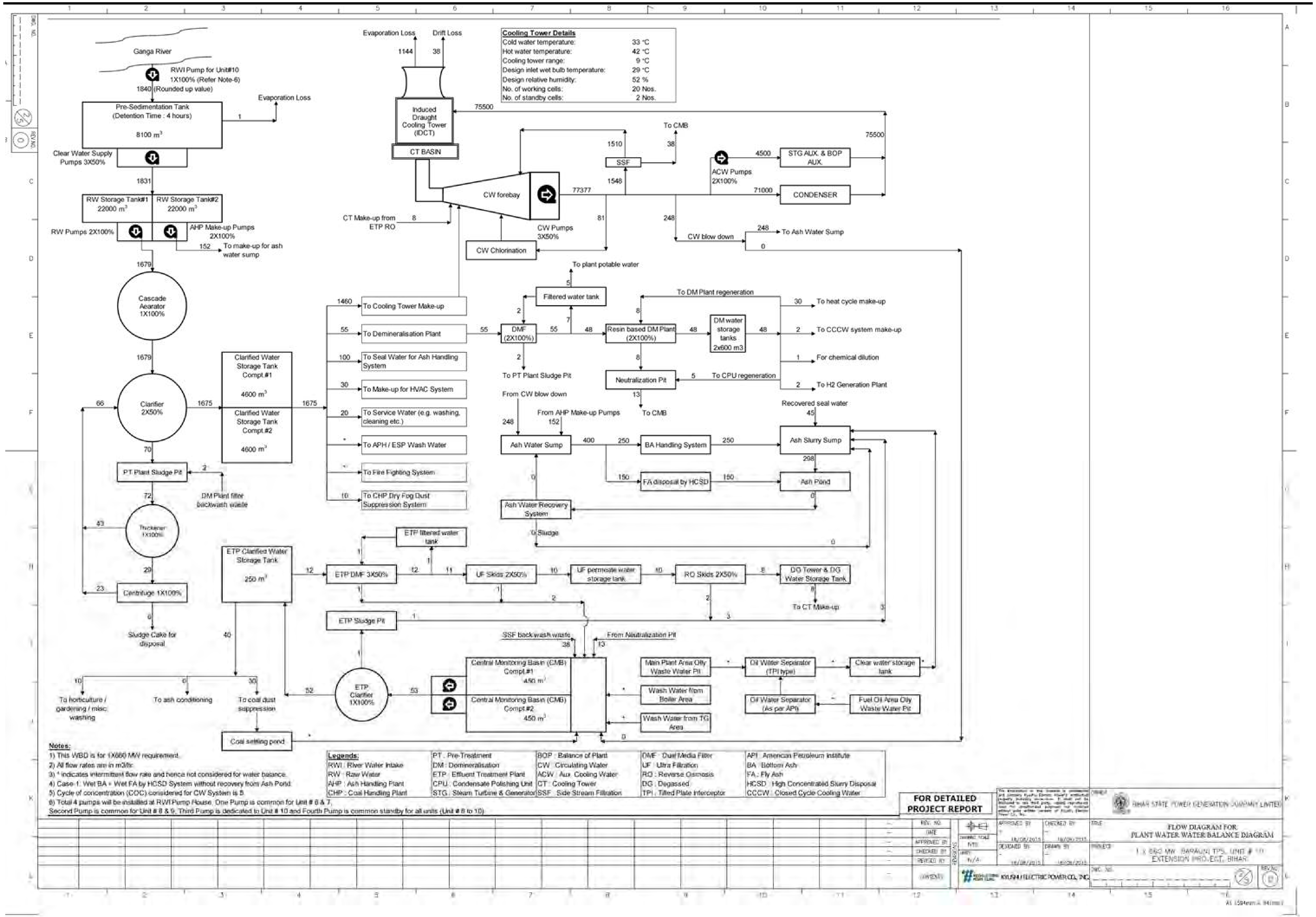
Previously, the plant consumptive water requirement such as Cooling Tower make-up water and process make-up water for the existing Unit No. 6 to 7 was taken from bore wells. However, during the construction of the Unit No. 8 & 9, it was considered to change the water source from the bore wells to the Ganga River for Unit No. 6 to 9.

The estimated Water requirement for unit no 6 & 7 (2 x 1110 MW) is 20 cusec and for unit no 8 & 9 (2 x 250 MW) is 25 cusec. The required amount of intake water considering 10% loss at pre-sedimentation tank is 50 cusec.

The Water Resources Department (WRD), Govt. of Bihar have granted permission to a maximum withdrawal of 60 cusec water from Ganga River for unit existing units (2 x 100 MW) and expansion unit (2 x 250 MW), vide letter No4038/06 -496 dated 66.62007(**Annex 2.2**) to Barauni Thermal Power Plant. Central Water Commission provided clearance for allocation of 45 cusec of water for BTPS during lean period from January to May (**Annex 2.3**).

Therefore, under current plant, 10 cusec water is available during non-lean season. However, during lean season, water is not available under current plan. Therefore BSPGCL need to take water withdrawal permission from Water Resource Department.

Figure 2.7 Water Balance Diagram for Operation Phase of Unit #10



Notes:
1) This WBD is for 1X660 MW requirement.
2) All flow rates are in m3/hr.
3) * indicates intermittent flow rate and hence not considered for water balance.
4) Case-1: Wet BA + Wet FA by HCSD System without recovery from Ash Pond.
5) Cycle of concentration (COC) considered for CW System is 5.
6) Total 4 pumps will be installed at RWI Pump House. One Pump is common for Unit # 6 & 7, Second Pump is common for Unit # 8 & 9, Third Pump is dedicated to Unit # 10 and Fourth Pump is common standby for all units (Unit # 8 to 10).

Legends:

RWI : River Water Intake	PT : Pre-Treatment	BOP : Balance of Plant	DMF : Dual Media Filter	API : American Petroleum Institute
RW : Raw Water	DM : Demineralisation	CW : Circulating Water	UF : Ultra Filtration	BA : Bottom Ash
AHP : Ash Handling Plant	ETP : Effluent Treatment Plant	ACW : Aux. Cooling Water	RO : Reverse Osmosis	FA : Fly Ash
CHP : Coal Handling Plant	CPU : Condensate Polishing Unit	CT : Cooling Tower	DG : Degassed	HCSD : High Concentrated Slurry Disposal
	STG : Steam Turbine & Generator	SSF : Side Stream Filtration	TPI : Tilted Plate Interceptor	CCCW : Closed Cycle Cooling Water

Water Quality

The raw water from the Ganga River has the following features. The raw water quality (Ganga River) is provided in **Annex 2.4**.

- High turbidity, alkalinity (CaCO3)
- Medium amount of positive ions / CATIONS such as calcium, magnesium, iron, and aluminium etc.
- Low amount of negative irons / ANIONS such as chloride, nitrate and fluoride etc.

Therefore, suitable water treatment plant (WTP) shall be provided for the Unit No. 10 to remove impurities from the river water and make it acceptable for use in the SC power plant. The water to be used for potable purposes will be adequately treated using a combination of clariflocculation and filtration techniques. The water from filtration unit will be subject to further treatment in Demineralization (DM) Plant prior to its utilization in heat cycle make up, stator cooling and for chemical feed.

2.3.4 *Chemicals*

The details of chemical to be used along with their storage quantity for proposed project operational phase have been provided in Table 2.7 below.

Table 2.7 Chemical Requirement-Operational Phase

Sl. No	Chemical Name	Function	Quantity
1	Hydrazine	Chemical conditioning of boiler feed water	Information yet to receive from KYUSHU Electric Power Co., INC.
2	Hydrochloric Acid	DM Plant cationic resin regeneration	
3	Sodium Hydroxide	DM Plant anionic resin regeneration	
4	Sulphuric Acid	Inhibits scale formation in boilers	
5	Chlorine	Control microbiological growth in cooling water	
6	Ammonia	SCR catalyst for NOx removal	
7	Alum	Removal of suspended solids and colloids in raw water	
8	Lime	Removal of suspended solids and colloids in raw water	
9	Polyelectrolyte	Removal of suspended solids and colloids in raw water	

2.3.5 *Manpower*

During operational phase manpower will be required for operation and maintenance of plant and auxiliary equipment and administrative functions etc. The project personnel for unit No 10 including BTPS Unit No 6, 7, 8 and 9 will be housed in a common residential township which is already exist in the old plant site with basic amenities and infrastructure.

2.4 *PROJECT CONSTRUCTION ACTIVITIES & SCHEDULE*

2.4.1 *Site Preparation*

Main Plant

The proposed main plant will be constructed on the reclaimed ash pond area of BTPS. The same has been utilised for construction of unit no.8 and 9. The proposed site was already developed for construction of unit no. 8 and 9. No additional side development will be required for construction proposed main plant.

The proposed main plant area is located outside the flood protection embankment. The area nearby BTPS is usually flooded during the rainy season; therefore from the boundary of power plant area of Unit No. 8 to 10, a protection bund is to be constructed at a distance of 300 m for the flood prevention around east, south side and some portion of the west side of the plant. The approach road from NH-31 to Main plant gate will also be protected. The high flood level at the water intake point is 43.22 m, therefore keeping approximately 2 m margin, the top level of the protection bund is planned as 45.5 m. Designed ground elevation of Unit No.10 construction site is to be kept same as of Unit No. 8 & 9 where the power house is at 45.5 m elevation and Boiler area is at 45.3 m elevation.

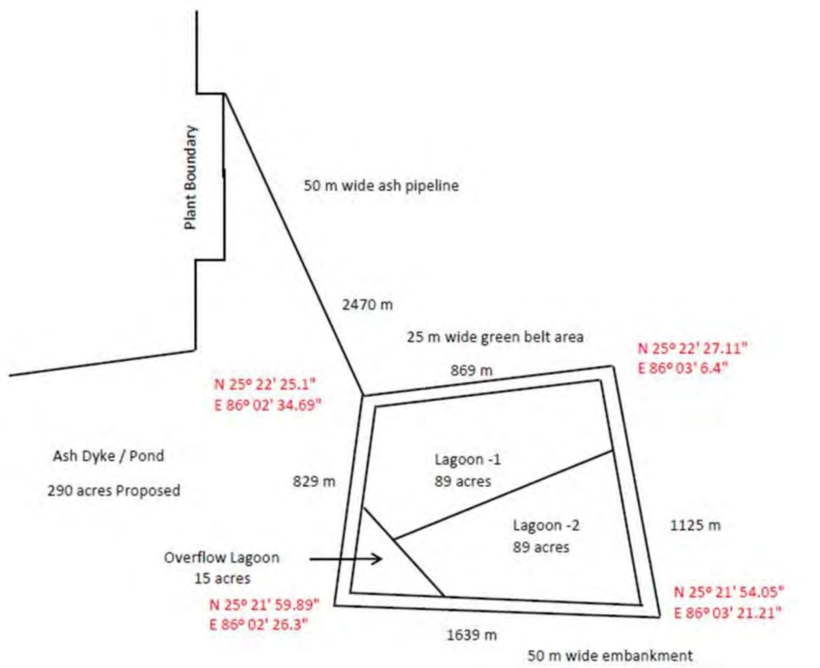
Ash Pond

As discussed in the *Section 2.3.1* the identified ash pond area is mostly Govt. land and some portion is also private land. The entire land is currently used for agriculture purpose. There is no residence, therefore R&R issues is not applicable for this land. The agricultural land has been divided into plots by earthen *bunds*, there are some mature trees on earthen *bunds,* during construction of ash dyke, and tree felling would be required. BSPGCL will take necessary approval for felling of trees in non-forest land from Forest Department as per Bihar Kashth & other Forest Produce Transit Regulations Rules, 1973.

The proposed ash pond area is located outside the flood protection embankment. The area nearby proposed ash pond is usually flooded during the rainy season. The elevation of the proposed ash pond is varied from 40.5 m to 42.0 m AMSL and the high flood level is 43.22 m. It is proposed to construct 18 m height ash dyke. Pre-cast tiles will be considered for the construction of ash dyke. It is planned that starter dyke will be constructed using excavated soil and subsequent raising of the dykes will be constructed using soil or deposited ash and inside the embankment will be filled with ash. The quantity of earth material for construction of ash dyke is currently unknown.. This earth material will be sourced from govt. approved quarry after environmental consideration.

It is proposed to construct two ash disposal lagoons of 89 acres each and one overflow lagoon of 15 acres. It is also proposed to develop 25 m wide greenbelt around the ash dyke. According to Environmental Impact Assessment (EIA) report of Unit No. 8 & 9, MoEF suggests that details regarding ash disposal area permeability including soil analysis report and whether it would be lined, if so details of the lining etc. Based on the suggestion, in the new ash disposal area for Unit No. 6 to 10, High Density Polyethylene (HDPE) lining is planned to be provided at the bottom of the area to form an impervious layer and this eliminates any chance of possible leaching, if any. The details of proposed ash pond/dyke is provided in Figure 2.8.

Figure 2.8 Details of Proposed Ash Pond



Water Intake Facility

For the purpose of sourcing water from Ganga River, an intake well, pump house and other associated infrastructure will be constructed by BSPGCL based on approved design/drawings. The water will be transported to de-siltation plant and the raw water reservoir onsite through a 3.5 km long intake water pipeline. The proposed water intake facility is mostly agriculture land and part is ROW of water. The proposed site has no permanent infrastructure like houses; therefore R&R is not applicable. The site has no trees, therefore tree felling would not be required.

2.4.2 *Construction Schedule*

The project is planned to be implemented and handed over to BSPGCL for commercial operation within a timeframe of 52 months for Unit No. The facilities which are considered essential during early stage of the construction are:

- Access roads
- Construction water and treated potable water
- Construction power
- Temporary housing facility (labor colony) for the construction staff with water supply, electricity, community facilities viz. health care center, vehicular sheds,
- Ancillary or small scale industries to feed the new plant at project stage
- Local availability of skilled and unskilled manpower
- Telecommunication facility
- A few railway lines are already available to existing power station of BTPS, etc.

The nearest airport at Patna is at a distance of 110 kms. The shipyard / sea port facility at Kolkata at a distance of 430 kms may also be utilized for sea transportation of heavy equipment.

2.4.3 *Resource Requirements – Construction Phase*

Construction Raw Material

The main raw materials required for construction of civil structure comprises of aggregates, sand, cement, steel. Aggregates, sands, cement and iron will be sourced from local authorized suppliers. As the main plant site is already developed for construction of unit no 8 & 9, no fill material will be required. The construction of ash dyke would require earth material, which will be sourced from Govt. approved quarry.

Water

During construction phase, water (quantity: information required from KYUSHU Electric Power Co., INC) will be required during peak construction period to meet the demand for construction activities viz. concrete mixing, dust suppression, etc. With respect to Unit No 8 & 9 (2 x 250MW) of the project, which is presently under implementation, water is being sourced through bore wells with the BTPS. It is planned that the construction stage water requirements for Unit 10 (1 x 660 MW) will be met from the Ganga River following the completion of water intake pipeline for proposed unit no 8 & 9. Potable water requirement for project personnel is presently being met by packaged drinking water and also from bore well. The same source will be utilised for proposed expansion unit.

Power

The power requirement during construction phase will be met by grid connection from Bihar State Electricity Board. Additionally, 2 nos. of 250 KVA DG sets will be installed at site to cater to the emergency power supply requirements.

Manpower

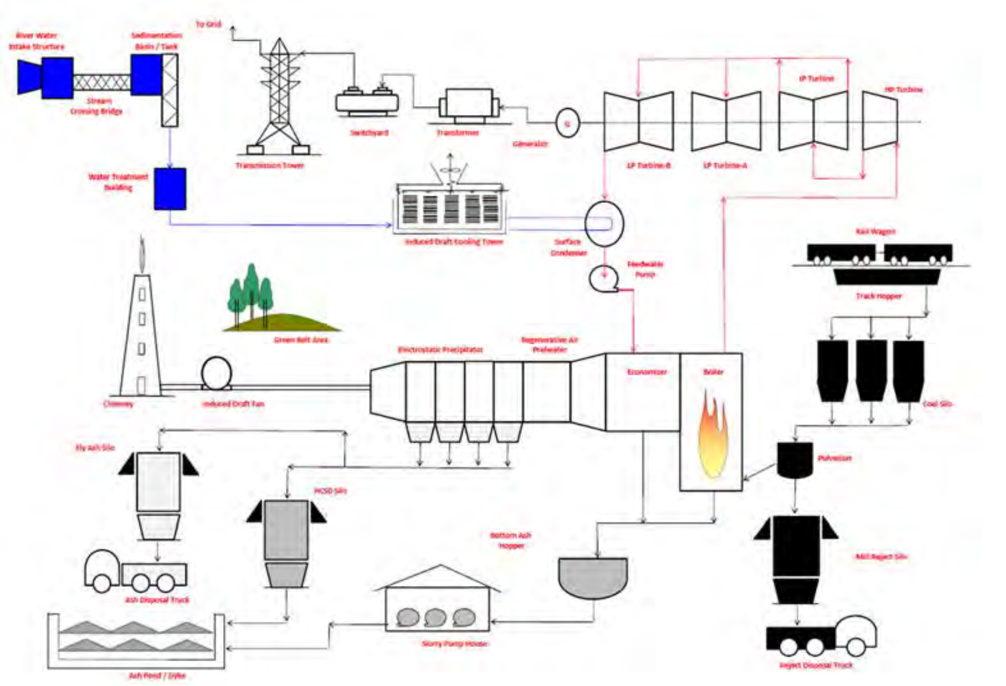
It is estimated that nearly about 1800-2000 nos. of worker will be required during peak construction phase of the proposed project. The different contractors will be involved for construction of plant and installation machineries. The outside workforce will be housed in temporary labour camps equipped with potable water supply, sanitation, first-aid and recreation facilities.

2.5 PROCESS DESCRIPTION & TECHNOLOGY

2.5.1 Process Description

The heat released by the burning coal is absorbed by the demineralized boiler feed water passing through the boiler wall tubing to produce high-pressure steam. The steam would then be discharged onto the turbine blades, which would make the turbine to rotate. The generators coupled to the turbines would also rotate and produce electricity. The electricity would pass to the transformer, which would increase the voltage to the desired level of the transmission grid system. The process of power generation is presented in **Figure 2.9**.

Figure 2.9 Flow Diagram of Thermal Power Generation Process



2.5.2 *Technology*

The proposed power generating unit will be of super critical (SC) steam parameters employing once through type Pulverized Coal fired boiler considering 100 % domestic coal as a design basis. It is proposed to use river water for Condenser cooling with closed cooling water (CCW) system.

The bottom ash (BA) will be collected in the wet form and fly ash (FA) in dry form. FA will be sent out for utilization (i.e. for road construction, back filling low lying areas, cement factories, bricks formation, etc.) and unutilized FA will be disposed to the ash dyke using HCSD system. FA will be stored in storage silos for the purpose of utilization. Unutilized fly ash will be converted into slurry form and will be disposed to the ash dyke along with BA, thus considered HCSD system for fly ash handling.

The switchyard will be located near the Steam Turbine and Generator (STG) building, from where the generated power will be evacuated at 400 kV level through suitable nos. of outgoing feeders.

The key design parameters are tabulated in below Table 2.8.

Table 2.8 Key Design Parameter

Sl. No.	Component		Design Parameter
1.	Gross output		660 MW (1 x 660 MW), 693 MW in case of emergency i.e. Valve Widely Open (VWO)
2.	Performance	Plant Efficiency (Gross)	42%
		Boiler Efficiency	87.7%
		TG Gross Heat Rate	1791 kcal/kWhr
3.	Fuel	Domestic Coal (Main)	3100 - 3300 kcal/kg (as received basis)
		Start-up fuel	LDO
4.	Boiler	Boiler type	SC Once-through Pulverized Coal Fired Boiler, Opposed Firing / Tangential fired
		Steam Pressure & Temperature	(SH outlet) 255 bar (a), 596 oC (RH outlet) 50 bar (a), 596 oC
		Boiler MCR	≈ 2000 t/h
		Minimum Load	40 % BMCR (without oil support firing)
		Mill Arrangement	8 nos. (7 + 1)
5.	AQCS (Air Quality Control System)		ESP, FGD (Space Provision only)
6.	Steam Turbine	Type	Tandem Compound, 4 cylinders (HP+IP+LP(A)+LP(B))
		Turbine Throttle Condition	245 bar (a) / 593 oC / 593 oC
		Rotating Speed	3000 rpm
		Condenser Back Pressure	65 mm of Hg (A) (average)
		Rated quantity of MCW to condenser	71,000 m3/hr.
		Temperature rise of MCW across condenser	9 C

Sl. No.	Component		Design Parameter
		Feed water System	9 stages of feed water heating incl. Deaerator i.e. 4 nos. LPH + Deaerator + 3 nos. HPH + Desuperheater
		BFP Configuration	2 x 50 % Turbine-Driven BFP + 1 x 30 % Motor-Driven BFP
7.	Generator	Voltage / Capacity	20~27 kV / 780 MVA
		Power factor	0.85 PF
8.	Generator Transformer		3 nos. Single Phase 260 MVA,20~27 kV / 420 / √3 kV
9.	Switchyard		400 kV GIS, Double Bus Scheme
10.	Main Cooling System		IDCT with river water make-up
11.	Chimney		Single flue RCC Chimney – 275 m height
12.	Coal Handling System		2 stream conveying from track hopper to coal silos (1350 MT/hr. each) and from Coal Silo to Coal Bunkers (1200 TPH)
13.	Plant Water System		2 stream Resin based DM water
14.	Ash Evacuation		Bottom Ash (Lean Slurry) + Fly Ash (HCSD)
15.`	Ash Storage & Transportation		Two (2) nos. of Ash storage silos each of capacity 2,200 Tonnes

[Source: Prefeasibility Report]

2.5.3 *Unit Process & Operation*

The power generation from 1 x 660 MW thermal power plant will involve the combined operation of the following major power generating equipment and auxiliary systems.

(a) Coal Handling Plant (CHP)
(b) Fuel Oil Handling System (FOHS)
(c) Plant Water System (PWS)
(d) Operation of Steam Generators & Auxiliaries
(e) Operation of Steam Turbine & Auxiliaries
(f) Condenser Operation
(g) Power Evacuation
(h) Ash Handling & Disposal System
(i) Effluent & Waste Treatment System
(j) Fire Protection System
(k) Compressed Air System

The aforesaid unit processes have been discussed in details in the subsequent sections:

Coal Handling Plant (CHP)

<u>*Coal Unloading, Transportation, Crushing and Feeding System*</u>
The coal will be transported from coalfields by Indian Railway System in bottom opening (BOBR) coal wagons to project site. As per estimation, considering gross plant heat rate of 2,042 kcal/kWhr (i.e. 42 % of thermal efficiency) for 660 MW SC unit, the coal requirement for the plant works out at full load with GCV of worst coal as 3,100 kcal/kg will be about 3.5 MTPA.

CHP will be designed on the worst coal basis of daily requirement of 11,200 TPD. CHP system capacity is taken as 2 x 1,350 TPH (from track hopper to coal silo) based on coal receipt by rakes of coal with fifty nine (59) wagons and each wagon with maximum payload of sixty six (66) metric tonnes.

Coal of 300 mm size unloaded into the track hopper from coal rakes will be conveyed to crusher house for crushing to size less than 50 mm or as per requirement of the coal milling plant. From the outlet of the crusher house, the crushed coal is transferred and distributed to top of the coal silos through two (2) nos. of vertical conveyors each of rated capacity 1,350 TPH.

Suitable number of rail tracks appropriately interconnected with each other will be laid ahead & prior to the track hopper for handling / return of empty rakes. CHP system will consist of two (2) fuel streams (1 operating + 1 standby) and each stream will have rated capacity of 1,200 TPH (from coal silo to bunker).

The CHP system envisaged will have track hopper system, coal crushing & screening system, crushed coal storage silo of twenty (20) days storage capacity & feeding system, bunker feeding arrangements etc.

The Coal Bunkers (above the Pulverizer / feeders) will have aggregate twelve (12) hours of storage capacity. The bunkers will be steel cylindrical silos with conical bottom and lined with stainless plates to ensure smooth coal discharge from the Bunkers.

Pollution Prevention System

- The CHP system will be complete with dust suppression / dust extraction system etc. to make the CHP system operation eco-friendly.
- All chutes will be lined to ensure smooth flow & discharge of coal as well as to ensure longer operating life of chutes. All Junction Towers and crusher house will be provided with floor cleaning chutes.
- CHP auxiliaries such as dust suppression / dust extraction system, on line for maintenance, sump pumps, vulcanizing machine, belt sealing arrangement, annunciation system etc. will be provided.

Fuel Oil Handling System

LDO will be used as ignition / start-up fuel for the boiler during start-up and low load operation. LDO will be used having a firing capacity equivalent to 30 % BMCR for start-up or low load operation. LDO will be fed / drawn from the proposed new LDO storage tank of 1 x 2,500 kL capacity with help of transfer pumps or pressuring pumps. The LDO will then be feed to boiler through LDO feeding system.

The LDO transfer pumps discharge lines will be provided with a recirculation line connecting back into the storage tanks. This having an automatic pressure control station to maintain the required supply pressure at the burners of the boilers.

The LDO unloading manifold, suction strainer and pumps of the FOHS will be selected and designed in conformance with the norms and guidelines issued by the Chief Controller of Explosives and related authorities. The oily water waste occurring during maintenance will be drained into the drain oil tank then transferred either to Oil Water Separator (OWS) of the proposed for expansion unit.

Plant Water System

Raw Water – Sourcing, pre-treatment Transportation & Storage
The water for the existing and proposed expansion unit will be sourced from Ganga River near Simariya *ghat* located at distance of 3.5 km west of the site. The intake water system will consists of 4nos (2 operational and 2 stand by) raw water intake pumps housed in a pump house along with associated infrastructure.

The pre-treatment (de-siltation) facility of raw water will be provided in the water intake facility. The raw water stored water intake facility will be subjected to pre-treatment through clariflocculation to ensure removal of suspended solids and colloids. Chemical dosing in the clariflocculators will be achieved using lime, alum, polyelectrolyte and other coagulant aids. The clarified water will then be stored in RCC reservoir of capacity to cater to one day clarified water requirement for the plant

This pre-treated water will be pumped to the site through 3.5 km long intake water pipeline. The water will be stored onsite in a twin chamber raw water reservoir of capacity which will have a storage provision to cater to 1 day raw water requirement for the proposed project in order to address any emergency situation viz. intake water system shutdown during periodic operational maintenance, pipeline leakage etc. The water requirement for the proposed project is estimated to be about 2140 m3/hr and will be primarily used to serve for boiler feed, cooling of condenser and auxiliary equipment and also to cater to the potable and service system water requirements.

It is estimated that 150 m^3/ hr sludge will be generated from the pre-treatment facility. The sludge will be regularly disposed in the ash pond.

Treated Water Usage
Cooling Tower Makeup Water: Major portion (1313 m^3/hr) of the clarified water will be utilized as makeup water in closed recirculating cooling water system using mechanical induced draft cooling towers. The makeup water to the cooling system will be supplied through makeup pumps. The estimated about 248 m^3/hr of blow down water will be generated. Closed Cooling Water (CCW) System and Induced Draft Cooling Tower (IDCT) has been proposed for the expansion unit.

Service System: Some portion (20 m^3/hr) of the clarified water will cater to the service system requirements viz. sealing and cooling for ash handling plant, quenching water for mill reject system, makeup for air conditioning plant, use in ventilation system, washing, cleaning and other housekeeping needs of coal handling plant etc. The service water pumps of adequate capacity will be installed and operated to meet the water requirement of proposed expansion unit service systems.

Potable Use: Clarified water for potable use onsite will be subjected to further treatment in filtration plant followed by their storage in filtered water reservoir. The filtered water will then be chlorinated and supplied for potable usage in residential township and plant site through potable water supply pumps of desired capacity.

Demineralization (DM) Plant: The water to be utilized in heat cycle make up, chemical feed and as a primary coolant in heat exchangers for the auxiliary cooling system in boilers, turbine generators and other common auxiliaries is required to be of the highest quality and hence will be subjected to phased treatment in DM Plant. Approximately 55 m^3/hr of water supplied to DM plant about 48 m^3/hr will be required to meet the aforesaid demand while the rest (7 m^3/hr) will be disposed as DM plant regeneration waste.

Water from filtered water reservoir will be fed into the DM Plant for demineralization through a number of unit treatment processes. In the DM Plant, water will be first passed through dual media filters and activated carbon filter (ACF) units to remove suspended and coarse colloidal particles and also protect the subsequent resin exchangers from chlorine and organic matter. Filtered water will be subsequently passed through strong acid cation exchanger (SAC) to remove major electrolytic cations (Ca2+, Mg2+, Na+ etc) followed by its passage through degassifiers to remove carbonic acid. The water will then be passed through strongly basic anion exchangers (SBA) to remove electrolytic anions (SO4-, Cl- etc.) resulting in water free from any dissolved content. In order to ensure complete removal of dissolved ions, the water will be finally passed through mix bed exchanger (MB) containing both cation and anion resins. The water so demineralized will be stored in DM water storage tanks and then transferred to unit condensate storage tanks by DM transfer pumps.

Acid and alkali handling, storage and feeding system will be installed for the DM Plant resin regeneration with the regeneration waste being disposed in guard pond following acid/alkali neutralization.

Operation of Steam Generator & Auxiliaries

The steam generator for the proposed project will be semi-outdoor, natural circulation, pulverized coal fired, balanced draft, single drum, dry bottom type with two pass configuration. The coal of size of (-) 20mmm will be pulverized in ring and roller bowl mill type pulverizers, mixed with pre-heated air and fed into boiler through a series of burners with the help of Primary Air (PA) Fans. The air for combustion will be drawn from the atmosphere by Force Draft (FD) fans and preheated using air heaters. The FD and ID fans will help to maintain a correct air-fuel ratio for stable and efficient combustion in the boiler/steam generating unit. The firing system will employ low NOx burners and will be utilizing LDO as an auxiliary fuel for boiler start up and flame stabilization.

The water will be supplied in the steam generating unit by feed water system comprising of three (3) nos. 50% capacity boiler feed pumps (2 operational and 1 standby). The boiler feed pump serves to raise the pressure of the feed water sufficiently for water to flow through the High Pressure Heaters (HPH) and feed regulating valve into the boiler. HPH serves to preheat the feed water utilizing the steam from High Pressure (HP) and Intermediate Pressure (IP) turbines with the feed water regulator valve to maintain the optimum level of water in the boiler drum. From the boiler drum the preheated feed water is distributed into tubes forming the walls of the boiler furnace. The water in the boiler walls is converted into steam by the heat generated during fuel combustion and is further heated (superheated steam) while passage through a heat exchanger before being led into turbines.

The Unit No. 10 will adopt steam cycle (SC) steam parameters to achieve higher efficiency and hence lower cost of generation. The steam cycle parameter is given in Table 2.9.

Table 2.9 Steam Cycle parameters

Sl. No,	Parameter	Value
1.	Main Steam Pressure	245 bar (a)
2.	Main Steam Temperature	593 °C
3.	Main Steam Flow Rate	1860 TPH
4.	Reheat Steam Pressure	48.9 bar (a)
5.	Reheat Steam Temperature	593 °C
6.	Reheat Steam Flow Rate	1540 TPH
7.	Feed water Temperature	295 °C

[Source: Prefeasibility Report]

The hot gases generated from fuel combustion will be drawn from the furnace through the boiler and air heater by ID fans and discharged through a 275 m single flue stack to be erected as part of the proposed project. BSPGCL will take clearance from Airport Authority of India (AAI) for construction of stack.

Effective removal of particulate matter generated from the combustion of pulverized coal will be achieved by installation of Electrostatic Precipitators (ESPs) between air heater and ID fans. With respect to the proposed project steam generating unit will be provided with ESP. The ESP will be designed to operate at maximum operational efficiency (about 99.89%) to achieve flue gas particulate matter concentration of ≤ 30mg/Nm^3.

Operation of Steam Turbine & Auxiliaries

The steam turbine would be standard multi-stage, multi-cylinder, tandem compound, single reheat, condensing type machine operating at 3000 rpm with nine (9) uncontrolled extractions for regenerative feed heating. The turbine will be designed for superheated inlet steam at 255 bar (a) pressure and 596 °C.

The superheated steam flowing from the boiler to the High Pressure Turbine (HPT) is adiabatically expanded while its passage through the nozzles and the rotating turbine blades and the enthalpy of steam is converted to mechanical energy. The steam then leaves the HPT to a heat exchanger known as "reheater" located in the boiler flue gas path where its temperature is increased. The "hot reheat steam" then flows to the Intermediate Pressure Turbine (IPT) and finally to Low Pressure Turbine (LPT) expanding on its way to the condenser.

Condenser Operation

The exhaust steam released from the LPT will get condensed in divided flow, double pass, horizontal, surface type, clarified water cooled condenser by circulation of cooling water (inlet temperature 33° C max) in a re-circulating cooling water system. Clarified water will be used as a cooling medium in the condenser and other auxiliary cooler with temperature of condensate being maintained at 42.4° C. The condenser will be provided with 2x100% capacity (1 operational and 1 stand by) vacuum pumps to remove non-condensable gases and maintain vacuum to ensure maximum expansion of the LPT exhaust steam in condenser.

The condensate generated will be removed by motor driven, vertical condensate extraction pumps of 2x100% capacity and supplied to "Deaerators" via three stage horizontal U-tube type LP feed heaters. The LP feed heaters and deaerator utilizes the steam from IP and LP turbines to preheat the condensate for storage in boiler feed water storage tank. The boiler feed pump draws water from the water storage tank for supply to boiler for steam generation.

Power Evacuation

The electrical power generated is being planned to be transmitted to major load center at Patna, being large-scale consumption region of Bihar State. From the result of power system analysis, Gaighat (new) substation is chosen as connection point, same being most cost effective out of all substations meeting the above requirements. Gaighat (new) substation will be located at Bakhtiyarpur is in southern side of the Ganga River, whereas BTPS is in northern side of the Ganga River. Accordingly, transmission line from BTPS connecting to Gaighat (new) substation will be crossing the Ganga River. It is at a direct distance of about 50 kms from BTPS. However, transmission line length is assumed to be approximately 60-80 kms from BTPS.

Ash Handling & Disposal System

The ash handling and disposal system for the proposed project is designed for handling and disposal of bottom ash (BA) and fly ash (FA) generated during the combustion of pulverized coal. Depending on the plant load factor (PLF) and quality of coal to be used (44.60% ash content) it is estimated that nearly about 196 tons/hr (maximum) of ash would be generated from expansion unit. The ash handling system for the proposed project is designed for a fly ash to bottom ash ratio of 9:1 i.e. about 176 tons/hr of fly ash and 20 tons/hr of bottom ash is required to be removed from expansion unit.

Bottom Ash Handling & Disposal

The bottom ash from the furnace characterized as coarser and heavier gets collected in the bottom ash hoppers provided with feed gate, feed hoppers and clinker grinders and having an effective BA storage capacity of 5 hrs generation. The bottom ash clinker will be ground in clinker hoppers and transported by jet pumps to slurry pump in the form of high concentrated ash slurry. The ash slurry is finally disposed to ash pond through a 2.5km long ash slurry pipeline by High Concentrated Slurry Disposal (HCSD) system. The design capacity of this system will be adequate to remove bottom ash within 1.25 hrs of operation per shift. The makeup water (400 m^3/hr) required for ash water sump will be sourced from cooling tower blow down and ash pond supernatant (through ash water recovery system) thereby maximizing water reuse and conservation.

Fly Ash Handling & Disposal

Extraction: The Fly Ash (FA) handling system will consist of two (2) stage conveying. First stage will be vacuum conveying system from the respective FA Hoppers to the Buffer Hoppers. And, the second stage conveying will be dense phase pressurized pneumatic conveying system from the Buffer Hoppers to dry FA silo.

Dry Fly Ash transportation (From Buffer Hopper to HCSD Silo or Main Dry Fly Ash Silo): Six (6) nos. pressure conveying pipe lines for the unit will be provided. Out of six (6) pipe lines, three (3) lines will be working and the three (3) lines will act as standby, to continuously transport the dry fly ash (both coarse and fine) from Buffer Hoppers either to Main Dry FA silo or HCSD silos.

Transport of dry FA from the unit Buffer Hoppers to the Main dry FA silo (1 x 1,500 tonnes) located near plant boundary, alternatively to the Alternate dry FA silos (2 x 2,200 tonnes) located at railway siding facility nearby TH complex on separate railway track will be with the help of five (5) nos. (3W + 2S) Transport Air Compressors (TAC) suitably sized and designed to cater to the ash evacuation requirements of the unit.

The same set of TAC will also be used for transport of dry FA from the unit Buffer Hoppers to the HCSD silos.

Dry Fly Ash Storage System: For dry FA storage and road transportation, one (1) no. main storage silo is envisaged. It will have the minimum effective capacity of 1,500 tonnes. For Alternate dry FA silo railway cum road transportation, two (2) nos. ash storage silos are envisaged. It will have capacity of 2,200 tonnes, each.

HCSD System: In the event that dry FA cannot be disposed-off through closed tankers, as a back-up HCSD system has been provided considering low water consumption and less land requirement for ash pond. With HCSD system the residual life of ash pond will also increase due to increase in slurry density.

Two (2) nos. of HCSD silos will be provided. Two (2) nos. of HCSD streams have been considered, out of which one (1) no. will be operating for the unit and another will always be available as standby.

Pollution Prevention Mechanism: The dry FA silo will be fitted with bag filters and fans for cleaning the vent air before discharging into the atmosphere. The dry FA silo will be provided with a dedicated aeration system

Effluent and Waste Treatment System

The major effluent generated from the proposed project will primarily comprise of:

- Cooling tower blow down
- Boiler blow down
- DM Plant Regeneration Waste
- Clari-flocculation sludge
- Filtration unit backwash
- Oil water effluent
- Coal Handling Plant Surface Run-off
- Ash Pond Supernatant
- Domestic Waste Water viz. Sewage
- Cooling Tower & Boiler Blowdown

Cooling tower blow down

Considering that a cooling water cycle of concentration (COC) will be maintained at five to maximize water reuse, cooling tower blow down will be generated at the rate of 248 m3/hr. Major portion of the blow down will be either reused/recycled for varied purposes viz. dust extraction/dust suppression at coal handling plant, preparation of bottom ash slurry for ash pond disposal and fire fighting activities. The remaining of the blow down water will be discharged into guard pond installed to serve as an equalization unit for all treated/untreated effluents. The guard pond will be located suitably in the low lying area onsite and will be designed to store 24hrs project effluent discharge.

Boiler blow down

Similar to cooling tower blow down, boiler blow down (5 m^3/hr) generated from process operation will be directed into the guard pond through boiler blow down drain pit to be reused for onsite dust suppression and green belt development.

DM Plant Regeneration Waste
Acidic and alkaline waste water generated following regeneration of DM plant ion exchangers will be led through acid/alkali resistant tile lined trenches and collected in neutralization pit. Drain and overflow of DM water storage tank, chemical tanks etc and floor washings of the water treatment facility will also be drained through such trenches to the neutralization pit. After necessary pH correction at the neutralization pit the effluent will be pumped to the guard pond for storage and reuse accordingly. The volume of DM regeneration waste generated is estimated to be about 7m^3/hr.

Clariflocculator sludge
The sludge generated at 70 m^3/hr from pre-treatment plant will be treated using a sludge thickener system. From the thickener the sludge will be transferred to a thickened sludge collection pit while the supernatant being collected in a storage sump. The sludge will be treated in a centrifuge and disposed as solid cake in the ash pond. The supernatant together with water generated from sludge treatment in the centrifuge will be pumped back to the raw water pre-treatment plant supply line using transfer pumps thereby maximizing water reuse.

Filtration Backwash
Nearly about 53m^3/hr of waste water is likely to generated from backwash from filtration units of DM plant, potable water treatment plant and side stream filtration (SSF) system. The SSF reject will be transferred to the bottom ash slurry pump and will be subsequently reused in the preparation of ash slurry for High Concentrated Slurry Disposal (HCSD). The backwash from DM and potable treatment plant will be collected in designated waste pits and pumped back to the raw water pre-treatment unit supply line.

Oily water effluent
Effluent generated from fuel oil storage area, BTG building and transformer yard will be initially collected in an oily waste retention pit. The collected effluent will be screened through an oil water separator (corrugated plate interceptor) for removal of oil. The treated will be collected in a retention pit and will be subsequently reused as make-up water for the ash water sump. The sludge from the retention pit will disposed at the ash pond through bottom ash slurry pump.

Coal Handling Plant Surface Run-off
Run-off from coal pile area and coal handling plant will be channelled through storm water drains to a settling unit for suspended solids removal and its subsequent discharge into storm water drainage system. However generation of surface run-off is of intermittent nature and is likely to occur only during monsoon.

Ash Pond Supernatant
About 298 m^3/hr of ash pond supernatant will be recovered from the bottom ash pond by a recovery system and treated in a clarifier. The sludge generated from the clarifier will be recycled back to the bottom ash pond for disposal while the treated water will be supplied to the ash water sump to serve as a make-up water for high concentrated slurry disposal of bottom ash and unused fly ash.

Domestic Waste Water
Sewage generated from sanitation facilities onsite will be treated in a sewage treatment plant (STP) with the treated water being reused for dust suppression and green belt development onsite.

Fire Protection System

The fire detection, protection & Alarm system will be designed in line with the requirements of Tariff Advisory Committee of India / IS-3034 / NFPA. The following fire detection and protection systems are proposed.

- Hydrant system for the extension unit including all the auxiliaries and buildings in the plant area. The system will be complete with piping, hydrants, valves, instrumentation, hoses, nozzles, hose boxes / stations etc.
- Automatic high velocity water spray system for all transformers located in transformer yard and those of rating 10 MVA and above located within the boundary limits of plant, main and unit turbine oil tanks and purifier, lube oil piping (zoned) in turbine area, generator seal oil system, lube oil system for turbine driven boiler feed pumps, consisting of detectors, deluge valves, projectors, valves, piping, instrumentation etc.
- Automatic medium velocity water spray system for cable vaults and cable galleries of main plant, switchyard control room, CHP control room and ESP control room consisting of smoke detectors, linear heat sensing cable detectors, deluge valves, isolation valves, piping, instrumentation, etc.
- Automatic medium velocity water spray system for conveyors, galleries, transfer points and crusher house consisting of Quartzoid Bulb (QB) detectors, linear heat sensing cables, deluge valves, nozzles, piping, instrumentation, etc.
- Automatic medium velocity water spray system for un-insulated fuel oil tanks storing fuel oil having flash point 65oC and below consisting of QB detectors, deluge valves, nozzles, piping, instrumentation, etc.
- Foam injection system for fuel oil storage tanks consisting of foam concentrate tanks, foam pumps, in-line inductors, valves, piping & instrumentation etc.
- For protection of control room, equipment room, computer room and other electrical and electronic equipment rooms, suitable clean agent system such as "lnergen" or "Argonite" system would be adopted.

- Fire detection & Alarm system - A computerized, intelligent addressable type early warning system as per NFPA standards will be provided to cover the complete power plant with compatible detection systems
- Portable and mobile extinguishers, such as pressurized water type, carbon-dioxide type, foam type, dry chemical powder type, will be located at strategic locations throughout the plant.
- Required fire tenders / engines of water type, DCP / foam type, trailer pump with fire jeep etc. will be provided in the fire station.

The clarified water will be used for supply of firewater. Clarified water cum fire water pump house will be constructed to house horizontal firewater pumps in the pump house for hydrant and spray system and the same will be driven by electric motor and diesel engines as per TAC guidelines.

The water for foam system will be tapped off from the hydrant system pumps. For the above firewater pumping station, automatic pressurization system consisting of jockey pumps will be provided. All necessary instrumentation & controls for the entire fire detection, alarm and protection system will be provided for safe operation of the system

Compressor System

For instrument air requirement of main plant and auxiliaries, air compressors of adequate capacity with air drying plants of same capacity will be provided. Suitably sized & configured Instrument air compressors along with its control system will be provided.

These compressors will be oil-free screw or reciprocating type provided with all accessories such as suction filters, inter-coolers, after coolers etc. The air-drying plants will be capable of achieving a dew point of (-) 40 °C at atmospheric pressure. Individual air receiver will be provided near air compressor for the instrument air requirement of the plant in case of trip of air compressors.

Separate plant service air compressor will be provided to meet plant / service air requirements of the proposed unit. These air compressors will be of the same type and make as the instrument air compressors

2.6 PROJECT FACILITIES

The project facilities to be provided by the BTPS as part of the proposed project (including future expansion) comprises of the following:

- Residential Township
- Employee Facilities

2.6.1 *Residential Township*

The existing residential colony will be redeveloped and modernised for the existing and proposed expansion units. It is estimated that a total about 500 employees would be initially working for operation, maintenance and administration of the proposed TPP. This excludes security and canteen staff, as these functions would be contracted out. Since the area is basically semi-urban, a satisfaction level of about 80% is considered for planning the residential accommodation of the units. The rest of the employees are expected to come from the neighbouring villages/town.

Besides the above, barrack would also accommodate security staff. The township will have an erector's hostel, which will be, ultimately converted to Trainee Hostel, besides; Guest House will be built for outsiders visiting the station.

2.6.2 *Employee Facilities*

The employee facilities will be developed so that it can meet the requirements of the existing and proposed facility. Apart from the main power plant building housing the power generating equipment and other buildings required for running and maintaining the station, the following facilities are required to be provided inside the power station premises for operation, maintenance and administration.

- Administrative Office
- Office for Technical and non-Technical staff
- Canteen
- First Aid Centre
- Car Park and Motor Cycle sheds
- Gate House Complex including Safety and Fire Office.

2.7 *POLLUTANT SOURCES & CHARACTERIZATION*

2.7.1 *Air Emission*

Construction Phase

Air emissions from point sources during construction phase will be mainly from combustion of diesel in the diesel generators which will be operated to meet emergency power requirement of the contractor labour camp, project office and equipment operation. The DG set exhaust emission is generally characterized by air pollutants viz. NOx, SOx, PM and CO generated from combustion of fuel. However during this phase the main air emissions will be in the form of fugitive dust generated from material and debris stockpiles, sourcing and transportation of raw materials, loading and unloading activities, batching plant operation. Such fugitive emissions are primarily characterized by particulate matter.

Operation Phase

Flue gas emissions from combustion is the major air pollutant source (point source) during the operation of the proposed coal based thermal power plant. The flue gas generated from the combustion of feed coal is primarily characterized by air pollutants viz. NOx, SOx, PM, CO, CO_2 and trace heavy metals (Hg, As, Cd etc) with some un-burnt hydrocarbons and other volatile organic compounds (VOCs) also likely to be emitted in small quantities. The presence of trace heavy metals in the flue gas is generally governed by the chemical quality of feed coal. The predicted emission from the Unit 10 is shown in Table 2.10.

Table 2.10 Predicted Emission from Unit No. 10

Pollutant	Predicted Values for 1 x 660 MW, Unit No. 10	
	Design Coal (mg/Nm^3)	Worst Coal (mg/Nm^3)
SO_2	605	625
NOx	500	485
PM	50	50

[Source: Source: Prefeasibility Report]

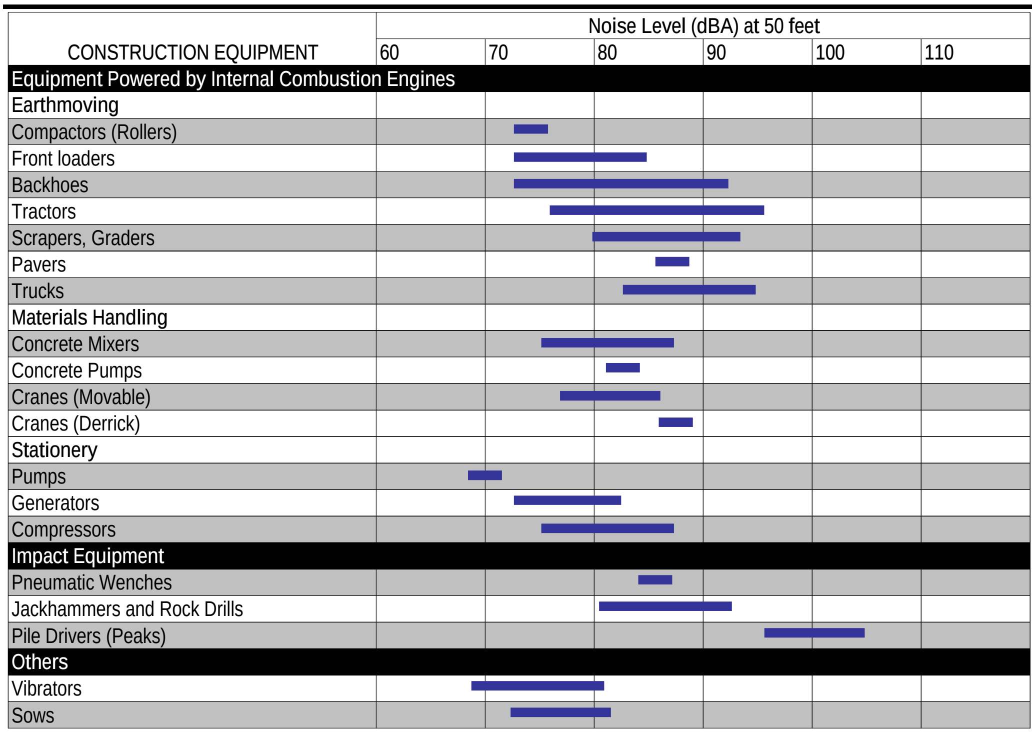
Generation of fugitive dust during operational phase will be contributed primarily from the operation coal unloading facility, coal handling plant, coal crushing & pulverising land. Fugitive emissions in the form of fly ash is also likely to occur during collection of fly ash from pre-heaters and ESP hoppers, pneumatic transportation of fly ash to silos and loading of fly ash into storage tankers. Handling of unused fly ash for preparation of ash slurry for disposal in ash pond may also lead to some fugitive emissions.

2.7.2 *Noise Emission*

Construction Phase

Operation of heavy construction equipment & machineries and vehicular movement has been identified as the principal contributor of increased noise levels during site preparation of main plant and ash pond area. Average noise emission ranges for different types of construction machineries have been provided in **Figure 2.10** below. There are no Indian Standards for noise emission limits for such operations and these values may be used as guidance for regulating noise emissions during this phase. Although the aforesaid activities are short term in nature and subjected to intermittent operation of noise generating equipment the noise emission assumes significance as the Indian standards for ambient noise levels are quite stringent.

Figure 2.10 Typical Noise Emissions from Construction Machinery



Source: USEPA[1]

Operation Phase

Principal contributor of noise during operation of proposed power plant includes coal unloading and crusher, compressors, boiler feed pump, boiler, turbine, ID fan, FD fan, DM Plant and cooling tower. Noise levels for major equipment of the plant along with configuration, building name and wall details, proposed in this project have been presented in Figure 2.11.

[1] U.S. Environmental Protection Agency, "Noise from Construction Equipment and Operations, Building Equipment and Operations, Building Equipment and Home Appliances" NTID3000.I, December 31, 1971

Figure 2.11 Noise Levels for Major Equipment

SL. NO.	DESCRIPTION	CONFIGURATION	NOISE LEVEL, DBA	BUILDING NAME	WALL DETAILS	
					THICKNESS, MM	MATERIAL
Steam Generator & Auxiliaries						
A1.1	Coal Purlverisers / Mills	8 x 17%	< 90	Boiler	-	-
A1.2	Induced Draft Fans	2 x 50%	< 85	Boiler	-	-
A1.3	Primary Darft Fans	2 x 50%	< 85	Boiler	-	-
A1.4	Primary Air Fans	2 x 50%	< 85	Boiler	-	-
A1.5	Mill Reject Compressor	2 x 100%	< 85	Boiler	230	Brick / Concrete Block Wall
A1.6	Air Pre-Heaters	2 x 50%	< 85	Boiler	-	-
A1.7	FGD System	Optional	< 85	Outdoor	-	-
A1.8	ESP	2 x 50%	< 85	Boiler	-	-
A1.9	ESP Control Room	Included	< 55	Boiler	230	Brick / Concrete Block Wall
A1.10	Chimney	1 x 100%	N/A	Outdoor	-	RCC
Steam Turbine Generator & Auxiliaries						
A2.1	Condensate Polishing Unit	3 x 33%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.2	Condenser	2 x 50%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.3	Condensate Extraction Pump	3 x 50%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.4	Vacuum Pump (Per Cell)	2 x 100%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.5	Motor Driven Boiler Feed pump	1 x 30%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.6	Turbine Driven Boiler Feed pump	2 x 50%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.7	Steam Turbine & Generator	1HP + 1IP + 2LP	< 90	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.8	HP/LP Bypass Valves	2 x 60% TMCR	< 105	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.9	ACW Pumps	2 x 100%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.10	CCW Pumps	3 x 50%	< 85	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.11	Generator	1 x 100%	< 90	Power House	230 / 345	Brick Wall / Sheet Cladding
A2.12	Generator Transformer	4 x 33%	< 85	Outdoor	-	-
A2.13	ICT 400/220 kV	Included	< 85	Outdoor	-	-
Balance of Plant						
A3.1	Circulating Water (CW) Pumps	3 x 50%	< 85	CW Bld.	230	Brick Wall / Sheet Cladding
A3.2	CT Fans	2 x 50%	< 85	Outdoor	-	RCC
A3.3	Raw Water Transfer Pumps	2 x 100%	< 85	Pump House	230	Brick Wall / Sheet Cladding
A3.4	Ash Water Make-up pumps	2 x 100%	< 85	Pump House	230	Brick Wall / Sheet Cladding
A3.5	Paddle Feeder	4 x 50%	< 85	Track Hopper	-	-
A3.6	Crusher	2 x 100%	< 85	Crusher House	230	Brick Wall / Sheet Cladding
A3.7	Coal Silo (7 Nos.)	7 x 14%	-	Outdoor	-	RCC
A3.8	HCSD Silo (2 nos.)	2 x 50%	-	Outdoor	-	RCC
A3.9	HCSD Pump House (Incl. Electrical Room)	2 x 50%	< 90	Pump House	230	Brick Wall / Sheet Cladding
A3.10	Dry Ash Silo (1 no.)	1 x 100%	< 85	Outdoor	-	RCC
A3.11	Transport Air Compressor	5 x 33%	< 85	Utility Bld.	230	Brick Wall / Sheet Cladding
A3.12	Instrument Air Compressor	2 x 100%	< 85	Compressor Bld.	230	Brick / Concrete Block Wall
A3.13	Service Air Compressor	2 x 100%	< 85	Compressor Bld.	230	Brick / Concrete Block Wall
A3.14	Hydrogen Generation Plant	Included	< 85	H2 Genration Bld.	230 / 345	Brick Wall
A3.15	EDG Building	1 x 100%	< 85	EDG Bld.	-	Brick / Concrete Block Wall
A3.16	GIS Switchyard	1 x 100%	< 85	GIS Bld.	230	Brick Wall

Source: KEPCO

The noise generated from a power plant therefore assumes significance taking into account the occupational health related problems likely to be experienced by personnel continuously operating in such high noise generating areas. With respect to the proposed project all noise related occupational health impacts will be addressed through specific provisions of *Factories Act, OSHA standards and IFC EHS Guidelines for Thermal Power Plants*.

2.7.3 Process Wastewater

The major effluent streams to be generated from the operation of the proposed power plant project comprises of cooling tower blow down, boiler blow down, DM Plant regeneration waste, filtration backwash, oily water effluent and coal handling run-off. The function of the Effluent Treatment Plant (ETP) is to collect and treat effluent generated by various equipment of power plant to comply with applicable environmental regulations and / or CPCB. The treatment consists of removing the oil, neutralization and removal of total suspended solids (TSS) from the effluents generated at different locations in the proposed extension unit before treatment, reuse and further disposal. The treated effluents will be reused for various applications within the plant premises in order to achieve the 'Zero Liquid Discharge (ZLD)' and also to minimize the fresh makeup water requirement. In addition to the aforesaid waste water streams generated from the main plant unit, effluent in the form of leachate will be generated from the ash pond area. As the coal ash is likely to contain trace heavy metals such as Hg, Cd, Sb, As, Cr, B, Ba, Cu, etc. hence the leachate migration from ash pond to the sub-surface aquifer may lead to ground water contamination. All waste effluent generated from the proposed project will conform to the CPCB Thermal Power Plant – Standard for Liquid Effluents and Effluent Guidelines – IFC EHS Guidelines for Thermal Power Plant.

2.7.4 Domestic Wastewater

Construction Phase

Domestic waste water will be generated during construction phase from operation of labour colonies. The domestic waste water generated from the labor camps will be treated using a combination of septic tank and soak pit.

Operational Phase

Considering a residential township of 500 personnel it is estimated that about 56KLD of waste water will be generated during operational phase, which will be treated in a sewage treatment plant (STP). The treated waste water will be reused for onsite landscaping and peripheral green belt development.

2.7.5 *Solid Waste & Hazardous Waste*

Construction Phase

Construction Waste
As there are no permanent structures on the proposed site, therefore, no demolition waste will be generated during the construction activities. The waste generation from the project site during the construction phase such as construction debris (concrete and masonry material) would be re-used as land filling material or may be used in construction of the internal roads. The unused cement slurry would be reused by the contractors for paving of the roads during construction. Metal scrap, plastics, glass etc. will be sold to recyclers. The proper segregation of wastes on site will increase the feasibility of recycling elements of the waste stream by off site contractors.

Domestic Solid Waste
During the construction phase, about 2000 workers will be staying in the temporary labour colony for 52 months. The estimated waste generation from the labour colony will be 700 kg/day (@ 350 gm/per capita/per day).

Municipal solid waste (generated from temporary labour colony during construction phase will be properly collected and will be subsequently dumped in the Barauni Solid Waste Dumping site based on a tipping fee arrangement.

Operational Phase

The major source of solid and hazardous waste streams is from coal combustion and raw water pre-treatment for cooling and DM water required for steam generation. A brief of the various waste generating sources and their characteristics are discussed below:

Bottom ash and fly ash:
Depending on the PLF and ash content of the feed coal it is estimated that about 196 tons/hr of ash will be generated (fly ash-176 tons/hr and bottom ash - 20 tons/hr) from coal combustion. The bottom ash will be mixed with water to form ash slurry and disposed in ash pond through HCSD. The fly ash will be collected from hopper and pneumatically conveyed to silos for storage and subsequent reuse. The fly ash generated from combustion of Indian coal mainly comprises of silicates, aluminates, alkalies including some toxic heavy metals in detectable quantities and hence needs to be properly disposed and/or reused. The details with respect to ash handling and disposal have been discussed in *section 2.5.9* of "Ash Handling & Disposal System".

Clarifloculator Sludge:
The sludge will be generated from raw water pre-treatment through chemical dosing. The details with respect to its treatment and disposal have been discussed in *section 3.6.9* of "Effluent & Waste Treatment System".

STP Sludge:
About 80 kg/hr of sludge will be generated from STP commissioned during operational phase. The sludge is planned to be used for landscaping and green belt development.

Hydrocarbon Wastes:
Waste oils from oil changes or leakage from equipment or diesel storage tanks. Used oil (from engine oil changes) is designated as hazardous.

Non-hazardous solid waste:
Non-hazardous wastes like paper, wood, plastics, containers (plastic or metallic used for substances other than chemicals) etc.

Miscellaneous Hazardous wastes:
Off specification hazardous materials, used containers (storing hazmat), used batteries, used air/fuel filters, bottom sludge from storage vessels etc.

Biodegradable waste:
The food waste generated from labour colonies during construction phase and from residential township and project office during operational phase.

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1 INTRODUCTION

Over the years, the Government of India has framed several policies and promulgated a number of Acts, Rules and Notifications aimed at management and protection of the environment. As a result, India now has a fairly comprehensive set of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run.

Moreover, the Indian Constitution has also incorporated specific articles to address environmental concerns through the 42nd Constitutional Amendment of 1976. As stated in the Constitution of India, it is the duty of the state (Article 48 A) to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It also imposes a duty on every citizen (Article 51 A) 'to protect and improve the natural environment including forests, lakes, rivers and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights.

To address the environmental and social risks from proposed expansion unit to protect and conserve the environment from any adverse impacts, the Government of India (GoI) has specified policy, regulations, and guidelines.

This section focuses on India national and local, legal and administrative framework under the purview of which the ESIA study will be governed.

3.2 ENVIRONMENT RELATED POLICIES IN INDIA

A series of environment policy statements have been announced in the last few decades as a part of the Governments' approach to integrate environmental and developmental aspects of planning. The policies reflect a gradual shift in emphasis from pollution abatement and control to proactive and voluntary approaches for pollution prevention, in keeping with global paradigm shifts and trends in environment management.

Following are some of the key policies that have been laid down by the Central Government:

3.2.1 National Environment Policy

The need for a comprehensive policy statement had been evidenced for some time in order to infuse a common approach to the various sectoral and cross-sectoral, approaches to environmental management. As a result, a National Environment Policy (NEP, 2006) has been drawn up as a response to India's national commitment to a clean environment, mandated in the Constitution in

Articles 48 A and 51 A (g), and strengthened by judicial interpretation of Article 21.

3.2.2 *National Forest Policy 1998*

One of the basic objectives of the forest policy is to safeguard forest land or land with tree cover for providing sustained benefits to the entire community. The policy does allow diversion of forest land for any non forest purpose but subject to the most careful examinations by specialists from the standpoint of social and environmental costs and benefits. Projects which involve such diversion should at least provide in their investment budget, funds for regeneration/compensatory afforestation.

The proposed expansion project does not involve any forest land; therefore, funds for regeneration/compensatory afforestation is not applicable for this project.

3.2.3 *National Conservation Strategy and Policy Statement on Environment and Development, 1992*

One of the basic objectives of the National Conservation Strategy and Policy Statement on Environment and Development is environmental considerations for integrated industrial growth. The action points in this regard include a mix of promotional and regulatory steps.

3.2.4 *Policy Statement on Abatement of Pollution, 1992*

The policy elements seek to shift emphasis from defining objectives for each problem area towards actual implementation, but the focus is on the long term, because pollution particularly affects the poor. To achieve the objectives maximum use will be made of a mix of instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, educational programs and information campaigns.

3.2.5 *National Water Policy, 2002*

In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community need to be taken into account for water resources development and management.

BSPGCL has to plan water conservation measures to optimise the water uses.

3.2.6 *National Rehabilitation Policy, 2006*

The provisions of NRP 2006 provide the basic minimum that all projects leading to involuntary displacement must address. State governments and

Central public sector undertakings/agencies are free to put in place greater benefit levels than those prescribed in NRP 2006. The principles of this policy may apply to the rehabilitation of persons displaced due to any reason.

BSPGCL has proposed to construct a new ash pond, R&R issues need to assess and follow the R&R related regulations.

3.2.7 National Climate Change Policy, 2008

India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "national missions".

Emphasizing the overriding priority of maintaining high economic growth rates to raise living standards, the plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively.

BSPGCL shall consider to reduce the greenhouse gas emission from the proposed expansion unit.

3.3 NATIONAL LEGAL PROVISIONS

The proposed project will be governed by various Acts, Rules and regulations set by Ministry of Environment and Forests (MoEF) at the Central level and other regulatory agencies at the State and local level. Various environmental standards, specifications and guidelines of Central Pollution Control Board (CPCB), Bihar State Pollution Control Board (BSPCB) and other State level agencies will also be applicable.

It is important to note here that the Central government framed 'umbrella legislation', called the Environment (Protection) Act (EPA), 1986 to broadly encompass and regulate an array of environmental issues. The Act does not allow any person to establish an industry, operation or process that discharge or emit any environmental pollutants in excess of standards prescribed under specific rules and notifications.

The Acts, Rules and Notifications applicable to environmental aspects of the construction and operational phases of the project are summarized and briefly described in the following sections.

3.3.1 Siting of Project: Areas to be Avoided Due to Environmental Consideration

The sections below describe the specific regulatory requirements for the project in accordance with the flow of the project lifecycle to assist in compliance to the legislation applicable for the proposed power plant.

The Environment (Siting for Industrial Projects) Rules, 1999

The Rules lay down detailed provisions relating to areas to be avoided for siting of industries, precautionary measures to be taken for site selecting as also the aspects of environmental protection which should have been incorporated during the implementation of the industrial development projects.

MoEF and CPCB Siting Guidelines

The siting of developmental projects in India is managed by Siting Guidelines for activities and projects delineated by the MoEF and the CPCB. The overall purpose of the guideline is to aid proponents in judiciously selecting project sites, keeping in mind various environmental sensitivities. In addition, the Environment Protection Rules (Rule 5) give power to the Central Government to restrict location of industries in certain areas based on environmental sensitivities like reserve forest, sanctuary, national park, Ramsar sites, etc. Additionally, state governments sometimes formulate state wide siting guidelines for development planning.

Considering the Siting Guidelines, the main plant site and coal stocking yard for the proposed project are not located in any environmentally sensitive area. The main plan is located adjacent to NH-31; considering this BSPGCL has planned to set up main plant away from 500 safety zone of NH. The proposed ash pond site is also selected 500 away from Ganga rive and also not located in the flood plain.

3.3.2 Forest Conservation and Wildlife Protection

Forest (Conservation) Act 1980 & Rules 1981 (as amended)

The Rules has a provision of use of forest land into non-forestry purpose. It also provide that all proposals involving forest land up to twenty hectares and proposals involving clearing of naturally grown trees in forest land or portion thereof for the purpose of using it for afforestation shall be sent to Chief Conservator of Forests and concerned Regional Office of the MoEF.

Proposed project has not involved any forest land for existing as well as proposed expansion unit; therefore, forest diversion is not applicable for this project.

The Wildlife (Protection) Act, 1972, Amendment 1991

The WPA (Wildlife Protection Act), 1972, provides for protection to listed species of flora and fauna and establishes a network of ecologically-important protected areas. There is a blanket ban on carrying out any industrial activity inside these protected areas. In case forest land within the protected areas network is to be diverted for any non-wildlife use, a no objection has to be

obtained from the Indian Board of Wildlife and the State Legislature, before the final consideration by MoEF.
The WLPA provides for protection of species listed in Schedules I, II, III and IV, regardless of its location, and the protection of all species in designated protected areas.

There is no protected area like National Park, Wildlife Sanctuary, Tiger Reserve, Bird Sanctuary within the 10 km study area. Therefore, Wildlife protection Act is not applicable for this project.

3.3.3 Pollution Control and Abatement

Environment (Protection) Act, 1986 (EPA)

This Act is an umbrella legislation designed to provide a framework for the co-ordination of central and state authorities established under the Water (Prevention and Control) Act, 1974 and Air (Prevention and Control) Act, 1981.

Control of Air Pollution

The Air (Prevention & Control of Pollution) Act, 1981 including Rules 1982 and 1983

The Act & Rules was enacted to prevent, control and reduce air and noise pollution. The Air Act lays down national ambient air quality standards for common pollutants with the intent of managing air quality for different category of areas (residential, industrial and sensitive). The EPR also specifies source emission standards determined on the basis of the impact of pollutants on human health, vegetation and property.

Emission due to combustion of coal is the main source of air pollution during operational phase of the proposed thermal power plant. The regulatory measures to control this pollution is described below:

Stack Height (EPA Notification (G.S.R. 742 (E), dt. 30th Aug, 1990)
For proper dispersion of SO_2 emissions from thermal power plants, stack height criteria have been adopted in the country. For larger capacities of boilers (500 MW and above), the stack height should be 275m (Table 3.1). For dispersion of the emissions BSPGCL will comply this regulatory norm. The stack height of the plant and other details is described in the project description chapter.

Table 3.1 Thermal Power Plants: Stack Height/Limits

Sl. No,	Generation Capacity	Sack Height (m)
1	500 MW and above	275
2	200 MW/210 MW and above to less than 500 MW	220

Sl. No,	Generation Capacity	Sack Height (m)
3	Less than 200 MW/210 MW	Less than 200 MW/210 MW H= 14 Q0.3 where Q is emission rate of SO2 in Kg/hr, and H is Stack height in meters

[Source: EPA Notification [G.S.R. 742(E), dt. 30th Aug; 1990]

Emission Standard for TPP

In order to control the emission from the thermal power plant following standard has been fixed for power plants under the national legal & regulatory provisions.

MoEF&CC amended the emission norms for coal-based thermal power plants on 7th December 2015. As per Environment (Protection) Amendment Rules, 2015 the emission standard for TPP plant to be installed from January 1, 2017 is given in **Table 3.3.**

Table 3.2 Emission Standard for Thermal Power Units

Sl. No.	Parameter	Standard
1	Particulate matter (PM)	30 mg/Nm^3
2	Sulphur di-oxide (SO2)	100 mg/Nm^3
3	Oxides of Nitrogen (NOx)	100 mg/Nm^3
4	Mercury (Hg)	0.03 mg/ Nm^3

[Source: S.O. 3305 (E), 7th Dec. 2015}

To control the air pollution from stack, BSPGCL will comply with the above mentioned regulatory norms. According to Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 BSPGCL will take Consent to Establish (CTE) from the BSPCB.

Flue Gas Desulphurization (FGD) Plant

The MoEF insists on making space provision for Flue Gas Desulphurization (FGD) Plant in the designs of thermal power units of 500 MW and above capacity and also at stations with capacity of 1500 to 2000 MW to facilitate their retrofitting at a later stage in case the need for such plant is established. In sensitive areas the installation of FGD may be insisted upon even for stations with smaller installation.

BSPGCL has planned to use the Indian coal from Jharkhand and Raniganj belt, and sulphur content in these coals is less than 0.5%. In order to meet emission standard, FGD is planned to be installed for the project.

Control of Noise Pollution

Noise Pollution (Regulation and Control) Rules 1989, Amendment 2000. With the objective of regulating ambient noise level in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, dated 26th December 1989 and amended in February 14, 2000 under the EPA. The Noise Rules lays down noise standards for different category of areas (residential, industrial, commercial and silence zone) (**Annex 3.1**). Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA, USA), which in turn are being enforced by Government of India through model rules framed under the Factories Act and Rules (**Annex 3.2**). The EPR lays down equipment specific noise emission standards for DG Sets and Construction Equipment, which would be in use during the construction stage.

DG Set Notification

The DG sets, machineries & vehicles to be utilized during the construction phase are the primary source of noise emission. To control the noise pollution, BSPGCL and Contractors employed for the project will follow the following regulatory measures. To the extent practicable, ensure that ambient noise levels in the surroundings do not deteriorate below Ambient Noise Standards as specified by the Noise Rules, 2000.

Specific standards for control of noise from DG sets and measures to be taken for reduction of noise by using acoustic treatment of rooms or exhaust muffler have also been specified through the Environment (Protection) Second Amendment Rules, 2002 notified through notification GSR 371 (E) on 17th May, 2002 (**Annex 3.3**).

Control of Water Pollution

The Water (Prevention & Control of Pollution), Act, 1974 including Rules, 1975 (as amended up to 1988)

The Water Act & Rules provides for the prevention and control of water pollution and maintaining or restoring good water quality for any establishment.

The Environment (Protection) Rules under the EPA lays down specific standards for quality of water effluents to be discharged into different type of water bodies (surface water bodies like lakes and rivers, marine discharge) which will be applicable for sewage and process water discharges from the plant site (**Annex 3.4**). According to the CPCB, there is also a classification system for the surface water bodies according to use-types specifying the desirable water quality parameters to be found in them (**Annex 3.5**).

As per DPR, BSPGCL has planned zero discharge from the proposed expansion unit. However, if any discharge occurred from the plant, BSPGCL will meet the discharge standard.

Effluent Discharge Standard from TPP

The process of power generation produces liquid effluents in form of condenser cooling water, boiler blow down, cooling tower blow down and ash pond effluent. The standards for liquid effluents from power stations have been prescribed in the EPA Notification dated 19th Nov. 1986 are given in **Annex 3.5**.

As discussed in the earlier section, BSPGCL has planned zero discharge from the proposed expansion unit. However, if any discharge occurred from the plant, BSPGCL will meet the discharge standard.

Temperature Limit for discharge of Condenser Cooling Water from Thermal Power plant

New thermal power plants commissioned after June 1, 1999, which will be using water from rivers/ lakes/ reservoirs, shall install cooling towers irrespective of location and capacity. The thermal power plants using sea water should adopt suitable system to reduce water temperature at the final discharge point so that the resultant rise in the temperature of receiving water does not exceed 7ºC over and above the ambient temperature of the receiving water bodies.

BSPGCL has planned to install cooling towers for the proposed expansion unit. Thermal discharge from the plant has not planned for this plant. Therefore, it is not applicable for this expansion unit.

3.3.4 Resource Utilization

Use of Beneficiated Coal

Ash Content Notification (January 02, 2014)

Vide Notification G.S.R. 02(E), dated January 02, 2014, Ministry of Environment & Forests has amended Rules in respect of use of washed/ blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis in Thermal Power Plants. As per the amended rules power located between 500- 750, 750-1000 shall be supplied with and shall use raw or blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis w.e.f January 01, 2016 & 2015 respectively while power located beyond 1000 kms from pit head shall be supplied with and use raw or blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis with immediate effect.

The proposed BTPS is standalone unit having capacity of 660 MW and TPP will operate with indigenous coal mine, however, presently has no coal linkage or captive coal mine. For 2x250 MW, the coal mine is located in Karanpura area of Jharkand, which is approximately 100 km. The power plant is not located in urban area, or ecologically sensitive area, or critically polluted area. As per feasibility report, BSPGCL is considering the mine located within 500 km. Therefore it is not applicable for the proposed expansion unit. However, if the mineloaction is falling under above mentioned category, BSPGCL shall consider to use of beneficiation coal.

Use of Surface Water

Water (Prevention and Control of Pollution) Cess Act, 1977

This Act provides for a levy and collection of a cess on water consumed by industries and local authorities. It aims at augmenting the resources of the central and state boards for prevention and control of water pollution. Following this Act, The Water (Prevention and Control of Pollution) Cess Rules were formulated in 1978 for defining standards and indications for the kind of and location of meters that every consumer of water is required to install.

BSPGCL has planned to source the industrial domestic use water for the existing and proposed units from River Ganga. As per Water Cess Act, BSPGCL will install the water meter and regularly submit the water cess to PCB.

Extraction of Groundwater

Of late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules (many of which are still in draft form) is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like ground water recharging. The Central Ground Water Board, the statutory authority set up by the Central government, has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

As discussed in the earlier section, BSPGCL has planned to source the industrial and domestic use water for the existing and proposed units from River Ganga. However, if they plan to abstract any ground water for proposed expansion unit BSPGCL will get a written approval from the State Groundwater Board / Regional Office of the Central Ground Water Board.

3.3.5 *Storage & Handling of Hazardous Materials*

There are several legislation that directly or indirectly deal with hazardous waste. The relevant legislation are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and issue is discussed in the section of the health and safety of the workers. Under the EPA 1986, the MoEF has issued several notifications to tackle the problem of hazardous waste management. These include:

Hazardous Wastes (Management and Handling) Rules, 1989

The Hazardous Waste Rules were introduced under Sections 6, 8, and 25 of the Environment (Protection) Act of 1986 (referred to as HWMH Rules 1989). The HWMH Rules, 1989 provide for the control of generation, collection, treatment, transport, import, storage and disposal of wastes listed in the schedules annexed to these rules. The HWMH Rules have been amended in 2000 and 2003, which widened the definition of hazardous waste.
With the recent amendment, these rules have become quite comprehensive. The rules define responsibility of hazardous wastes generators, require safe handling practices and maintenance of manifest system during transport of

hazardous waste and also describe technological aspects to be followed up by re-refiners and recyclers of hazardous wastes. The rules also cover liabilities of occupier, transporters and operator of a facility for any damage caused due to improper handling and disposal of hazardous wastes for reinstating or restoring environmental damages caused. The occupier of hazardous waste collection, storage, transportation and disposal requires prior permit called "authorization" under the rules.

The following kinds of hazardous waste may be generated during the construction of plant and operation of the proposed power plant:

- Spent oil and lubricants from construction equipments and DG sets.
- Paint residues during the painting of structures, camps, etc.

BSPGCL will be responsible for managing such wastes properly, by sending them to authorized recyclers (waste oil) or storing them in secure containers for disposal at a later stage. Under the rules the occupier of a unit requires prior authorization i.e. permission for collection transport, treatment, reception, storage and disposal of hazardous wastes, to be granted by the competent authority (Bihar State Pollution Control Board) as per Form 1 of the Rules.

The Petroleum Rules, 2000

The Petroleum Rules, 2000 also lays down safeguards and measures for storing of different classes of petroleum, which will be applicable to the onsite diesel storage to be located within the plant site. These rules also specify the type of container that should be used for storing various classes of Petroleum (including diesel).

The proposed project will be storing LDO during operation of the power plant. BSPGCL will follow the Rules and will take necessary precautionary measures.

Battery (Management and Handling) Rules, 2001

The responsibility of the consumer to ensure that used batteries are not disposed of in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler, reconditioner or at the designated collection centers.

The proposed project will use the batteries during the construction and operation of the power plant. BSPGCL will follow the Rules and will take necessary precautionary measures.

Fly Ash Utilization

The Coal fired thermal power stations produce enormous quantities of ash. The ash has traditionally been disposed off in the ash ponds which have the potential of polluting the surface and ground water unless adequate care is taken. In order to check the percolation of heavy metals to the ground water, ash pond lining is being provided wherever necessary. The fly ash, collected in the dry form, could be beneficially used for brick making, coal mines backfilling, road construction activities and cement manufacturing.

MoEF's notification dated 25th March 2015 in respect of Fly ash utilization and amended with a notification dated 3rd Nov 2009, stipulate the steps to be taken by coal/lignite based thermal power plants to ensure 100 % utilization of ash generated by it. The notifications also stipulate to use ash and ash products in construction activities of roads, buildings, flyover embankments etc. The notification in particular specifies the responsibilities of a thermal power plant with respect to management fly ash and is discussed below.

Fly Ash Notification 2015

All coal or lignite based thermal power stations would be free to sell fly ash to the user agencies subject to the following conditions:

i. Every coal or lignite based thermal power plants shall, (A, suitable date prospective to final notification is to be specified) upload the stock of each type of fly ash available with them on their website and, thereafter shall update the stock position for each type of fly ash at least once in every fortnight.
ii. A radius of hundred kilometres from a coal or lignite based thermal power plant, the coast of transportation of fly ash for building and road construction projects shall be borne by such coal or lignite based thermal power plant and the cost of transportation beyond a radius of hundred kilometres and up to five hundred kilometres shall be shared equally between the user construction agency engaged and the coal or lignite based thermal power plant.
iii. The coal or lignite based thermal power plants within a radius of five hundred kilometres shall bear the entire cost of transportation of fly ash to the site of road construction projects under Pradhan Mantri Gramin Sadak Yojna and asset creation programs of the Government involving construction of building, road, dams and embankments.

New coal and, or lignite based thermal power stations and, or expansion units commissioned after this notification have to achieve the target of fly ash utilization as per **Table 3.4.**

Table 3.3 Targets for Fly Ash utilization for TPS Commissioned after dated 3rd Nov. 2009

Sl. No.	Fly ash utilization level	Target date
1	At least 50% of fly ash generation	One year from the date of commissioning
2	At least 70% of fly ash generation	Two years from the date of commissioning
3	At least 90% of fly ash generation	Three years from the date of commissioning
3	100% of fly ash generation	Four years from the date of commissioning

BTPS has for coal based power plant (2 x 110 MW and 2 x 250 MW), and it is estimated that 741048 tons/ year of fly ash will be generated from 2 x 250 MW units. BSPGCL had already drawn up plan to utilise these fly ash. The proposed expansion unit (1x 660 MW) will generate 1537536 tons/year fly ash. BSPGCL shall plan to achieve use the fly ash as per notification.

Municipal Solid Waste Management

<u>*Municipal Wastes (Management and Handling) Rules, 2000*</u>

The Municipal Solid Waste (Management and Handling) Rules, 2000 (MSW Rules) establishes regulations governing collection, segregation, transportation, and disposal of all types of municipal solid wastes (domestic waste).

During construction and operation of power plant municipal solid waste will be generated from the labour camp and TPP residential area. BSPGCL and its contractor will comply the Rules for the management of the waste.

Transport of Raw Materials & Pollution Control

<u>*Motor Vehicle Act (MVA) and Rules, 1989 (MVR)*</u>

The Central Motor Vehicle Act (MVA) and Rules, 1989 (MVR) prescribe that vehicles falling in the category of transport vehicles undergo an annual fitness certification. The motor vehicle inspectors attached to the State Transport Department generally carry out this function. Additionally, vehicle owners also have to obtain Pollution under Check Certificate (PUCC) from a recognized testing center and display it on their vehicles. Additionally, to address the problem of risk associated with transportation of hazardous substances by road and the consequences of transportation emergencies, should they arise, provisions have been laid down in the MVR. Accordingly, any road carriage involved with the transportation of hazardous goods which can be harmful to human life or which can possibly cause damage to the environment in case of accidents and spillages shall have to comply with the labelling requirements and safety guidance specified in the MVR.

Given the fact that BSPGCL will conform to the high standards of environmental protection, they will restrict vehicles that do not have PUCC or do not comply with labelling guidelines specified under the MVR (for vehicles carrying hazardous substances like petroleum products) within their premises.

3.3.6 *Health, Safety and Security of the Community & Workers*

Construction of plant and associated facilities, operation of the plant and various project activities will require contractual labour, skilled and semiskilled personnel. Most of these activities will deal with labour issues governed by several laws and rules. The issues covered will include:

Factories Act, 1948 and its Amendment in 1987

The primary aim of the 1948 Act has been to ensure the welfare of workers not only in their working conditions in the factories but also their employment benefits. While ensuring the safety and health of the workers, the Act contributes to environmental protection. The Act contains a comprehensive list of 29 categories of industries involving hazardous processes, which are defined as a process or activity where unless special care is taken, raw materials used therein or the intermediate or the finished products, by-products, wastes or effluents would:

- Cause material impairment to health of the persons engaged
- Result in the pollution of the general environment

Public Liability Insurance Act (PLIA), 1991

The Act covers accidents involving hazardous substances and insurance coverage for them. Where death or injury results from an accident, this Act makes the owner liable to provide relief as is specified in the Schedule of the Act. The PLIA was amended in 1992, and the Central Government was authorized to establish the Environmental Relief Fund, for making relief payments.

National Environment Tribunal Act, 1995

The Act provided strict liability for damages arising out of any accident occurring while handling any hazardous substance and for the establishment of a National Environment Tribunal for effective and expeditious disposal of cases arising from such accident.

Workmen's Compensation Act, 1923

If personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer shall be liable to pay compensation in accordance with the provision of this Act.

The Maternity Benefit Act, 1961

No employer shall knowingly employ a woman in any establishment during the six weeks immediately following the day of her delivery or her miscarriage. Again no pregnant woman shall be involved in any work which is likely to interfere with her pregnancy or normal development of the foetus, or is likely to cause her miscarriage or otherwise to adversely affect her health. Given the fact that BSPGCL and its contractor will comply all the rules related to Health, Safety and Security of the Community & Workers.

3.3.7 *Protection of Workforce & Wages*

Contract Labour (Regulation & Abolition) Act 1970 & Central Rules, 1971

This is an act to regulate the employment of contract labour and to provide for its abolition in certain circumstances. The act applies to every establishment in which 20 or more workmen are employed or were employed on any day of the proceeding twelve months as contract labour; and also to every contractor who employs or who employed on any day of the preceding twelve month or more workmen.

Welfare and Health of Contract Labour

The facilities required to be provided under sections 18 and 19 of the Act, namely sufficient supply of wholesome drinking water, a sufficient number of latrines and urinals, washing facilities and first-aid facilities, shall be provided by the contractor in the case of the existing establishments within seven days of the commencement these rules and in the case of new establishments within seven days of the commencement of the employment of contract labour therein.

Child Labour

The Constitution of India (Part III, Fundamental Rights No. 24)
No child below the age of fourteen years shall be employed to work in any factory or mine engaged in any other hazardous employment.

The Child Labour (Prohibition and Regulation) Act, 1986 & Rules
The Child Labour Prohibition Act was enacted to protect the interest of the children, those who have not completed the age of fourteen, because of their economic and social conditions. Act to prohibit the engagement of children in certain employments and to regulate the conditions of work (Section 7) of children in certain other employments (Part II, Section 3).

The Factories Act, 1948
No child who has not completed his fourteen year shall be required for allowed to work in any factory. Again, specific provisions are outlined for young persons (above 14 years of age) in terms of working hours (not exceeding 4.5 hours in a day and not during night), certificate of fitness, work period not more than 5 hour each over two shifts, maintenance of register of all child workers.

Wages

The Payment of Wages Act, 1936, amended in 2005
Every employer shall be responsible for the payments to persons employed by him of all wages are required to be paid under this act.

The Equal Remuneration Act 1976

It is the duty of employer to pay equal remuneration to men and women workers for same work or work of a similar nature.

Given the fact that BSPGCL and its contractor will comply all the rules related to protection of workforce and wages.

3.3.8 *Land Acquisition and Involuntary Resettlement*

Land Acquisition Act, 1894, as modified up to the 1st Sept., 1985

The Land Acquisition Act (LA Act) of 1894 deals with acquisition of land and compensation to be provided to people who are displaced or affected by such acquisition.

Major part of the land (ash pond) is government land; however, land has been utilised for agricultural purpose. BSPGCL will followthe Act and compensation has been given to the property owners.

The National Resettlement & Rehabilitation (R&R) Policy 2007

The national policy on R&R recognizes that involuntary displacement of people, depriving them of their land, shelter, livelihood, resources or uprooting them from their socio-economic environment, etc. results in psychological and socio-economic consequences on the affected population. It thus emphasizes that rehabilitation and resettlement issues are intrinsic to the development process and should be formulated through a participatory mechanism which involves the people likely to be affected. Appreciating loss of livelihood as a major concern as the loss of assets, the policy states that the resettlement and rehabilitation planning should adopt a broader framework and address these issues. The objectives which have been highlighted in the policy are presented below:

- Minimize displacement and to promote, as far as possible, non-displacing or least-displacing alternatives;
- Ensure adequate rehabilitation package and expeditious implementation of the rehabilitation process with the active participation of the affected families;
- Ensure that special care is taken for protecting the rights of the weaker sections of society, especially members of the Scheduled Castes and Scheduled Tribes, and to create obligations on the State for their treatment with concern and sensitivity;
- Provide a better standard of living, making concerted efforts for providing sustainable income to the affected families;
- Integrate rehabilitation concerns into the development planning and implementation process; and
- Where displacement is on account of land acquisition, to facilitate harmonious relationship between the requiring body and affected families through mutual cooperation.

Appreciating the spirit of the national policy the social assessment study has laid lot of emphasis on the participation of different stakeholders in the assessment process. The project affected families have thus been given special emphasis in the entire assessment exercise.

3.3.9 *Indigenous People Protection*

The National Resettlement & Rehabilitation (R&R) Policy 2007

In case of projects involving land acquisition on behalf of a Requiring Body displacing 200 or more tribal families (except projects involving only linear acquisitions), a Tribal Development Plan shall be prepared laying down the detailed procedure for settling land rights due but not settled and restoring titles of tribal on alienated land by undertaking a special drive together with land acquisition. The objectives which have been highlighted in the policy are presented below:

- Each affected family of ST followed by SC categories shall be given preference in allotment of land-for-land, if available.
- In case of projects involving land acquisition on behalf of a Requiring Body, each tribal AF shall get an additional one-time financial assistance equivalent to 500 days minimum agricultural wages for loss of customary rights/usages of forest produce.
- Tribal AFs will be re-settled in the same Schedule Area in a compact block so that they can retain their ethnic, linguistic and cultural identity. Exceptions would be allowed only in rare cases where the Requiring Body in case of projects involving land acquisition, or the State Government in other cases of displacement, is unable to offer such land due to reasons beyond its control.
- Settlements predominantly inhabited by tribal shall get land free of cost for community and religious gatherings.
- In case of projects involving land acquisition on behalf of a Requiring Body, tribal AFs resettled out of the district will get 25% higher R&R benefits in monetary terms.

3.3.10 *Cultural & Heritage Site Protection*

The Ancient Monuments and Archaeological Sites and Remains Act, 1958

The Ancient Monuments and Archaeological Sites and Remains Act, 1958 provide for the preservation of ancient and historical monuments and archaeological sites and remains of national importance, for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects.

The Antiquities and Art Treasures Act, 1972

The present provisions are the sanctions for infringement of laws concerning underwater cultural heritage, with particular respect to looting, illicit excavation and export under the said Acts.

Appreciating the spirit of the above mentioned acts the baseline study has focused on cultural and heritage sites in the study area.

3.3.11 International Agreements & Conventions

India is signatory to a number of multilateral environment agreements (MEA) and conventions. An overview of some of the major MEAs and India's obligations applicable to this present power plant is presented below.

Montreal Protocol & the Vienna Convention

Scientific concerns about damage to the ozone layer prompted governments to adopt the Vienna Convention on the Protection of the Ozone Layer in the year 1985. The Montreal Protocol adopted subsequently sets out the time schedule to "freeze" and reduce consumption of ozone depleting substances (ODS). India acceded to the Montreal Protocol on 17th September 1992.

For the purpose of the proposed project, BSPGCL will emphasise the use of non-ODS technologies and substances and to abide by the Ozone Depleting Substances (Regulation) Rules, 2000 under the Environment (Protection) Act, 1986 published by the MoEF and minimizing gaseous emissions to the extent possible.

Stockholm Convention

The Stockholm Convention is a global treaty in response to the urgent need to protect human health and the environment from persistent organic pollutants (POPs). The Convention was adopted with the formal voted approval of delegates from 127 countries on 22 May 2001, at Stockholm in Sweden.

Thus, BSPGCL will avoid the usage of such chemicals falling under the POPs category to the extent possible in any of the planned activities.

Basel Convention

The Basel Convention basically aims at controlling the trans-boundary movement of hazardous wastes apart from promoting environmentally sound management of hazardous wastes. "Reduction at source" is another prime focus of the Basel Convention.
In order to conform to the principles of the Basel Convention BSPGCL needs to adopt a responsible approach towards management of all hazardous waste generated within their power plant premises.

Kyoto Protocol

The emission of significant amounts of carbon dioxide and other greenhouse gases, primarily by industrialised and developed nations, has come into sharp focus in the last few decades as it may result in rising raise global temperatures and resultantly cause change in climatic patterns across the globe. To address this issue, the Kyoto Protocol, wherein further supplements and strengthens the United Nations Framework Convention on Climate Change is an international treaty on climate change under which developed countries have committed to reduce their emissions of carbon dioxide and five other greenhouse gases.

India has formally accepted the treaty by ratifying on the 26th of August, 2002 and thus, the aim of BSPGCL will be to abide by the objectives of the protocol. BSPGCL will focus on the minimum emission of green-house gases like CO_2 and the optimal use of fuel resources.

UN Framework Convention on Climate Change (UNFCCC), 1992

The primary goals of the UNFCCC were to stabilize greenhouse gas emissions at levels that would prevent dangerous anthropogenic interference with the global climate. The convention embraced the principle of common but differentiated responsibilities which has guided the adoption of a regulatory structure.

United Nations Convention on Biological Convention

The Convention on Biological Diversity was negotiated under the patronage of the United Nations Environment Programme (UNEP). Many biodiversity issues are addressed in the convention, including habitat preservation, intellectual property rights, biosafety, and indigenous peoples' rights.

India is a signatory to the protocol and also has a separate Biodiversity Act to regulate the protection and conservation of biodiversity. BSPGCL will therefore act responsibly and cause no harm to biodiversity and natural resources of the area in any way whatsoever.

Ramsar Convention on Wetlands

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. In the study area, there are few reservoirs and water bodies. However, none of these are designated as Ramsar sites. BSPGCL will conform to the overall goal of the Ramsar Convention and cause no adverse effects on these ecosystems of great importance.

3.3.12 *Clean Development Mechanism*

The CDM is defined under the Kyoto Protocol to the UN Framework Convention on Climate Change (UN FCCC) as a 'flexibility mechanism' which allows an investor or donor country to fund projects which reduce greenhouse gas (GHG) emissions in a host country. In return, the donor country receives 'credits', which contribute to their GHG emissions targets. In the CDM, the donor country will be an industrialised country with emissions targets, whilst the host country will be a developing country (DC) without targets. The credits that will be transferred are called certified emissions reductions (CERs).

To qualify and get approval for Carbon Emission Reductions (CERs), BSPGCL has to prepare a Project Design Document (PDD) and subsequently get necessary approvals and validations from the designated National Clean Development Mechanism (CDM) Authority and UNFCCC. Section (D) of the standard PDD Document requires documentation on analysis of environmental impacts of the proposed technology changes/up gradations to be carried out.

3.4 *INTERNATIONAL ENVIRONMENTAL GUIDELINES & STANDARDS FOR THERMAL POWER PLANT*

3.4.1 *World Bank PPAH Emission Standard*

In 1998, the World Bank Group has issued Thermal Power: Guidelines for New Plants, which define procedures for establishing maximum emission levels for fossil-fuel based thermal power plants with a capacity of 50 or more megawatts of electricity (MWe) that use coal, fuel oil, or natural gas. The guidelines include emission limits for particulate matter, SO2 and NOx for various types of power plants, including engine-driven power plants. The guidelines also include ambient air quality standards, as well as provisions applicable to noise, liquid effluents and solid wastes from power plants. Stack Emission Standard is given in **Table-3.5**. Effluent discharge standard for thermal power plant is given in **Table 3.6**.

Table 3.4 Stack Emission Standard for Power Plant

Parameter	Maximum Value	Comments
Particulate Matter	50 mg/Nm^3	Removal Efficiency of 99.9% if standard not achievable.
Nitrogen Oxides	750 mg/Nm^3 (260 ng/J or 360 ppm)	At least 95% of the time that the plant or unit are operating.
Sulfur Dioxide	Less than 0.20 tons/day per MWe, for the first 1,000 MWe, plus 0.10 tons/day for each additional MWe	Concentration not to exceed 2,000 mg/Nm.^{3}

As per Draft Emission standard 2015, emission standard for particulate matter is 30 mg/Nm^3, SO2- 100 mg/Nm^3 and NOx 100 mg/Nm^3. Compared to PPAH emission standard, National emission standard is more stringent.

Table 3.5 Effluent Discharge Standard for Thermal Power Plant

Parameters	Maximum Value	Comments
pH	6 to 9	
Total Suspended Solids (TSS)	50 mg/l	
Oil & Grease	10 mg/l	
Total Residual Chlorine	0.2 mg/l	Chlorine shock dosing preferred*
Chromium (Total)	0.5 mg/l	
Chromium (Hexavalent)	0.1 mg/l	
Copper	0.5 mg/l	
Iron	1.0 mg/l	
Nickel	0.5 mg/l	
Zinc	1.9 mg/l	
Temperature Increase	3^{o}	**

* Chlorine shocking may be preferable; that is, dosing at high levels for a few seconds at intervals, rather than continuous low level release. The maximum value is 2 mg/l for up to 2 hours, not to be repeated more often than once in 24 hours. The maximum allowable 24 hour average is 0.2 mg/l. The same limits apply to bromine and fluorine.
**Less than or equal to 3^{o}C at the edge of the mixing zone, or where the mixing zone is not defined, 100 m from the point of discharge, when there are no sensitive ecosystems within this distance.

As per national discharge standard for liquid effluent from the TPP, it is categorized as discharge of condenser cooling water, boiler blow down, cooling tower blow down and ash pond blow down. However, in PPAH, there are only common discharge standard for the TPP. Certain parameters like suspended solid, oil & grease, copper, chromium are more stringent than the national discharge standard.

3.4.2 *International Best Practices / Standards*

High Concentration Slurry System for Ash Handling

The conventional method of ash evacuation through dumpers is not only costly but also has environmental problems. HCSS is now using the high concentration slurry system for ash handling. It involves transportation of fly ash in the form of slurry of homogeneous nature at a specific concentration (58% to 64% solid concentration). As the ash slurry is used at a specific concentration and also it is a homogeneous mix, it maximizes the usage of the land area and takes care of the environmental consequences otherwise likely in way of dust formation and contamination caused by ash laden effluent.

Flue Gas Conditioning by Auto Controlled Dosing of Ammonia Gas at ESP Inlet and Improving Performance of ESP

In power plants the statutory limit for maintaining the SPM level is 100 mg/Nm^3. With electro static precipitation SPM in flue gas was maintained at around 140 mg/Nm^3. For further reducing the SPM level, various improvement works were carried out such as modification of rapping timer logic and sequence, modification of ESP internals and tuning of ESP field controllers. These resulted in reduction of SPM level to around 100 mg/Nm^3.

However to further reduce SPM level, flue gas conditioning with ammonia dosing was found to be the most suitable solution. The implementation of flue gas conditioning with ammonia dosing showed remarkable improvement of stack emission.

Initiatives towards Achieving the Status of Zero Effluent Discharge

In a thermal power plant the waste water generally comes from Boiler and turbine area. The waste water generally contains fly ash particles. These plant drains ultimately discharge the waste water to near by water bodies. Draining of waste water to the water bodies leads to water pollution.

This recycling of water and reuse of the same for the internal consumption like formation of ash slurry, dust suppression at coal stock yard, watering for plantation and fire quenching will result in significant reduction in fresh water intake and ultimately result in achieving the status of "zero effluent discharge" plant.

Minimizing SO_2 Emission

Trombay Thermal Power Station belonging to Tata Power Co. had minimized the SO_2 emission through introducing imported coal (Chinese coal). The imported coal has lower 0.3 % sulphur and 10 % ash compared to Indian coal (sulphur - 0.5% & high ash - 40%).

They also introduced the Flue Gas De-Sulphurisation stream (FGD) for effective removal of SO_2. The scrubber efficiency (SO_2 removal efficiency) is observed at 90 % against the manufacturer's guarantee of 85 % removal.

3.5 INSTITUTIONAL FRAMEWORK

To promote conservation and sustainable use of biodiversity, India has an extensive body of laws and policies. The key ministries and departments involved in the management of environment, conservation biodiversity include MoEFCC, BFD, BSPCB, etc. The responsibilities of each of them are described below.

Ministry of Environment, Forests and Climate Change (MoEF&CC)

The MoEF&CC is the nodal agency in the administrative structure of the Central Government for planning, promoting, coordinating and overseeing implementation of India's environmental, forestry and wildlife policies and programmes. MoEF&CC's work is guided by the set of legislative and regulatory measures aimed at the preservation, conservation, and protection of the environment. These are as follows:

- EIA Notification 2006 (as amended)
- Environment Protection Act, 1986
- Coastal Regulation Zone Notification 2011

- Hazardous Waste (Management and Handling) Rules 1989 (as amended)
- Air (Prevention and Control of Pollution) Act, 1981
- Water (Prevention and Control of Pollution) Act, 1974
- Wildlife (Protection) Act 1972
- Manufacturing, Storage and Import of Hazardous Chemicals Rules, 2000 (as amended)

MoEF&CC is the responsible agency to issue the prior Environmental Clearance (EC) for all greenfield and expansion of thermal power plant. Other specific functions of MoEF&CC are monitoring and control of pollution; forest conservation, development, and wildlife protection. MoEF&CC, through its six regional offices monitors the conditions stipulated in the EC issued to various projects.

Bihar Forest Department (BFD)

BFD has mandated to protect, conserve and manage the state's forests (including mangrove forests) and wildlife resources. Forest Department has specific roles in declaring protected area, eco-sensitive zones, evaluating and apprising forest diversion proposal, wildlife clearance, etc. Forest Department's work is guided by set of legislative and regulations; these are:

- Forest Conservation Act, 1980 (amended in 1988)
- The Wild Life Protection (WLP) Act 1972(as amended in 2002 and 2006)
- Indian Forest Act 1927

Bihar State Pollution Control Board (BSPCB)

BSPCB is a statutory authority entrusted to implement environmental laws and rules within the jurisdiction of the state. BSPCB ensures proper implementation of the statutes, judicial and legislative pronouncements related to environmental protection within the State. BSPCB is responsible of implementing the following environmental Acts and Rules, either directly or indirectly:

- Water (Prevention & Control of Pollution) Cess Act, 1977
- Air (Prevention & Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986 and Rules and notifications made there under (including EIA notifications)
- Manufacture, storage and Import of Hazardous Chemicals Rules, 1989
- Municipal Solid Waste (Management & Handling) Rules, 2000

4 DESCRIPTION OF ENVIRONMENT

4.1 INTRODUCTION

This chapter describes the existing environmental settings in the project study area. This includes the physical environment comprising air, water and land components, the biological environment, and socio-economic environment. The major purposes of describing the environmental settings of the Study area are:

- To understand the project need and environmental characteristics of the area.
- To assess the existing environmental quality, as well as the environmental impacts of the future developments including any changes anticipated as part of the project.

4.2 METHODOLOGY ADOPTED FOR THE STUDY

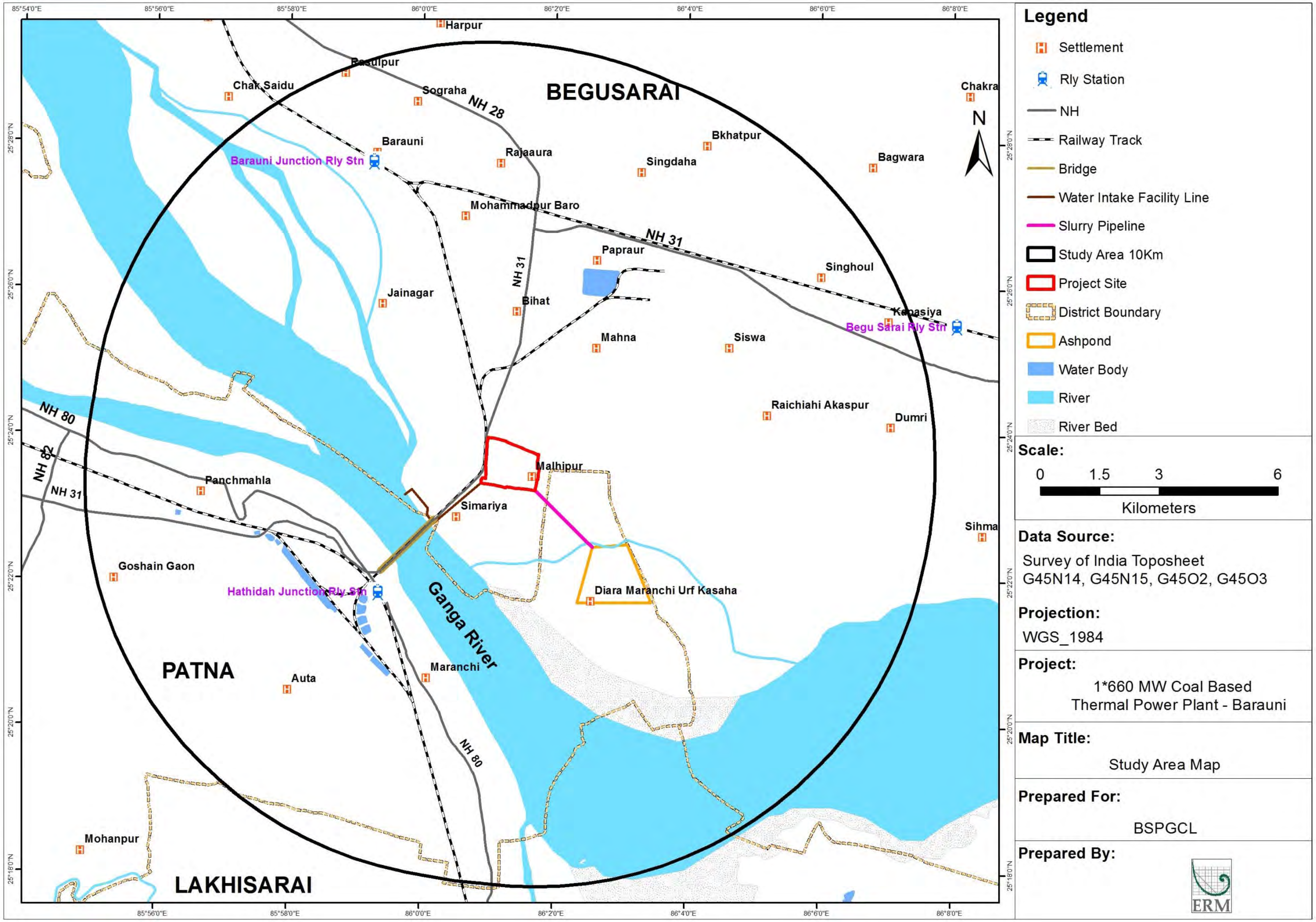
4.2.1 *Study Area*

The study area has been defined as 10 km radius from the boundary of the proposed power plant. The study area falls within three districts of Bihar. Majority of the study area in the north and east is included in Begusarai district; areas south of Ganga River and a small portion on the northern side of River Ganga and some section in the south of the study area is included under Patna district. A small portion at the south of the study area is included under Lakhisarai District. As the study area section under Lakhisarai district is very small, the environmental baseline report concentrated on Patna and Begusarai districts only. The land in which the proposed power plant would be commissioned would be located in Begusarai district and the proposed ash pond would be developed in Patna district. The study area map representing the district boundaries is provided in Figure 4.1.

4.2.2 *Baseline Data Collection*

The baseline was established by survey of the project site and the surrounding areas, collection of primary baseline data for the period April to June 2015 representing the pre-monsoon season. The baseline monitoring included collection of primary data on meteorological conditions, ambient air quality, water quality, soil quality, noise level, ecology, socio-economics and traffic density in the study area. The primary physical monitoring was conducted by M/s. Mitra S. K. Pvt. Ltd, Kolkata, NABL/ MoEF&CC accredited Laboratory, under the supervision of ERM. In addition to the above, collection of primary and secondary information on various environmental aspects like hydrogeology, hydrology, drainage pattern, ecology, landuse, socioeconomic data etc. was done through site visit, consultation, literature surveys of past studies undertaken in the project area. The framework for baseline data collection in provided in ***Table 4.1.***

Figure 4.1   *Study Area Map*



Source: Survey of India Toposheet G45N14, G45N15, G45O2, G35O3

Table 4.1 Baseline Environmental Conditions Monitoring Framework

S. No.	Environmental Component	Sub-category	Sampling Locations	Parameters	Duration	Frequency	Methodology
1	Land Environment	Topography	10 km area surrounding the proposed TPP	Contour Levels	-	Once	GIS
		Land Use	10 km area surrounding the proposed TPP	Landuse/Landcover	April-May 2015	Once	Image Processing
		Soil	Thermal power plant and proposed ash pond area (8 samples)	Soil texture,Sand,Silt,Clay, pH(1:2.5) at 26 ^{0}C,Electrical Conductivity (1:2.5) at 25^0 C,Cation exchange capacity,Na,Sodium Absorption Ratio,Permeablility,Water Holding Capacity,Porosity,Bulk density,Specific Gravity,Hg,Cd,Pb,Ni,Zn,Cu,Fe,N,P,K,Organic Carbon,Cr,As,PAH,Ca,Mg	April 2015	Once during the Study Period	Sample collection and analysis
		Geology	Regional Geology	General Geology	NA	NA	Secondary sources
2	Air Environment	Meteorological Conditions	Within the BTPS Colony	Wind speed, wind direction, Solar Radiation, relative humidity, temperature, rainfall	3 months (April-June 2015)	Hourly	Automated Weather station, IMD Data
		Ambient Air Quality	10 km area surrounding the TPP; 10 locations (10x2x12 =240 samples)	Particulate matter(<10 micron), Particulate matter(<2.5 micron), Ozone, CO, Lead, SO2, NO2, Ammonia, Benzene, Benzo(a)pyrene, Mercury, Arsenic & Nickel	3 months (April-June 2015)	24 hrs and 8 hours	AS per CPCB Guidelines
3	Noise Environment	Ambient Noise Levels	10 km area surrounding the TPP; at 12 location (10 samples)	Leq hourly Leq Day Leq Night	June 2015	Once during the Study period for 24 hrs duration	Primary Noise level Measurement using Digital Noise meter

S. No.	Environmental Component	Sub-category	Sampling Locations	Parameters	Duration	Frequency	Methodology
4	Water Environment	Hydrology	10 km area surrounding the TPP	Regional Hydrology	-	Once	Secondary (Central Groundwater Board)
		Drainage Pattern	10 km area surrounding the TPP	Drainage pattern and other surface water bodies	May 2015	Once	GIS
		Surface Water Quality	At 3 locations (3 locations x 3 samples in three months)	Colour, odour, temp, pH, EC, DO,turbidity, TDS, NH3-N, NO2 + NO3, Total P, BOD, COD, K, Na, Ca, Mg, CO3, HCO3, Cl, SO4, F, B, Total and Faecal Coliforms, Sodium Absorption Ratio (SAR) Mercury, Iron, Copper, Zinc, Nickel, Cadmium, Lead. pesticides as lindane, Oil and grease, E coli	April 2015, May 2015, June 2015	Thrice	Primary water Sample collection, analysis and interpretation against CPCB Water Use Criteria
		Hydrogeology	10 km area surrounding the TPP	Regional hydro geology	-	Once	Secondary sources (Central Groundwater Board)
		Ground Water Quality	At 21 locations (21 samples)	Colour, odour, pH, taste, turbidity, TDS, Al, Ammonia, Anionic Detergents (as MBAS), Ba, B, Ca, Cl, Cu, F, Free residual chlorine, Fe, Mg, Mn, Mineral Oil, Phenolic compounds, Se, Ag, SO4, Sulphide, Total alkalinity, Total hardness, Zn, Cd, Cyanide, Pb, Hg, Mo, Ni, Polychlorinated biphenyls, PAH, Total Arsenic, Total Chromium, Total Coliform, E coli, BOD, COD, Oil and Grease, pesticides as lindane	April-June 2015	Once	Primary water Sample collection, analysis and interpretation against IS:10500, 2012 Drinking Water Standards
5	Natural Hazards	Flood, earthquake, wind and cyclone	Regional	Historical records, vulnerability of the area of concern to natural hazards	NA	NA	District disaster management plans, National Institute of Disaster Management

4.3 LIMITATIONS

This report is based on certain scientific principles and professional judgement to certain facts with resultant subjective interpretation. Professional judgement expressed herein is based on the available data and information.

ERM is not engaged in the baseline data collection and reporting for the purposes of advertising, sales promotion, or endorsement of any client's interests, or other publicity purposes. The client acknowledges that any report prepared by ERM is for the exclusive use of the client and agrees that ERM's report or correspondence will not be used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular. The client also agrees that none of its advertising, sales promotion, or other publicity matter containing information obtained from these reports will make reference to ERM's name.

4.4 ENVIRONMENTAL BASELINE

4.4.1 Overview

Establishing baseline helps in understanding the prevailing environmental and socio economic status of the study area. It provides requisite information of the environment decision makers to assess impact and take appropriate measures for protecting the surrounding environment. The entire baseline is broadly structured in the following pattern:

Physical Environment

- Land Environment
  - Topography;
  - Land use;
  - Soil Type and Quality;
  - Geology;
- Air Environment
  - Meteorological condition;
  - Ambient Air Quality;
  - Ambient Noise Level;
- Water Environment
  - Drainage pattern;
  - Surface and Ground water Quality;
  - Water Environment
- Natural Hazards

Ecology and Biodiversity

- Flora
- Fauna
- Protected Areas

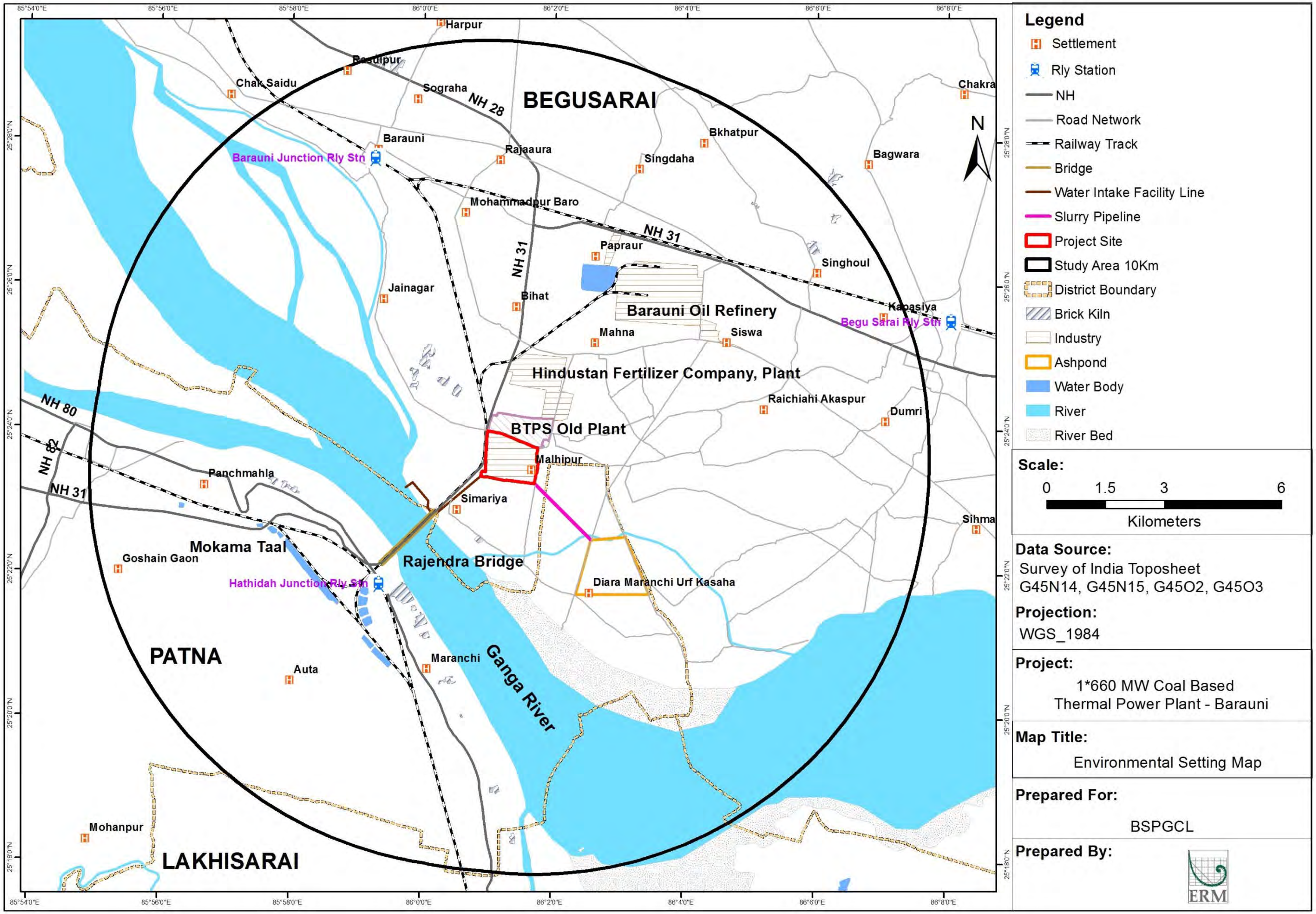
Key environmental components studied as part of the baseline studies including primary data generation with frequency of monitoring and use of secondary information has been presented in ***Table 4.1***.

4.5 ENVIRONMENTAL SETTING OF THE STUDY AREA

The study area is located in Begusarai, Patna and Lakhisarai districts of the state of Bihar;

- River Ganga flows across the study area from North west to South east
- Northern and eastern portion of the study area, north of Ganga River falls under Begusarai district. Most of the area south of the Ganga River and a small portion area at the north of Ganga River falls under Patna District. A small portion area in the south falls under Lakhisarai district.
- Study area has a gentle topography and slopes towards the Ganga River.
- Majority of the area within the study area is agricultural land.
- Two National Highways - NH-31 and NH-28 are passing through the study area. These two roads connect the area with rest of Bihar. Railway line of North Eastern Railway and Eastern Railway passes through the study area.
- Industrial units like Barauni Thermal Power Plant, Barauni Oil Refinery and an abandoned unit of Hindustan Fertilizer Company are located within the study area. Few brick kilns are also present towards the south of Ganga River.
- The major settlements within the study area are Barauni, Bihat, Akashpur, Mahna, Hajipur, Simariya, Panchmahla, Maranchi, Kiul, Bariyahi, Ramdiri, Raichiahi, Kasaha Diara and Janjira Dumra.
- The areas at the north bank of river Ganga are flooding prone and to protect the major industrial units and major settlements, embankments are constructed.
- Mokama Taal wetland area, an Important Bird Area is located at the south of the Ganga River about 3 km from the proposed plant area.

Figure 4.2 Environmental Setting Map



Source: Survey of India Toposheet G45N14, G45N15, G45O2, G35O3

4.6 LAND ENVIRONMENT

4.6.1 Topography

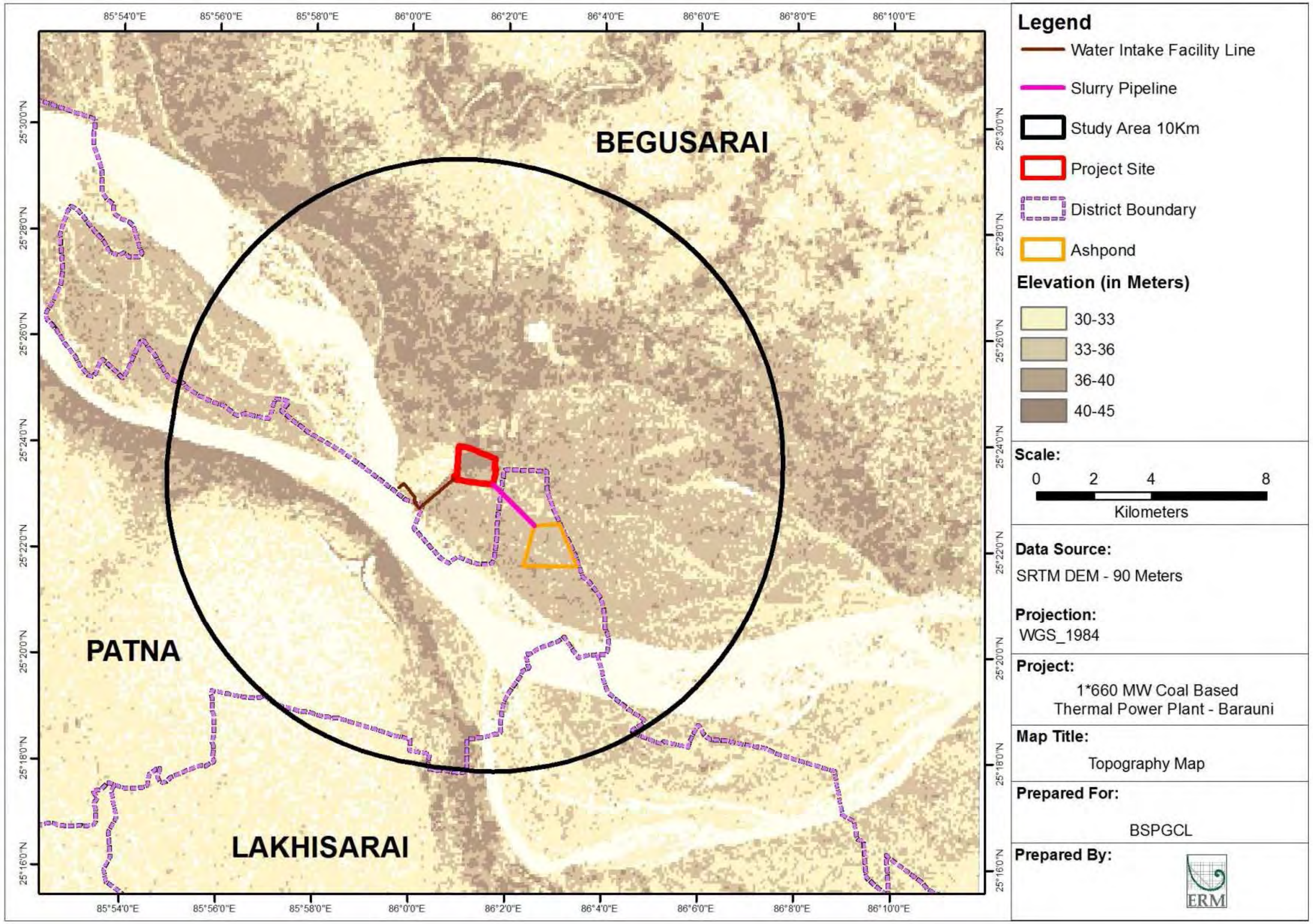
District Begusarai lies in middle part of the North Ganga Plain. North Ganga plain is a major physiographic unit of the Indian landmass. It extends from the Himalayan terrain in the north to the River Ganga in the south. In general, it is low lying flat terrain (MSL 45m-32m) having a southerly to south-easterly slope. The study area is having a flat terrain sloping towards the River Ganges on both the banks. Topography map of the study area is provided at ***Figure 4.3.***

4.6.2 Geology[1]

Patna district is a part of the Indo-Gangetic alluvial plain, one of the three main physiographic divisions of India, which separates Extra-Peninsular regions on the north from the peninsular region on the south. The district forming a part of the flood plains of the Ganga has a monotonously flat relief. The area under study is underlain by alluvial sediments of quaternary age. The quaternary sediments are deposited unconformable on the Archaean basement.

[1] Groundwater Scenario, Rajsamand District Rajasthan, Central Groundwater Board, March 2009

Figure 4.3 Topography Map of the Study Area



Source: SRTM DEM

4.6.3 *Land Use and Land Cover*

Land use and land cover of the study area was studied using LANDSAT 8 satellite image dated 10^{th} April 2013. Landuse map of study area is given in ***Figure 4.4***.

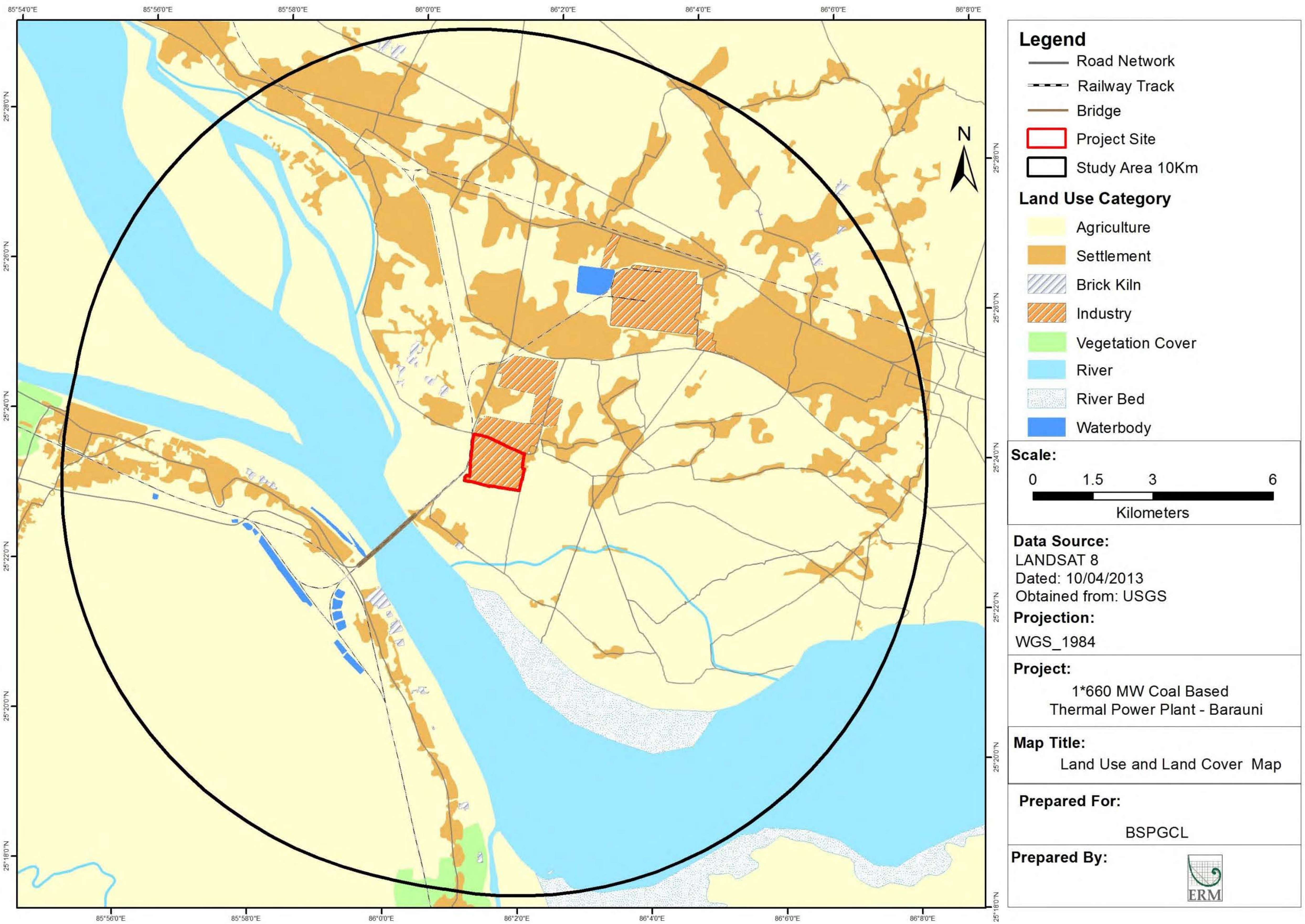
The predominant land use and land cover of the study area within 10 km includes agricultural land (60.36%) followed by Ganga River (approximately 18%), settlement (15.67%), Industrial areas etc. (2.08%), vegetation (0.40%), road (0.55%), railway (0.23%). Agricultural land in the area is primarily mono-cropped. Vegetation is primarily plantation in agricultural lands. River bed of Ganga river covers an area of 1.88%, waterbodies cover an area of 0.40%. Land use of the study area is given in ***Table 4.2.*** The proposed 1x 660 unit would be constructed within the same premise of the 2x 250 MW plant. The proposed ash pond would be constructed in mono-cropped agricultural land.

Table 4.2 Land Use and Land cover within 10 km radius of study area

Land use Type	**Area (Sq. Km)**	**Percentage (%)**
Agriculture	219.60	60.36
Brick Kiln	1.01	0.28
Industry	7.57	2.08
River	72.86	20.03
Road	2.00	0.55
Settlement	56.99	15.67
Vegetation Cover	1.47	0.40
Total Including the proposed plant area	**363.79**	**100**

Source: LANDSAT 8 satellite image dated 10April 2013

Figure 4.4 Landuse Map and Land Cover of the Study Area

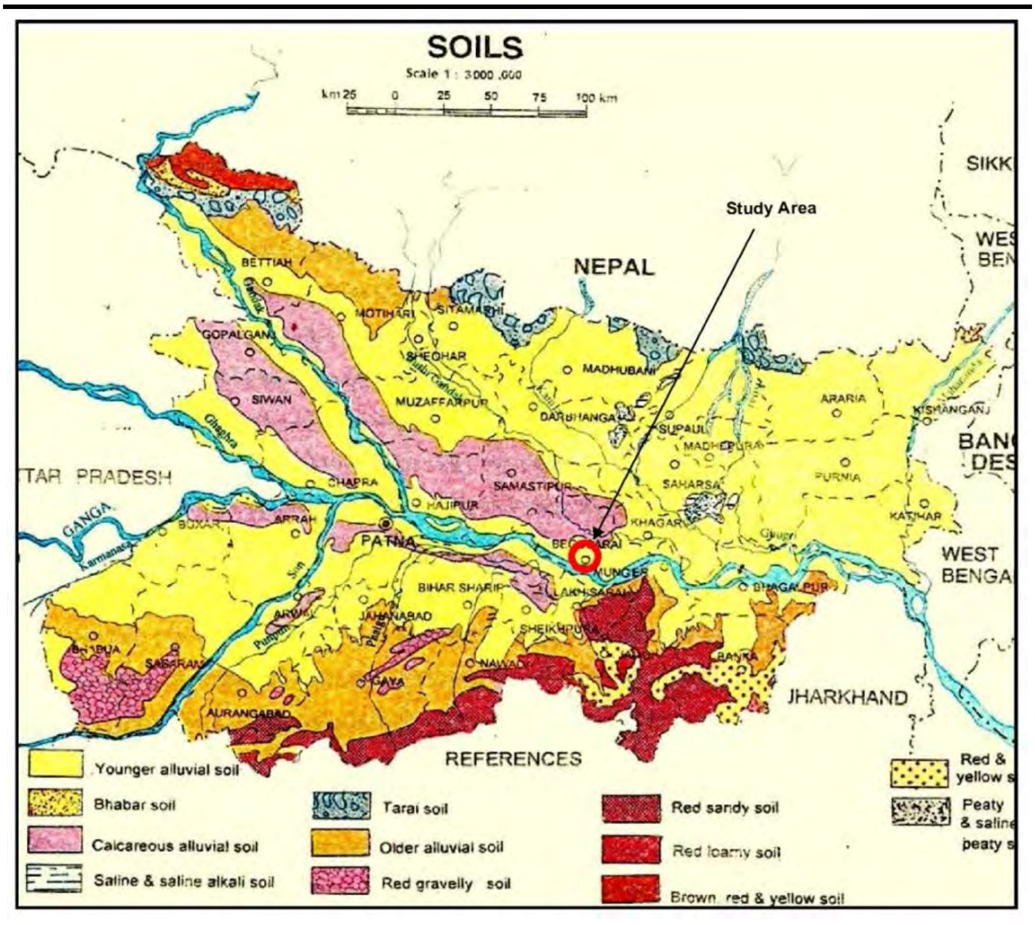


Source: LANDSAT 8 satellite image dated 10April 2013

4.6.4 *Soil Type and Quality*

The study area is located in the lower Gangetic plain, which has soil of younger alluvial nature. Texturally the soil present in study area is Sandy-Coarse loamy and Sandy-Fine loamy in nature. The soil of the area is rich with humus and is very fertile. Soil map of Bihar is shown in ***Figure 4.5***. The soils of Begusarai district is classified as fine sandy loam soils (38.02%), clayey soils (21.56%), coarse sandy loam soils (19.46%), saline/calcareous soils (13.69%) and sandy soils (7.25%)[1]. Soil of Patna district is classified as medium to heavy soils (35.6 %), sandy loam soils (32.9%) and clay to clay loam soils (31.3%)[2].

Figure 4.5 Soil Map of Bihar



Source –http://www.bameti.org/pdf/agriculture_profile_of_the_state[3])

Soil Quality Monitoring and Analysis

As part of the baseline study, soil samples were collected from six locations from the Study area for physical and chemical parameters. In addition, two ash samples were also collected from the existing construction site of 2x 250 MW plant (as the entire Project site was an ash dyke). The soil and ash sampling locations are described in ***Table 4.3*** and method of soil sample

[1] Agriculture contingency plan of Degusarai district, 2012
[2] Agriculture contingency plan of Patna district, 2012
[3] BAMETI: Bihar Agricultural Management and Extension Training Institute

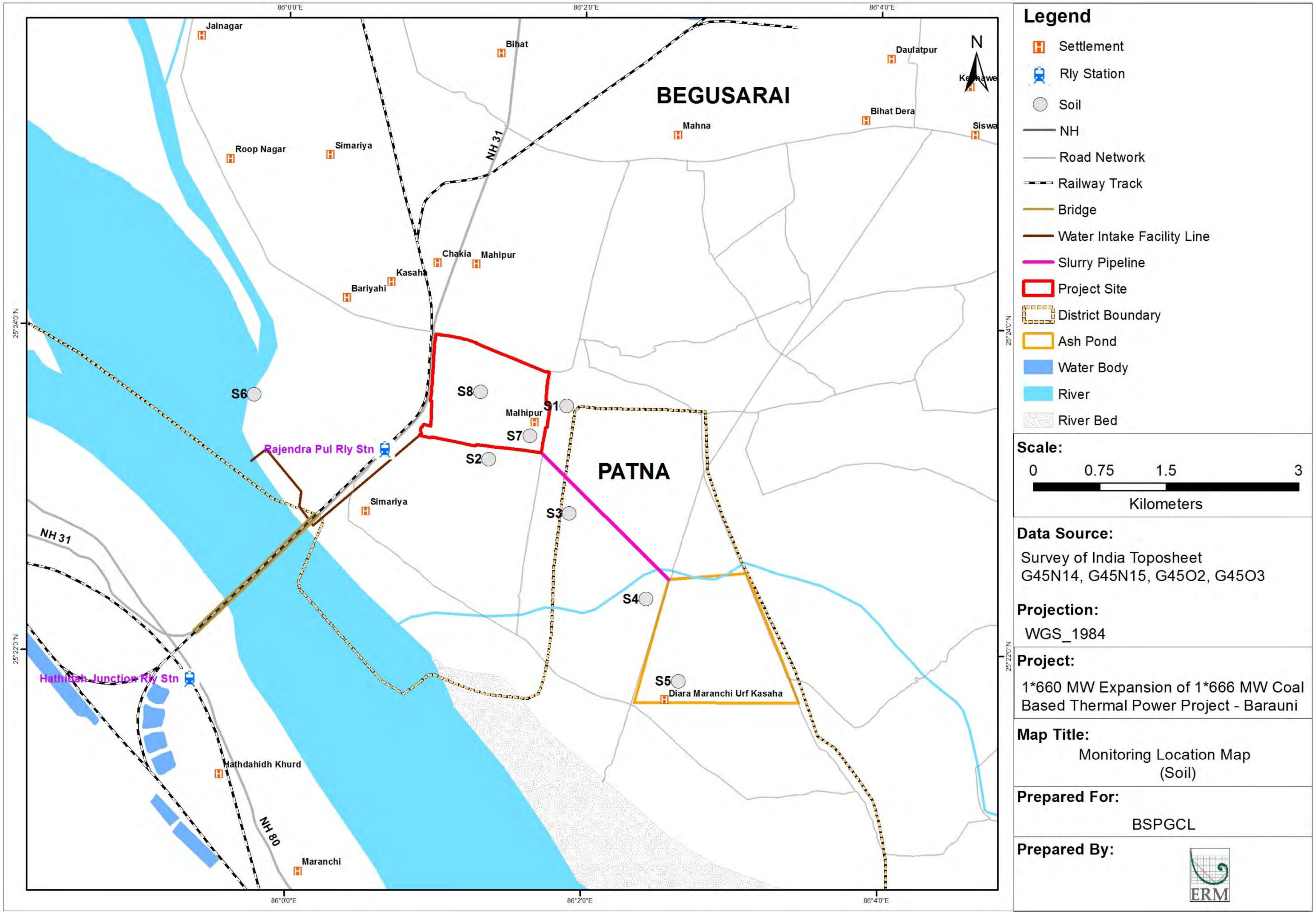
analysis provided in ***Table 4.4.*** Soil sampling locations are shown in **Figure 4.6.**

Table 4.3 Details of Soil and Ash Sampling Locations

S.N.	Sampling Location	Station Code	Geographical Coordinates	Distance w.r.t TPP	Direction w.r.t TPP	Landuse
1	Agricultural land near Malipur Bintola	S1	25°22'51.60"N 086°1'54.48" E	0.2	E	Agriculture
2	Wheat Cultivation area near southern boundary of new plant	S2	25°23'36.26"N 086°1'18.12" E	0.45	S	Agriculture
3	Wheat Cultivation area near Sitarampur Village	S3	25°23'34.7"N 085°59'46.5"E	0.76	SE	Agriculture
4	AL near Sitarampur village	S4	25°23'11.40"N 086°1'21.72" E	2	SE	Agriculture
5	Corn field near Kasaha Diara	S5	25°23'31.2"N 086°1'53.04" E	3	SE	Agriculture
6	AL near Bundh near Simariya	S6	25°21'50.04"N 086°2'39.12"E	2	W	Agriculture
7	Ash sample from new plant	S7	25°22'20.28"N 086°2'25.80" E	Within Project Site		Ash Sample
8	Ash sample from new plant	S8	25°23'20.04"N 086°1'38.28" E	Within Project Site		Ash Sample

Soil sampling locations were identified based on reconnaissance survey of the area and prevailing activities within the study area. Samples were collected by hand sampling augur from surface region. All samples were taken at depth of 30 cm from the ground surface. Samples were homogenised before testing. The samples were packed in dependable, waterproof containers and analysed as per ASTM, USEPA, IS-2270, M.L. Jackson (Soil Chemical Analysis). The methodology of analysis of each parameter is given in ***Table 4.4.*** The soil quality analysis results are presented in ***Table 4.5*** and described in the further subsections.

Figure 4.6 *Soil and Ash Sampling Locations within the Study Area*



Source: Survey of India Toposheet G45N14, G45N15, G45O2, G35O3

Table 4.4 Method of Soil Analysis

S.N	Parameter	Method
1	Soil texture	TPM/MSK/E/1/AL, Soil & Plant Analysis,C.S.Piper
2	Sand	TPM/MSK/E/1/AL, Soil & Plant Analysis,C.S.Piper
3	Silt	TPM/MSK/E/1/AL, Soil & Plant Analysis,C.S.Piper
4	Clay	TPM/MSK/E/1/AL, Soil & Plant Analysis,C.S.Piper
5	pH(1:2.5) at 26^{0}C	IS 2720 (Part 26) 1987 Reaffirmed 2007
6	Electrical Conductivity (1:2.5) at 25^{0}C	IS 14767 :2000
7	Cation exchange capacity	IS 2720 (Part 24) 1976 Reaffirmed 2005
8	Na	TPM/MSK/E/1/D, Methods of Soil Analysis (Soil Science society for America) Part II, pg. 1033
9	Sodium Absorption Ratio	TPM/MSK/E/1/AF,DIAGONISIS AND IMPROVEMENT OF SALINE AND ALKALINE SOIL
10	Permeability	IS 2720 (Part -17) 1986 Reaffirmed 2002
11	Water Holding Capacity	TPM/MSK/E/1/Q, Soil & Plant Analysis,C.S.Piper
12	Porosity	TPM/MSK/E/1/AE,Methods of Soil Analysis (Soil Science society for America) Part I
13	Bulk density	IS 2720 (Part -29) 1975 Reaffirmed 2005
14	Specific Gravity	IS 2720 (Part- 1) 1980 Reaffirmed 2002
15	Hg	USEPA 245.5 - 1974
16	Cd	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
17	Pb	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
18	Ni	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
19	Zn	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
20	Cu	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
21	Fe	TPM/MSK/E/1/M, Methods of Soil Analysis (Soil Science society for America) Part II
22	N	TPM/MSK/E/1/AK, Subbiah Asija,1956
23	P	TPM/MSK/E/1/L, Methods of Soil Analysis (Soil Science society for America) Part II, pg1040-1041
24	K	TPM/MSK/E/1/E, Methods of Soil Analysis (Soil Science society for America) Part II, pg. 1026
25	Organic Carbon	IS 2720(Part 22) 1972 Reaffirmed 1995
26	Cr	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007
27	As	EPA 3050 B -December,1996 , VGA
28	PAH	USEPA 3540 C - December,1996, USEPA 8270 D - February ,2007
29	Ca	TPM/MSK/E/1/F, Methods of Soil Analysis (Soil Science society for America) Part II, pg1003
30	Mg	TPM/MSK/E/1/F, Methods of Soil Analysis (Soil Science society for America) Part II, pg1006

Table 4.5 Result of Soil and Ash Analysis

Parameters	Unit	Agricultural land near Malipur Bintola	Wheat Cultivation area near southern boundary of new plant	Wheat Cultivation area near Sitarampur Village	Agricultural land near Sitarampur village	Corn field near Kasaha Diara	Agricultural land near Bundh near Simariya	Ash sample 1 from under construction 2x 250 MW site	Ash sample 2 from under construction 2x 250 MW site
		S1	S2	S3	S4	S5	S6	S7	S8
Texture		Silty Clay	Silty Clay Loam	Clay	Sandy Loam	Sandy Loam	Clay	Loamy Sand	Loamy Sand
Sand	%	18.7	17.2	21.6	55.2	56.7	14.8	73.1	74
Silt	%	40.2	43.1	31.3	26.1	25.9	33.8	25.7	23.4
Clay	%	41.1	39.7	47.1	18.7	17.4	51.4	1.2	2.6
pH(1:2.5) at 26 ^{0}C		8.21	8.01	8.08	8.33	8.16	8.21	7.32	7.22
Electrical Conductivity (1:2.5) at 25 ^{0} C	us/cm	92.91	191.88	149.79	89.38	126.29	145.87	87.72	55.61
Cation exchange capacity	meq/100 g	20.21	19.56	28.72	15.67	14.94	29.16	9.4	10.1
Na	mg/kg	30	50	20	10	20	40	40	30
Sodium Absorption Ratio		0.05	0.08	0.03	0.02	0.03	0.06	0.14	0.12
Permeability	cm/hr	6.1	5.6	6.3	4.61	4.52	5.86	3.72	3.81
Water Holding Capacity	%	37.2	39.6	43.8	38.2	38.4	42.4	45	50.65
Porosity	%	57.34	54.13	51.41	51.41	49.57	56.97	46.93	52.6
Bulk density	gm/cc	0.93	1.11	1.21	1.21	1.18	1.05	0.95	0.91
Specific Gravity		2.18	2.42	2.49	2.49	2.34	2.44	1.79	1.92
Hg	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cd	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Pb	mg/kg	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Ni	mg/kg	22.6	24.6	23.6	19.12	19.38	24	9.5	6.78
Zn	mg/kg	17.26	17.68	20.06	18.36	17.88	19.64	8.45	7.18
Cu	mg/kg	24.5	19.4	23.1	13.32	14.94	23.5	12.8	11.52
Fe	mg/kg	29.1	76.34	66.96	95.47	75.08	106.05	<5.0	<5.0
N	mg/kg	155.66	132.63	138.4	86.51	138.42	138.43	51.9	40.36

Parameters	Unit	Agricultural land near Malipur Bintola	Wheat Cultivation area near southern boundary of new plant	Wheat Cultivation area near Sitarampur Village	Agricultural land near Sitarampur village	Corn field near Kasaha Diara	Agricultural land near Bundh near Simariya	Ash sample 1 from under construction 2x 250 MW site	Ash sample 2 from under construction 2x 250 MW site
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
P	mg/kg	18.67	3.84	<3.0	4.54	<3.0	<3.0	133.24	85.4
K	mg/kg	80	50	80	50	40	80	30	50
Organic Carbon	%	0.74	0.41	0.33	0.24	0.26	0.38	0.41	0.12
Cr	mg/kg	16.72	17.62	20.22	13.94	14	17.34	5	<5.0
As	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ca	mg/kg	7444.3	7345.2	8426.3	6857.6	6663	8620.1	1175.5	881.7
Mg	mg/kg	411.4	352.6	652.7	293.9	294	411.4	176.3	235.1

Note: < or less than values depicts below detection limit.

Discussion of Results

Soil Type and Quality

Soil texture of the samples was observed to be of clayish, silty clayish, silty clay load and sandy loam. pH values of the soil samples varied between 8.08-8.21 which is moderately alkaline as per the Standard Soil pH classification[(1)] as given in **Table 4.6**.

Table 4.6 Standard Soil pH Classification

pH	Classification	Sample
<4.5	Extremely acidic	
4.51- 5.00	Very strong acidic	
5.01- 5.50	Strongly acidic	
5.51- 6.00	Moderately acidic	
6.01- 6.50	Slightly acidic	
6.51- 7.30	Neutral	
7.31- 7.80	Slightly alkaline	
7.81- 8.50	Moderately alkaline	**S1,S2, S3, S4,S5, S6**
8.51- 9.00	Strongly alkaline	
> 9.00	Very strongly alkaline	

Source: Agriculture Handbook, 2011

Sodium Absorption Ratio (SAR) varied between 0.02-0.08. Water holding capacity varied between 37.2-43.8% with porosity varied between 49.57 to 57.34%. Permeability of the soils collected from agricultural lands varied between 4.52-6.30 cm/hr. Organic carbon contents of the soils varied between 0.24-0.74%. Macronutrient contents of nitrogen, phosphorus and potassium contents varies between 86.51- 155.66 mg/kg, <3.0-18.67 mg/kg, 40-80 mg/kg respectively. Mercury (<0.1 mg/kg), cadmium (<2.0 mg/kg), lead (<5.0 mg/kg) and arsenic (<0.25 mg/kg) contents for all the soil samples were found to be BDL. Zinc, nickel and copper contents of the soil samples varied between 17.26-20.06 mg/kg, 19.12-24.2 mg/kg and 13.32-14.94 mg/kg respectively. PAH concentrations at all the samples were found to be <0.2 mg/kg.

The area in proximity to the proposed thermal power plant area and ash pond area is primarily used for cultivation of wheat and maize. NPK and organic carbon content of the soil samples were observed to be low, which is primarily due to the fact that the soil samples were collected during the harvesting period after nutrient uptake by the growing plants.

Currently, in India, there are no specific concentration based soil contamination standards. In absence of any existing standards, to assess for safe heavy metal contents, Dutch standards have been considered for the purpose of interpretation of soil quality with respect to heavy metals analysis.

(1) Agriculture Handbook, 2011

The observed values for metals namely Zinc, Lead, Cadmium, Copper and Mercury (inorganic), Nickel and Arsenic have been observed to be much below the soil remediation intervention values specified in Soil Remediation Circular July 2013 Revision as presented in ***Table 4.7.***

Table 4.7 Soil Remediation Intervention Values as per Dutch Standards

Parameter	**Intervention Values (mg/kg dry matter)**
Zinc	720
Arsenic	76
Lead	530
Cadmium	13
Copper	190
Mercury (inorganic)	36
Nickel	100

Source: Soil Remediation Circular July 2013 Revision

Quality of the Ash Samples

Two ash samples were collected from the site of the construction area of 2x 250 MW thermal power plants. The construction site is being developed at the ash deposition area of the old 110 MW plant. As the proposed 1X660 MW plant would be developed at the same area the analysis of ash samples would provide a baseline for future cases of comparison.

The pH values of the ash samples varied between 7.22 and 7.32 which is neutral to slight alkaline as per the Standard Soil Classification as mentioned in **Table 4.6**. SAR values of the ash samples varied between 0.12 and 0.14. Permeability and water holding capacity varied between 3.72-3.81cm/hr and 45-60.65%. Porosities of the samples were observed to be in between 46.93% and 52.6%. Organic carbon contents of the samples were 0.12 and 0.41%. Nitrogen, phosphorus and potassium contents of the ash samples were 40.36-51.9 mg/kg, 85.4-133.24 mg/kg and 30-50 mg/kg respectively. Concentration of Hg, Cd, Pb, As, PAH were all found to be below detection limits. Zn, Cu and Ni concentrations of the ash samples varied between 7.18-8.45 mg/kg, 11.52-12.8 mg/kg and 6.78-9.5 mg/kg respectively. In summary the values of metals like Hg, Cd, Pb, Zn, Cu, Ni and As were found to be in compliance to the Intervention values of Dutch Standards as mentioned in ***Table 4.7***. Analysis of ash samples does not reveal presence of arsenic, PAH, heavy metals like Hg, Cd, Pb, Zn, Cu, Ni etc. which could lead to future soil and groundwater pollution and affect the health of the locals.

4.7 AIR ENVIRONMENT

4.7.1 *Climate and Meteorology*

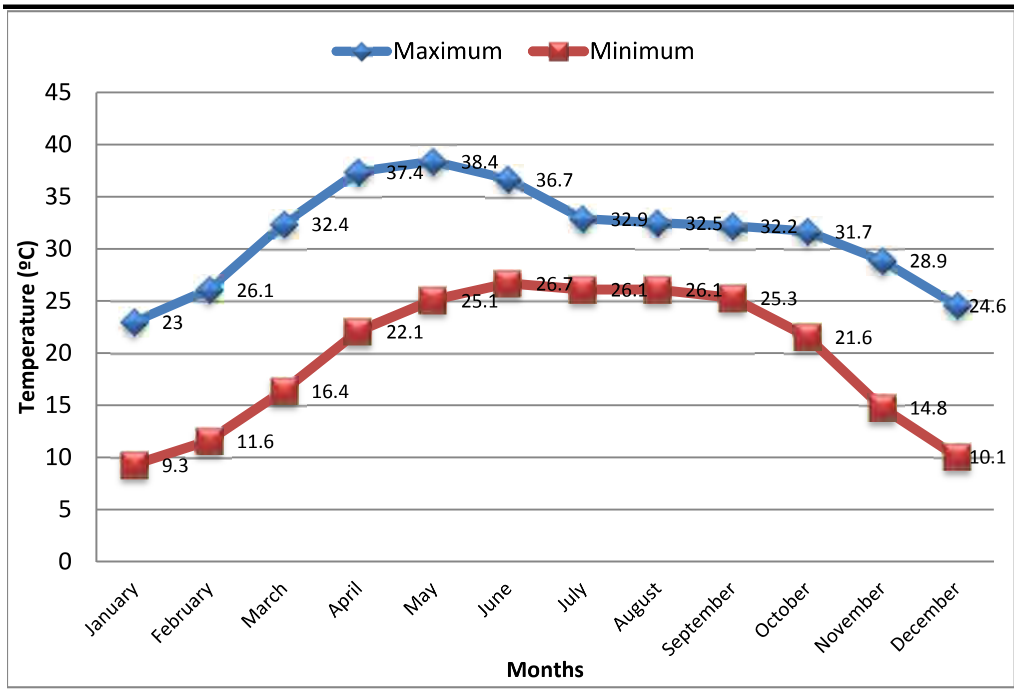
Being part of the Gangetic plains of the Indian subcontinent, Climate of the study area can be classified as[1]:

- Summer: March – May;
- Monsoon: June - September;
- Post monsoon: October – December;
- Winter: January – February.

Temperature

The winter season starts from December and continues till the end of February. January is observed as the coldest month with mean minimum temperature (from the year 1951 to 2000) as 9.3 °C where May is the hottest month with mean maximum temperature as 38.4 °C. The monthly mean minimum and maximum temperature is shown in **Figure 4.7.**

Figure 4.7 Monthly Mean Minimum and Maximum Temperature Variations (Year 1951-2000)



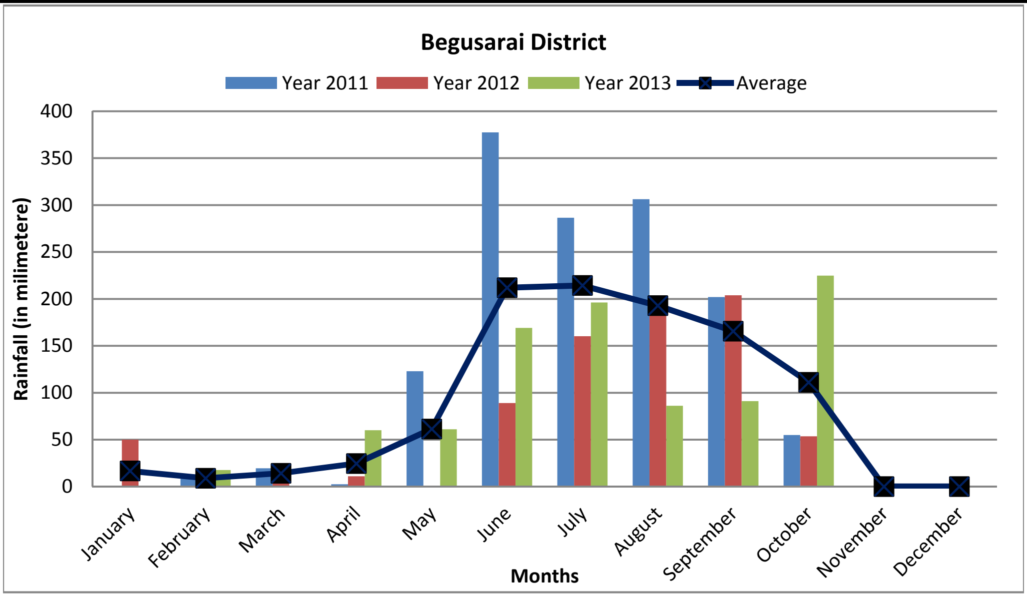
Source: Monthly mean maximum & minimum temperature and total rainfall based upon 1901-2000 data, National Data Centre, IMD, Pune

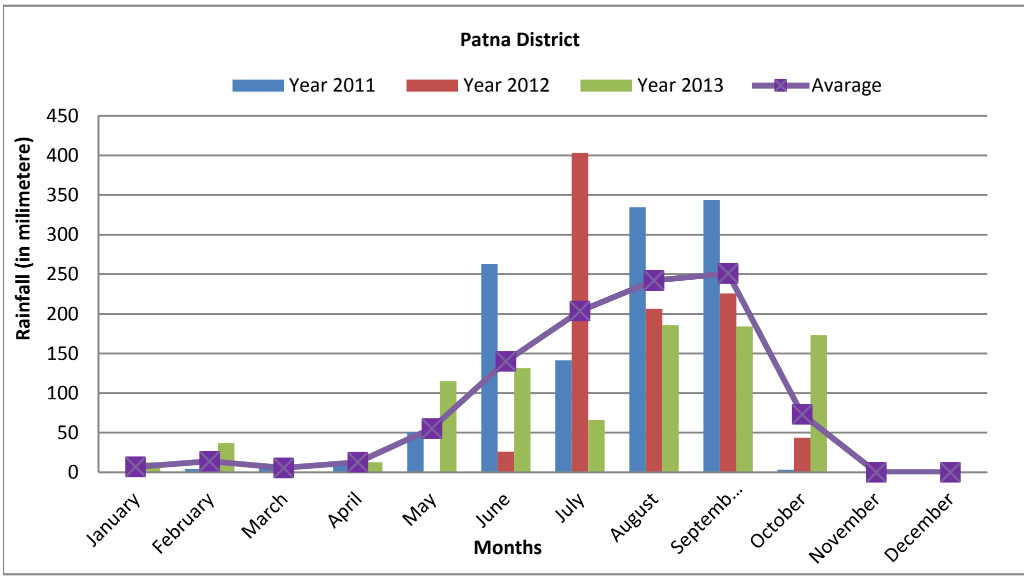
[1] Climate Profile of India, IMD 2010

Rainfall

Rainfall pattern of Patna and Begusarai districts from 2011 to 2013 is presented in ***Figure 4.8***. Average total rainfall for the districts was 1004.2 mm and 1021.3 mm. Maximum rainfall occurred from the months June to October. Average rainfall from June- October was 910.1 mm for Patna district and 895.7 mm for Begusarai district. No rainfall was recorded in November and December.

Figure 4.8 ***Rainfall Pattern (Year 2011-2013)***



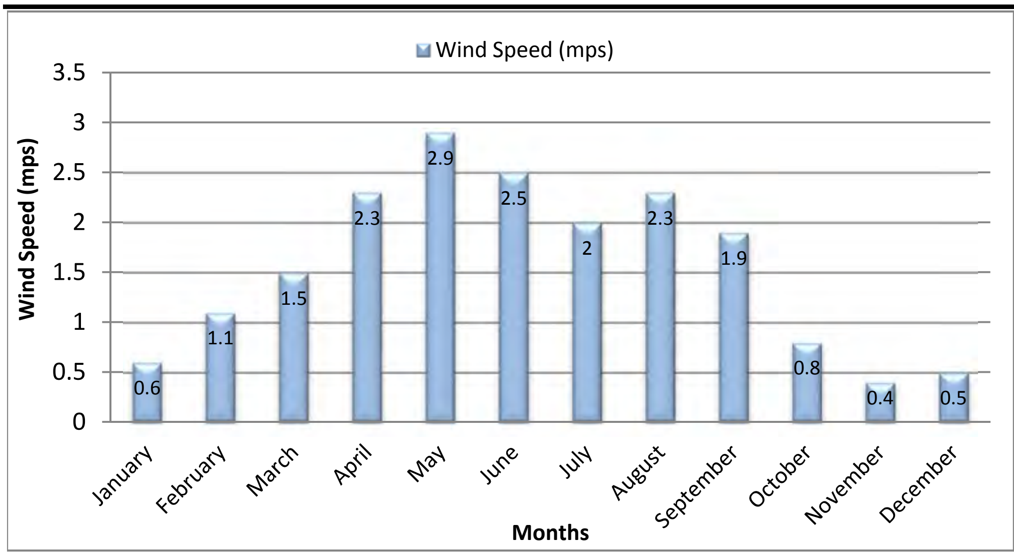


Source: District Rainfall, Hydromet Division, India Meteorological Department, New Delhi

Wind Speed and Wind Direction

The wind speed and wind direction of an area influences the dispersal of pollutants from a point and non-point sources. As the proposed project activity will cause air pollution from point (stack emission) and fugitive (ash pond, coal handling, movement of vehicle etc.) source, analysis of wind speed and direction data is considered important for predicting the air quality impacts based on pollutant dispersion. Analysis of IMD data collected from Patna observatory station for past 29 years (1971-2000), revealed highest monthly wind speed of 2.9 metre per second (mps) in May followed by 2.5 mps in April. The lowest monthly mean wind speed is 0.4 mps recorded in November. Annual variations in average wind speed from 1971 to 2000 are provided at ***Figure 4.9***.

Figure 4.9 ***Annual Variation in Average Wind Speed (Year 1971-2000)***



Source: Atlas of Windroses (1971-90), India Meteorological Department

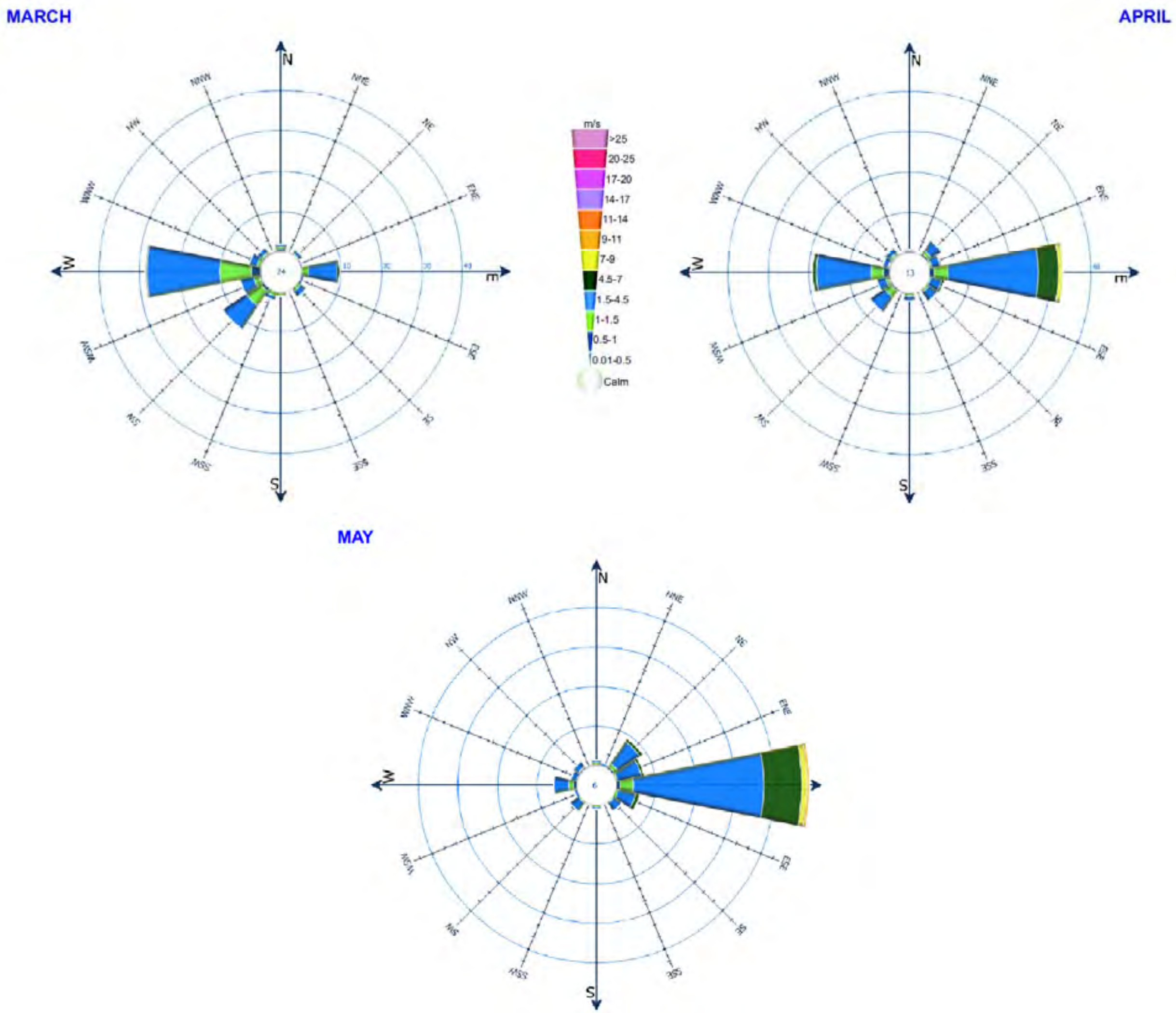
Wind rose diagram for pre monsoon, monsoon, post monsoon and winter seasons based on long term (1971 to 2000) meteorological data is provided in ***Figure 4.10, Figure 4.11, Figure 4.12*** and ***Figure 4.13*** respectively and summarised in ***Table 4.8*** Predominant Wind Direction. From the figure it is observed that during pre-monsoon and monsoon predominant wind direction is from east.

Table 4.8 ***Predominant Wind Direction***

Season	**Month**	**Predominant Winds Direction**		
		I	**II**	**III**
Winter	January	Calm	W	SW
	February	Calm	W	SW
Pre monsoon	March	W	C	SW
	April	E	W	Calm
	May	E	NE	Calm
Monsoon	June	E	Calm	NE
	July	E	Calm	W
	August	E	Calm	SE
	September	E	Calm	ESE
Post monsoon	October	Calm	E	SW
	November	Calm	W	SW
	December	Calm	W	SW

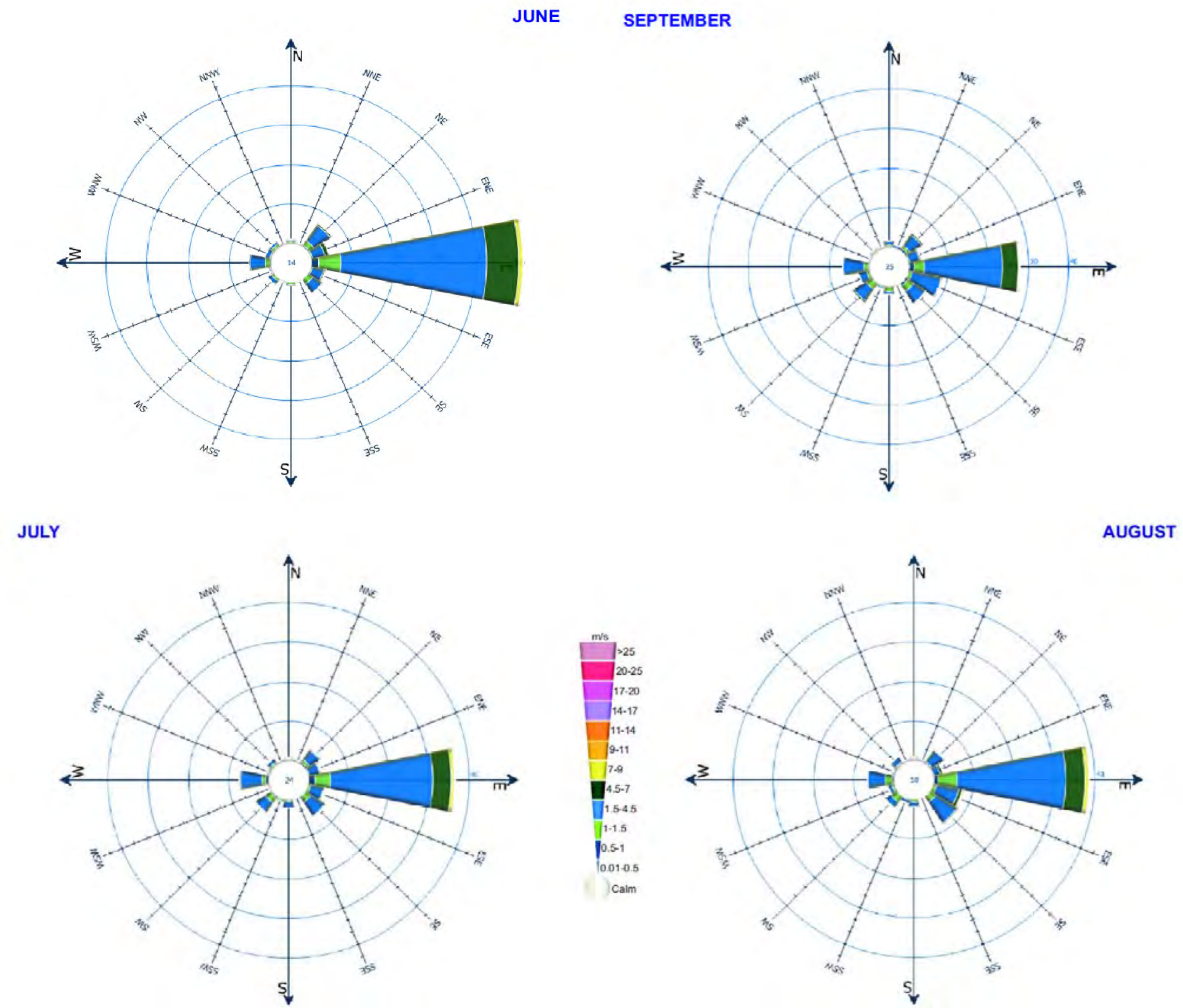
Source: Atlas of Wind roses (1971-90), India Meteorological Department; Note: I, II, and III are first, second and third predominant wind directions

Figure 4.10 Pre Monsoon Wind Rose Diagram of Patna, 1971-2000



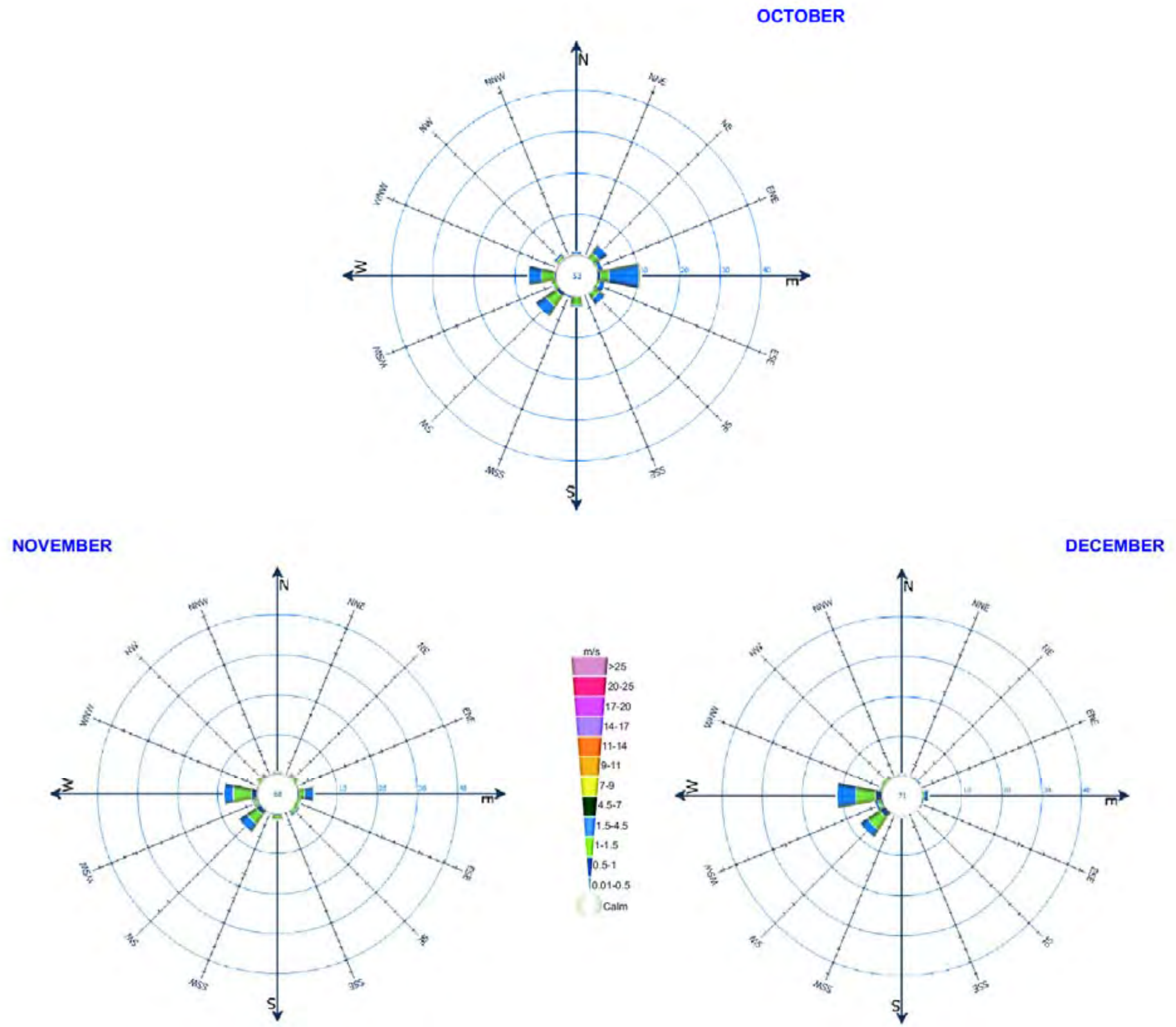
Source: Atlas of Wind Rose 1971-2000, IMD

Figure 4.11 Monsoon Wind Rose Diagram of Patna, 1971-2000



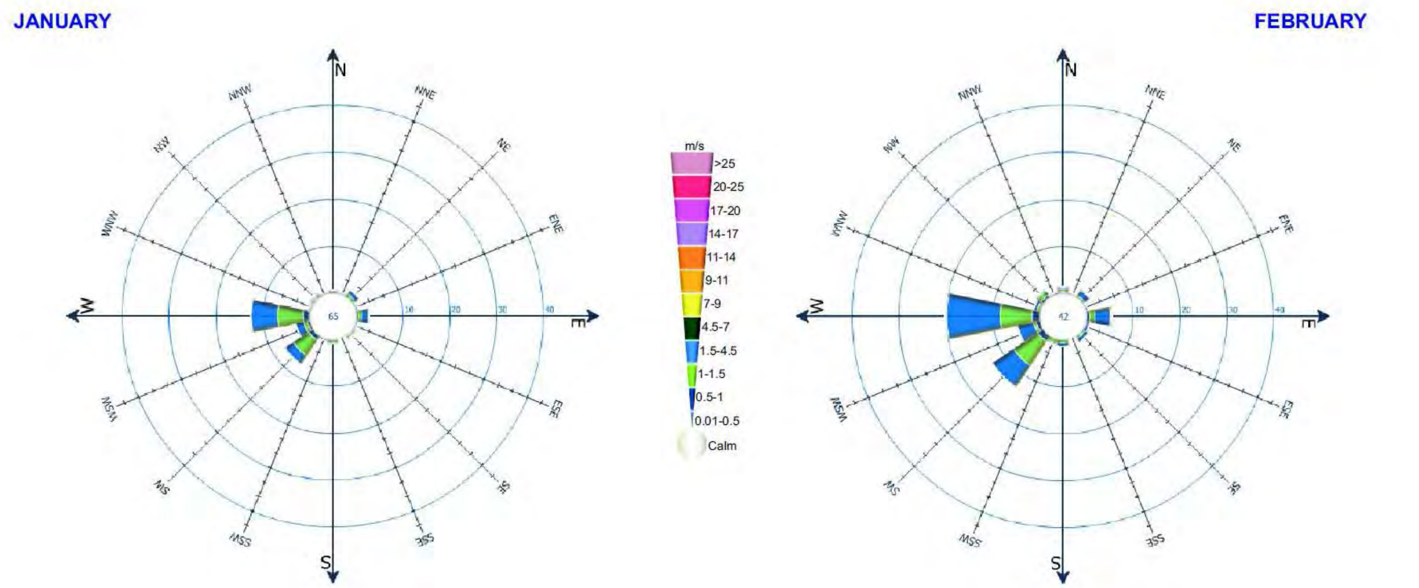
Source: Atlas of Wind Rose 1971-2000, IMD

Figure 4.12 Post Monsoon Wind Rose Diagram of Patna, 1971-2000



Source: Atlas of Wind Rose 1971-2000, IMD

Figure 4.13 Winter Wind Rose Diagram of Patna, 1971-2000



Source: Atlas of Wind Rose 1971-2000, IMD

4.7.2 *On-site Meteorology*

Meteorological parameters were also monitored onsite for two months from 11th April 2015 to 18th June 2015, continuously on hourly basis, by installing automatic Weather Monitoring System on rooftop of a building within the BTPS colony (Coordinate 25^0 23/ 55.12// N; 86^0 01/ 41.65//E). The parameters monitored by the weather monitoring station included temperature, relative humidity, wind speed, wind direction and rainfall which are summarised in ***Table 4.9.*** The detailed data is attached as ***Annex 4.1.***

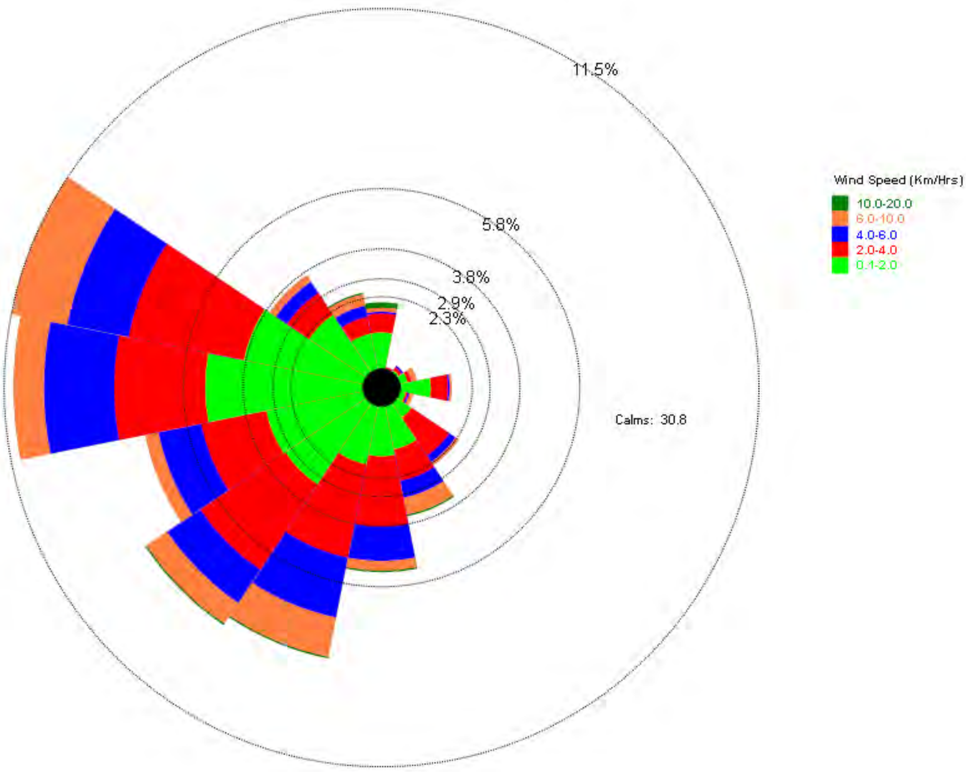
Table 4.9 Meteorological Data Observed at Project site

Aspects	Wind Speed (km/hr)	Temperature (^{0}C)	Relative Humidity (%)	Solar Radiation (W/m^2)
Minimum	Calm	23.2	8.5	0.0
Maximum	25.0	45.5	89.9	992.0
Average	2.38	32.43	56.86	257.49

Observations:

During the monitoring period temperature varied from 23.2 to 45.5 ºC. Relative humidity during the monitoring period varied from to 8.5% to 89.9%. Wind speed varied from 0.0 to 25.0 km/hr with an average of 2.38 km/hr. Three days with rainfall was observed during the entire study period. The 24-hourly maximum rainfall observed during the monitoring period was 12.1 mm. The predominant wind direction during the monitoring period was from west. Approximately 30.46% of the winds were recorded to be calm. Wind rose diagram for 24 hours, is presented in ***Figure 4.14.***

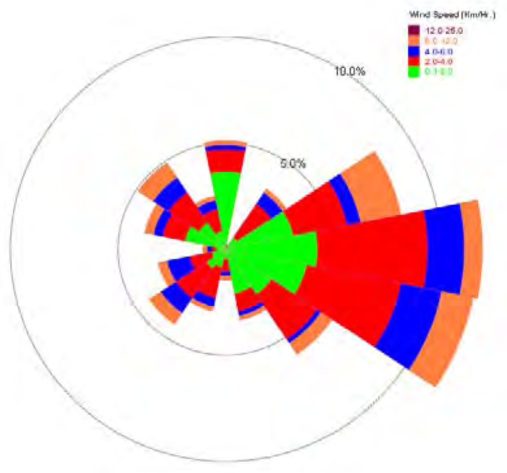
Figure 4.14 Site Specific Wind rose (April to June)



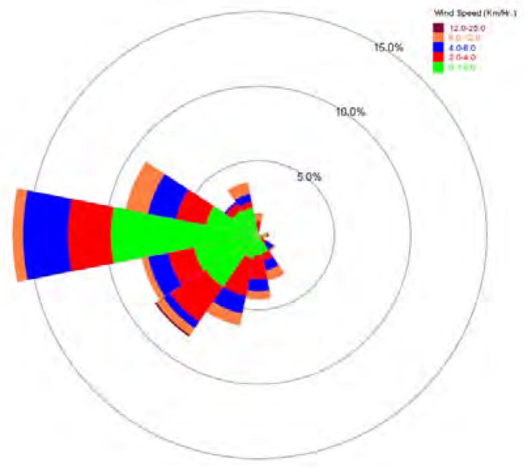
Source: Developed based on site specific meteorological data collected during April to June 2015

The Patna station is located more than 90 km from the site; variation of predominant wind direction at the BTPS location compared to the Patna station is could be due tolocal variations primarily due to proximity (3 km) of the site to the Ganga River.

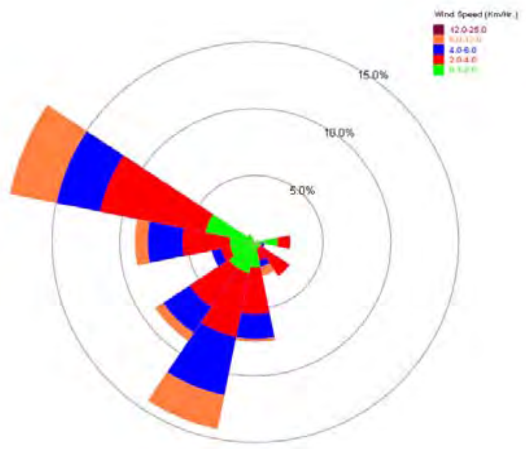
Figure 4.15 Monthly Wind Roses



Windrose (April)



Windrose (May)



Windrose (June)

4.7.3 *Ambient Air Quality*

The sources of air pollution within the study area are listed below;

- Emission and discharge of Barauni Oil Refinery
- Construction activities of BTPS new plant
- Fugitive dust emission from movement of vehicles in dilapidated major highways and other private roads, fugitive dust emission from movement of vehicles in unpaved roads, fugitive dust emission from old ash pond of BTPS and ash pond of Hindustan Fertilizer Plant
- Emissions from brick kilns

Barauni area is not included under Critically Polluted Industrial Cluster (CPIC) as per MoEF&CC notification.

Ambient Air Quality monitoring was conducted at ten locations within the 10 km radius study area for pre-monsoon season (April-June, 2015). The monitoring parameters included Respirable Particulate Matter (RPM) i.e. PM_{10} and $PM_{2.5}$, Nitrogen di-oxide (NO_2), Sulphur Dioxide (SO_2), Lead, Ammonia, Benzene, Benzo (α) pyrene, particulate phase, Arsenic, Nickel, Carbon Monoxide (CO), Ozone (O_3) and Mercury (Hg). These parameters were monitored on 24-hourly basis, except CO and O_3, which were monitored on eight hourly basis, and twice a week during the study period.

Methodology & Location of AAQM Stations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring procedure and is based on the following considerations:

- Meteorological conditions on synoptic scale;
- Topography of the study area;
- Representatives of regional background air quality for obtaining baseline status; and
- Location of residential areas and other important receptors.

The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters)/EPA. The applied testing procedures and detection limits are given in ***Table 4.10.***

Table 4.10 Methodology for Analysis of Ambient Air Quality

S.N	Parameter	Methodology	Detection Limit
1	PM_{10} (μg/m^3)	IS: 5182(Part-23)-1999	4 μg/m^3
2	$PM_{2.5}$ (μg/m^3)	USEPA CFR-40,Part-50, Appendix-L,2006	4 μg/m^3
3	SO_2 (μg/m^3)	IS: 5182 (Part-2)-2001	3 μg/m^3
4	NO_2 (μg/m^3)	IS: 5182 (Part- 6)-2006	3 μg/m^3
5	NH_3 (μg/m^3)	Air Sampling, 3rd Edn. By James P. Lodge (Method-401)	10 μg/m^3

S.N	Parameter	Methodology	Detection Limit
6	O_3 (µg/m³)	Air Sampling , 3rd Edn.By James P. Lodge (Method-411)	19.62 µg/m³
7	CO (mg/m³)	IS: 5182 (Part- 10)-1999	0.01 mg/m³
8	Pb (µg/m³)	EPA IO-3.2	0.02 µg/m³
9	Ni (ng/m³)	EPA IO-3.2	4.0 ng/m³
10	As (ng/m³)	APHA 22nd- 3114 C	1 ng/m³
11	Benzene (µg/m³)	IS 5182: Part. 11	2.08 ng/m³
12	Benzo(a) pyrene (ng/m³)	IS 5182: Part. 12	0.4 µg/m³
13	Hg (ng/m³)	EPA IO-5.0	2 ng/m³

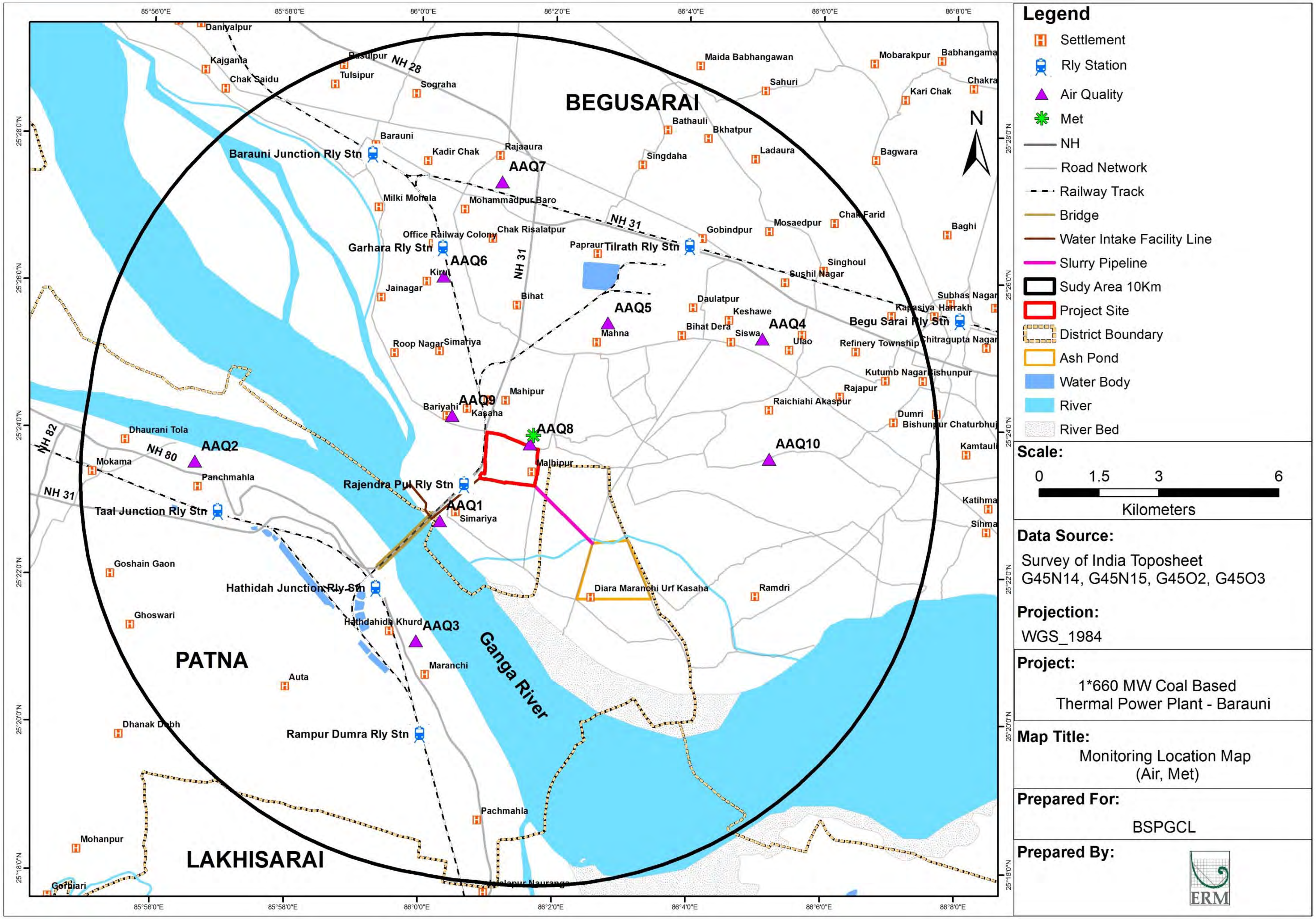
The ambient air quality monitoring locations in the study area are given in ***Table 4.11*** (and shown in ***Figure 4.16***) and the results presented in ***Table 4.12.*** The detailed results are provided as ***Annex 4.2.***

Table 4.11 Ambient Air Quality Sampling Locations in the Study Area

S.N	Sampling Location	Station Code	Distance w.r.t TPP	Geographical Coordinates	Direction w.r.t TPP	Justification for the selection
1	Simariya Ghat	AAQ1	1.4	25°22'44.78"N 86° 0'18.03"E	SW	The location is downwind w.r.t. the proposed site; at south west at the major settlement
2	Sikharichawk (Panchmahla)	AAQ2	7.1	25°23'31.89"N 85°56'38.06"E	W	The location is at downwind w.r.t. the proposed site; at the west beyond the Ganga River which could be impacted due to the emission from the plant
3	Maranchi	AAQ3	4.4	25°21'6.76"N 85°59'57.47"E	S	The location is selected to assess the baseline air quality at areas south of the project site beyond river Ganga which could be affected due to stack emission from the plant
4	Makardahi	AAQ4	6.2	25°25'14.88"N 86° 5'6.00"E	NE	The location is upwind w.r.t. the proposed site; effect of refinery emissions on the baseline air quality could be assessed
5	Mahna	AAQ5	3.6	25°25'27.14"N 86° 2'47.40"E	NE	The location is at crosswind w.r.t. the proposed site; effect of refinery emissions on the baseline air quality could be assessed at the site

S.N	Sampling Location	Station Code	Distance w.r.t TPP	Geographical Coordinates	Direction w.r.t TPP	Justification for the selection
6	Kiul	AAQ6	4	25°26'4.48"N 86° 0'20.02"E	NW	The location is crosswind w.r.t. the proposed site at a major settlement that could be affected due to the emissions from proposed project
7	Hajipur	AAQ7	6.2	25°27'21.61"N 86° 1'12.07"E	N	The location is crosswind w.r.t. the proposed site at north at a major settlement within the study area
8	BTPS Colony	AAQ8	0.05	25°23'48.00"N 86° 1'38.42"E	NE	The location was selected to assess the effect of the proposed project on the colony of BTPS
9	Bariyahi	AAQ9	0.9	25°24'10.80"N 86° 0'28.43"E	NW	The location is at the nearest settlement downwind w.r.t. proposed site
10	Akashpur	AAQ10	5.8	25°23'36.92"N 86° 5'12.83"E	E	The location is at upwind w.r.t. the proposed site

Figure 4.16 Map Showing Meteorology and Ambient Air Quality Sampling Locations in the Study Area



Source: Survey of India toposheet

Table 4.12 Ambient Air Quality within the Study Area

Parameters	Unit	Observed	Simariyaghat	Shikarichawk (Panchmahla)	Maranchi	Makardahi	Mahna	Kiul	Hajipur	BTPS Colony	Bariyahi	Akashpur
			AAQ1	**AAQ2**	**AAQ3**	**AAQ4**	**AAQ5**	**AAQ6**	**AAQ7**	**AAQ8**	**AAQ9**	**AAQ10**
PM_{10}	$\mu g/m^3$	**NAAQS**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
24 hourly		Max	92.00	92.00	95.00	99.00	95.00	87.00	**132.00**	**122.00**	87.00	90.00
		Min	46.00	46.00	46.00	56.00	44.00	45.00	68.00	59.00	45.00	43.00
		Average	73.54	69.54	65.29	74.04	69.25	66.75	95.17	80.00	69.42	66.17
		98 Percentile	92.00	88.78	93.62	94.86	93.62	86.54	**132.00**	**109.58**	86.08	87.24
$PM_{2.5}$	$\mu g/m^3$	**NAAQS**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**	**60**
24 hourly		Maximum	55.00	55.00	56.00	55.00	55.00	48.00	**76.00**	**66.00**	48.00	52.00
		Minimum	22.00	22.00	20.00	27.00	22.00	22.00	29.00	27.00	26.00	22.00
		Average	36.79	36.17	34.08	37.54	35.96	34.46	48.58	41.54	35.88	33.83
		98 Percentile	51.32	50.40	55.54	51.78	54.54	48.00	**73.24**	**61.40**	48.00	47.86
SO_2	$\mu g/m^3$	**NAAQS**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
24 hourly		Maximum	9.20	9.60	10.20	10.20	9.60	9.60	11.20	9.20	9.50	8.20
		Minimum	4.30	4.50	4.00	4.60	4.20	4.30	5.50	4.80	4.20	4.50
		Average	6.26	6.10	6.62	7.14	6.48	6.21	7.71	7.01	6.56	6.02
		98 Percentile	8.91	9.09	9.92	10.20	9.60	9.14	10.74	8.88	9.09	7.88
NO_2	$\mu g/m^3$	**NAAQS**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**
24 hourly		Maximum	38.50	35.20	35.20	39.70	38.50	39.60	41.20	43.20	32.20	38.50
		Minimum	18.50	16.60	19.60	15.50	16.60	18.50	19.60	20.20	16.60	15.20
		Average	29.35	24.60	25.31	28.71	27.37	26.50	30.65	29.09	26.27	26.52
		98 Percentile	37.53	34.92	33.82	38.41	37.63	39.09	40.05	41.04	32.20	37.44
CO	mg/m^3	**NAAQS**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
8 hourly		Maximum	0.88	0.62	0.88	0.55	0.56	0.62	0.96	0.63	0.65	0.62
		Minimum	0.22	0.16	0.14	0.16	0.16	0.16	0.23	0.18	0.15	0.15
		Average	0.41	0.33	0.33	0.33	0.32	0.37	0.46	0.34	0.35	0.33
		98 Percentile	0.78	0.59	0.73	0.53	0.54	0.62	0.92	0.59	0.64	0.57
NH_3	$\mu g/m^3$	**NAAQS**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**
24 hourly		Maximum	26.60	25.20	28.50	25.20	26.60	23.30	20.81	27.40	29.60	26.30

Parameters	Unit	Observed	Simariyaghat	Shikarichawk (Panchmahla)	Maranchi	Makardahi	Mahna	Kiul	Hajipur	BTPS Colony	Bariyahi	Akashpur
			AAQ1	**AAQ2**	**AAQ3**	**AAQ4**	**AAQ5**	**AAQ6**	**AAQ7**	**AAQ8**	**AAQ9**	**AAQ10**
		Minimum	15.90	<10	<10	<10	<10	<10	27.49	13.30	12.20	<10
		Average	20.19	-	-	-	-	-	28.50	19.44	20.16	-
		98 Percentile	26.60	-	-	-	-	-	13.30	26.07	28.08	-
O_3 8 hourly	μg/m^3	**NAAQS**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
		Maximum	47.50	48.70	42.20	55.20	51.20	62.20	62.20	68.50	45.80	48.30
		Minimum	<19.62	<19.62	<19.62	<19.62	<19.62	<19.62	25.50	<19.62	<19.62	21.20
		Average	-	-	-	-	-	-	39.01	-	-	30.84
		98 Percentile	-	-	-	-	-	-	62.20	-	-	47.01
Pb 24 hourly	μg/m3	**NAAQS**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
		Maximum	0.05	0.05	0.03	0.05	0.05	0.05	0.06	0.04	0.04	0.04
		Minimum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-
Ni 24 hourly	ng/m3	**NAAQS**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
		Maximum	8.55	8.32	9.31	11.99	8.57	8.99	19.47	9.69	8.66	7.58
		Minimum	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-
As 24 hourly	ng/m3	**NAAQS**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**
		Maximum	4.52	3.66	3.22	5.20	5.23	5.55	4.55	5.60	4.55	5.60
		Minimum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-
Benzene 24 hourly	μg/m^3	**NAAQS**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
		Maximum	5.66	3.63	4.55	4.52	4.55	4.25	5.62	4.55	3.66	4.20
		Minimum	<2.08	<2.08	<2.08	<2.08	<2.08	<2.08	<2.08	<2.08	<2.08	<2.08
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-
Benzo (a)	ng/m^3	**NAAQS**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Parameters	Unit	Observed	Simariyaghat	Shikarichawk (Panchmahla)	Maranchi	Makardahi	Mahna	Kiul	Hajipur	BTPS Colony	Bariyahi	Akashpur
			AAQ1	**AAQ2**	**AAQ3**	**AAQ4**	**AAQ5**	**AAQ6**	**AAQ7**	**AAQ8**	**AAQ9**	**AAQ10**
pyrene, particulate phase 24 hourly		Maximum	1.88	1.85	<0.04	2.85	2.66	2.33	3.22	2.62	2.56	2.52
		Minimum	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-
Hg 24 hourly	ng/m^3	**NAAQS**	-	-	-	-	-	-	-	-	-	-
		Maximum	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
		Minimum	-	-	-	-	-	-	-	-	-	-
		Average	-	-	-	-	-	-	-	-	-	-
		98 Percentile	-	-	-	-	-	-	-	-	-	-

Source: Baseline Monitoring, April-June 2015

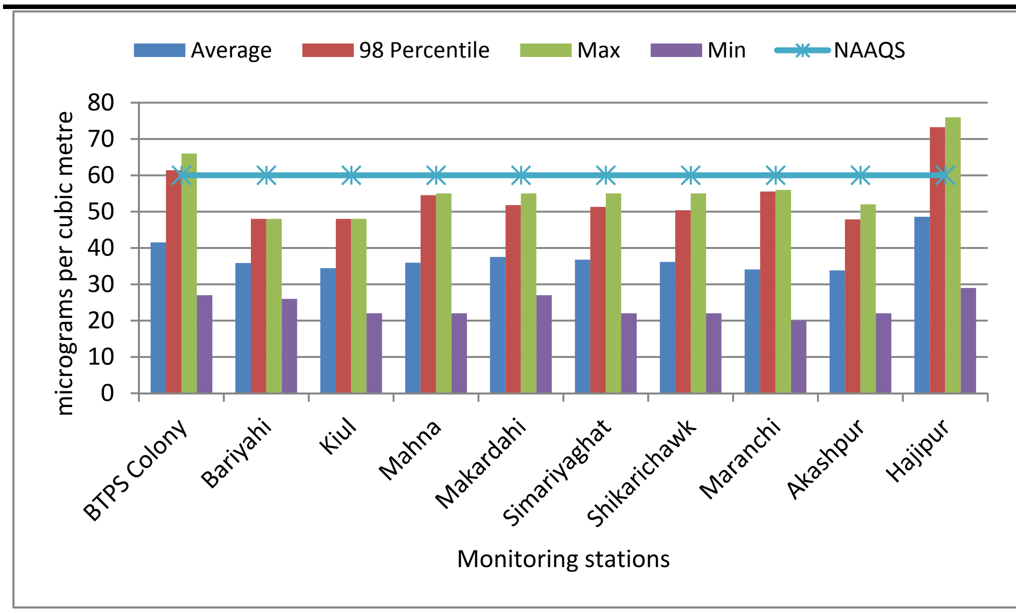
Discussions of Results

The observations from the monitoring were compared with the National Ambient Air Quality Standards (NAAQS) and the interpretations are discussed in the following subsections.

$PM_{2.5}$

The monitored average $PM_{2.5}$ concentration varied from 33.83 µg/m³ to 48.58 µg/m³. The monitoring location Maranchi observed the minimum $PM_{2.5}$ concentration (of 20.00 µg/m³), whereas the maximum was observed at AAQ 7 (Hajipur) (of 76.00 µg/m³). Average $PM_{2.5}$ concentrations were found to vary between 33.83-48.58 µg/m³. The 98 percentile concentration of most of the monitoring locations was observed to be within the prescribed NAAQS limits for industrial, residential, rural and other areas (of 60 µg/m³) excepting AAQ 7 (Hajipur (of 73.24 µg/m³) and AAQ 8 (BTPS Colony) (of 61.40 µg/m³). Higher $PM_{2.5}$ values at AAQ 7 (Hajipur) is possibly due to the proximity of the site to a dilapidated pucca road, where plying of vehicles could lead to generation of re-intrained dust. Higher values of $PM_{2.5}$ at BTPS colony could possibly be due to proximity of the site to NH-31, Bundh road old ash pond area and 2x250 MW TPP construction site. Movement of vehicles in NH-31, bundh road could lead to generation of re-intrained dust, wind blown dust from old ash pond area and dust generated from construction site could possible resulted in higher $PM_{2.5}$ levels at this location. Graphical representation of $PM_{2.5}$ values are depicted graphically in ***Figure 4.17.***

Figure 4.17 Graphical Representation of $PM_{2.5}$ in the Study Area

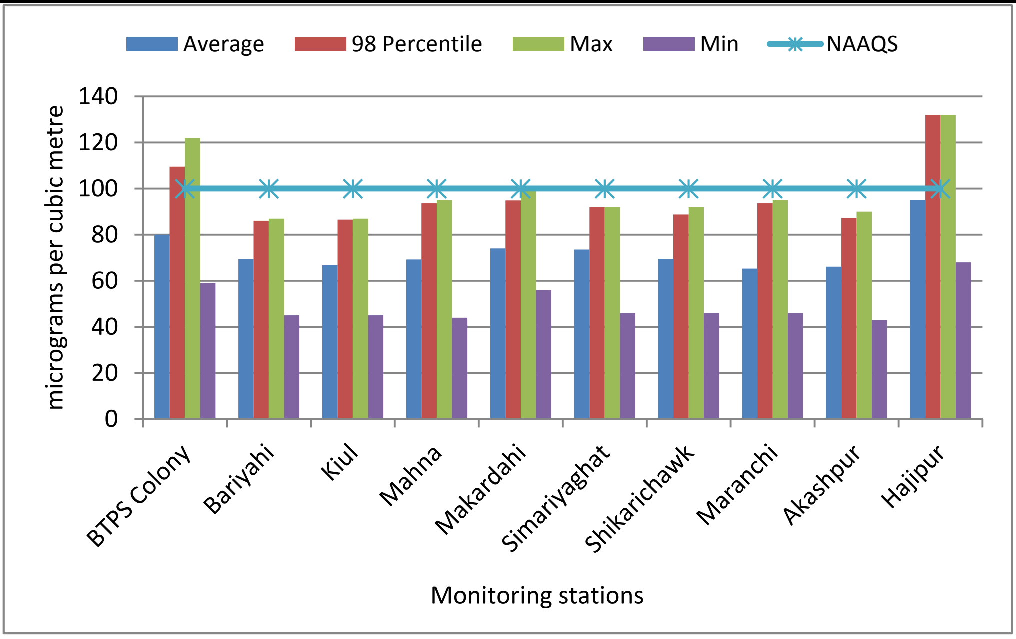


Particulate Matter (PM_{10})

The monitored average PM_{10} concentration varied from 65.29 µg/m³ to 95.17 µg/m³. The monitoring location AAQ 5 (Mahna) observed the minimum PM_{10}

concentration (of 44.00 µg/m^3), whereas the maximum was observed at AAQ 7 (Hajipur) (of 132.00 µg/m^3). Average PM_{10} concentrations were found to vary between 65.29-95.17 µg/m^3.The 98 percentile concentration of most of the monitoring locations was observed to be within the prescribed NAAQS limits for industrial, residential, rural and other areas (of 100 µg/m^3) excepting AAQ 7 (Hajipur) (of 132.00 µg/m^3) and AAQ 8 (BTPS Colony) (of 109.58 µg/m^3). The possible reasons for incremental values at PM_{10} at AAQ 7 (Hajipur) and AAQ 8 (BTPS colony) is similar as explained for $PM_{2.5}$. Graphical representation of PM_{10} in the study area is presented in ***Figure 4.18.***

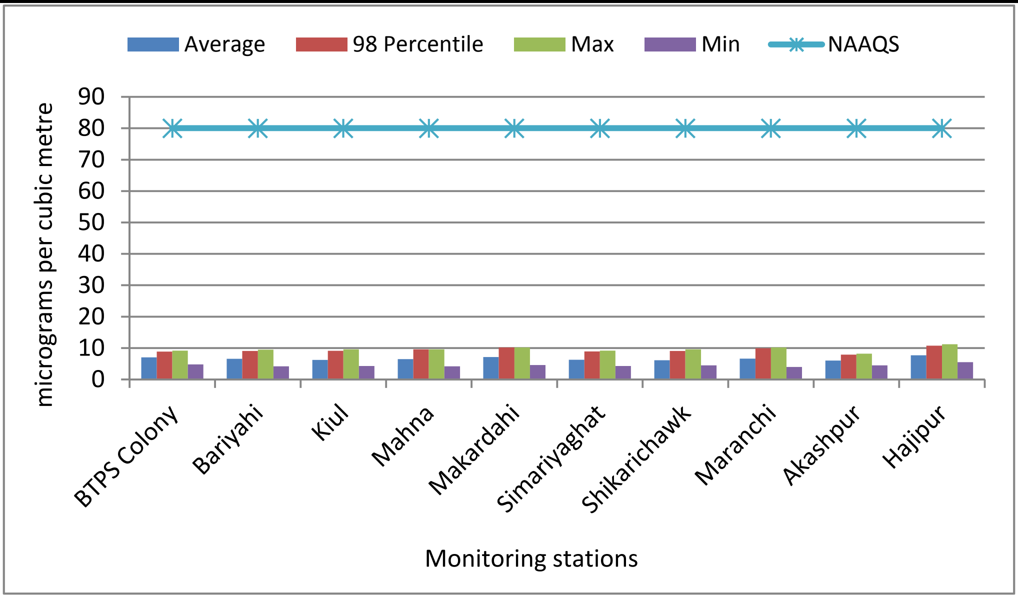
Figure 4.18 Graphical Representation of PM_{10} in the Study Area



<u>*Sulphur dioxide (SO_2)*</u>

The monitored average SO_2 concentration varied from 6.02 µg/m^3 to 7.71 µg/m^3. The monitoring location AAQ 3 (Maranchi), observed the minimum SO_2 concentration (of 4.00 µg/m^3), whereas the maximum was observed at AAQ 7 (Hajipur) (of 11.20µg/m^3). The 98 percentile concentration of SO_2 at all locations monitoring locations was observed to be below the prescribed NAAQS limits for industrial, residential, rural and other areas (of 80µg/m^3). Graphical representation of SO_2 concentrations in the study area is given in ***Figure 4.19.***

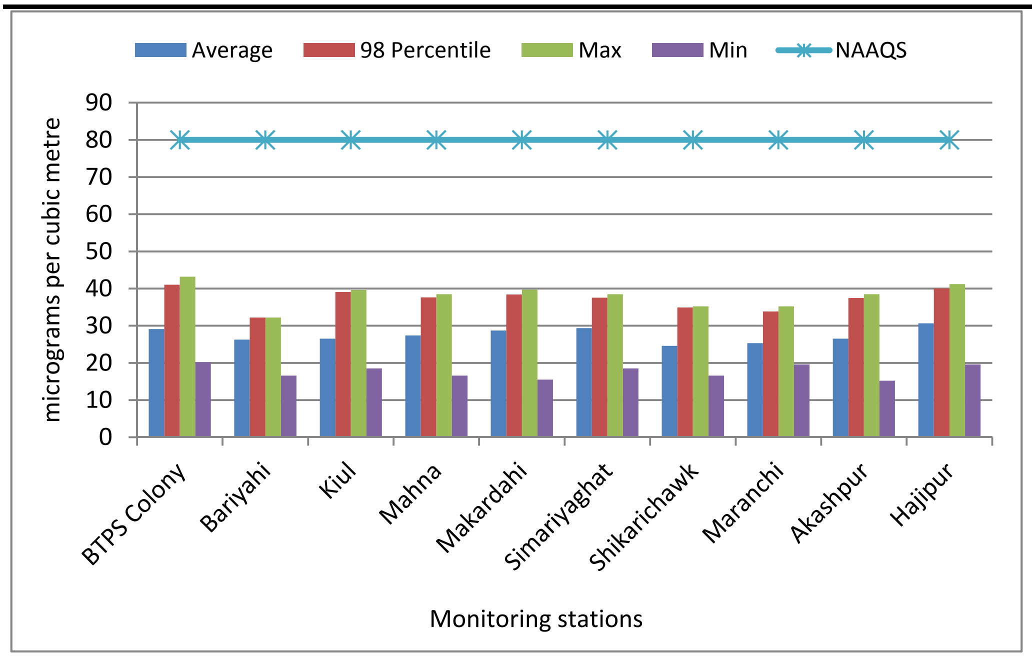
Figure 4.19 ***Graphical representation of SO_2 concentrations in the study area***



<u>*Nitrogen Dioxide (NO_2)*</u>

The monitored average NO_2 concentrations at the stations varied from 24.60 µg/m³ to 30.65 µg/m³. The monitoring location AAQ 10 (Akashpur) revealed the minimum NO_2 concentration (of 15.20 µg/m³), whereas the maximum was observed at AAQ 8 (BTPS Colony) (of 43.20 µg/m³). The 98 percentile concentration of NO_2 at all monitoring locations was observed to be below the prescribed NAAQS limits for industrial, residential, rural and other areas (of 80µg/m³). Graphical representation of NO_2 concentrations in the study area is given in ***Figure 4.20.***

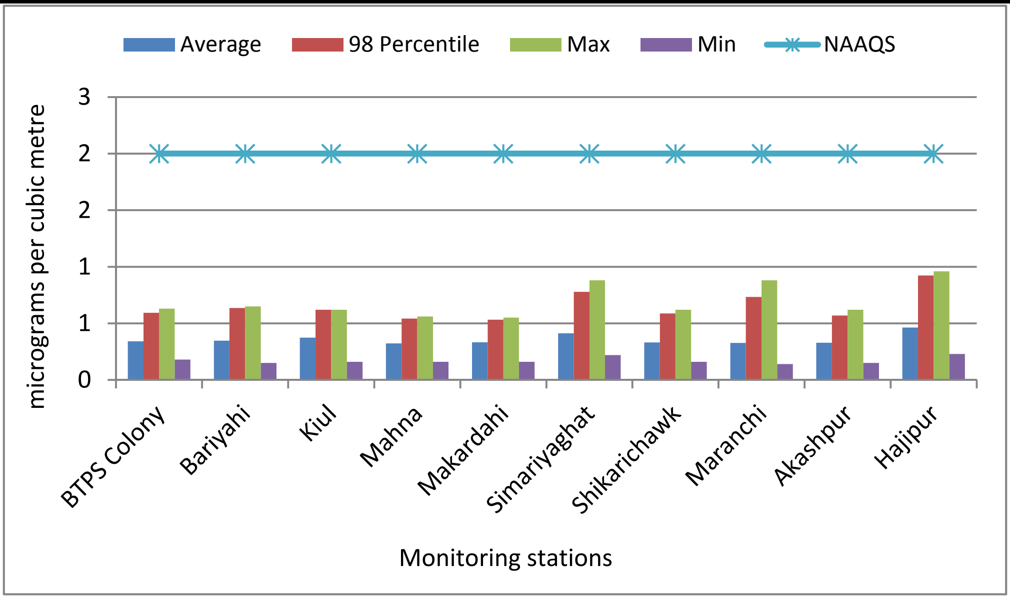
Figure 4.20 ***Graphical Representation of NO_2 Concentrations in the Study Area***



Carbon Mono-oxide (CO)

The monitored average CO concentration varied from 0.32 mg/m³ to 0.46 mg/m³. The monitoring location AAQ 10 (Akashpur) and AAQ 9 (Bariyahi) revealed the minimum NO_2 concentration (of 0.15 mg/m³), whereas the maximum was observed at AAQ 7 (Hajipur) (of 0.96 µg/m³). The 98 percentile concentration of CO at all monitoring locations was observed to be below the prescribed NAAQS limits for industrial, residential, rural and other areas (of 2 mg/m³). Graphical representation of CO concentrations in the study area is given in ***Figure 4.21.***

Figure 4.21 ***Graphical representation of CO in the Study Area***



Ozone (O_3)

The monitored maximum and minimum O_3 concentrations at the stations varied between <19.62 µg/m³ – 68.50 µg/m³. Maximum ozone concentrations at all the stations were in compliance to the NAAQ standards for industrial, residential, rural and other areas of 100 µg/m³.

Ammonia (NH_3)

The monitored maximum and minimum NH_3 concentrations at the stations varied between <10 µg/m³ – 29.60 µg/m³. Maximum ammonia concentrations at all the stations were in compliance to the NAAQ standards for industrial, residential, rural and other areas of 400 µg/m³.

Lead (Pb)

The monitored maximum and minimum lead concentrations at the stations varied between <0.02 µg/m³ – 0.06 µg/m³. Maximum lead concentrations at all the stations were in compliance to the NAAQ standards for industrial, residential, rural and other areas of 1.0 µg/m^3.

Nickel (Ni)

The monitored maximum and minimum nickel concentrations at the stations varied between <4.0 ng/m^3 – 19.47 ng/m^3. At the stations majority of the samples were observed to be below detection limit (BDL). There are no 24 hourly NAAQ standard for nickel. Maximum nickel concentrations at all the stations were in compliance to the NAAQ annual standard for industrial, residential, rural and other areas of 20 ng/m^3.

Arsenic (As)

The monitored maximum and minimum arsenic concentrations at the stations varied between <1.0 ng/m^3 – 5.60 ng/m^3. At the stations majority of the samples were observed to be BDL. There are no 24 hourly NAAQ standard for arsenic. Maximum arsenic concentrations at all the stations were in compliance to the NAAQ annual standard for industrial, residential, rural and other areas of 6 ng/m^3.

Benzene

Benzene is found in air as a result of emission from burning coal and oil, motor vehicle exhaust, wood burning etc. The monitored maximum and minimum benzene concentrations at the stations varied between <2.08 µg/m^3 – 5.66 µg/m^3. At all the stations majority of the samples were observed to BDL. Higher benzene values at AAQ 1 (Simariya Ghat) and AAQ 7 (Hajipur) are probably due to the proximity of the sites to the major roads, where vehicular emission is a possible source. There is no 24 hourly NAAQ standard value for benzene, the annual standard for industrial, residential, rural and other areas is 5 µg/m^3

Benzo (a) Pyrene, particulate phase (BaP)

BaP is a polycyclic aromatic hydrocarbon (PAH) that is a by product of incomplete combustion or burning of organic (carbon-containing) items, e.g., gasoline and wood. The monitored maximum and minimum benzo-alpha-pyrene concentrations at the stations varied between <0.4 ng/m^3 – 2.85 ng/m^3. At all the stations majority of the samples were observed to be BDL. There is no 24 hourly NAAQ standard for BaP. Higher maximum values at all the stations could possibly due to vehicular emissions, emission from oil refinery etc.

Mercury (Hg)

Mercury concentrations at all the stations were found to be <2.0 ng/m^3.

4.7.4 *Ambient Noise Levels*

The baseline noise monitoring in the study area was carried out during May-June 2015 with the objective of assessing the background noise levels.

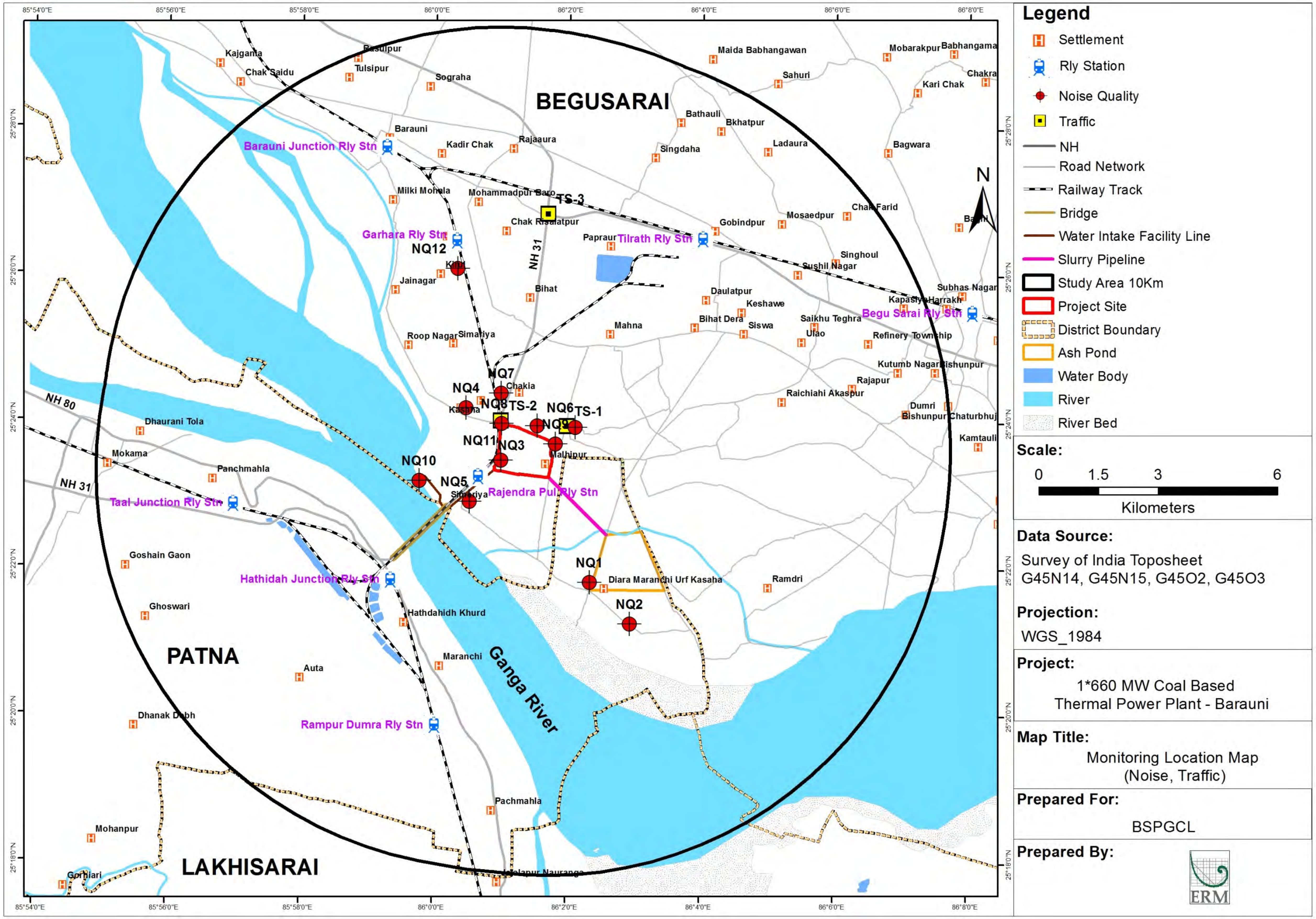
Details of noise measurement locations in the study area are given in ***Table 4.13*** and shown in ***Figure 4.22.*** The recorded noise levels in the study area are summarised in Table 4.14 and details results are given in ***Annex 4.3.***

Table 4.13 Noise Sampling Locations in the Study Area

SN.	Sampling Location	Station Code	Type of Activity	Geographical Coordinates	Distance w.r.t TPP	Direction w.r.t TPP	Remarks
1.	Kasaha Diara	NQ 1	Residential	$25^0$21'50.2" N $86^0$02'22.9" E	2.8	SE	Settlement near the ashpond area which may get impacted due to noise generated during construction of ashpond and movement of vehicles
2.	Dumra Janjira	NQ 2	Residential	$25^0$21'08.9" N $86^0$03'04.2" E	4.1	SE	Settlement near the ashpond area which may get impacted due to noise generated during construction of ashpond and movement of vehicles
3.	BTPS Colony	NQ 3	Residential	$25^0$23'54.2" N $86^0$01'41.2" E	0.23	N	Baseline noise levels at the BTPS colony which may get impacted due to construction and operation of old and new plants
4.	Bariyahi	NQ 4	Residential	$25^0$24'10.4" N $86^0$00'28.2" E	1	NW	A major settlement located in proximity to old and new plants

S N.	Sampling Location	Station Code	Type of Activity	Geographical Coordinates	Distance w.r.t TPP	Direction w.r.t TPP	Remarks
5.	Simariya Ghat	NQ 5	Residential	$25^0$22'46.3'' N $86^0$00'26.4'' E	1	SW	A major settlement located in proximity to old and new plants and transportation route
6.	Near Raichiahi-Chowrasta Towards Akashpur	NQ 6	Residential	$25^0$23'50.7'' N $86^0$03'19.8'' E	0.7	NE	A major settlement located in proximity to old and new plants and transportation route
7	Near Railway Crossing towards Bariyahi	NQ 7	Residential	$25^0$24'10.4'' N $86^0$00'28.2'' E	0.8	N	A settlement within the study area which may get impacted due to transportation of project vehicles
8	Near Chakiya Thermal Bus Stand	NQ 8	Industrial	$25^0$23'57.0'' N $86^0$00'59.8'' E	0.02	N	Baseline noise levels at the entry point of the old plant
9	Malipur Bintola	NQ 9	Residential	N $25^0$23'43.06 '' E $86^0$01'46.65 ''	0.09	E	Baseline noise levels at a hamlet located adjacent to the eastern boundary of the old plant
10	Simariya village near water Intake point	NQ 10	Residential	$25^0$23'57.6'' N $85^0$59'56.4'' E	1.9	SW	At receptor location near the water intake point
11	Entry Point of New Plant	NQ 11	Industrial	$25^0$23'26.5'' N $86^0$01'06.1'' E	At the boundary of the project site		At the entry point of the new point to assess baseline noise levels
12	Kiul	NQ 12	Residential	$25^0$26'03.8'' N $86^0$00'21.6'' E	4	NE	A major settlement within the study area which may get impacted due to transportation of project vehicles

Figure 4.22 Map Showing Noise and Traffic Sampling Locations in the Study Area



Source: Survey of India Toposheet

Discussion of Result

The hourly equivalent noise levels (Leq hourly) monitored for 24 hours at all the locations during pre-monsoon season of 2015 varied from 36.6 to 77.8 dB(A). The day time equivalent noise level reckoned from 0600 to 2200 hours (Leq day) varied from 51.8 to 62.2 dB(A) while night time equivalent noise level reckoned from 2200 to 0600 hours varied from 39.6 to 47.1 dB(A).

Hourly distribution of noise levels at each location during the study period has been presented in

Figure 4.23, whereas the comparison of the ambient noise levels (Leq) with respect to the applicable day and night time standards have been presented in ***Figure 4.24*** and ***Figure 4.25***, respectively.

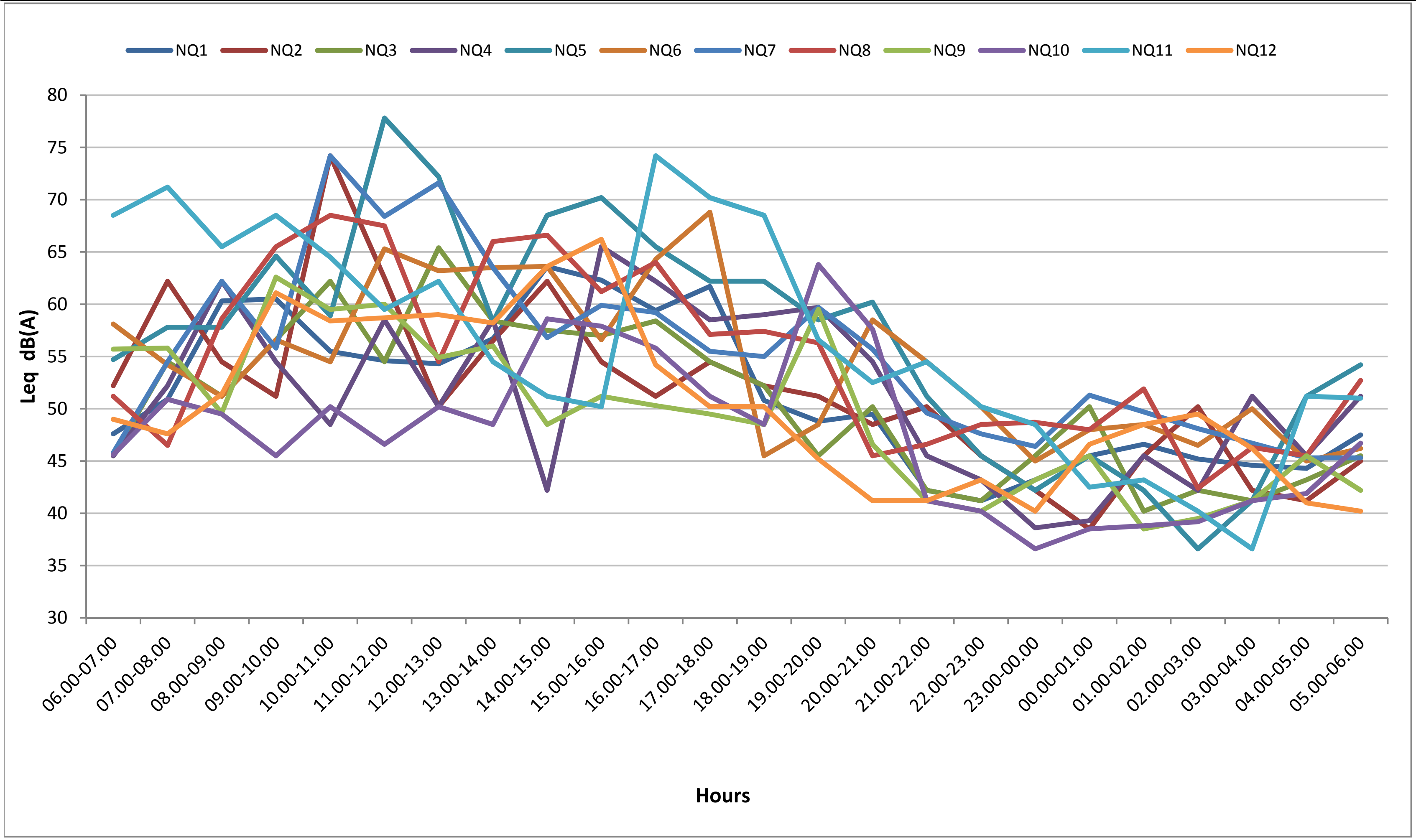
The day time equivalent noise levels monitored at Simariya Ghat, Railway crossing towards Bariyahi village and near Raichiahi were found to be exceeding the prescribed CPCB day time noise standards for residential areas (55 db(A)). The night time equivalent noise levels for Dumra Janjira, Near Raichiahi, Railway crossing towards Bariyahi Village and Kiul village were exceeding the prescribed CPCB night time noise standards for residential areas (45 db(A)). Day time and night time equivalent noise at Entry point of old and new plant were observed to be within the prescribed industrial noise limit of 75 dBA and 70 dBA during day and night time respectively. Higher day time and night time noise levels at residential areas could possibly due to noise generated from vehicle plying at the NH-31 and other village roads.

Table 4.14 Noise Levels in the Study Area during May-June 2015

S.N	Sampling Locations	Landuse	Leq Day (dBA)	Leq Night (dBA)	Lmax (dBA)	Lmin (dBA)	CPCB Limits Leq (dBA)	
							Day	Night
1	NQ-1	Residential	54.6	43.8	63.6	41.2	*55*	*45*
2	NQ-2	Residential	54.2	45.2	74.2	38.5	*55*	*45*
3	NQ-3	Residential	53.2	44.2	65.4	40.2	*55*	*45*
4	NQ-4	Residential	54.1	43.2	65.5	38.6	*55*	*45*
5	NQ-5	Residential	62.2	44.2	77.8	36.6	*55*	*45*
6	NQ-6	Residential	57.5	45.2	68.8	45.0	*55*	*45*
7	NQ-7	Residential	57.5	46.6	74.2	45.3	*55*	*45*
8	NQ-8	Industrial	58.5	46.6	68.5	42.4	*75*	*70*
9	NQ-9	Residential	52.5	42.2	62.6	38.5	*55*	*45*
10	NQ-10	Residential	51.8	39.6	63.8	36.6	*55*	*45*
11	NQ-11	Industrial	61.2	47.1	74.2	36.6	*75*	*70*
12	NQ-12	Residential	53.2	45.2	66.2	40.2	*55*	*45*

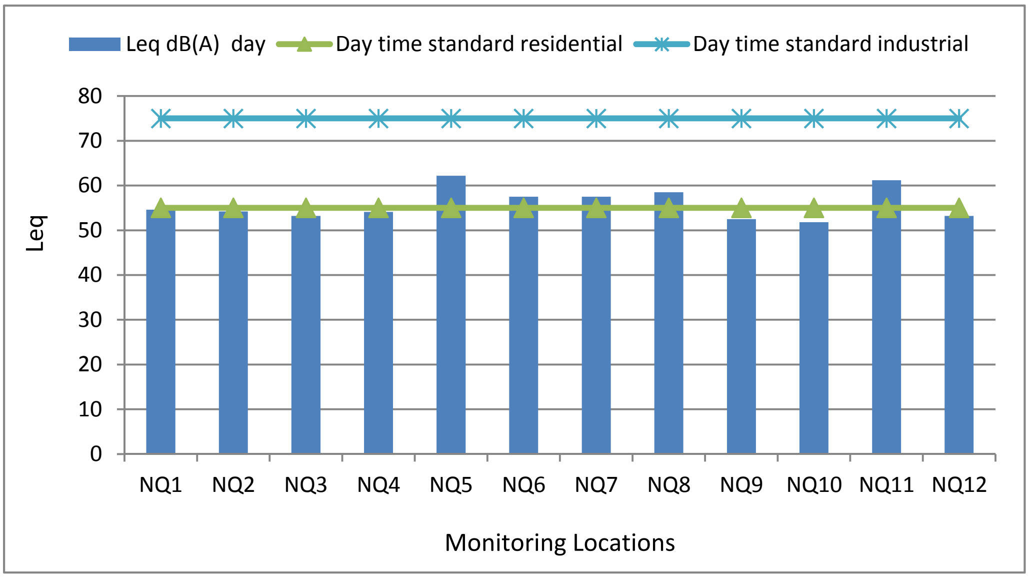
NQ1= Purba Kasaha Diara, NQ2= Janjira Dumra, NQ3= BTPS Colony, NQ4=Bariyahi Village, NQ5=Simariya Ghat, NQ6=Near Raichiahi – Chawk Towards Akashpur, NQ7=Railway Crossing towards Bariyahi Village,NQ8= Near Chakiya Thermal Bus Stand, NQ9= Malipur Bintola, NQ10=Simariya village near Water Intake Point, NQ11=Entry Point of New Plant, NQ12= Kiul Village

Figure 4.23 Hourly Noise Levels in the Study Area during May-June 2015



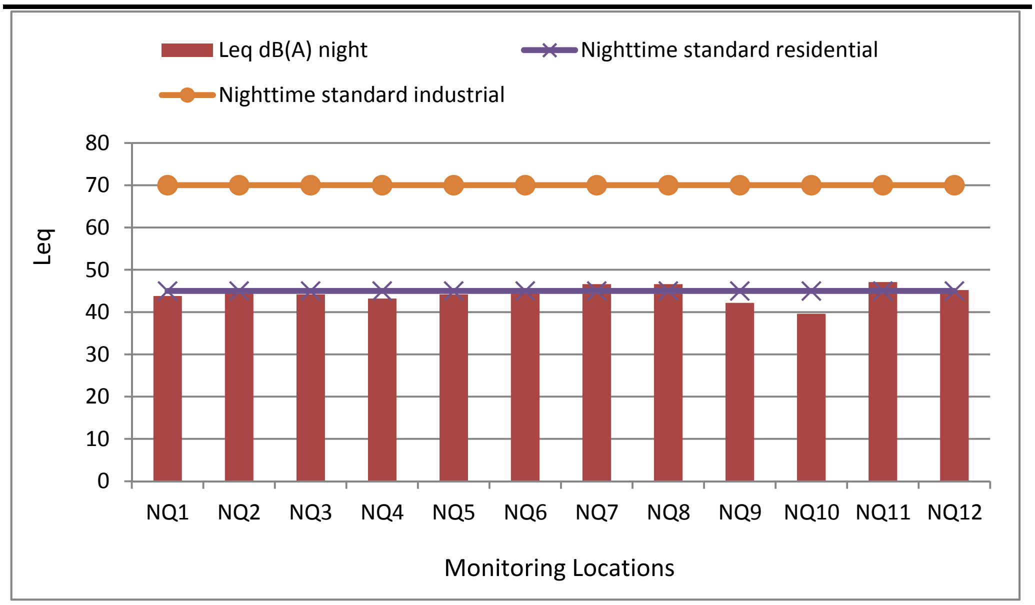
NQ1= Purba Kasaha Diara, NQ2= Janjira Dumra, NQ3= BTPS Colony, NQ4=Bariyahi Village, NQ5=Simariya Ghat, NQ6=Near Raichiahi – Chawk Towards Akashpur, NQ7=Railway Crossing towards Bariyahi Village,NQ8= Near Chakiya Thermal Bus Stand, NQ9= Malipur Bintola, NQ10=Simariya village near Water Intake Point, NQ11=Entry Point of New Plant, NQ12= Kiul Village

Figure 4.24 Day Time Noise Levels in the Study Area during May-June 2015



NQ1= Purba Kasaha Diara, NQ2= Janjira Dumra, NQ3= BTPS Colony, NQ4=Bariyahi Village, NQ5=Simariya Ghat, NQ6=Near Raichiahi – Chawk Towards Akashpur, NQ7=Railway Crossing towards Bariyahi Village,NQ8= Near Chakiya Thermal Bus Stand, NQ9= Malipur Bintola, NQ10=Simariya village near Water Intake Point, NQ11=Entry Point of New Plant, NQ12= Kiul Village

Figure 4.25 Night Time Noise Levels in the Study Area during May-June 2015



NQ1= Purba Kasaha Diara, NQ2= Janjira Dumra, NQ3= BTPS Colony, NQ4=Bariyahi Village, NQ5=Simariya Ghat, NQ6=Near Raichiahi – Chawk Towards Akashpur, NQ7=Railway Crossing towards Bariyahi Village,NQ8= Near Chakiya Thermal Bus Stand, NQ9= Malipur Bintola, NQ10=Simariya village near Water Intake Point, NQ11=Entry Point of New Plant, NQ12= Kiul Village

4.7.5 Traffic Survey

A traffic survey was conducted in the month of May 2015 on three locations, which would be used by project related vehicles so as to assess the baseline traffic scenario in the area. 24 hourly surveys were conducted for 2 days at each location. At each station one survey was conducted on one week day (Monday-Friday) and at one weekend day (Saturday-Sunday). The details of traffic survey locations are given in ***Table 4.15*** and map showing locations of traffic survey is provided as ***Figure 4.22.*** Summary traffic values observed in the study area is given in ***Table 4.16***. The detailed observations are given in ***Annex 4.4.***

Table 4.15 Summary of Traffic Count Survey Locations

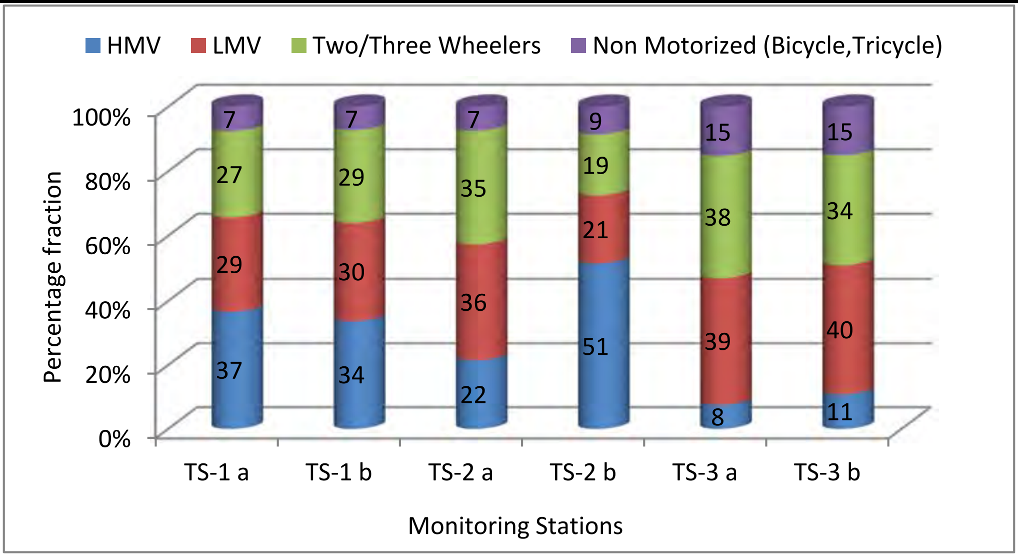
S.N.	Sampling Location	Station Code	Geographical Coordinates	Distance w.r.t TPP	Direction w.r.t TPP	Justification for Selection of Location
1	NH-31 (at Zero Mile towards Begusarai)	TS-1	$25^0$26'49.5'' N $86^0$01'41.0'' E	0.53	NE	Major road connecting the area with district headquarter Begusarai
2	NH- 31 (Chakia Thermal Power Bus stop)	TS-2	$25^0$24'00.1'' N 86^0.00'59.3'' E	0.08	NE	Main access road to the the TPP
3	Bundh Road near BTPS Colony	TS-3	$25^0$23'55.7'' N $86^0$01'58.8'' E	5.6	N	Access road to the proposed ash pond, alternate access road to the plant

Table 4.16 Traffic Values observed in the Project study area

Description	TS-1		TS-2		TS-3	
Date	28.05.15	30.05.15	24.05.15	26.05.15	27.05.15	30.05.15
	Thursday	Saturday	Sunday	Tuesday	Wednesday	Saturday
Total Traffic (Nos.)/24 Hours (To & fro)	6542	7267	5414	5781	2913	2974
Average Traffic Flow/Hr	273	303	226	241	121	124
Max Traffic Flow (Nos)/Hr	570	635	338	359	228	232
Min Traffic Flow (Nos)/Hr	41	93	65	95	0	25
Maximum Traffic Flow Hours	10:00 to 11:00 hrs	11:00 to 12:00 hrs	15:00 to 16:00 hrs	16:00 to 17:00 hrs	16:00 to 17:00 hrs	14:00 to 15:00 hrs
Minimum Traffic Flow Hours	03:00 to 04:00 hrs	04:00 to 05:00 hrs	03:00 to 04:00 hrs	02:00 to 03:00 hrs	02:00 to 03:00 hrs	02:00 to 03:00 hrs

TS-1 a= NH-31 (at Zero Mile towards Begusarai), weekday; TS-1 b= NH-31 (at Zero Mile towards Begusarai), weekend; TS-2 a= NH- 31 (Chakia Thermal Power Bus stop) , weekday; TS-2 b= NH- 31 (Chakia Thermal Power Bus stop) , weekend; TS-3 a = Bundh Road near BTPS Colony, weekday; TS-3 b = Bundh Road near BTPS Colony, weekend

Figure 4.26 *Break -up of Vehicle Composition*



TS-1 a= NH-31 (at Zero Mile towards Begusarai), weekday; TS-1 b= NH-31 (at Zero Mile towards Begusarai), weekend; TS-2 a= NH- 31 (Chakia Thermal Power Bus stop) , weekday; TS-2 b= NH- 31 (Chakia Thermal Power Bus stop) , weekend; TS-3 a = Bundh Road near BTPS Colony, weekday; TS-3 b = Bundh Road near BTPS Colony, weekend

Discussion of Result

TS1- NH-31 (at Zero Mile towards Begusarai)

Total no of vehicles in 24 hours observed on weekday (Thursday) and weekend (Sunday)were 6542 nos and 7267 nos respectively (***Table 4.15***). As per observations made for traffic density, the during weekday minimum traffic was observed to be 41 numbers of vehicles during the early morning between 03:00 to 04:00 hrs, while maximum traffic observed is 570 numbers between 10:00 to 11:00 hrs. During weekend, minimum 93 numbers of vehicles were observed during the early morning between 04:00 to 05:00 hrs, while maximum traffic observed is 635 numbers between 11:00 to 12:00 hrs.

The observations of traffic distribution indicate that Heavy Motor Vehicles (HMVs) constitute the maximum percentage (37% & 34%) of traffic for both the days followed by Light Motor Vehicles (LMVs) and two & three wheelers. Percentages of non-motorized vehicles were least for both days. The percentage frequency of distribution of vehicles is presented in ***Figure 4.26.***

TS2- NH- 31 (Chakia Thermal Power Bus stop)

Total no of vehicles in 24 hours observed at weekday (Tuesday) and weekend (Sunday)were 5781 nos and 5414 nos respectively (***Table 4.15***). As per observations made for traffic density, the during weekday minimum traffic was observed to be 95 numbers of vehicles during the late night between 02:00 to 03:00 hrs, while maximum traffic observed is 359 numbers between 16:00 to 17:00 hrs. During weekend, minimum 65 numbers of vehicles were observed during the early morning between 03:00 to 04:00 hrs, while maximum traffic observed is 341 numbers between 15:00 to 16:00 hrs.

The observations of traffic distribution indicate that LMVs constitute the maximum percentage (36%) followed by two/three wheelers (35%), HMVs (22%) and non –motorized vehicles (7%). A contrasting traffic composition was observed during the weekend with HMVs constituting the maximum percentage of vehicles (51%), followed by LMVs (21%), two/three wheelers (19%) and non-motorized vehicles (9%). The percentage frequency of distribution of vehicles is presented in ***Figure 4.26.***

TS3- Bundh Road near BTPS Colony

Total no of vehicles in 24 hours observed at weekday (Wednesday) and weekend (Saturday)were 2913 nos and 2974 nos respectively (***Table 4.15***) which was much less that the other two survey locations located in NH-31. As per observations made for traffic density, during weekday no vehicle was observed during 02:00 to 03:00 hrs, while maximum traffic observed is 228 numbers between 16:00 to 17:00 hrs. During weekend, minimum 25 numbers of vehicles were observed during the early morning between 02:00 to 03:00 hrs, while maximum traffic observed is 232 numbers between 14:00 to 15:00 hrs.

The observations of traffic distribution indicate that LMVs constitute the maximum percentage (39% & 40%) of traffic for both the days followed by two/three wheelers (38% & 34%). Percentages of HMVs were much less compared to the other stations (8% & 11%). The percentage frequency of distribution of vehicles is presented in ***Figure 4.26.***

Traffic count was much higher in the survey locations at NH-31 compared to the Bandh road as the national highway 31 is an important road starting from Barhi in Jharkhand and passes through Bihar, West Bengal and ends in Guwahati, Assam. The road serves as the main connecting link between South and North Bihar. Movement of heavy trucks, trailers etc. are frequent in the road for carriage of goods. Buses commute in the road for transportation of passengers. There is no marked difference in traffic numbers at the locations in week days and week ends which could be due to the fact there are no major Govt. and private offices in the roads.

4.8 WATER ENVIRONMENT

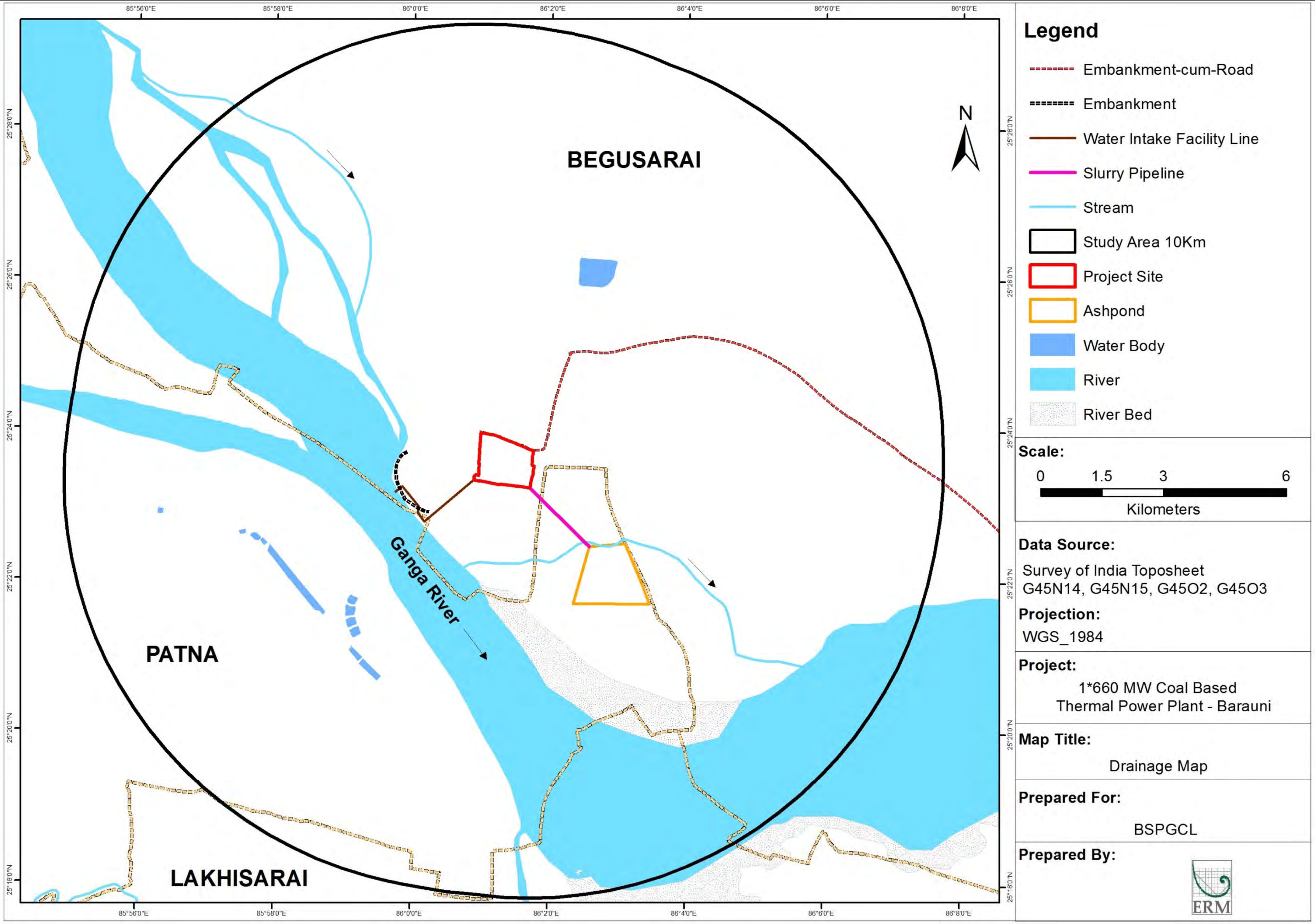
4.8.1 Hydrology

The hydrology of the area has been studied in order to establish the baseline conditions of the physico-chemical and biological conditions of the surface and groundwater quality of the study area.

The study area is located at the basin of the lower Ganga River. Ganga is a snow fed and major river of the Indian subcontinent. The river originates from

Gaumakh in Garhwal Himalayas. It passes the towns and cities like Gangotri, Haridwar in Uttarakhand, Kanpur, Allahabad, Varanasi, GHajipur in UP and enter in the boundary of Bihar at Chausa, near Buxar. It is joined by the three great tributaries during its course in Bihar, the Ghaghra, the Gandak, and the Son. It passes through the cities& towns viz. Patna, Barh, Mokama, Begusarai, Munger, Khagaria, Bhagalpur, Kahalgaon, Pirpainti, in Bihar and exit to Saheb ganj in Jharkhand and then to West Bengal. The River Ganga flows through the middle of the study area from west to east. The nearest stretch of the river is located at an approximate distance of 2.4 km south of the proposed plant. As the River Ganga is flood prone in this stretch, embankments constructed at the northern bank near Simariya and also at the north of the BTPS project site. Both the BTPS project site and the proposed ash pond is located in flood prone areas.

Figure 4.27 Map showing Drainage Pattern within 10 km Study Area



Source Survey of India Toposheet

4.8.2 *Hydrogeology*[1]

Patna district is underlain by unconsolidated formation which is quaternary to Upper quaternary of age group. Lithologically, the district is made up of recent alluvium, clay, silt, sand, gravel pebbles with concentration of calcareous materials. From the groundwater potential point of view the entire Patna district falls under good to very good category. The presence of kankar (nodules of $CaCO_3$) and fine sand at places render the top clay zone semi-pervious in nature, where ground water occurs under phreatic condition. These aquifers are made up of fine to medium grained sand occasionally coarse with thin layers of gravel at places. The depth to piezometric surface in the area varies from 6.25m to 16.30 m. The deep tube wells tapping these deeper aquifers have yield from 260m^3/hr to 1500m^3/hr. with a drawdown of 6 m. The transmissivity of the aquifer varies from 3786 m^2/day to 14133 m^2/day. Hydrogeology of the study area is presented below[2] and the hydrogeology of Bihar with study area is shown in ***Figure 4.28.***

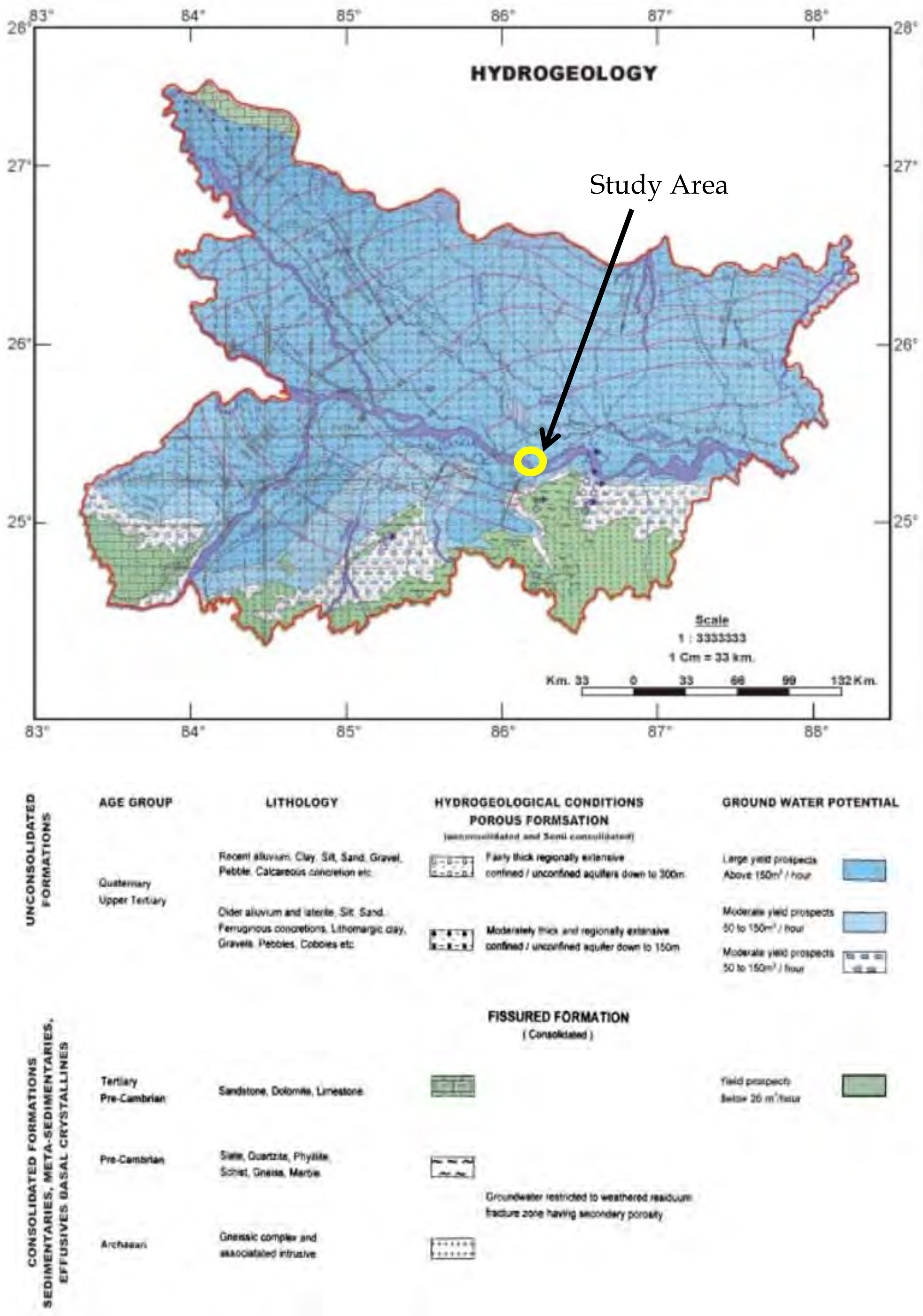
- Age Group- Upper Tertiary, quaternary
- Lithology- Recent alluvium, clay, silt, sand, gravel, pebble, calcareous concentration etc.
- Hydrogeological condition- Porous formation , fairly thick, regionally extensive, confined/unconfined aquifers down to 300 m
- Groundwater potential- Large yield prospects, greater than 150 m^3/hour.

Groundwater in the area is used for domestic purposes viz. drinking, bathing, washing and is primarily tapped by tube wells. Groundwater is also used for irrigation purpose and is sourced primarily from bore wells. The industrial units within the area *viz.* the operating IOCL refinery and existing unit of BTPS, new unit under construction also source water from groundwater.

(1) Source: District Groundwater Brochure, Central Ground Water Board, Ministry of Water Resources, July 2007

(2) State of Environment Report, Bihar, February 2007

Figure 4.28 *Hydrogeology of Bihar*



Source: State of Environment Report, Bihar, February 2007

4.8.3 *Water Quality*

The baseline water quality in the study area was analysed for ground and surface water samples. The sampling locations were selected based on reconnaissance survey with the considerations of:

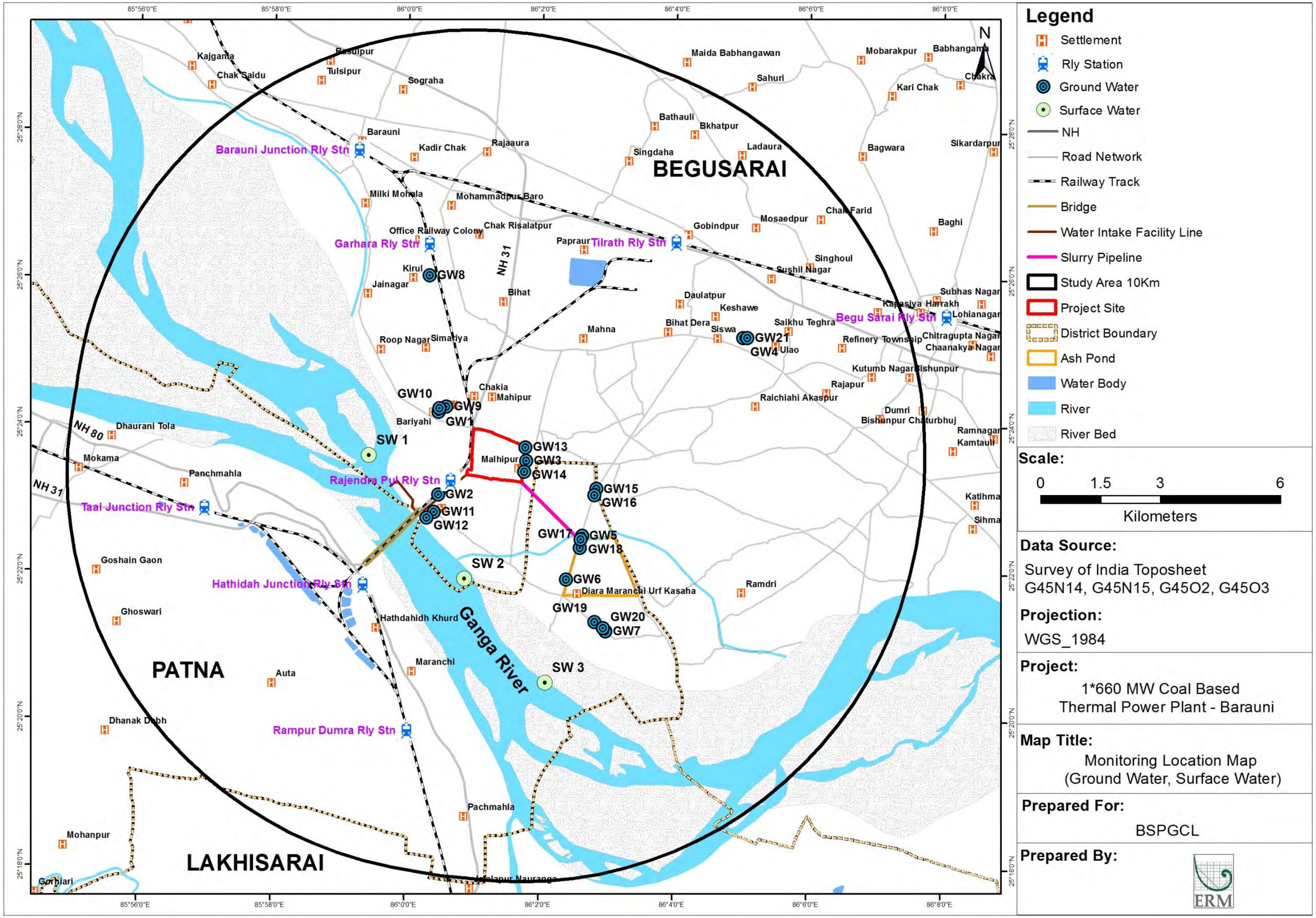
- presence of water resource;
- access to water resource; and
- representative coverage of study area.

The quality of groundwater was compared with IS: 10500, 2012 Drinking Water Standards and surface water was compared with CPCB Water Use Criteria. Total of 21 groundwater locations from 9 villages within the study area and 3 surface water locations from Ganga River were identified. Groundwater samples were collected once from these locations. At each location, 3 surface water samples were collected, once in each month, during the study period of April-June 2015. The details of the sampling locations identified in the study area for water quality monitoring are given in

Table 4.18 and shown in ***Figure 4.29.***

The water quality was assessed for physical, chemical and bacteriological parameters as per the Bureau of India Standards IS: 10500, 2012 specifications with additional parameters such as COD, BOD etc. The analytical protocols followed for analysis of water samples is provided in ***Table 4.17*** and the results are presented in ***Table 4.19*** and ***Table 4.20.***

Figure 4.29 Water Sampling locations in the Study Area



Source: Survey of India toposheets

Table 4.17 Analytical Protocol Followed for Water Quality Monitoring and Analysis

SN	Parameter	Protocol Followed
1.	pH at 26 deg C	APHA 22nd Edition 4500-H+B
2.	Colour	APHA 22nd Edition. 2120B
3.	Odour	APHA 22nd Edition. 2150B
4.	Turbidity	APHA 22nd Edition. 2130B
5.	TDS	APHA 22nd Edition,2540C
6.	Al	APHA 22nd Edition. 3111 D
7.	Ammonia	APHA 22^{nd} Edition-2012, 4500NH_3 – F
8.	Anionic Detergent	APHA 22nd Edition. 5540-C
9.	Ba	APHA 22nd Edition. 3111 D
10	B	APHA 22^{nd} Edition 4500-B C
11	Ca	APHA 22nd Edition. 3500 Ca B
12	Cl	APHA 22nd Edition. 4500 Cl B
13.	Cu	APHA 22nd Edition 3111B
14.	F	APHA 22nd Edition. 4500 F
15.	Free Residual Chlorine	IS 3025(Part.2b)-1986 Reaf.2003
16.	Fe	APHA 22nd Edition 3500 Fe
17.	Mg	APHA 22nd Edition 3500 Mg B
18.	Mn	APHA 22^{nd} Edition, 3111B
19.	Mineral Oil	IS 3025 Part (39) 1991
20	Phenolic compounds	APHA 22nd Edition. 5530 C
21.	Se	APHA 22nd Edition..3114C
22.	Ag	APHA 22nd Edition. 3111 B
23.	SO4	APHA 22nd Edition. 4500 SO_{4-E}
24.	Sulphide	APHA 22nd Edition. 4500 S-
25.	Total Alkalinity	APHA 22nd Edition. 2320B
26.	Total Hardness	APHA 22nd Edition. 2340 C
27.	Zn	APHA 22nd Edition. 3111 B
28.	Cd	APHA 22^{nd} Edition, 3111B
29.	Cyanide	APHA 22nd Edition.4500 CN-F
30.	Pb	APHA 22^{nd} Edition.3111B
31.	Hg	APHA 22nd Edition. 3112B
32.	Mo	APHA 22^{nd} Edition.3111B
33.	Ni	APHA 22nd Edition. 3111B
34.	Polychlorinated biphenyls	US EPA 8082 - Dec,1996
35.	PAH	APHA 22nd EDITION - 2012 6440C / US EPA 8270C - December ,1996
36.	Total Arsenic	APHA 22nd Edition. 3114 B
37.	Total Chromium	APHA 22nd Edition. 3111 D
38.	BOD	APHA 22nd Edition.5210 B
39.	COD	APHA 22nd Edition.5220 B
40.	Oil & Grease	APHA 22nd Edition. 5520 B
41.	SAR	Diagnosis & Improvement of Saline & Alkali Soils Pg. No. 72
42.	Pesticide as lindane	US EPA 508 - 08/01/1995 , AOAC 18th Ed. 2005 (Rev.2007) Official Method 990.06
43.	Benzo Alpha Pyrene	APHA 22nd EDITION - 2012 6440C / US EPA 8270C - December ,1996
44.	Total coliform	APHA 22nd Edition,2012,9221 B,Pg-9-66
45.	*E.coli*	APHA 22nd Edition,2012,9221F

Table 4.18 Water Sampling Locations in the study area

S.N.	Settlement Name	Sampling Location	Station Code	Type of Sample	Geographical Coordinates	Distance w.r.t TPP	Direction w.r.t TPP	Justification for the selection
Ground water sampling locations								
1	Bariyahi	Bariyahi Village -1	GW-1	Ground Water	25°24' 10.8" N 086°00'28.3" E	1	NW	To assess groundwater quality at a major settlement located close to the plant
2		Bariyahi Village -2	GW-9	Ground Water	25°24' 15.3" N 86°00' 35.3" E	0.8	SW	To assess groundwater quality at a major settlement located close to the plant
3		Bariyahi Village -3	GW-10	Ground Water	25°24' 13.9" N 86°00' 28.9.3" E	0.02	E	To assess groundwater quality at a major settlement located close to the plant
4	Simariya Ghat	Simariya Ghat -1	GW-2	Ground Water	25°23' 03.4" N 86°00'28.6" E	6	NE	To assess groundwater quality at a major settlement located close to the plant and proposed ash pond
5		Simariya Ghat -2	GW-11	Ground Water	25°22' 49.4" N 86°00'24.8" E	2	SE	To assess groundwater quality at a major settlement located close to the plant and proposed ash pond
6		Simariya Ghat -3	GW-12	Ground Water	25°22' 44.5" N 86°00'18.0" E	2.6	SE	To assess groundwater quality at a major settlement located close to the plant and proposed ash pond
7	Malipur Bintola	Malipur Bintola 1	GW-3	Ground Water	25°23' 31.3" N 86°01'47.3" E	4.2	SE	To assess groundwater quality at a major settlement located close to the plant

S.N.	Settlement Name	Sampling Location	Station Code	Type of Sample	Geographical Coordinates		Distance w.r.t TPP	Direction w.r.t TPP	Justification for the selection
8		Malipur Bintola-2	GW-13	Ground Water	25°23' 42.2" N 86°01'46.5" E		4	NW	To assess groundwater quality at a major settlement located close to the plant
9		Malipur Bintola 3	GW-14	Ground Water	25°23' 22.6" N 86°01'45.5" E		0.8	NW	To assess groundwater quality at a major settlement located close to the plant
10	Jangira Dumra	Jangira Dumra 1	GW-7	Ground Water	25°21'12.96" N 86°2'59.28" E		1	NW	To assess groundwater quality at a settlement located close to proposed ash pond
11		Jangira Dumra 2	GW-19	Ground Water	25°21' 20.4" N 86°02'49.2" E		1.2	SW	To assess groundwater quality at a settlement located close ash pond
12		Jangira Dumra 3	GW-20	Ground Water	25°21' 15.5" N 86°02 '57.1" E		1.4	SW	To assess groundwater quality at a settlement located close to proposed ash pond
13	Vijaygarh Tola	Vijaygarh Tola 1	GW-5	Ground Water	25°22'30.72" N 86°2'37.68" E		0.02	E	To assess groundwater quality at a settlement located close to proposed ash pond
14		Vijaygarh Tola 2	GW-17	Ground Water	25°22' 20.7" N 86°02'35.6" E		0.03	E	To assess groundwater quality at a settlement located close to proposed ash pond
15		Vijaygarh Tola 3	GW-18	Ground Water	25°22' 27.8" N 86°02'36.5" E		1.89	E	To assess groundwater quality at a settlement located close to proposed ash pond

S.N.	Settlement Name	Sampling Location	Station Code	Type of Sample	Geographical Coordinates		Distance w.r.t TPP	Direction w.r.t TPP	Justification for the selection
16	Makardahi	Makardahi 1	GW-4	Ground Water	25°25'12.72" N 86°5'4.92" E		1.85	E	To assess groundwater quality of a dug well used as drinking water source within the study area
17		Makardahi 2	GW-21	Ground Water	25°25' 12.7" N 86°05' 04.6" E		2.2	SE	To assess groundwater quality at a major settlement located close to the plant
18	Sitarampur	Sitarampur 1	GW-15	Ground Water	25°23' 08.9" N 86°02'50.1" E		2	SE	To assess groundwater quality at a major settlement located close to the plant
19		Sitarampur 2	GW-16	Ground Water	25°23' 03.8" N 086°02'48.5" E		3.94	SE	To assess groundwater quality at a major settlement located close to the plant
20	Kasaha Diara	Kasaha Diyara 1	GW-6	Ground Water	25°21'55.08" N 86°2'23.64" E		4.1	SE	To assess groundwater quality at a settlement located close to proposed ash pond
21	Kiul	Kiul Village	GW-8	Ground Water	25°26 '02.9" N 86°00' 19.6" E		6.1	NE	To assess groundwater quality at a major settlement located close to the plant
Surface water sampling locations									
1	Ganga River	Ganga River-Upstream	SW1	Surface Water	25°23'35.23'' N 85°59' 25.68''E		2.5	W	Upstream of project site and ash pond
2	Ganga River	Ganga River-Near Simariya Ghat	SW2	Surface Water	25°21'55.05'' N 86°00'52.1''E		2.6	S	The site is located at south of the new plant near the Simariya Ghat

S.N.	Settlement Name	Sampling Location	Station Code	Type of Sample	Geographical Coordinates		Distance w.r.t TPP	Direction w.r.t TPP	Justification for the selection
3	Ganga River	Ganga River-Downstream	SW3	Surface Water	25°20'30.54'' N 86°02'04.82'' E		5	S	Downstream of the project site and ash pond

Discussion of Results for Surface Water Quality

The result of surface water quality is given in ***Table 4.19.*** The observations from the analysis of all sources at the three sampling months (April, May and June, 2015) are discussed below, the surface water sampled were compared with the designated best use classification to obtain the water quality status of the stretch of Ganga River in the study area.

SW-1 Ganga River upstream

The station is at upstream at Ganga River. It is located about 2 km upstream of the Simariya Ghat. The parameter wise classification at the three sampling months and overall classification for SW-1 is as given:

- pH of the samples varied between 7.46-7.88 with very little variation between the months.
- Turbidity content of the sample collected in May was higher (58 NTU) compared to April (21 NTU) and June (10.6 NTU) samples.
- Dissolved Oxygen (DO) levels varied between 5.0-8.8 mg/l at the sampling months. DO levels were high at the sample collected in April (8.8 mg/l), whereas the samples collected in May and June showed DO levels 5 mg/land 5.7 mg/l respectively.
- Biochemical Oxygen Demand (BOD) was observed to be <2.0 mg/l during April and June and 2.3 mg/l during May.
- Total Coliform contents were observed to be 350 MPN/100 ml during April, 1600 MPN/100 ml during May and 22 MPN/100 ml during June, whereas faecal coliform and *E. coli* was present at the April sample only.
- Ammonia nitrogen was observed to be <1.0 mg/l at all the months
- Electrical conductivity (EC) values varied between 255-325 µs/cm at the sampling months.
- Sodium Absorption Ratio (SAR) values at three months varied between 0.35-0.62
- Boron values were found to be <0.5 mg/l during April and May samples, however, the June sample revealed Boron value of 2.8 mg/l.
- Oil and grease content at all the monthly samples were found to be <1.4 mg/l
- Pesticides (as lindane) of all the monthly samples were found to be <0.00001 mg/l
- Heavy metal viz. Cu, Zn, Ni, Cd, Pb, Hg contents at the samples collected in April, May and June are all found to be below detection limits (BDL).

Water in the stretch of Ganga River is used for bathing, catching fish and also for supply of water to the towns located at the banks of the river.Considering the above classification the samples collected in April and June complies with CPCB "B" criterion (*Outdoor bathing (Organized*)), and the May sample qualified with "C" (*Drinking water source after conventional treatment and disinfection*) criterion. All the samples also qualifies for category "D", i.e. *Propagation for Wildlife and Fisheries* also April and May samples were also compliant to Criteria "E" (*Irrigation, Industrial Cooling and Controlled Waste Disposal*). The June sample with Boron values <2.0 mg/l did not qualify for the criterion.

SW-2 Ganga River near Simariya Ghat

The station is at south of the BTPS plant area and is located about 1.8 km downstream of Simariya Ghat. Simariya Ghat is a Hindu pilgrimage extensively used for bathing. Rituals like *Mundan, Shradhh* etc. are practiced here. A jetty is located at the Ghat for anchorage of the vessels commuting between Simariya Ghat and Hatidah on the other side of the River. The parameter wise classification at the three sampling months and overall classification for SW-2 is as given:

- pH of the samples varied between 7.61-7.88 with very little variation between the months.
- Turbidity content of the sample collected in May was higher (62 NTU) followed by June (59 NTU) compared to April (22.5 NTU) samples.
- DO levels were varied between 5.2-8.4 mg/l at the sampling months. DO levels were high at the sample collected in April (8.4 mg/l), whereas the samples collected in May and June showed DO levels 5.2 mg/land 6.1 mg/l respectively.
- BOD values were observed to be <2.0 mg/l during April and during May and June the values were observed as 2.64 mg/l and 2.1 mg/l respectively.
- Total coliform contents were observed to be 1600 MPN/100 ml during April and May and 34 MPN/100 ml during June, whereas faecal coliform and *E. coli* was present at all the monthly samples.
- Ammonia nitrogen was observed to be <1.0 mg/l at all the months
- EC values varied between 250-325 μs/cm at the sampling months.
- SAR values at three months varied between 0.44-0.65
- Boron values were found to be <0.5 mg/l during April and May samples, however, the June sample revealed Boron value of 4.1 mg/l.
- Oil and grease content of all the monthly samples were found to be <1.4 mg/l
- Pesticides (as lindane) of all the monthly samples were found to be <0.000001 mg/l
- Heavy metal viz. Cu, Zn, Ni, Cd, Pb, Hg contents at the samples collected in April, May and June are all found to be below detection limits (BDL)

Considering the above classification the samples collected in April and May complies and June qualifies with CPCB criterion "B". All the samples also qualify for category "D" and also April and May samples were also compliant to Criteria "E". The May sample with Boron values 4.1 mg/l did not qualify for the criterion. The water in the stretch of Ganga River is used for bathing, catching fish and also for supply of water to the towns located at the banks of the river.

SW-3 Ganga River Downstream

The station is at south of the proposed ash pond area plant area and is located about 5 km downstream of Simariya Ghat. The parameter wise classification at the three sampling months and overall classification for SW-2 is as given:

- pH of the samples varied between 7.61-7.87 with very little variation between the months.
- Turbidity content of the sample collected in May was higher (60 NTU) followed by June (47.2 NTU) compared to April (23.8 NTU) samples.
- DO levels were varied between 5.8-7.9 mg/l at the sampling months. DO levels were high at the sample collected in June (7.9 mg/l), whereas the samples collected in April and May showed DO levels 7.6 mg/land 5.8 mg/l respectively.
- BOD values were observed to be <2.0 mg/l during April and May and during June the values were observed as 2.0 mg/l.
- Total coliform contents were observed to be 1600 MPN/100 ml during May and 22 MPN/100 ml during June and <1.8 MPN/100 ml during April, whereas Faecal coliform and *E. coli* was present only at the June sample.
- Ammonia nitrogen was observed to be <1.0 mg/l at all the months
- EC values varied between 262-315 μs/cm at the sampling months.
- SAR values at three months varied between 0.39-0.65
- Boron values were found to be <0.5 mg/l during April and May samples, however, the June sample revealed Boron value of 3.9 mg/l.
- Oil and grease content of all the monthly samples were found to be <1.4 mg/l
- Pesticides (as lindane) of all the monthly samples were found to be <0.000001 mg/l
- Heavy metal viz. Cu, Zn, Ni, Cd, Pb, Hg contents at the samples collected in April, May and June are all found to be below detection limits (BDL)

The water in the stretch of Ganga River is used for the same purposes as mentioned above. Considering the above classification the samples collected in April and June complies with CPCB criterion "A" (*Drinking without any conventional treatment*) whwreas the sample for the month of May qualifies for criterion "C". All the samples also qualify for category "D" and also April and May samples were also compliant to Criteria "E". The May sample with Boron values 3.9 mg/l did not qualify for the criterion.

Table 4.19 Surface Water Quality in the Study Area

Sl. No	Parameter	Unit	30/04/2015	30/04/2015	30/04/2015	24/05/2015	24/05/2015	24/05/2015	11/06/2015	11/06/2015	11/06/2015	CPCB water Use Criteria				
			SW1 Upstream	**SW2 Near Simariya Ghat**	**SW3 Downstream**	**SW1 Upstream**	**SW2 Near Simariya Ghat**	**SW3 Downstream**	**SW1 Upstream**	**SW2 Near Simariya Ghat**	**SW3 Downstream**	**Class A**	**Class B**	**Class C**	**Class D**	**Class E**
1	Colour	Hazen	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	-	-	-	-
2	Odour		Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	-	-	-	-	-
3	Temperature	deg c	26	26	27	27	27	28	27	27	26	-	-	-	-	-
4	pH		7.46	7.61	7.87	7.88	7.86	7.61	7.88	7.73	7.77	6.5-8.5	6.5-8.5	6-9	6.5-8.5	6-8.5
5	EC	us/cm	325	325	315	255	250	262	274	292	280	-	-	-	-	≤2250
6	DO	mg/l	8.8	8.4	7.6	5	5.2	5.8	5.7	6.1	7.9	≥6	≥6	≥5	≥4	-
7	Turbidity	NTU	21	22.5	23.8	58	62	60	10.6	59	47.2	-	-	-	-	-
8	TDS	mg/l	194	184	172	139	138	144	152	167	154	-	-	-	-	-
9	NH3-N	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	≤1.2	-
10	NO2+NO3	mg/l	1.03	1.06	1.07	0.49	0.9	0.65	0.43	0.65	0.77	-	-	-		-
11	Total Phosphorous	mg/l	0.26	0.17	0.18	0.28	0.16	0.36	0.07	0.17	0.14	-	-	-	-	-
12	BOD	mg/l	<2.0	<2.0	<2.0	2.3	2.64	<2.0	<2.0	2.1	2	≤2	≤3	≤3	-	-
13	COD	mg/l	<4.0	<4.0	<4.0	11.9	15.8	7.9	<4.0	11.9	11.9	-	-	-	-	-
14	Potassium	mg/l	3	3	3	3	3	3	3	3	3	-	-	-	-	-

Sl. No	Parameter	Unit	30/04/2015	30/04/2015	30/04/2015	24/05/2015	24/05/2015	24/05/2015	11/06/2015	11/06/2015	11/06/2015	CPCB water Use Criteria				
			SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	Class A	Class B	Class C	Class D	Class E
15	Sodium	mg/l	18	18	17	12	11	12	10	12	10	-	-	-	-	-
16	Ca	mg/l	34.5	32.93	29.79	29.79	29.79	28.8	30.4	28.8	32	-	-	-	-	-
17	Mg	mg/l	16.93	15.05	13.17	10.35	9.41	10.94	11.52	16.32	10.56	-	-	-	-	-
18	CO3	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-	-	-	-	-
19	HCO3	mg/l	155.82	155.82	160.8	128	128	128	135.42	135.42	135.42	-	-	-	-	-
20	Chloride	mg/l	20.9	20.87	17.1	13.72	13.72	13.72	11.76	11.76	13.72	-	-	-	-	-
21	Sulphate	mg/l	12.1	15.6	14.5	13.8	13.6	14.6	17.2	16.4	16.7	-	-	-	-	-
22	Fluoride	mg/l	0.3	0.3	0.24	0.32	0.34	0.39	0.29	0.2	0.14	-	-	-	-	-
23	Boron	mg/l	<0.1	<0.1	<0.1	<0.5	<0.5	<0.5	2.8	4.1	3.9	-	-	-	-	≤2
24	SAR		0.62	0.65	0.65	0.48	0.44	0.48	0.35	0.44	0.39	-	-	-	-	≤26
25	Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-
26	Fe	mg/l	2.19	0.43	0.77	5.48	5.55	3.6	0.37	3.38	2.48	-	-	-	-	-
27	Cu	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	-	-	-	-
28	Zn	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	-	-	-	-
29	Ni	mg/l	<0.02	0.022	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	-	-	-	-	-
30	Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-

Sl. No	Parameter	Unit	30/04/2015	30/04/2015	30/04/2015	24/05/2015	24/05/2015	24/05/2015	11/06/2015	11/06/2015	11/06/2015	CPCB water Use Criteria				
			SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	SW1 Upstream	SW2 Near Simariya Ghat	SW3 Downstream	Class A	Class B	Class C	Class D	Class E
31	Pb	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	-
32	Pesticides as lindane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-	-	-	-
33	Oil and grease	mg/l	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	-	-	-	-	-
34	Total coliform	MPN/100 ml	350	1600	<1.8	1600	1600	1600	22	34	22	≤50	≤500	≤5000	-	-
35	Faecal coliform	/100 ml	Present	Present	Absent	Absent	Present	Absent	Absent	Present	Present	-	-	-	-	-
36	*E Coli*	/100 ml	Present	Present	Absent	Absent	Present	Absent	Absent	Present	Present	-	-	-	-	-

Source: Baseline Monitoring April-June 2015

Analysis Results of Ground Water Quality

The detailed results of physicochemical characteristics of groundwater samples collected within the study area are presented in ***Table 4.20.*** 21 samples were collected from 9 villages within the study area. Out of the 21 samples only one sample was collected from an open well in Makardahi village; other samples were collected handpumps.

Discussion of Results

Physico-Chemical Parameters

- pH of the groundwater samples were found in the range of 7.08 to 8.33 as against the drinking water norm of 6.5 to 8.5. Graphical representation of TDS concentration in the groundwater samples is given in ***Figure 4.30.***
- The level of dissolved solids in the groundwater samples varied from 218 mg/l to 867 mg/l. Majority of the samples were observed to have TDS levels within the acceptable limit of IS: 10500, 2012 standard i.e. 500 mg/l. In 8 samples, the TDS levels were observed to be in exceedance to the acceptable limit; however, the values were within the Permissible limit of 2000 mg/l. All the three samples collected from Malipur Bintola (628-760 mg/l), all 2 samples collected from Makardahi (828 & 867 mg/l) and one sample from Bariyahi, Sitarampur and Vijaygarh Tola were found to be exceeding the acceptable limit. Highest TDS value was recorded for the sample collected from Makardahi open well. Graphical representation of TDS concentration in the groundwater samples is given in ***Figure 4.31***.
- Total hardness in the groundwater samples varied from 168 mg/l to 631.12 mg/l. Most of the groundwater samples showed total hardness concentrations in exceedance to the acceptable limit of 200 mg/l. The sample collected from open well in Makardahi village (631.12 mg/l) showed total hardness values in exceedance to the permissible limit (600 mg/l). Graphical representation of TDS concentration in the groundwater samples is given in ***Figure 4.32***.
- Chloride concentrations ranged from 5.88 mg/l to 157.65 mg/l in the groundwater samples. Highest chloride value was recorded from the Makardahi open well. All the groundwater samples had chloride concentration below the acceptable limits (250 mg/l).
- Total alkalinity varied from 190.92 mg/l to 519.12 mg/l in the groundwater samples. Similar to that of total hardness value, alkalinity values were also highest at the sample collected from Makardahi open well. Total alkalinity was found to be exceeded the acceptable limit (200 mg/l) in all the water samples excepting two samples collected from Simariya Ghat, however the samples were observed to have alkalinity concentration within permissible limit of 600 mg/l. Graphical representation of alkalinity concentration in the groundwater samples is given in ***Figure 4.33***.

- Fluoride levels in the groundwater samples (0.14-0.62 mg/l) were observed to be in compliance to the acceptable limit of 1 mg/l.
- Sulphate concentrations in the groundwater samples were observed to be in the range of 6.6 mg/l to 110.6 mg/l which were found to be within the acceptable sulphate concentration limit of 200 mg/l.
- Fe concentration at the samples varied between <0.05-3.21 mg/l. Fe concentrations at 11 samples were found to be within acceptable limit (0.3 mg/l) of IS: 10500. Among 8 samples that exceeded the acceptable limit, 3 samples revealed vary high values viz. One sample from Malipur Bintola (2.71 mg/l) and 2 samples from Sitarampur (3.21 mg/l & 2.79 mg/l). Other samples that exceeded the acceptable limits were two samples from Simariya Ghat (1.41 mg/l & 0.73 mg/l), Kiul village (0.8 mg/l), Jangira Dumra -2 (0.8 mg/l and Vijaygarh Tola (0.8 mg/l). Higher Fe concentrations at few samples are probably to local geological characteristics.
- Arsenic concentrations at all samples (except one sample collected from Vijaygarh Tola-2 which revealed concentration of 0.02 mg/l) were found to be <0.01 mg/l which is in compliance to the acceptable limit of IS:10500 standards. Presence of arsenic in water in exceedance to the limit could possibly due to local geological features. The local villagers also revealed presence of arsenic problem in the area.
- Levels of cyanide (<0.01 mg/l), anionic detergents (<0.02 mg/l), mineral oil (<0.1 mg/l), phenolic compounds (<0.001 mg/l), polyaromatic hydrocarbon (PAH) (<0.0001 mg/l), pesticides (as lindane), Benzo alpha pyrene (<0.00001 mg/l) were all observed to be BDL in all the groundwater samples.

Figure 4.30 Graphical Representation of pH in Groundwater Samples

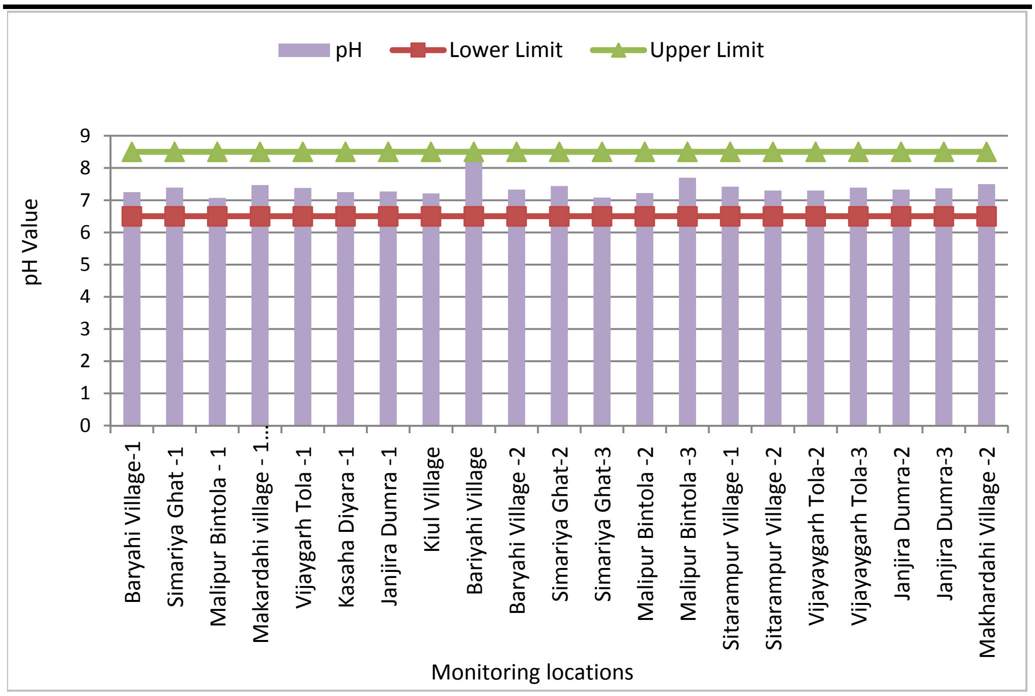


Figure 4.31 Graphical Representation of TDS in Groundwater in the Study Area

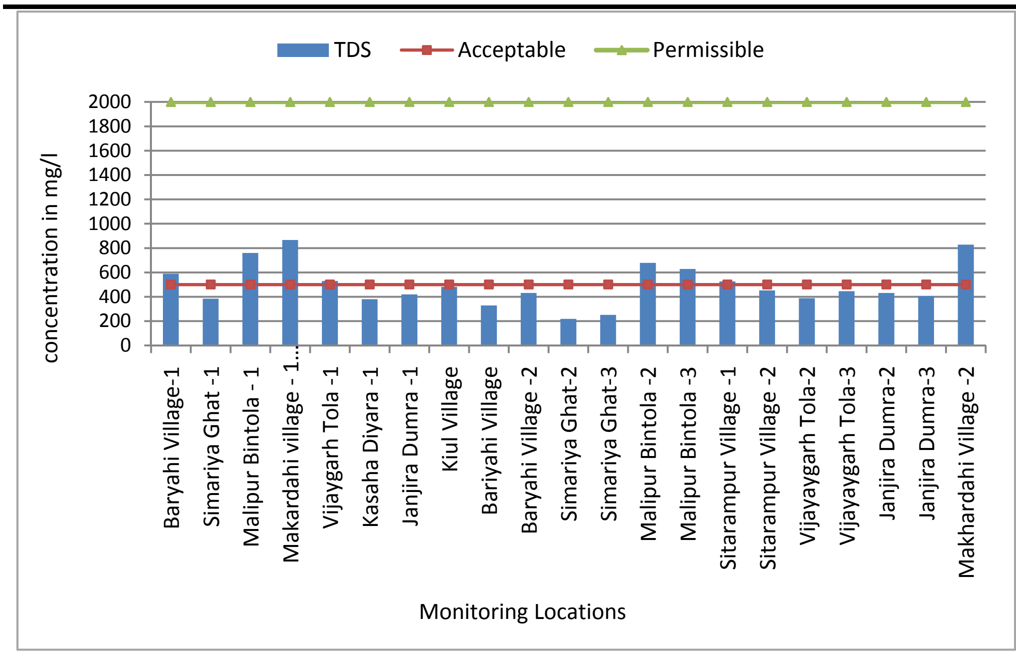


Figure 4.32 Graphical Representation of Total Hardness in the Study Area

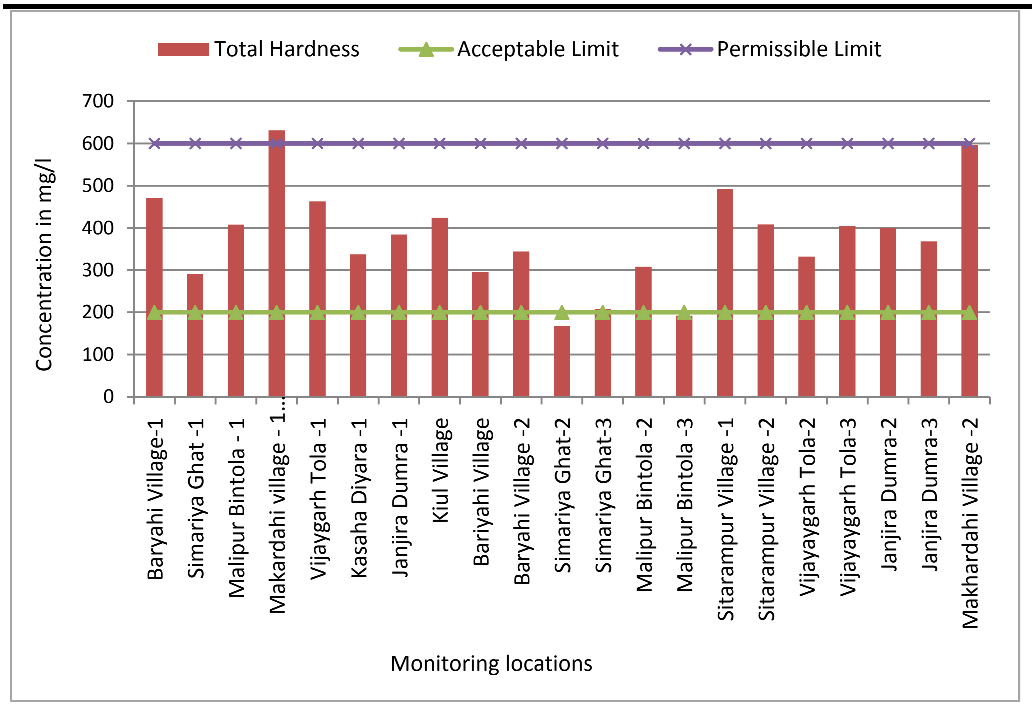
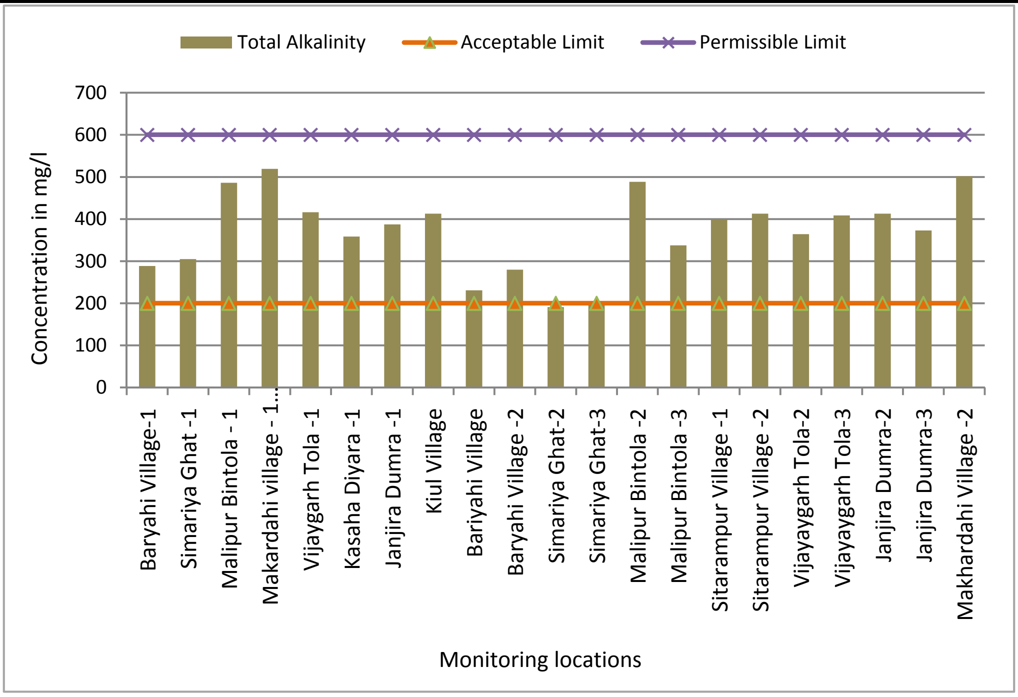


Figure 4.33 Graphical representation of Total Alkalinity in the Study Area



Heavy Metals

- Zinc concentrations of the samples varied between <0.02- 0.61 mg/l which are in compliance to the acceptable limit of 5 mg/l
- Lead concentrations at most of the samples were found to be <0.005 mg/l. 8 samples revealed lead concentrations varying between 0.006-0.01 mg/l which are in compliance to the acceptable limits of IS:10500, 2012.
- Copper (<0.02 mg/l), mercury (<0.001 mg/l) and total chromium (<0.01 mg/l) concentraions at all the samples were found to BDL and in compliance to the acceptable limits of IS:10500, 2012.

Bacteriology

- Total coliforms in the water samples varied from absent to <1.8 MPN/100 ml -920 MPN/100ml. Total coliforms were reported at 8 sampling locations. Very high total coliform value (920 MPN/100ml) was recorded from the Makardahi open well.
- Faecal Coliforms was recorded only on two samples viz. from Makardahi open well and one sample from Vijaygarh Tola.

Table 4.20 Results of Groundwater Quality in the Study Area

Sl No.	Parameter	Unit	30/04/2015 Bariyahi Village-1 (Hand Pump)	30/04/2015 Simariya Ghat -1 (Hand Pump)	30/04/2015 Malipur Bintola - 1 (Hand Pump)	30/04/2015 Makardahi village - 1 (Open Well)	30/04/2015 Vijaygarh Tola -1 (Hand Pump)	30/04/2015 Kasaha Diyara -1 (Hand Pump)	30/04/2015 Janjira Dumra -1 (Hand Pump)	10/06/2015 Kiul Village (Hand Pump)	10/06/2015 Bariyahi Village (Hand Pump)	10/06/2015 Bariyahi Village -2 (Hand Pump)	10/06/2015 Simariya Ghat-2 (Hand Pump)	11/06/2015 Simariya Ghat-3 (Hand Pump)	11/06/2015 Malipur Bintola -2 (Hand Pump)	11/06/2015 Malipur Bintola -3 (Hand Pump)	11/06/2015 Sitarampur Village -1 (Hand Pump)	11/06/2015 Sitarampur Village -2 (Hand Pump)	11/06/2015 Vijaygarh Tola-2 (Hand Pump)	11/06/2015 Vijaygarh Tola-3 (Hand Pump)	11/06/2015 Janjira Dumra-2 (Hand Pump)	11/06/2015 Janjira Dumra-3 (Hand Pump)	11/06/2015 Makardahi Village -2 (Hand Pump)	Drinking water standard IS 10500:2012	
																								(Acceptable Limit)	Permissible limit
1	pH		7.25	7.39	7.07	7.47	7.38	7.25	7.27	7.21	8.33	7.33	7.44	7.08	7.22	7.7	7.42	7.3	7.3	7.39	7.33	7.37	7.5	6.5-8.5	NR
2	Colour	Hazen	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5	15
3	Odour		UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	Agreeable	Agreeable
4	Turbidity	NTU	<1.0	***3.3***	<1.0	***4.1***	**35.7**	<1.0	<1.0	**5.2**	***1.1***	<1.0	<1.0	**5.4**	**16**	***1.21***	**17.2**	**34.5**	***3.4***	<1.0	***3.1***	<1.0	***1.6***	1	5
5	TDS	mg/l	***589***	384	***760***	***867***	***530***	380	420	482	329	431	218	251	***678***	***628***	***526***	453	388	446	432	406	***828***	500	2000
6	Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.2
7	Ammonia	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.47	<0.1	<0.1	<0.1	0.31	<0.1	0.55	<0.1	<0.1	<0.1	<0.1	0.14	<0.1	<0.1	0.5	NR
8	Anionic Detergent	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2	1
9	Ba	mg/l	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05	0.06	0.24	0.07	<0.05	<0.05	0.16	0.18	0.13	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.7	NR
10	B	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	**1.0**	**1.0**	<0.5	<0.5	<0.5	**0.8**	<0.5	<0.5	**0.9**	0.5	1
11	Ca	mg/l	134.85	73.7	109.76	144.26	119.17	94.08	103.49	108.8	86.4	102.4	46.4	54.4	84.8	36.8	120	120	99.2	113.6	107.2	100.8	132.8	75	200
12	Cl	mg/l	89.27	18.99	125.36	157.65	45.59	9.5	11.4	37.23	47.03	45.07	11.76	29.39	107.77	192.02	50.94	17.63	9.8	17.63	5.88	11.76	164.6	250	1000
13	Cu	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	1.5
14	F	mg/l	0.22	0.56	0.43	0.52	0.14	0.21	0.18	0.25	0.18	0.41	0.52	0.35	0.54	0.16	0.19	0.14	0.24	0.2	0.14	0.27	0.62	1	1.5
15	FRC	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	1
16	Fe	mg/l	0.19	**1.42**	0.13	0.3	0.21	0.12	0.25	**0.8**	0.22	<0.05	0.27	**0.73**	**2.71**	**0.35**	**2.79**	**3.21**	0.8	0.08	0.8	0.1	**0.41**	0.3	NR
17	Mg	mg/l	31.99	25.4	31.99	64.92	39.51	24.46	30.11	36.48	19.2	21.12	12.48	17.28	23.04	24	46.08	25.92	20.16	28.8	31.68	27.84	63.36	30	100
18	Mn	mg/l	**0.55**	***0.199***	**1.78**	***0.3***	**0.94**	**0.92**	**0.89**	**0.6**	**0.41**	**0.57**	0.06	0.06	**0.75**	**1.19**	**0.8**	**1.04**	**0.97**	**1.03**	1	**0.01**	**0.42**	0.1	0.3
19	Mineral Oil	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	NR
20	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002
21	Se	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	NR
22	Ag	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.1	NR
23	SO4	mg/l	110.6	12.9	54	98.2	39.2	6.6	11.4	20.8	32.3	39.7	9.8	9.4	34.6	6.4	60	17.7	7.2	14.8	6.8	12.7	85.8	200	400
24	Sulphide	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05	NR
25	Total Alkalinity	mg/l	***288.4***	***304.88***	***486.16***	***519.12***	***416.12***	***358.44***	***387.28***	***412.92***	***230.88***	***279.72***	190.92	199.8	***488.4***	***337.44***	***399.6***	**412.92**	***364.08***	***408.48***	***412.92***	***372.96***	***501.72***	200	600
26	Total Hardness	mg/l	***470.4***	***290.08***	***407.68***	**631.12**	***462.56***	***337.12***	***384.16***	***424***	***296***	***344***	168	***208***	***308***	192	***492***	***408***	***332***	***404***	***400***	***368***	***596***	200	600
27	Zn	mg/l	0.03	0.41	<0.02	<0.02	0.05	<0.02	<0.02	0.32	0.07	<0.02	0.08	0.61	0.46	<0.02	0.34	0.17	0.22	<0.02	<0.02	0.09	<0.02	5	15
28	Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	NR
29	Cyanide	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	NR
30	Pb	mg/l	<0.005	0.008	0.007	0.006	0.007	0.006	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	0.01	NR
31	Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	NR
32	Mo	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	NR
33	Ni	mg/l	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	NR
34	PCB	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	NR
35	PAH	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	NR
36	Total Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.02**	<0.01	<0.01	<0.01	<0.01	0.01	0.05

Sl No.	Para meter	Unit	30/04/2015 Bariyahi	30/04/2015 Simariya	30/04/2015 Malipur	30/04/2015 Makarda	30/04/2015 Vijaygar	30/04/2015 Kasaha	30/04/2015 Janjira	10/06/2015 Kiul	10/06/2015 Bariyahi	10/06/2015 Bariyahi	10/06/2015 Simariya	11/06/2015 Simariya	11/06/2015 Malipur	11/06/2015 Malipur	11/06/2015 Sitaramp	11/06/2015 Sitaramp	11/06/2015 Vijaygarh	11/06/2015 Vijaygarh	11/06/2015 Janjira	11/06/2015 Janjira	11/06/2015 Makarda	Drinking water standard IS 10500:2012	
37	Total Chromium	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	NR
38	BOD	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	-	-
39	COD	mg/l	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	7.94	<4.0	<4.0	7.94	<4.0	<4.0	7.94	<4.0	<4.0	<4.0	<4.0	7.94	-	-
40	Oil & Grease	mg/l	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	-	-
41	Pesticide as lindane	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.002	-
42	BAP	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-	-
43	Total coliform	MPN/100 ml	<1.8	<1.8	<1.8	920	<1.8	<1.8	<1.8	<1.8	<1.8	14	<1.8	<1.8	11	<1.8	<1.8	13	34	47	27	<1.8	27	Shall not be detectable in 100 ml sample	
44	*E.coli*	/100 ml	Absent	Absent	Absent	Presentt	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Shall not be detectable in 100 ml sample	

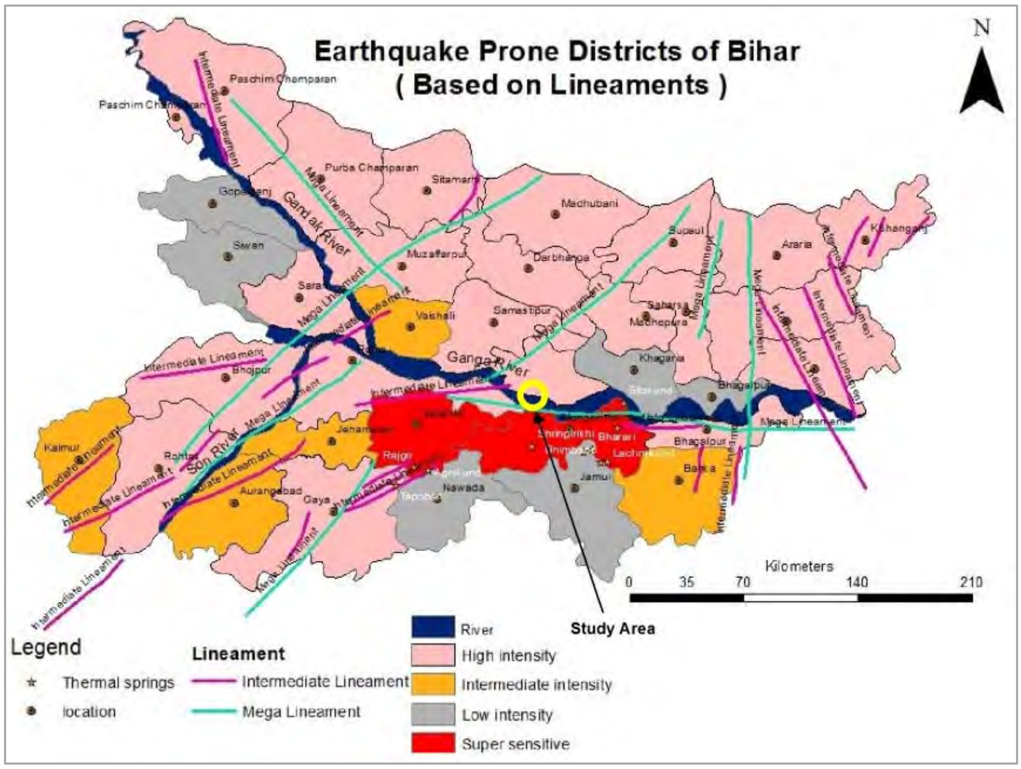
Source: Baseline Monitoring`, UO= Unobjectionable, NR= No relaxation, PCB= Polychlorinated Biphenyl, FRC= Free Residual Chlorine, BAP= Benzo alpha pyrene. Values in excess of Acceptable limits is shown in bold and italic scripts; while values in excess of permissible limits are shown in bold scrtipts

4.9 NATURAL HAZARDS CLASSIFICATION OF THE STUDY AREA

4.9.1 *Earth Quake Hazard*

The seismic zonation map prepared by Bureau of Indian Standards classify the Indian subcontinent into four zones, in which Zone II is the area of minimum risk and Zone V are the areas wherein earthquakes of high intensity damaging property could occur.. Seismic zone map of Bihar provided in *Figure 4.34*, shows that the study area falls in Zone IV - *High Damage Risk Zone.*

Figure 4.34 Earthquake Hazard Map of Bihar

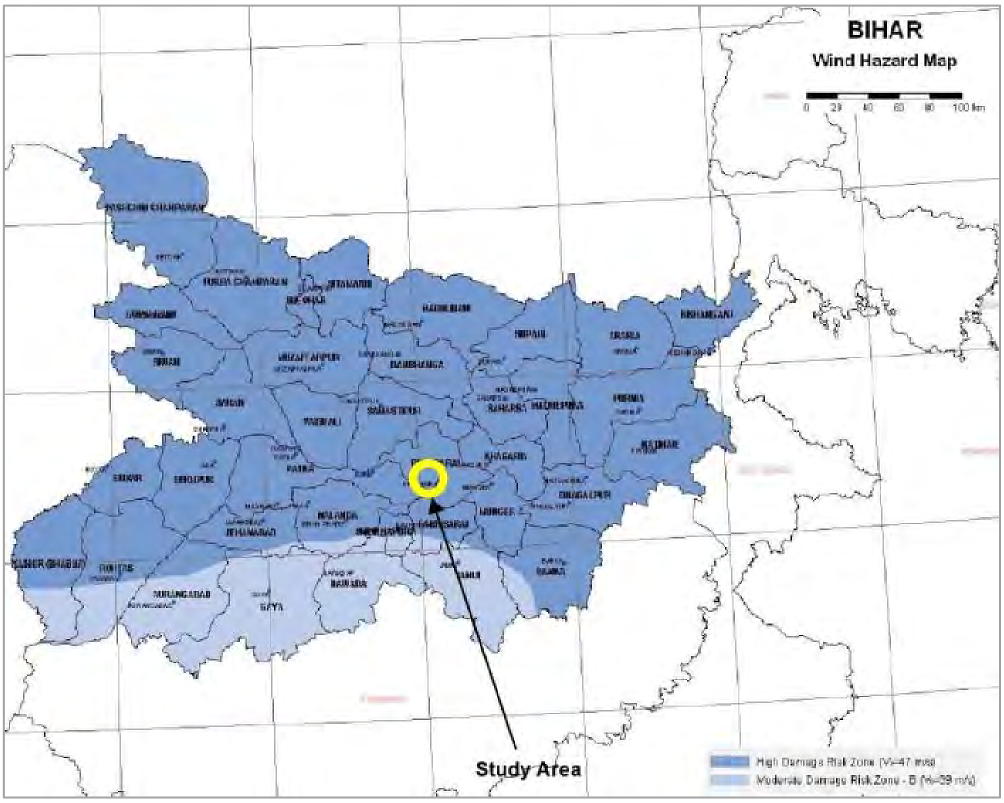


Source: National Disaster Management Authority

4.9.2 *Wind and Cyclone Hazard*

Following ***Figure 4.35*** depicts wind hazard map of Bihar. This figure shows that study area lies in high Damage Risk Zone.

Figure 4.35 Wind and Cyclone Hazard Map of Bihar

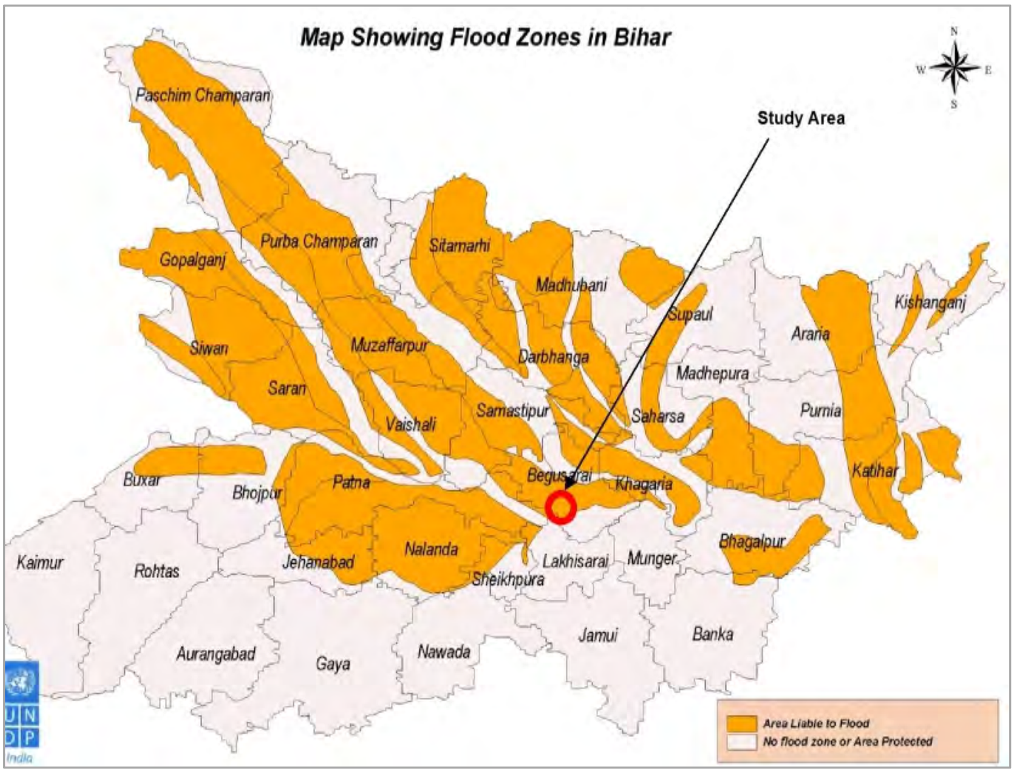


Source: National Instiitute of Disaster Management

4.9.3 Flood Hazard

Begusarai is a flood prone district. Every year Begusarai is affected by floods causing a severe damage to crops, buildings, roads, human lives and animals. The Ganga and the Burhi Gandak flow through this district. In normal cases, when water level raises mainly in these rivers, 13 blocks of Begusarai district namely Bachwara, Teghra, Barauni, Matihani, Balia, Sahebpur Kamal, Bakhri, Nawkothi, Chaurahi, Gadhpura, Cheriabariarpur, Khodawandpur, Samho Akha Kurha are affected by the floods. Flood hazard map of Bihar is shown is ***Figure 4.36***. High Flood Levels (HFL) at Ganga River near the water intake point is reported to be 43.2 m. Both the proposed plant area and the ash pond are located at the flood prone areas. The elevation of the proposed site is approximately 45 m. The area nearby BTPS usually is flooded during rainy season.Thus, at 300 m distance from the boundary of Unit No. 8 & 9, an embankment is to be constructed for the flood prevention. The flood level at the water intake point at the Ganges is 43.2 m, therefore keeping 2 m margin, the top level of embankment is planned 45.5 m. Ash dyke would also be constructed keeping in mind the High Flood Levels.

Figure 4.36 Flood Hazard Map of Bihar



Source: National Instiitute of Disaster Management

4.10 ECOLOGY & BIODIVERSITY

An ecological survey was undertaken from 28th to 30th April 2015 at the study area comprising 10 km from the boundary of the proposed TPP to understand and establish the ecological baseline of the study area.

The vegetation of the area is classified as Group C3a West Gangetic Moist Mixed Deciduous as per Champion and Seth Vegetation Classification, 1968(1). The vegetation classification of the Study area is provided in Table below.

Table 4.21 Vegetation Classification of the Region

Classification Scheme	Classification
Plant Diversity Centers of India	Gangetic Plain
Biogeographic Provinces of India	7B Lower Gangetic Plain
Phyto-geographical Centers of India	Gangetic Plain
Agro Ecological Sub Region (ICAR)	Sub-humid, Northern Plains
Agro-Climatic Region (Planning Commission)	Lower, Middle, Upper Trans Gangetic plains

The ecological surveys were conducted with following objectives:

(1) Champion H. & Seth S.K., 1968, A Revised Survey of the Forest Types of India, Nataraj Publishers, Dehradun, India.

Flora

- Identification of floral species (terrestrial and aquatic), sensitive habitats, endangered species;
- Classification of flora for any endangered or protected species or endemic floral species prevailing in the study area;
- Identification of areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value; and
- Identification of aquatic flora in the water bodies falling in the study area.

Fauna

- Identification of fauna (terrestrial, aerial and aquatic), based on spotting, pug marks, droppings, nesting etc.;
- Identification and classification of any species recognized as critically endangered or endangered (in accordance with the IUCN Red List, or according to the schedules of the Wildlife (Preservation) Act 1972 and amendments);
- Identification of areas which are important or sensitive for ecological reasons including their breeding, nesting, foraging, resting, over wintering areas including wildlife migratory corridors /avian migratory routes; and
- Identification and assessment of aquatic ecological resources within the study area.

4.10.2 Survey Methodology

The study area has considered taking 10 km from proposed plant boundary. The study area is largely flat agricultural land and lacks natural forests and continuous patch of vegetation. Aquatic habitats within the study area include the stretch of Ganga River and also village ponds. Mokama Taal IBA, located is located within the study area is and is approximately 3 km from the proposed TPP. The plant species lists have been identified on the basis of trees, shrubs, herbs. The faunal species described are fish, amphibians, reptiles, avifaunal species and mammals.

Faunal species from the study area were recorded based on direct sightings, indirect evidences such as dung, droppings, scats, nests etc. and consultation with Forest Department officials and local community. During consultation with communities, pictorial representations of species were used in form of field guides and other literature of the faunal species of India. The methology for faunal survey within the study area are discussed in the following sections:

Fish

Fish were studied by field observation and secondary data was collected from the locals, published and unpublished documents.

Herpetofauna

Search was carried out along the hedges of the aquatic habitats located in the study area to identify and list the amphibians found. Identification followed standard literature. [(1)]

Avifauna and Aquatic Birds

Avifauna was enumerated by habitat surveys at sample plots. Standard field guide [(2)] were followed for avian nomenclature.

Mammals

Habitat survey for mammals was conducted. Identification followed standard literature. [(3)(4)]

Secondary literature from published books and research publications were also consulted for the flora and fauna of the study area. The enumerated list of faunal species is compared to the species listed in IUCN Red data list (vers 2015.2) and species listed in schedule 1-6 of Wildlife Protection Act, 1972 to confirm their conservation status. Community consultations were also conducted to understand the presence of faunal species in the area. Species identification was assisted by using field guides for various faunal groups.

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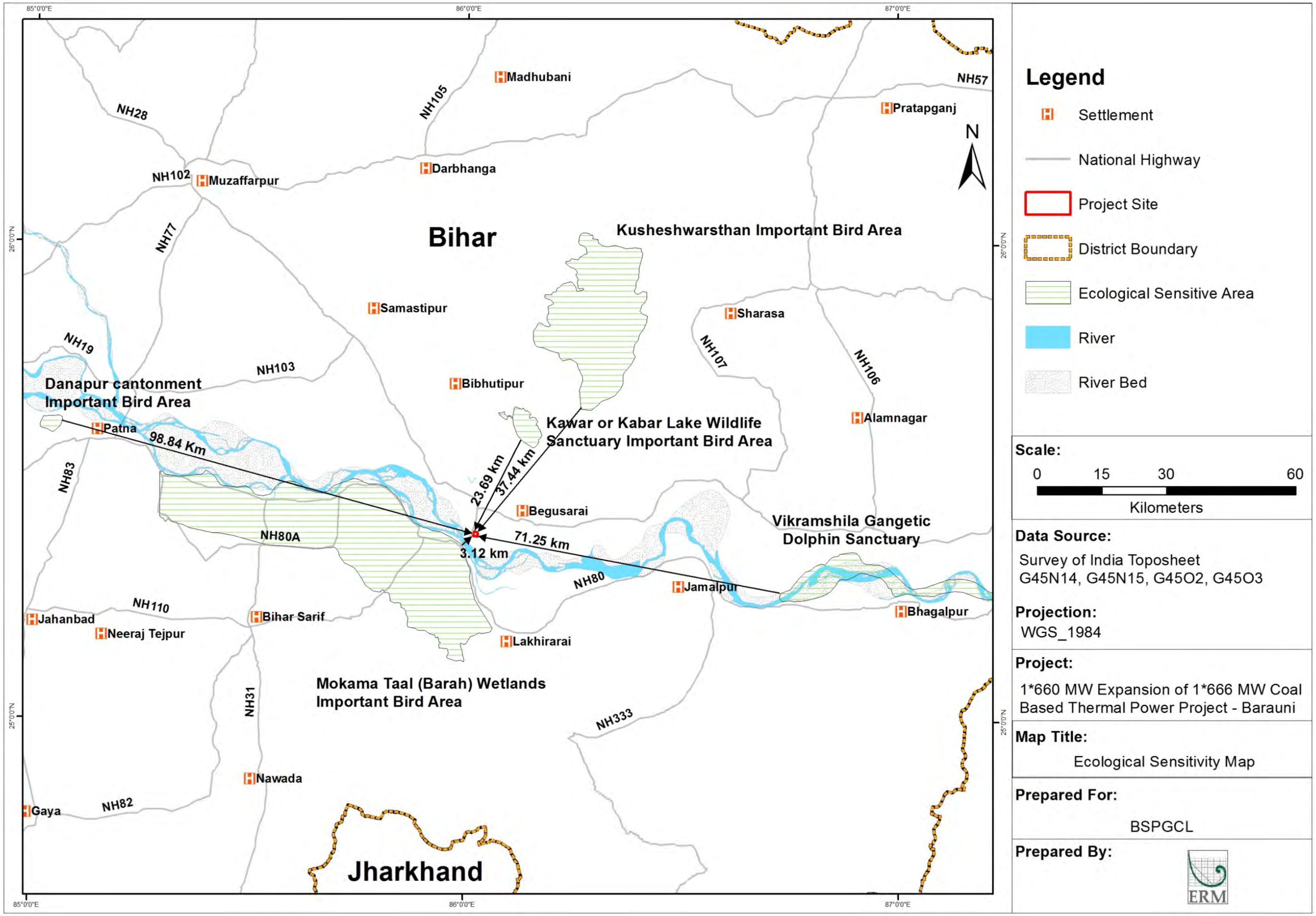
(1) Daniels. J.C. 2005. The book of Indian Reptiles and Amphibians. Bombay Natural History Society and Oxford University press 1st Edn. pp. 268.

(2) Birds of Indian Subcontinent. 2011. Richard Grimmett, Carol Inskipp & Tim Inskipp. Helm Field Guides, Oxford University Press, India, 528 p.

(3) Prater. S. H. 2005. The Book of Indian Animals. Bombay Natural History Society and Oxford University press 12th Edn. pp. 324.

(4) Menon, V. 2014. Indian Mammals A Field Guide. Hachette Book Publishing India Pvt. Ltd, Gurgaon. pp. 384.

Figure 4.37 Ecological Sensitivity Map



4.10.3 Floral Assessment

The habitats in the study area include agricultural land, open scrub and water bodies. Plant species in the study area observed as trees, shrubs, herbs, grasses and climbers are provided below;

Trees: *Acacia auriculiformis, Aegle marmelos, Albizzia lebbek, Albizzia procera, Alstonia scholaris, Arotocarpus integrifolia, Azadirachta indica, Bambusa arundinacea, Bombax ceiba, Borassus flabellifer, Cassia fistula, Cassia siamea, Cebia pentandra, Dalbergia sissoo, Delonix regia, Erythrina indica, Eucalyptus globosus, Ficus benghalensis, Ficus racemose, Ficus religiosa, Flacourtia sapiaria, Moringa oleifera, Lagerstroemia speciose, Leucaena leucocephala, Mangifera indica, Millingtonia hortensis, Mimusops elengi, Peltophorum pterocarpum, Phoenix sylvestris, Polyalthia longifolia, Pongamia glabra, Samanea saman, Syzygium cumini, Swietenia mahagoni, Tectona grandis, Terminalia arjuna, Trema orientalis, Zizyphus mauritiana , Neolamarckia cadamba, Adina cordifolia* etc.

Shrubs: *Abutilon indicum, Calotropis gigantean, Ervatamia divaricate, Hibiscus rosa-sinensis, Jasminum multiflorum, Lantana camara, Nerium indicum, Thevetia peruviana, Hibiscus mutabilis, Gardenia jasminoides, Ricinus communis, Vitex negundo Adhatoda vasica, Cassia tora, Datura metel*

Herbs: *Croton banplandianum, Ocimum basilicum, Colocasia esculentum, Argemone Mexicana, Parthenium hysterophorus, Phyla nodiflora, Solanum xanthocarpum, Aclypha indica, Aerva aspera, Amaranthus spinosus, Clerodendron viscosum, Crotalaria retusa, Heliotropium indicum, Leonurus sibiricus, Sida rhombifolia, Blumea lacera, Celosia cristata, Cassia occidentalis, Solanum nigrum, Ageratum conyzoides, Cassia sophera, Boerhaavua repens* etc.

Climbers: *Bougainvillea spectabilis, Coccinia cordifolia, Ipomoea pes-caprae, Mikania cordata, Quisqualis indica* etc.

Grass: *Cynodon dactylon, Andropogon aciculatus, Andropogon aciculatus, Eragrostis* sp., *Impera cylindrica Saccharum officinarumi* etc.

Aquatic macrophytes: *Alternantha sessilis, Azolla pinnata, Canna indica, Ceratophyllum demersum, Eichhornia crassipes, Lemna minor, Cyperus rotundus, Ipomea carnea, Saggittaria saggittifolia, Ipomoea aquatica, Potamogeton crispus, Wolffia arrhiza, Ceratophylum demersum, Trapa bispinosa, Eclipta alba, Pistia stratiotes, Vallisneria spiralis, Hydrilla verticillata, Nymphaea rubra* etc.

Figure 4.38 Habitat within the study area

Agricultural fields in the study area

Agricultural Fields in the study area

Homestead plantation in study area

Ganga River in the study area

Source: Site and surrounding areas survey by ERM during 28th to 30th April 2015

4.10.4 *Faunal Assessment*

Fish

The fish fauna recorded during the survey include species like *Anabas testudineus, Aplocheilus panchax, Barbus ticto, Catla catla, Channa striatus, Cirrhinus mrigala, Clarias batrachus, Labeo rohita, Macrognathus aral, Macrognathus pancalus, Oreochromis niloticus, Puntius chola, Glossogobius giuris,Labeo boga, Puntius sophore, Heteropneustes fossilis, Notoptetrus notopterus Pseudambassis ranga, Oxygaster bacails* etc.

Herpetofauna

The Herpetofaunal (amphibian and reptilian) species found in the study area are discussed below;

Amphibians

A total of three (03) species belonging to 2 families were observed from the study area. None of the species bear any conservational significance. The details of the species are given in ***Table 4.22***.

Table 4.22 Amphibians observed/recorded from the Study Area

Sn	Common Name	Zoological Name	Family	Occurrece	Source	WPA Schedule / IUCN Status
1	Common Indian Toad	*Duttaphrynus melanostictus*	Bufonidae	Buffer	PS	-/ LC
2	Indian Pond Frog	*Euphlyctis hexadactylus*	Dicroglossidae	Buffer	PS	-/LC
3	Indian Bull Frog	*Hoplobatrachus tigerinus*	Dicroglossidae	Core+Buffer	PS	-/LC

Notes: LC-Least Concern; PS-Primary Survey;

Reptiles

A total of Six (6) species belonging to 4 families were observed or reported (1) from the study area. The details of reptiles are given in ***Table 4.23.***

Table 4.23 Reptiles observed/reported from the Study Area

Sn.	English / Popular Name	Scientific Name	Family	Occurrence	Source	WPA Schedule / IUCN Status
1	Spectacled Cobra	*Naja naja*	Elapidae	Buffer	CC	II/LC
2	Common Indian Krait	*Bungarus fasciatus*	Elapidae	Buffer	CC	IV/LC
3	Indian Rat snake	*Ptyas mucosus*	Colubridae	Core+Buffer	CC	IV/LC
4	Checkered Keelback	*Xenochrophis piscator*	Colubridae	Buffer	CC+ PS	II/ LC
5	Russell's Viper	*Daboia russelii*	Viperidae	Buffer	CC	IV/ LC
6	Indian Garden Lizard	*Calotes versicolor*	Agamidae	Core+Buffer	CC+ PS	-/-

Notes: LC-Least Concern, PS-Primary Survey; CC-Community Consultation

Avifauna

A total of 29 species of birds belonging to 23 families were recorded. No migratory species was recorded during the study period from the study area.

A total of Thirty one (31) avifaunal species were observed from the core zone, fifty two (52) avifaunal species from buffer zone and 14 species of aquatic bird species were observed in the large water areas. Identified avifaunal species from the study area is shown in Figure 4.39 and the detailed list provided in ***Table 4.24.***

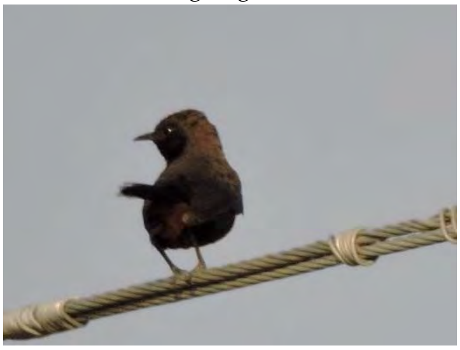
(1) Forest Working Plan, Begusarai Division; Community Consultation

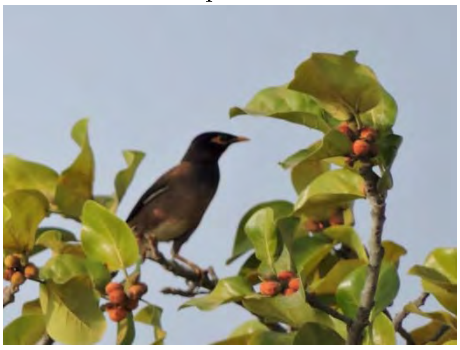
Figure 4.39 Avifaunal Species observed within the Study Area


Ringed Dove


Laughing Dove


Indian pond heron


Indian Robin


Common Myna


Indian Roller

Source: Site and surrounding areas survey by ERM during 28th April to 30th April 2015

Table 4.24 Avifaunal Species observed in the Study Area

Sr. No.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	FG	Habitats
1	**PHALACROCORACIDAE**						
1	Little Cormorant[a]	*Phalacrocorax niger*	R	LC	IV	P	Water bodies
2	**ARDEIDAE**						
2	Pond Heron[a]	*Ardeola grayii*	R	LC	IV	I	Water bodies/agricultural lands
3	Cattle Egret[a]	*Bubulcus ibis*	R	LC	IV	I	Water bodies/agricultural lands
3	**CICONIIDAE**						
4	Asian Openbill[a]	*Anatomus oscitans*	R	LC	IV	P	Water bodies
4	**ACCIPITRIDAE**						
5	Black-	*Elanus*	R	LC	I	C	Homestead

Sr. No.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	FG	Habitats
	Winged Kite	*caeruleus*					plantation
5	**COLUMBIDAE**						
6	Spotted Dove	*Streptopelia chinensis*	R	LC	IV	G	Homestead plantation/agricultural lands
7	Common Pigeon	*Columba livia*	R	LC	IV		Homestead plantation/agricultural lands
6	**PSITTACIDAE**						
8	Rose-ringed Parakeet	*Psittacula krameri*	R	LC	IV	F	Homestead plantation
7	**CUCULIDAE**						
9	Greater Coucal	*Centropus sinensis*	R	LC	IV	O	Homestead plantation
10	Asian Koel	*Eudynamys scolopaceus*	R	LC	IV	O	Homestead plantation
8	**RAMPHASTIDAE**						
11	Coppersmith Barbet	*Megalaima haemacephala*	R	LC	IV	F	Homestead plantation
9	**APODIDAE**						
12	Little Swift	*Apus affinis*	R	LC	IV	I	Homestead plantation/agricultural lands
10	**MEROPIDAE**						
13	Green Bee-eater	*Merops orientalis*	R	LC	IV	I	Homestead plantation/agricultural lands
11	**CORACIIDAE**						
14	Indian Roller	*Coracias benghalensis*	R	LC	IV	I	Homestead plantation/agricultural lands
12	**ORIOLIDAE**						
15	Indian Golden Oriole	*Oriolus kundoo*	R	LC	IV	I	Homestead plantation
13	**DICRURIDAE**						
16	Black Drongo	*Dicrurus macrocercus*	R	LC	IV	I	Open Scrub/ Agricultural land
14	**STURNIDAE**						
17	Common Myna	*Acriotheres tristis*	R	LC	IV	O	Homestead plantation/agricultural lands
18	Asian Pied Starling	*Gracupica contra*	R	LC	IV	O	Homestead plantation/agricultural lands
15	**CORVIDAE**						
19	House Crow	*Corvus splendens*	R	LC	V	O	Homestead plantation/agricultural lands
20	Rufous Treepie	*Dendrocitta vagabunda*	R	LC	IV	O	Homestead plantation
16	**PYCNONOTIDAE**						
21	Red-vented Bulbul	*Pycnonotus cafer*	R	LC	IV	O	Homestead plantation/agricultural lands
17	**MUSCICAPIDAE**						

Sr. No.	Common Name	Scientific Name	Migratory Status	IUCN Status	WPA Sch.	FG	Habitats
22	Large Grey Babbler	*Turdoides malcolmi*	R	LC	IV	I	Homestead plantation/agricultural lands
18	**NECTARINIDAE**						
23	Purple Sunbird	*Nectarinia asiatica*	R	LC	IV	N	Homestead plantation/agricultural lands
19	**PLOCEIDAE**						
24	House Sparrow	*Passer domesticus*	R	LC	IV	G	Homestead plantation/agricultural lands
20	**CERILYDAE**						
25	White-throated Kingfisher [a]	*Halcyon smyrnnsis*	R	LC	IV	P/C	Homestead plantation/agricultural lands/ water bodies
21	**TURDINAE**						
26	Oriental Magpie Robin	*Copsychus saularis*	R	LC	IV	I	Homestead plantation/agricultural lands
27	Indian Robin	*Saxicoloides fulicata*	R	LC	IV	I	Homestead plantation/agricultural lands
22	**RHIPIDURIDAE**						
28	White-browed Fantail	*Rhipidura aureola*	R	LC	IV	I	Homestead plantation
23	**CHARADRIIDAE**						
29	Red-wattled Lapwing	*Vanellus indicus*	R	LC	IV	I	Agricultural lands/water bodies

Notes: FG- Foraging Guild: C-Carnivore, F-Frugivore, G-Granivores, I-Insectivores, N-Nectarivores, O-Omnivores P-Piscivores, Migratory Status (MS): R- Resident, LC-Least Concern (IUCN Ver. 3.1), Schedule – I, IV, V (Indian Wildlife Protection Act -1972); [a]: Aquatic Associates

The survey was undertaken in non-migratory season thus winter visitors (October-March) were not captured in the present study.

Mammals

A total of 7 species belonging to 7 families were observed/reported from the study area. One Schedule I species as per Wildlife Protection Act, 1972, Gangetic Dolphin (*Platanista gangetica*) is reported from the study area. Gangetic dolphin is also an IUCN Endangered species (ver. 2015.2). A list of species observed/reported from the study area is given in and represented in ***Table 4.25.***

Table 4.25 Details of Mammals observed/ reported from the Study area

Sn.	English Name	Scientific Name	Family	Occurrence	Sources	WPA Schedule / IUCN Status
1	Common Fox	*Vulpes bengalensis*	Canidae	Buffer	CC	II/LC

Sn.	English Name	Scientific Name	Family	Occurrence	Sources	WPA Schedule / IUCN Status
2	Rhesus Macaque	*Macaca mulatta*	Cercopithecidae	Buffer	CC	II/LC
3	Five Striped Squirrel	*Funambulus pennantii*	Sciuridae	Core+Buffer	CC+PS	IV/LC
4	Bandicoot rat	*Bandicota indica*	Muridae	Core+Buffer	CC+PS	V/LC
5	Indian Flying Fox	*Pteropus giganteus*	Pteropodidae	Core+Buffer	CC+PS	V/LC
6	Indian Hare	*Lepus nigricollis*	Leporidae	Core+Buffer	CC+PS	IV/LC
7	Gangetic Dolphin	*Platanista gangeticus*	Platanistadae	Core+Buffer	CC+PS	I/EN

Notes: IUCN-International Union for Conservation of Nature, EN- Endangered; LC-Least Concern; WPA-Wildlife Protection Act, 1972,; PS-Primary Survey; CC-Community Consultation

4.10.5 *Protected Areas*

Nearest sanctuaries from the proposed TPP site is Kawar Lake Wildlife Sanctuary about 24 km from the project site and Vikramshila Dolphin Sanctuary, about 70 km from the project site. Mokama Taal IBA is located at a distance of 3.12 km from the project site. Brief description of Mokama Taal IBA and Kawar Lake Wildlife Sanctuary and IBA (also a Ramsar Site) is described at the boxes below and locations of the IBAs are shown in ***Figure 4.37.***

Box 4.1 Mokama Taal

Mokama Taal wetlands cover more than 1,000 ha of shallow waterbodies, located in Patna, Samastipur and Begusarai districts of Bihar. The waterbodies are situated about 75 km of Patna city at the southern bank of the River Ganga, which drains the wetland. The waterbodies are located about 3 km south of the BTPS. The topography of the area is generally flat land. It is a tract of alluvial plain, sloping gently from south to north. Kawar (Kabar) Lake, an IBA site is close to Mokama, and when the birds get disturbed at Kawar they fly to Mokama.

About 149 species of birds have been recorded from the area. The site also holds, on a regular basis, over 20,000 breeding and migratory waterbirds. The Black Ibis (*Pseudibis papillosa*), Glossy Ibis (*Plegadis falcinellus*), Eurasian Spoonbill (*Platalea leucorodia*), Greylag Goose (*Anser anser*) and Barheaded Goose (*A. indicus*) are some of the species reported from the area. Similarly, Lesser Whistling Duck (*Dendrocygna javanica*) is found in thousands, along with a few hundred Large Whistling Duck (*D. bicolor*) Ten globally threatened and Near Threatened species are found here. Critically endangered species like Indian vulture (*Gyps indicus*), White rumped vulture (*Gyps bengalensis*), endangered species like Greater Adjutant Stork (*Leptoptilos dubius*) and vulnerable species like Lesser Adjutant Stork (*Leptoptilos javanicus*), Pallus Fish Eagle (*Haliaeeetus leucoryphus*), Greater spotted eagle (*Clanga clanga*) etc. are also reported from the area.

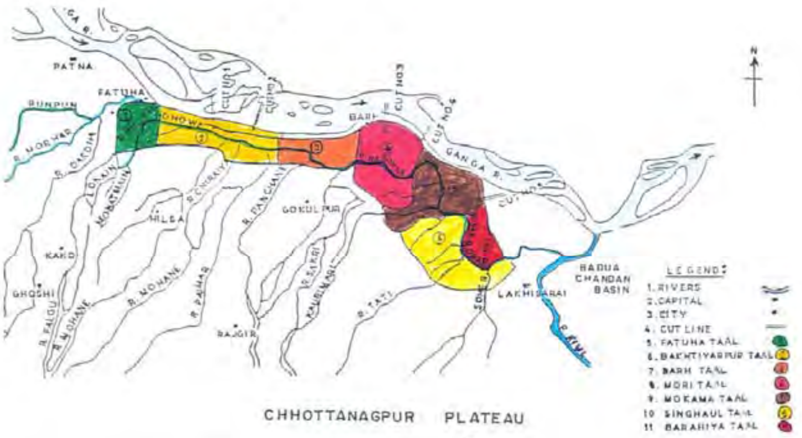


Figure 1. Index map of Mokama group of Taals

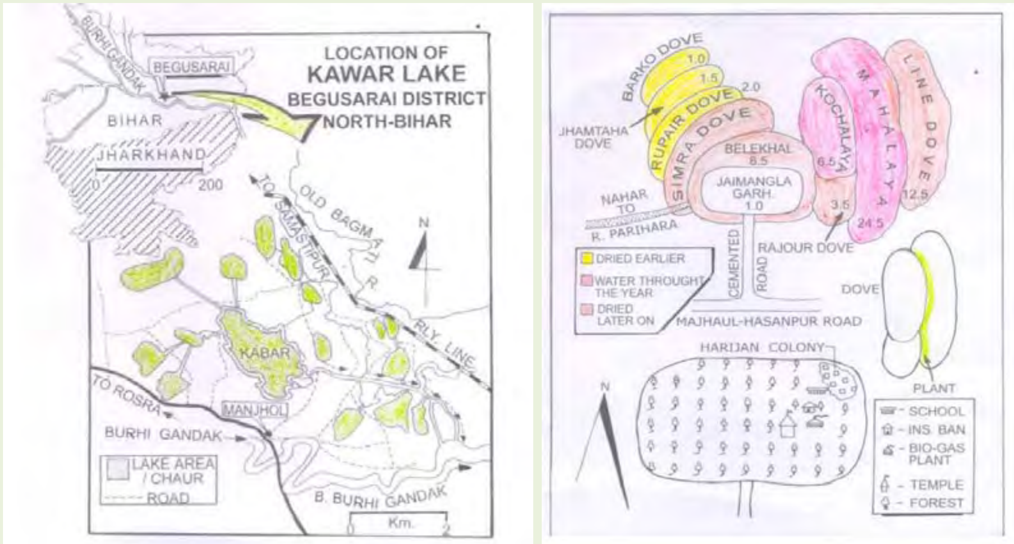
Source: BirdLife International (2015) Important Bird Areas factsheet: Mokama Taal (Barah) Wetlands. http://www.birdlife.org

Sinha, C.P. 2008. Mokama Taal-An Ephemeral Lake Requiring Holistic Management. In Sengupta, M abd Dalwani, R (Eds) Proceedings of Taal2007:The 12th World Lake Conference, 1586-1590.

Box 4.2 Kawar (Kabar) lake Wildlife Sanctuary

Kawar (Kabar) Lake Wildlife Sanctuary, also a Ramsar Site, is the largest freshwater lake in northern Bihar. It is a residual oxbow lake formed by the changing course of the River Gandak, a tributary of the Ganga. During monsoon, the Kawar Lake joins with the nearby Nagri Lake, Bikrampur Chaur and Burhi Gandak, a tributary of the River Ganga, to form a lake of about 7,400 ha. During summer water level receeds and the mud flat areas are converted to paddy fields. There is a permanent island (Jaimanglagarh) of about 130 ha in the southeast corner of the lake. Kawar Lake experiences tropical monsoon climate typical of the middle Gangetic plain. The lake supports a rich and diverse aquatic flora. Submerged macrophytes include *Hydrilla verticillata, Potamogeton crispus* and *Najas minor*. Emergent macrophytes include *Oryza sativa* and *Ipomea aquatica*.

The lake is eutrophic, sustaining rich plant and animal life, and a major waterfowl habitat in the Indo-Gangetic Plain (1).It supports huge numbers of migratory ducks and Coot (*Fulica atra*) through the winter, as well as large concentrations of resident species such as Dabchick (*Tachybaptus ruficollis*) and Asian Openbill (*Anastomus oscitans*). Critically endangered species like Indian vulture (*Gyps indicus*) and White rumped vulture (*Gyps bengalensis*), vulnerable species line Sarus Crane (*Grus antigone*), Greater spotted eagle (*Clanga clanga*) are reported from the area. Near Threatened Oriental White Ibis (*Threskiornis melanocephalus*), Ferruginous Pochard (*Aythyca nyroca*) and Rufous-vented Prinia (*Prinia burnesii*) are also found. Every year, more than 20,000 waterbirds are found here, thus fulfilling A4iii criteria of BirdLife International. Kabar Lake has been declared as Wildlife Sanctuary in 1989.



Source: BirdLife International (2015) Important Bird Areas factsheet: Kawar (Kabar) Lake Wildlife Sanctuary. http://www.birdlife.org
Roy, S.P., Raja. R, Prabhakar, A. M., Singh, J. P. 2008. Sustainable Development of Kawar Lake, Begusarai (North-Bihar, India) In Sengupta, M abd Dalwani, R (Eds) Proceedings of Taal2007: The 12th World Lake Conference, 1586-1590.

4.11 SOCIO-ECONOMIC ENVIRONMENT

4.11.1 Approach

For the purpose of establishing the social baseline for the project and examining the social impact of the project, the assessment has been undertaken through a combination of a desk based review of secondary

(1)George, P. V. (1964) Notes on migrant birds in North Bihar, J. Bombay Nat. Hist. Soc. 61: 370-384 Shahi S.P. (1982) Bird massacre in Manjhaul. Hornbill 3: 17-22.

literature and available government/ non-government data and consultation with the project and the administration representatives.

A phased participatory approach and triangulation method was not adopted as primary consultations with the local community members or primary sample survey with the potential affected families could not be undertaken, as permissions for the same were not granted by BSPGCL.

Barauni Thermal Power Station (BTPS) is located in Barauni Tehsil, Begusarai District in the state of Bihar. The project components are spread across Patna District and Begusarai District.

4.11.2 Methodology

The socio-economic profile assessment related methodology included the following:

Review of secondary literature

A desk based review and assessment of the available primary and secondary data and information for the project area, the administrative block, the district and the state has been done. Some of the documents and literature that were reviewed includes, but not limited to:

- Census of India 2001 and 2011;
- Village Directory, Patna District and Begusarai District, Bihar
- Bihar Statistical Handbook, 2012;
- Reports published by directorate of economics and statistics, Bihar;
- Health Action Plans (NRHM), Patna and Begusarai District;
- District Industrial Profile, Patna and Begusarai District;
- Information available in the public domain (media reports and papers/ studies on aspects like environment, community, tribal rights etc);
- NGO and other civil society reports.

This was an ongoing process and secondary data was also collected during the site visit.

Scoping Study Visit

ERM team carried out a site visit from 24th to 27th March, 2015 and undertook preliminary discussions with the management/representatives of Bihar State Power Grid Corporation Limited (BSPGCL) and Barauni Thermal Power Plant (BTPP).

The visit was undertaken in order to gauge the status of the existing project, plans for proposed expansion and the activities which the expansion will entail. The discussions were also focussed around the land requirement and the status of acquisition, community sensitivities and understanding the layout and design aspects of the project components. Further, the discussions also involved sharing the objective of this assessment and ERM's involvement in the same. In addition, the team also undertook a site reconnaissance to the proposed plant area, ash pond area, water intake point and the residential colony.

Table 4.26 Site visit schedule and meetings undertaken

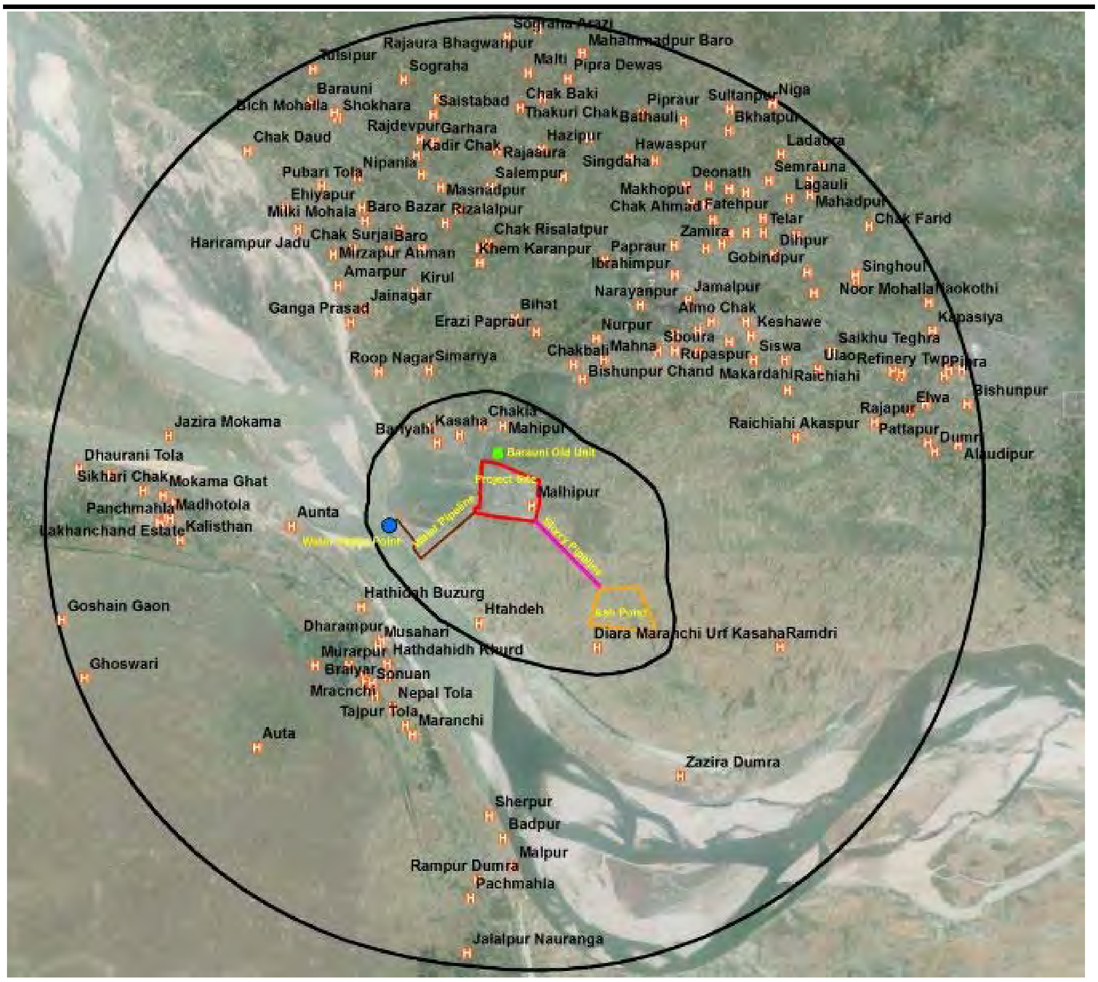
Date	Activity Brief	Discussion Topics
24-03-2015	• General meeting with the Barauni TPS GM, AGM etc. • Discussions with ESE (Extension Project) and ESE (Ganga Water Supply Project + Rly Sliding) and SE (Civil); •	• Understanding the layout of facilities for the proposed project; • New land required/acquired for the proposed project;
25-03-2015	• Visit to the boundary points of the ash pond area; • Visit to the Ganga River water intake point, sedimentation tank, water pipeline area;	• Site observations – land-use area; • Discussion regarding the status of land acquired;
26-03-2015	• Visit to the main plant area for extension project; • Visit to the residential colony area, overlooking the village adjacent to the east side of the plant boundary;	• Site observations – land-use area;
27-03-2015	• Discussion with Exec. Engineer Department of Planning & Design of BSPGCL • Gathered topo sheets from Survey of India; • Discussion with BPIC Consultant in charge for land liasoning for the new land acquisition of the BTPS extension project;	• Clarifications on land required/acquired, litigations etc. if any; • Clarification on project layout and design elements; • Cross-verifying information for Form – I;

Defining the Study Area

This section outlines the socio-economic baseline of the study area identified as the area within 10km radius zone from the mining lease boundary area. It is expected that the social impacts will not exceed beyond this geographical area.

The study area is further divided into **core zone** and **buffer zone**. The core zone for this study has been considered as the entire project area (which includes all the project components – main plant area, ash dyke and pipeline, water intake point and pipeline, railway siding, coal storage area, switchyard and residential colony) along with the associated affected villages and the buffer zone is considered as the area beyond core zone and till 10km boundary from the main plant area.

Figure 4.40 Villages falling under the study area



Source: Google earth pro accessed on 15th November, 2015

This social baseline section presents an understanding of the socio-economic milieu of the study area, which covers an area of 10 km radius from the proposed thermal plant area. The baseline will help to assess the envisaged impacts of the project and take appropriate measures to avoid or minimize the extent and magnitude of impact. Although the discussion will be concentrated on the study area (core area and periphery area), comparisons will be drawn to the block and district where appropriate.

Table 4.27 Project Components and Associated Affected Villages

Sr. No.	Project Components	Villages in the vicinity area
1.	Main Power Plant for Unit 10, Railway Siding, and Coal Storage Area	• The power plant is located on the existing land owned by BTPS. No additional land is being acquired for the same. • The villages Chakia and Malhipur, located to the North and North West portion of the power plant located at a distance of 1 – 2 km and village Ramdiri is located adjacent to the Eastern boundary of the power plant area.

Sr. No.	Project Components	Villages in the vicinity area
2.	Ash Dyke Area	• The ash dyke area is proposed on 290 acres of government land – South East of the main power plant area. • The village Diara Maranchi urf Kasaha is located adjacent to the South West boundary of the ash dyke area. • It is reported that farmers from Village Ramdiri are undertaking cultivation on this land parcel. Village Ramdiri is located within 1 km of the ash dyke area towards the Northern side.
3.	Ash Pipeline Area	• There are 2 Ramdiri villages in the vicinity area. The ash pipeline will also displace nearly 10 households in Ramdiri village (located in the eastern side of the power plant and residential colony).
4.	Water Intake and Water Pipeline	• The water intake is from River Ganga and the water pipeline will pass through Simariya Ghat village.
5.	Residential Colony	• Village Ramdiri is located adjacent to the residential colony.

Figure 4.41 Location of the Villages in the Project Area

Source: Google Earth pro accessed on 14th January, 2016

Site visit & Stakeholder Consultations

The team undertook a subsequent site visit between 9th and 13th June, 2015 to undertake meetings with government representatives, particularly land officials at the district level and block level – land acquisition officers, circle officer/inspector etc. Information and documents/records pertaining to the private land acquired and the government land transfer in case of ash dyke area and also the records of litigation on the ash dyke land were collected.

Table 4.28 Site visit schedule and meetings undertaken

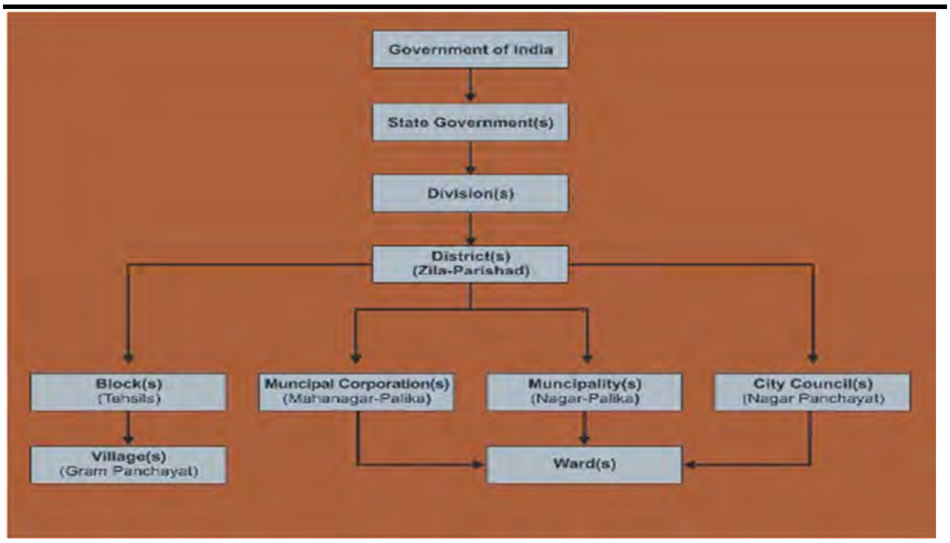
Date	Activity Brief	Discussion Topics
9th June, 2015	• BSPGCL Senior Management Team Executive Engineer – Planning and Design – P&D Dept., Chief Engineer P&D Dept, Electrical Executive Engineer	• Discussion on various points and aspects of pre- feasibility report; • Understanding land requirement for various project components;
	• Director for Land Acquisition, Bihar • Subordinate to Section Officer	• ERM seeking cooperating for sharing land acquisition related information and associated documents etc. for Patna District and Begusarai District; • Discussion regarding the current status on the land acquisition in this project context;
10th June, 2015	• Director, Land Acquisition Officer for Patna District. • Assistant Dir. Land Acquisition Officer Patna District	• ERM seeking cooperation for sharing land acquisition related information and associated documents etc. for Patna District;
11th June, 2015	• Assistant Director Land Acquisition Officer Patna District	• Discussion to understand the current status of compensation payments regarding acquired land – 129 acres private land; • Understand the land acquisition process followed in Bihar and in the case of BTPS; • Status update on any proceedings regarding identifying raiyati claims over gair majurwa land.
	• Other staff members of LA office relevant to BTPS project	• Documentation Support
	• Discussion with Executive Engineer – Planning and Design – P&D Dept. and Project Manager, Proposed Unit 10	• Sharing the concept note and discussion on the feasibility of conducting stakeholder meeting;
12th June, 2015	• Meeting with General Manager of BTPS and ESE Extension Project at in the Administrative Building	• Introduced ERM as the agency authorized to undertake EIA/ESIA study; • Shared the concept note for stakeholder meeting with GM; • Mutually agreed on some of the points concerning stakeholder meeting;
	• Meeting with Circle Officer (CO) and Circle Inspector (CI) in Mokama	• Documentation Support; • Discussion regarding the SLP Supreme Court Case on 290 acres of government land (transferred legally to BTPS, however physical possession has not been taken); • Understanding the role of CO/CI in the land acquisition process;

4.11.3 *Socio-Economic Baseline Profile of the District*

National Level

For administrative purposes, India has been divided into 29 states and 7 union territories (including a national capital territory). A state further has a four-tier administrative structure comprising of division, district, taluka/tehsil/block, and village. The district forms one of the most important units of administration. Some of the states have introduced the system of Panchayati Raj, which includes a three-tier structure of local self- government in rural areas at the village, block and district levels. An illustration of the administrative set-up in India is presented in ***Figure 1.3***.

Figure 4.42 Administrate set-up in India



General Administration – State

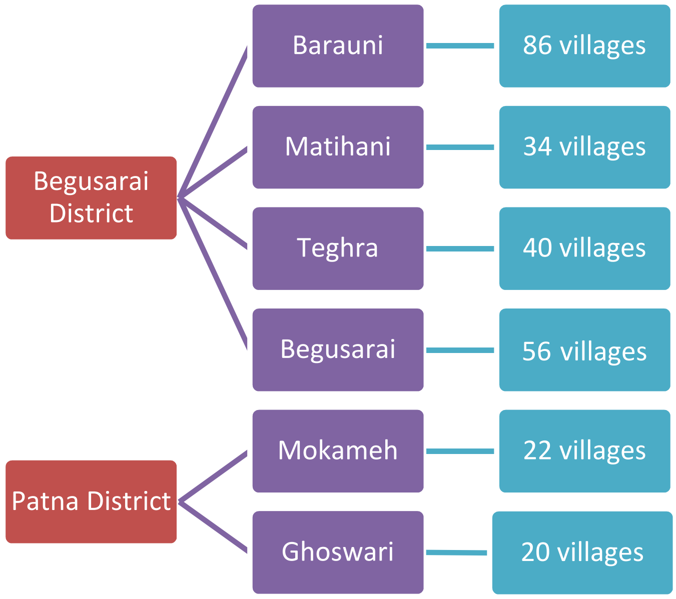
The Bihar state is located on the eastern part of the country and shares a border with Nepal. Elsewhere it is bordered by: Uttar Pradesh to the east, Jharkhand to the south and Bangladesh to the west. For administrative purpose, the state is divided into 9 divisions, 38 districts, 101 sub divisions and 534 sub-districts or blocks. The administrative head of each district is the Deputy Commissioner. The capital of the state is Patna. While Patna district is among the most populous of all, Sheikhpura District is the least populous.

District and Tehsil Level

The project components are spread across the Barauni Tehsil in Begusarai District and Mokameh Tehsil in Patna District. The main power plant area, coal storage area, switchyard, railway siding, railway colony and water intake/pipeline are located in Begusarai District, whereas the ash dyke area and a majority section of the ash pipeline falls in Patna District. For the purpose of general administration, each of the districts is divided into several sub-districts and a number of gram panchayats (comprising of villages) are categorized under each sub-district or tehsil. This is also representative of the

Panchayati Raj system in India which has defined three tier levels of governance (i.e. District, Sub-District or Tehsil and Gram Panchayat). The administrative profile of district and tehsils falling in the study area have been presented in the figure below. The total number of revenue villages associated within each of the Sub-district has also been indicated.

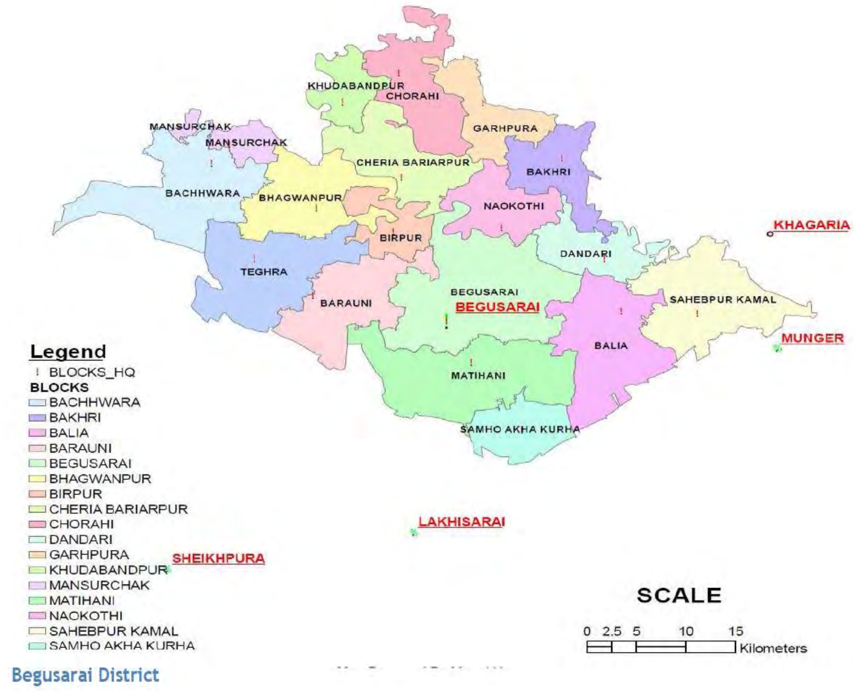
Figure 4.43 Administrative Profile of the Study Area



Source: Census, 2011

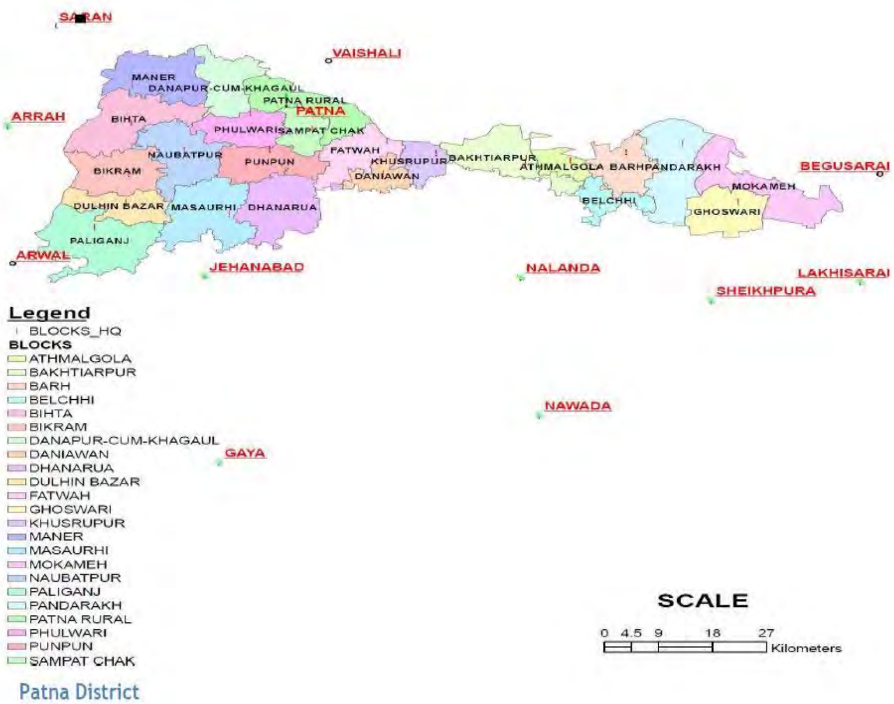
The Patna District is divided into 17 blocks or tehsils and the Begusarai District is divided further into 23 blocks or tehsils. Of these, as indicated, the entire study area is spread across 4 tehsils in Begusarai District and 2 tehsils in Patna District. The project (main plant area) itself is located in Barauni Tehsil in Begusarai District. The administrative divisions under each of the District have been presented below through the district maps.

Figure 4.44 ***Patna District Map***



Source: Bihar State and District Maps, Directorate of Economics and Statistics

Figure 4.45 ***Begusarai District Map***



Source: Bihar State and District Maps, Directorate of Economics and Statistics

Profile of the Study Area

As mentioned, the entire study has been defined into core and buffer area. The core area refers to the project area and the villages affected due to the project components (either directly or indirectly due to vicinity). The buffer area refers to the area from the core zone boundary up to 10 km radius from the plant area. In total, there are 5 revenue villages in the core area and 99 revenue villages in the buffer area.

Table 4.29 Break-up of Core and Buffer Villages Sub-District wise

Districts	Sub-Districts	Core Area Villages	Buffer Area Villages	Total Villages in the Study Area
Begusarai	Barauni	2	59	61
	Matihani	3	2	5
	Teghra		13	13
	Begusarai		9	9
Patna	Mokameh		14	14
	Ghoswari		2	2
Total		**5**	**99**	**104**

Demographic Profile

Begusarai District is spread over a geographical area of 1918 km^2 and Patna District is spread over an area of 3202 km^2. The population of Begusarai and Patna Districts are 29.7 lakhs and 58.3 lakhs respectively. In Begusarai District, Barauni, Matihani, Begusarai and Teghra tehsils population constitutes 9%, 5%, 18% and 9% respectively of the district population. Even though the sex ratio across Begusarai and Patna districts is around 895, the tehsils are in the range of 876 to 897. Based on the numbers alone, it is difficult to hypothesize the reasons behind such a pattern.

Table 4.30 provides the key demographic profile of the Tehsil and the District while comparing it to the state.

Table 4.30 Comparative demographic indicators of the Tehsil/District/State

	Population	% Rural Population	Sex Ratio	SC%	ST%
Bihar	104099452	88%	916	15.9%	1.3%
Begusarai District	2970541	81%	895	14.6%	0.1%
Barauni Tehsil	273414	68%	890	12.4%	0.2%
Matihani Tehsil	152725	100%	879	8.7%	0.0%
Begusarai Tehsil	540009	51.5%	884	7.6%	0.1%
Teghra Tehsil	257751	50%	894	5.7%	0.0%
Patna District	5838465	57%	897	15.8%	0.2%
Mokameh Tehsil	202411	67.6%	876	16.6%	0.1%
Ghoswari Tehsil	74898	100%	883	18.1%	0.0%

Source: PCA, 2011

Nearly 81% of the population in Begusarai district and 57% of population in Patna district is rural and lives in settlement located close to water bodies and agricultural fields. The districts have a proportion of nearly 15% SC population; however the ST population is negligible at 0.1%. The SC population is lowest in Begusarai Tehsil and Teghra Tehsil. Begusarai and Patna districts have a sex ratio of 895 and 897 respectively which is much below the state average of 916 (which is also lower than the national average of 940. The population growth rate over the decade 2001-11 for Begusarai and Patna district was 26.44% and 22.34% respectively.

A detailed list of the villages falling within the study area of 10 km is presented in ***Annex 4.5. Table 4.31*** presents the key demographic indicators for the core area villages.

Table 4.31 Villages in the Core Area – Begusarai & Patna District

Villages	Total HH	Total Population	Sex Ratio	% SC proportion	% Total Literacy
Begusarai district					
Malhipur (CT)	2322	12439	880	3.9	56.7
Chakia	118	691	1015	10.0	65.8
Patna District					
Ramdiri	1379	6712	862	1.4	56.7
Ramdiri	81	363	871	0.0	44.4
Ramdiri	1430	6568	926	7.6	64.8

Source: Census 2011

As per the 2011 Census records, the Core area, covering 4 villages and 1 census town(CT), has a total of 5330 households *(2440 households in Barauni sub district and 2890 households in Matihani sub district)* and a population of 26773 *(13130 population in Barauni sub district and 13643 population in Matihani sub district)* . The entire population in the study area falls in the rural category except Malhipur in Barauni sub district which is categorised as census town [(1)] (CT) in census 2011. The literacy rates are relatively low in the core area villages. ***Table 4.32*** presents the key demographic indicators among the buffer area villages.

Table 4.32 Villages in the Buffer Area – Begusarai and Patna District

Villages	Total HH	Total Population	Sex Ratio	% SC proportion	% Total Literacy
Begusarai District					
Buffer area villages of Barauni sub- district	42540	222760	888	12.07	69.8
Buffer area villages of Teghra sub-district	14393	78945	890	7.37	68.6
Buffer area villages of Begusarai Sub District	2502	12238	869	19.26	66.3
Buffer area villages of Matihani Sub District	4440	21323	877	6.94	63.83

(1) Census Town (CT) refers to places that satisfy the following criteria are termed as CTs. The criteria inlucdes: i) a minimum population of 5000; ii) at least 75% of the male main working population engaged in non-agricultural pursuits; and iii) a density of population of at least 400 per sq. km.

Villages	Total HH	Total Population	Sex Ratio	% SC proportion	% Total Literacy
Patna District					
Buffer area villages of Mokameh sub- district	10710	63301	879	14.16	65.07
Buffer area villages of Ghoswari sub- district	2078	13760	885	16.27	48.33

Source: Census 2011

Buffer area covers part of the two districts of Begusarai and Patna. The majority of the study area falls under Begusarai District, while the South Eastern part of the area falls under Patna District. There are a total of 99 villages (59 villages in Barauni Sub district, 13 villages in Teghra sub district, 9 villages in Begusarai sub district, 2 village in Matihani sub district tehsil of Begusarai district and 14 villages in Mokameh sub district, 2 villages in Ghoswari sub district of Patna district) within the buffer area.

Literacy Profile

The total literacy rate in Bihar is 63.82%, where the male literacy rate is 73.9% and the female literacy rate is 53.5%. The decadal increase in literacy rate in Bihar is the highest among all the states in India. According to the Economic Survey of Bihar (2012), the literacy rate in Bihar increased from 47% in 2001 to 63.8% in 2011, implying an increase of 16.8 %.

Literacy profile of the study region is highlighted in ***Table 4.33***. The total literacy rate is in the range of 50% to 70% across the Districts and Tehsils, with the exception being Begusarai Tehsil and Teghra Tehsil with rates of 35.7% and 35.4% respectively.

Table 4.33 Literacy Profile at Tehsil and District Level

	Total Literacy Rate	Male Literacy Rate	Female Literacy Rate
Bihar	63.8%	73.3%	53.5%
Begusarai District	63.9%	71.6%	55.2%
Barauni Tehsil	67.9%	75.3%	59.5%
Matihani Tehsil	64.9%	72.3%	56.5%
Begusarai Tehsil	35.7%	59.8%	59.3%
Teghra Tehsil	35.4%	60.0%	62.1%
Patna District	70.7%	78.5%	62.0%
Mokameh Tehsil	65.2%	72.4%	56.9%
Ghoswari Tehsil	50.2%	61.2%	37.5%

Source: Census 2011

The average literacy rates among the core villages vary across a range of 44% to 65%. The female literacy rates ranges from 38% to 55% within core area. Average male and female literacy rate is 65.87% and 48.64% respectively.

Table 4.34 Literacy Profile of the Core Area Villages

	Literacy Rate	Male Literacy Rate	Female Literacy Rate
Begusarai District			
Malhipur (CT)	56.67%	61.96%	50.64%

	Literacy Rate	Male Literacy Rate	Female Literacy Rate
Chakia	65.85%	77.70%	53.74%
Patna District			
Ramdiri	56.71%	66.86%	44.75%
Ramdiri	44.37%	49.37%	38.52%
Ramdiri	64.80%	73.50%	55.57%

Source: Census 2011

As per census, 2011 the average male and female literacy rate in the buffer area villages in the study area is 71.03% and 55.18% respectively. Highest male literacy rate (77.3%) and female literacy rate (62%) was observed in buffer area villages located in Barauni sub district and buffer area villages located in Teghra sub district of Bagusarai district respectively. The lowest Male and female literacy rate at 58.3% and 36.7% respectively observed in Ghoswari sub district of Patna District Male and female literacy rate ranged within 58.3% to 77.3% and 36.7% to 62% with an average literacy rate of 71.03% to 55.18% respectively.

Table 4.35 Literacy Profile of the Buffer Area Villages

	Literacy Rate (%)	Male Literacy Rate (%)	Female Literacy Rate (%)
Begusarai District			
Buffer area villages of Barauni sub- district	69.8	77.3	61.4
Buffer area villages of Teghra sub-district	68.6	74.5	62
Buffer area villages of Begusarai Sub District	66.3	74.4	56.8
Buffer area villages of Matihani Sub District	63.8	69.5	57.3
Patna District			
Buffer area villages of Mokameh sub- district	65.07	72.2	56.9
Buffer area villages of Ghoswari sub- district	48.33	58.3	36.7

Source: Census 2011

Social Groups, Caste/Community Profile and Gender

Hindus are the most dominant religious group and comprise 80-85 percent of the total population in the study area. There is a relatively smaller proportion of Muslims ~10-15 percent. Christianity occupies the status of a minority religion in the study area and overall in the state, with less than 0.5% of the total population. Other religious groups such as Sikhs and Jains constitute a very small proportion of the total population.

Among the Hindus, the major caste groups dominant in the state include the Other Backward Caste [(1)] category (yadavs, kurmis, kushwahas, koeris), the

(1) The collective term is used by the Government of India to refer to those castes which are socially and economically disadvantaged. Backwardness is expressed in lack of adequate opportunity for group and individual self-development, especially in economic and in matters of health, housing and education. It is measured in terms of low levels of income, the extent of illiteracy and the low standard of life demonstrated by living conditions.

Dalits category (Scheduled Castes (1) – Dusadh, Musahar), the forward caste category (Bhumihar, Brahmin, Rajputs, Kayasth) and the Adivasis (Scheduled Tribes (2)). There is continued practice of caste-based social interactions and caste based discrimination of SCs/STs has been highlighted across several studies (3) .

In the study area, it was indicated that the population constitutes of forward caste group and the dalit caste group. Bhumihars are reportedly a dominant caste group in the study area, followed by Rajputs and Brahmins. Caste composition in the above highlighted tables indicates that there is a relatively small proportion of SC population in the study area and an even negligible proportion of ST population.

Sex ratio is an important indicator of not only the gender balance of the society but also of the status of women. As mentioned, the national level data indicates 940 females per 1000 males and at Bihar level the data is much lower indicating 916 females per 1000 males. There has been a declining trend in sex ratio in Bihar between 2001 and 2011. From the literacy data indicated above, it can be observed that the female literacy rate is significantly lower than male literacy rate (with a difference of at least 10%). Women in the study area are engaged in works such as agricultural cultivation, wage labour, household work and taking care of children. Women's work typically tends to be classified as marginal, secondary or subsidiary work. This classification has implications for the significance attributed to women's work and wages paid. The NSS (2004-05) data indicated that Bihar ranked second from the bottom among the 18 major states (including Delhi) with respect to its female worker population ratio (WPR). The agricultural sector continues to be the largest employer of women with 86% of them working in it. Women continue to be rooted in traditional norms of social behaviour which include unequal treatment in decision making at the household level and lesser economic and social freedoms and opportunities relative to their male counterparts.

4.11.4 *Land Profile*

Land- its ownership, management and use in the state is a unique and complex system very different from that prevailing in other parts of the country. The section below discusses the different issues associated with the ownership, use and management of land and resources in the state.

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(1) Scheduled Caste is the legal and constitutional name collectively given to the groups which have traditionally occupied the lowest status in Indian society and they are considered to be "untouchables" by the Hindu religious groups. They are recognized by the Indian constitution as disadvantaged group.
(2) The Scheduled Tribe group are entitled to special rights conferred by the Indian Constitution. They are known to have such characteristics as - indications of primitive traits, distinctive culture, geographical isolation, shyness of contact with the community at large, and backwardness.
(3) One such example is: http://scstwelfare.bih.nic.in/docs/scst%20report%20of%2016th%20August%20Copy.pdf

Land Use Pattern at the State Level & District Level

Bihar falls in the riverine plane of the Ganga basic area. Because of this topographic nature, land put to agricultural use here is high as compared to other states in India.

Table 4.36 Land Use Pattern in Bihar (2005-06, 2006-07 & 2007-08) (Area in '000 hectares)

Land Use	2005-06	2006-07	2007-08
Geographical Area	**9359.57**	**9359.57**	**9359.57**
(1) Forests	621.64 (6.6)	436.06 (4.7)	432.09 (4.6)
(2) Barren and Unculturable Land	436.13 (4.7)	436.06 (4.7)	432.09 (4.6)
(3) Land put to Non-agricultural use	1646.63 (17.6)	1646.89 (17.6)	1652.66 (17.1)
Land Area	1285.65 (13.7)	1285.98 (13.7)	1292.11 (13.8)
Water Area	360.98 (3.9)	360.91 (3.9)	360.55 (3.9)
(4) Culturable Waste	45.71 (0.5)	45.65 (0.5)	45.59 (0.5)
(5) Permanent Pastures	17.4 (0.2)	17.33 (0.2)	16.47 (0.2)
(6) Land Under Tree Crops	240.28 (2.6)	240.52 (2.6)	240.96 (2.6)
(7) Fallow Land (excluding current fallow)	129.41 (1.4)	119.97 (1.3)	119.35 (1.3)
(8) Current Fallow	666.18 (7.1)	566.39 (6.1)	568.61 (6.1)
Total Unculturable Land (1 to 8)	**3803.38 (40.6)**	**3694.45 (39.5)**	**3697.36 (39.5)**
Net Sown Area	**5556.19 (59.4)**	**5665.12 (60.5)**	**5662.20 (60.5)**
Gross Sown Area	7396.49 (79.0)	7718.95 (82.5)	7764.65 (83.0)

Source: The Economic Survey, Bihar, 2011

The table indicates that the area under forests has remained unchanged at 6.6% and so has the area under non-agricultural use at 17.6%. The area under net sown area has undergone a marginal change. In 2007-08, net sown area was 60.5% as compared to 59.4% in 2005-06. The increase in net sown area is 109 thousand hectares. Cropping intensity has shown a marginal increase and land under both fallow and current fallow have registered a decrease in 2007-08. This indicates that, with growing population, the pressure on land is now even higher.

At the district level, the total geographical area in Begusarai District is 187.83 ('000 hectares) and in Patna District is 317.24 ('000 hectares). The total unculturable land area is 35.7% and 36.5% respectively. In both Begusarai and Patna District, the area under cultivation is above 60%. While the net sown area in Begusarai is 64.3%, it is 63.5% in Patna district. The cropping intensity in Begusarai and Patna District is 1.45 and 1.11 respectively. This indicates that the irrigation facilities are relatively better in Begusarai than in Patna.

Land Use of the Study Area

Individual village wise land use data is available for the villages in the study area based on the census/village directory. Land use classification (2011) indicates that forest area constitutes a negligible proportion in the study area and of the total area; the proportion of cultivable land available is above 60%.

The area under non-agricultural use ranges from 22% to 38% in some of the core area villages.

Of the total net area, more than 50% area in core villages constitutes of unirrigated land which is dependent primarily on rainfall. Review of the land information suggests that there is some forest land in periphery area but none of the core villages has any forest area.

Table 4.37 Land Use Profile in the Study Area

Core Area Villages	Total Area (in Ha)	Forest Area (% of total area)	Area under Non-Agricultural Uses (% of total area)	Net Area Sown (% of total area)	Net Area Sown	
					Total Unirrigated Land Area (% of total area)	Area Irrigated by Source (% of total area)
Begusarai District						
Malhipur (CT)	Data is not available					
Chakia	139	0.0	21.69%	78.30%	65%	34.99%
Patna District						
Ramdiri	283	0.0	36.40%	63.60%	50%	50%
Ramdiri	2	0.0	100.00%	0.00%	0%	0%
Ramdiri	327	0.0	38.84%	61.16%	45%	55%
Total in Core area villages	751	0.0	34.9%	65.09%	51.29%	48.70%
Periphery area villages	20959.15	3%	23.58%	64.24%	65.15%	34.84%

Source: Census 2011

According to the Agricultural Census of 2005-06, the concentration of marginal holdings in Bihar is very high in the Scheduled Castes (95%) and Scheduled Tribes (88%). Also, 79.3% of all individual and join holdings of SCs are concentrated within only 3.98% of the total area enclosed by the individual and joint holdings of all social groups. (1)

According to another study of disparities in distribution of land in Bihar (2), the proportion of marginal landholders is highest among STs and SCs (95.1% and 92.6% respectively) amongst all communities. While the average land holding per household is 1.13 acres across the whole area of study, the same for STs and SCs is only 0.65 acres and 0.72 acres respectively. In addition, the concentration of families facing near absolute landlessness is highest amongst the SC is 53.5% whereas the same for the ST is 47.98%.

(1) Sc & ST Welfare Department, Government of Bihar, 2012

(2) Landlessness and Social Justice published by Praxis - Institute for Participatory Practices, based on a Land Mapping project carried out in Bihar in 2009 in the districts of Gaya, Jamui, Patna, Nawada and West Champaran.

4.11.5 *Occupation & Livelihoods*

Workers Participation Rate (WPR) depicts the engagement of main and marginal workers in different occupations at household, commercial or agricultural level. WPR is calculated as the ratio of working population (both main and marginal workers) to the total population (working and nonworking population) of the town/village. It also indirectly indicates the employment opportunities in informal sectors like household industries, industrial and commercial activities etc. the higher the WPR, the more active local population in terms of employment, which could be due to the commercial activities in the vicinity.

The WPR ranges from 22 to 40 percent in the core area villages and 27% to 36% in the buffer area villages. The WPR range is relatively broader in the core area villages; however it is to be noted that only 1 village is skewing the data and the remaining villages have a WPR above 31%. The proportion of main workers in the total working population is approximately is nearly 65% on an average in the core area villages.

Table 4.38 Occupational pattern of the villages under core area

Core Area Villages	WPR	Main Worker (1)%	Marginal Worker (2)%	Non – Worker %	CL (3) %	AL (4) %	HH (5) %	OW (6) %
Begusarai District								
Malhipur (CT)	31.27	70.74	29.25	68.72	1.18	51.92	2.75	44.13
Chakia	39.50	63	36.99	60.49	17.21	65.56	1.83	15.38
Patna District								
Ramdiri	36.59	51.14	48.85	63.40	5.65	65.63	1.18	27.52
Ramdiri	22.31	97.53	2.46	77.68	3.70	90.12	0	6.17
Ramdiri	32.71	49.93	50.06	67.28	15.86	46.95	1.25	35.92
Total in Core area villages	33.05	60.25	39.74	66.94	6.50	55.29	1.89	36.29
Total In Buffer area villages								

Source: Census 2011 Data

(1) Main Workers are those workers who had worked for the major part of the reference period (i.e. 6 months or more)
(2) Marginal Workers are those workers who have not worked for major portion of reference period (i.e. less than 6 months).
(3) Cultivator is person engaged in cultivation of land owned or held from Government or held from private persons or institution for payment in money, kind or share. Cultivation includes effective supervision or direction in cultivation. A person who has given out her/his land to another person or persons or institution for cultivation for money, kind or share of crop and who does not even supervise or direct cultivation in exchange of land, is not treated as cultivator. Similarly, a person working on another person's land for wages in cash or kind or a combination of both (agricultural labourer) are not treated as cultivator.
(4) A person who works on another person's land for wages in money, or kind or share is regarded as agriculture labourer. He or she has no risk in the cultivation, but merely works on another person's land for wages. An agriculture labourer has no right of lease or contract on which she or he works.
(5) Household industry is defined as an industry being run by one or more member of a household at home or within village in rural areas and only within the precincts of the house where the household lives in urban areas. The larger proportion of workers in the household industry consists of members of household. The industry is not run on the scale of a registered factory which would qualify or has to be registered under the Indian Factories Act.
(6) All workers i.e. those who have engaged in some economic activity during the last one year, but are not cultivators or agriculture labourers or in household industry are 'Other Workers'.

Note: WPR – Work Participation Ratio, CL – Cultivators, AL – Agriculture Labourer, HH – Household Workers, OW – Other Workers.

The proportion of agriculture cultivators and agriculture labourers overall constitute of a majority of the working population (~ 60%). Within these two categories, the proportion of agricultural labourers is markedly greater than cultivators. The proportion engaged in household industry seems insignificant. The occupation pattern

This is followed by the proportion engaged in other workers and these may include people engaged in thermal power industries, fertilizer based industries, sand mining, other jobs, self-employed etc.

Table 4.39 Occupational pattern of the villages under buffer area

Buffer Area Villages	WPR	Main Worker %	Marginal Worker%	**Non – Worker %**	CL%	AL%	HH%	OW%
Begusarai District								
Buffer area villages of Barauni sub- district	27.40	64.17	35.82	72.59	9.95	29.09	5.24	55.71
Buffer area villages of Teghra sub-district	26.61	84.23	15.76	73.38	8.11	15.08	5.37	71.42
Buffer area villages of Begusarai Sub District	30.70	54.78	45.21	69.29	15.69	32.19	5.72	46.38
Buffer area villages of Matihani Sub District	32.86	59.14	40.85	67.13	30.59	46.66	2.41	20.33
Patna District								
Buffer area villages of Mokameh sub- district	34.62	66.13	33.86	65.37	12.49	45.40	13.21	28.88
Buffer area villages of Ghoswari sub- district	36.51	56.38	43.61	63.48	4.65	78.30	3.08	13.95

Source: Census 2011 Data

Work Participation ratio (WPR) that is defined as percentage of total workers including main and marginal workers out of the total population of the study area represents that percentage of working population in mostly villages under core area is seems to have relatively high unemployment rate as WPR of study area various from 22.31% to 39.50%

The occupational pattern of the study area villages shows that working population in most of study area villages are actually agriculture labour who works on other's field at certain wage rate mutually negotiated between cultivator and agriculture worker.

Agriculture and Allied

Agriculture Pattern at the State Level

Traditionally, Bihar's economy is dominated by the rural sector and around 90% of the population lives in the rural areas and agriculture has been the mainstay for their livelihood. Bihar is endowed with fertile Gangetic alluvial soil with abundant water resources , particularly ground water resources.

Based on soil characterization, rainfall, temperature and terrain, three main agro-climatic zones in Bihar have been identified as:

- Zone I (North West Alluvian Plain) 36%
- Zone II (North East Alluvian Plain) 20%
- Zone III (South Bihar Alluvian Plain) 44%

The major agricultural products of Bihar are cereals, pulses, oil seeds and cash crops. The rice wheat cropping system occupies more than 81% of the gross cropped area (1). Over the past decade, there has been additional efforts being put by the State Government to strengthen support services such as irrigation, seed, farm mechanism, credit flows, farmer awareness programs, easy and time bound access to fertilizer are being triggered to made agriculture moe viable and productive (2) .

Rainfall in Bihar is largely due to South-west monsoon which accounts for 85% of the total rainfall in the state. The average rainfall in Bihar is 1091 mms. Other sources, viz., winter rain, hot weather rain and North West monsoon account for remaining 15% of the rainfall. However, the rainfall witnesses year to year variation which is responsible for both droughts and floods resulting in variation in the agriculture income.

Agriculture Pattern in the District/Region and Study Area

As indicated, agriculture is the main source of sustenance for majority population of the Begusarai and Patna District. Both the districts lie on the same agro-climatic zone which is the middle gangetic plain region. A further segregation indicates that Begusarai district falls in the North West Alluvian Plain, whereas Patna District falls in the South Bihar Alluvial Plain Zone (BI-3).

The districts receive an annual rainfall of 1069 mm and 1054 mm respectively. And the groundwater (used for irrigation purpose) is identified to be safe across both the Districts. Being surrounded by Ganga River, some of the area is well-irrigated whereas the other areas are more dependent on rainfall for irrigation.

The main food crops of the districts are wheat, maize and paddy. Sugar cane is among the main cash crops in Begusarai District. Both the districts are rich in groundwater resources, which are relied upon for irrigation purpose. Other important crops include: pigeonpea in Begusarai District and chickpea, and pigeonpea in Patna District.

There is no reported regular contingency for agriculture in Begusarai district, however some of the occasional contingencies include drought, floods, heat wave, cold wave and frost. Whereas in Patna district, heat wave, cold wave,

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(1) http://www.landuseindia.in/live/hrdpmp/hrdpmaster/hrdp-asem/content/e48335/e48799/e48940/e51439/e51511/12.LandUtilisationPracticesinBihar_UKB_reduce.pdf

(2) Bihar Economic Survey 2011. Retrieved from: http://gov.bih.nic.in/documents/Economic-Survey-2011-English.pdf

frost and pests/disease outbreak form a part of regular contingencies that the agriculture sector faces, followed by occasional droughts and hail storms.

Animal husbandry plays an important part in the rural economy and is another source of household income. Livestock in the study area districts mainly comprises of cattle. In addition, buffalo and goats are also commonly owned by households, whereas sheep is owned by a relatively smaller proportion. Most commonly in Begusarai District, livestock consists of non-descript local varieties of cattle, buffaloes, poultry, goats etc. instead of improved variety or the crossbred variety. In Patna district, there is a significant presence of crossbred cattle.

Non-Farm based livelihood

Non- farm based livelihood under the categories of other workers represent that its proportion is relatively very high.

<u>*Industries*</u>

Bihar has had a relatively low growth trajectory at the industrial front. Bihar's industrial sector contributed to only about 16% to its Gross State Domestic Product (GSDP) as against 26% for the national average, as per the Bihar Economic Survey, 2011. The contribution of manufacturing sector as a whole is less than 5% to the GSDP and has also witnessed a sharp decline since 2004-05. This trend is confirmed in case of mining and quarrying sector also. Only the construction sector has proved to be the key driver in the growth trajectory of the state, whose share increased to almost twice in 2009-10 (11.18%) compared to 2004-05 (5.52%) [(1)] .

In Begusarai District, there is the Barauni Industrial area spread across an area of nearly 8.5 hectares of land. The total number of plots is 46, out of which nearly 28 plots are allotted to industrial units. Overall, the District has witnessed a reduction in the registration of new industrial units on a yearly basis relatively since 2006-07. In the years 2009-10 and 2010-11, there were 203 and 226 new registered units and in the year 2011-12, there were 161 new units registered. Majority of the industries established are agro-based followed by mineral based industries (non-metallic), engineering units, repairing and servicing units, wood/wooden based furniture units, chemical and chemical based industries etc. Barauni refinery is one of the country's biggest oil refinery located in Begusarai, Bihar.

In Patna District, there are 4 Industrial Areas – Patliputra, Fatuha, MIP Bihta and Bihta. They are spread across an area of 42 ha, 98 ha, 269 ha and 42 ha. Overall, the yearly figures of new industrial units registered over a period of time have fluctuated. In the years 2008-09 and 2009-10, there were 236 and 229 new industrial units registered and in the year 2010-11, there were 517. Majority of the industries are agro-based and metal based (steel fab.) followed

(1) http://gov.bih.nic.in/documents/Economic-Survey-2011-English.pdf

by wood/wooden based furniture, repairing and servicing, rubber, plastic and petro based products etc. There is a rising trend of growth in the food processing sector in the district because of the availability of surplus agro products and a huge market.

Migration-linked livelihood

In the villages of Bihar across all districts, migration for seeking employment is a predominant feature. Most of them migrate to the urban centres in India in search of employment.

According to a study conducted by the Institute of Human Development in 18 villages of north Bihar, migration in search of work has recorded a substantive rise in the decades between the years 1980 - 2000. The study notes that during the early 1980s, the most important destinations were rural areas of Punjab and Haryana. By the 1990s, Bihari migrants began opting for urban destinations like Delhi, Mumbai, Kolkata, Guwahati, Hyderabad and Surat. Migrants have known to contribute significantly to Bihar's economy in the form of newly acquired knowledge and technical know-how, and small savings by way of remittances.

A combination of marginal land holdings, low wages combined with employment uncertainty, lack of educational institutions combined with lack of industry and absence of market and investment opportunities are among the key push factors that drives migrants out of the state. Both the census and NSS reports suggest that Bihar has the highest rate of gross inter-state out-migration in the country.

Fisheries

In both the districts and more importantly in Patna district, fisheries are an important source of livelihood for the families dependent. In Patna district, there are over 400 farmer owned ponds, 1150 reservoirs and 739 village tanks whereas in Begusarai district, there are over 80 farmer owned ponds, 230 reservoirs and 150 village tanks.

In the study area, it was reported that the communities are not dependent on fishing as their primary livelihood source. Some of the families residing in Simariya ghat and adjacent to Ganga River undertake fishing during monsoons and in the post-monsoon period. For some such households, fishing may form as a secondary occupation and source of livelihood.

Others

The other employment avenues in the districts and the study area include: wage labour activities (for instance, NREGA), employment in government services/administration and various self-employment opportunities ((setting up retail shops, hotels, among others).

Education Infrastructure

As mentioned, in 2011, the total literacy rate in Bihar is 63.82%, where the male literacy rate is 73.9% and the female literacy rate is 53.5%. The National Family Health Survey of 2005-06 estimated the male and female rates in Bihar to be 70.4% and 37.4% respectively. Thus, the increase in literacy in the first half of the last decade has been accompanies by a very steep increase in gender gap from 26.1% to 33%.

The district wise classification suggests that the literacy rate in rural Patna and Begusarai is just average in relative terms for all the communities and also the SC community. While the ST community in Begusarai ranks above average in literacy rate, the ST community in Patna district ranks below average. Out of 38 districts, 18 districts (including Patna) have around 4 primary schools for every ten thousand of population. Begusarai district ranks below average in terms of the total number of primary schools and upper primary schools (1). The coverage of secondary and senior secondary level education through schools and colleges is far less and shows large inter-district variations. Both Patna and Begusarai districts have average to above average score in terms of the total number of secondary education institutions.

The following section covers the access to infrastructural facilities in the study area.

The study area possesses necessary educational infrastructure to cater to the educational needs of the population. A review of the census 2011 indicates that every village in the study area has at least one government primary school and one government middle school, with an exception of Ramdiri village (which has very few numbers of households) in the core area.

Table 4.40 Education facilities in with in core area

Core area Villages	Govt. Primary School	Govt. Middle School	Govt. Secondary School	Nearest Facility	Govt. Senior Secondary School	Nearest Facility
Begusarai District						
Malhipur (CT)	Available	Available	Not Available	Bihat (2km)	Not Available	Bihat (2km)
Chakia	Available	Available	Available	_	Not Available	Masauri (5 -10 km)
Patna District						
Ramdiri	Available	Available	Not Available	Matihani (10+ km)	Not Available	Maithani (10+ km)
Ramdiri	Not Available	Not Available	Not Available	Matihani (10+ km)	Not Available	Maithani (10+ km)
Ramdiri	Available	Available	Not Available	Matihani (10+ km)	Not Available	Maithani (10+ km)

Source: Census 2011 Data

(1) http://gov.bih.nic.in/documents/Economic-Survey-2011-English.pdf

The government secondary school facility is only available in Chakia village among the core area villages. For access to secondary schools, the students of the other villages have to travel to nearest towns which are at a distance of 5-10kms, with some being beyond the distance of 10 kms (such as Matihani).

The education facilities for the buffer area villages have been presented in the table below. It indicates that overall there is a reduction in the infrastructural facilities, with an increase in the education levels.

Table 4.41 Education facilities with in buffer area

Buffer area Villages	Govt. Primary School	Govt. Middle School	Govt. Secondary School	Govt. Senior Secondary School
Begusarai District				
Buffer area villages of Barauni sub- district	25	17	6	2
Buffer area villages of Teghra sub-district	3	2	1	1
Buffer area villages of Begusarai Sub District	2	1	0	0
Buffer area villages of Matihani Sub District	1	2	0	0
Patna District				
Buffer area villages of Mokameh sub- district	5	5	6	5
Buffer area villages of Ghoswari sub- district	2	2	2	1

Source: Census 2011 Data

Healthcare

Bihar is among the few states which has the lowest budgetary capacity and spends the least on health care on a per capital basis. The National Rural Health Mission was initiated in 2005 in order to resolve the issues of accessibility and affordability of healthcare to the population below the poverty line and the lower and middle classes, in rural India. Bihar is among the 18 states where such an initiative was launched and which has also been a key trigger for improvement in the healthcare facilities in the State.

According to the Bihar Economic Survey, 2011, the state has shown a steady improvement in vaccination coverage, institutional deliveries and infant mortality based on studies undertaken between 2002-04 and 2007-08. The status of antenatal care has witnessed a gradual change. Between 2007-08 and 2008-09, Bihar has seen a decline in some maternal health indicators in keeping with the national pattern, while child health indicators have improved in the same period. There has been a continuous change in the health infrastructure trends (the total number of primary health centres and health sub-centres etc.) in the state. A report by the State Health Society indicates that there has been an increase in the footfall of patients in the government health care facilities between 2006 and 2010. The number of institutional deliveries has also improved.

Health infrastructure in the study area comprises of a network of public and private institutional set up (like sub centres, dispensaries and health centres operated by the government) responsible for health care delivery in the area.

Most of the villages in the study area do not have a sub health centre or a primary health centre in the village itself or in the nearby villages. The nearest facility is typically in the range of 5-10 kms and for some villages it is above 10 kms.

Table 4.42 Medical facilities with in core area

Core Area Villages	Community Health Centre		Primary Health Centre		Primary Health Sub Centre		Maternity And Child Welfare Centre		Hospital Allopathic (Numbers)	
	Numbers	**Distance to nearest facility**	**Numbers**	**Nearest facility distance range**	**Numbers**	**Nearest facility distance range**	**Numbers**	**Nearest facility distance range**	**Numbers**	**Nearest facility distance range**
Begusarai District										
Malhipur	Data Not Available		Data Not Available		Data Not Available		0	3 km	1	
Chakia	0	10+km	0	10+km	0	5-10km	0	5-10km	0	5-10km
Patna District										
Ramdiri	0	10+ km	0	< 5 Kms	1		1		0	10+ km
Ramdiri	0	10+ km	0	10+ km	1		1		0	10+ km
Ramdiri	0	10+ km	0	10+ km	0	10+ km	0	10+ km	0	10+ km

Source: Census 2011 Data

Table 4.43 Health care facilities with in buffer area

Buffer area Villages	Community Health Centre	Primary Health Centre	Primary Health Sub Centre	Maternity And Child Welfare Centre	Hospital Allopathic (Numbers)
	Numbers	*Numbers*	*Numbers*	*Numbers*	*Numbers*
Begusarai District					
Buffer area villages of Barauni sub- district	0	0	12	12	0
Buffer area villages of Teghra sub-district	0	0	0	0	0
Buffer area villages of Begusarai Sub District	0	0	1	1	0
Buffer area villages of Matihani Sub District	0	0	0	0	0
Patna District					
Buffer area villages of Mokameh sub- district	0	1	5	2	0
Buffer area villages of Ghoswari sub- district	0	0	0	0	0

Source: Census 2011 Data

4.11.6 *Physical Infrastructure*

The network of physical infrastructure in the study are comprises of roads, transport coverage, electricity, drinking water, sanitation and solid waste management. These have been discussed subsequently in terms of their availability and arrangement. The adequacy aspect needs to be further substantiated with the help of primary consultations.

Water Sources

<u>*Drinking Water*</u>

All the villages have drinking water sources within the village. Review of census 2011 data, as indicated in the table above, shows that most of the villages use hand pumps, tube wells and bore wells for drinking water and other purposes.

The Ganga River flows through the study area and within 3.5 kms of the main power plant location and hence the land is well irrigated. Further, the study area also constitutes stretches of Tal lands, where backwaters of Ganga River stagnate in low lands during Kharif season floods between September-December every year. The river bed area is generally well-irrigated and multi-cropped. Open wells and borewells are among the most common form of irrigation sources available in the study area.

Table 4.44 Drinking Water facilities with in Core area

Core Villages	Tap Water-Treated	Covered Well	Hand Pump	Tube Wells/Borehole	River/Canal	Tank/Pond/Lake
Begusarai District						
Malhipur	Data Not Available					
Chakia	NA	NA	A	A	NA	NA
Patna District						
Ramdiri	NA	NA	A	A	NA	NA
Ramdiri	NA	NA	A	A	NA	NA
Ramdiri	NA	NA	A	A	NA	NA

Source: Census 2011 Data

Solid Waste Management

There are no proper mechanisms of disposal of solid waste available at the village level. Waste from households (mostly household and cattle waste) is dumped either in the open space near to the household or thrown in the nearby land. There is no formal system of composting wet waste or solid waste of cattle.

Road & Transportation

The study area is well connected with the nearest towns – Barauni and Matihani. The roads are not in a good condition or paved/cemented for those leading to the villages. The Rajendra Setu Bridge is among the main connecting bridges between the two sides of the Ganga River. However, the road infrastructure crumbles particularly during the monsoon season. In some cases, the pathways leading to the ash pond area and the surrounding villages are in a bad condition and do not comprise of proper roads.

Electricity, Postal Service, Bank, Telecommunication

The villages in the study area are reported to be electrified. However, the household level power connections are not available in 100% of the households in the villages. Postal services and bank facilities are not available in all the villages in the study area. Mostly people have to travel to Malhipur town or Barauni town for access to majority of such services. Similarly, telecommunications services are not available in all the villages in the studyu area, although mobile connections are gaining popularity and usage.

Rural Development Schemes of the State Government

National Rural Employment Guarantee Scheme – Bihar (MGNREGS)
This is a centrally sponsored scheme and the state has been prepared under the provision of National Rural Employment Guarantee Act, 2005. It guarantees 100 days of employment in a financial year to any rural household whose adult members are willing to do unskilled manual work. In case of failure to provide job, the labourer will be compensated with unemployment allowance. The scheme has been launched in 23 districts in India since 2006. This scheme has been implemented in both Begusarai and Patna District.

Swarna Jayanti Gram Swarojgar Yojana (SGSY)
This is a centrally sponsored scheme and this was launched in 1999 by restructuring IRDP (Integrated Rural Development Programme), and a number of allied programmes such as TRYSEM (Training of Rural Youth for Self Employment), DWCRA (Development of Women & Children in Rural Areas), SITRA (Supply of Improved Toolkits to Rural Artisans), GKY (Ganga Kalyan Yojana) and MWS (Million Wells Schemes). This is a holistic programme covering all aspects of self-employment such as organisation of the poor into Self-Help Groups, training, credit, technology, infrastructure and marketing. This scheme is being implemented in the study area districts.

Indira Awas Yojana (IAY)
IAY is a centrally sponsored scheme and it is a flagship rural housing scheme, which is being implemented by the Government of India with an aim of providing shelter to the poor below poverty line. The Government of India has decided that allocation of funds under IAY (Indira Awas Yojana) will be on the basis of poverty ratio and housing shortage. IAY was firstly launched during 1985-86 as a sub-scheme of RLEGP (Rural Landless Employment Guarantee Programme). IAY is a beneficiary-oriented programme aimed at providing houses for SC/ST households who are victims of atrocities, households headed by widows/unmarried women and SC/ST households who are below the poverty line. This scheme is being implemented in the study area districts.

The Integrated Wastelands Development Project

This is a centrally sponsored scheme and it strives to develop non-forest wasteland on village/micro-watershed basis. The scheme also helps generate employment in rural areas besides, enhancing people's participation in wasteland development leading to equitable sharing of benefits and sustainable development. Major activities taken up under this scheme are soil and moisture conservation, afforestation and pasture development, promotion of horticulture/agro-forestry, encouraging natural regeneration, wood substitution and fuel wood conservation measures, and dissemination of technology, as decided by the user group living in or around the project area. This scheme is being implemented in Patna district.

5 IMPACT ASSESSMENT

5.1 INTRODUCTION

This section identifies and assesses the potential changes in the environment that could be expected from the proposed expansion unit (Unit No. 10) of BTPS. The impacts due to proposed project activities have been identified and predicted qualitatively as well as quantitatively, wherever feasible. The proposed project activities would create impact on the environment in two distinct phases:

a. Construction phase
b. Operational phase

Impacts are identified and predicted based on the analysis of the information collected from the following:

- Project information (as outlined in ***Section 2***);
- Baseline information (as outlined in ***Section 4***).

The identification of likely impacts during construction and operational phases of the proposed project have been done based on likely activities having their impact on environmental parameters. The details of the activities and their impacts have been worked out in the following sections.

The initial step in undertaking the ESIA study is to identify the scope of the assessment i.e. to identify the range of environmental and socioeconomic topics to be studied (technical scope), the geographical area to be covered (spatial scale) and the timeframes over which the project will be carried out (temporal scale).

5.2 IMPACT ASSESSMENT METHODOLOGY

The principal impact assessment steps are summarised in ***Figure 5.1*** and comprise:

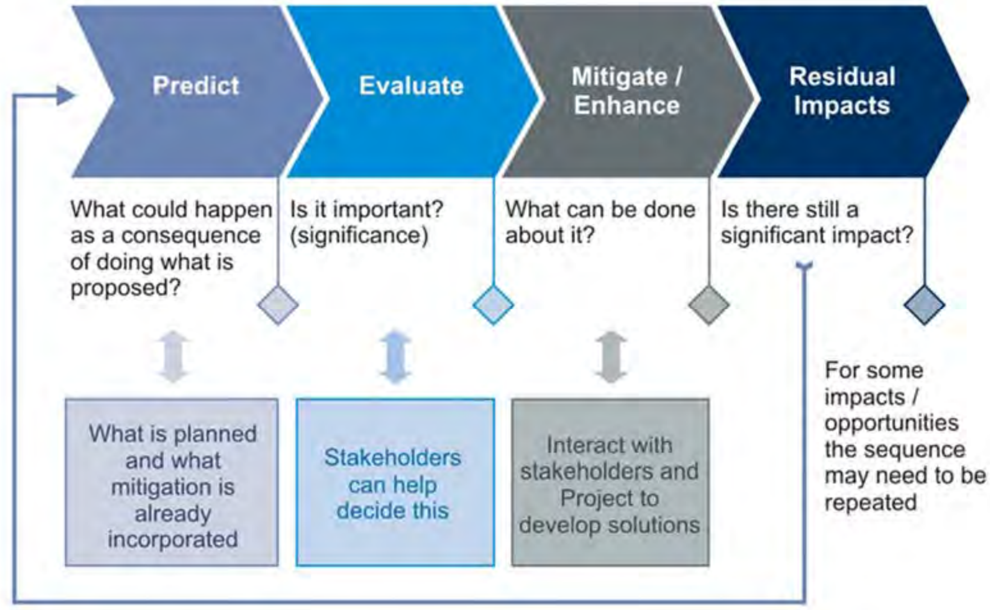
Impact prediction: to determine what could potentially happen to resources/ receptors as a consequence of the project and its associated activities.

Impact evaluation: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/ receptor.

Mitigation and enhancement: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts.

Residual impact evaluation: to evaluate the significance of impacts assuming effective implementation of mitigation and enhancement measures.

Figure 5.1 Impact Assessment Process



5.2.1 *Impact Evaluation Criteria*

The criteria have been developed to evaluate impacts due to the proposed marine indusrial cluster project on various environmental components is based on assessment of:

- *Magnitude (severity)* of impact, i.e. actual taking place to the environment; and
- The sensitivity/importance/ value of receptors or the affected resources. The significance of an impact is assessed as per ***Figure 5.2***.

Nature & Type of Impact

Following nature of impacts could be there for an impact due to activities related to project.

a. Negative, when impact is considered to represent adverse change from the baseline or introduced a new undesirable factor; and
b. Positive or beneficial, when impact is considered to represent improvement to baseline or introduced a new desirable factor.

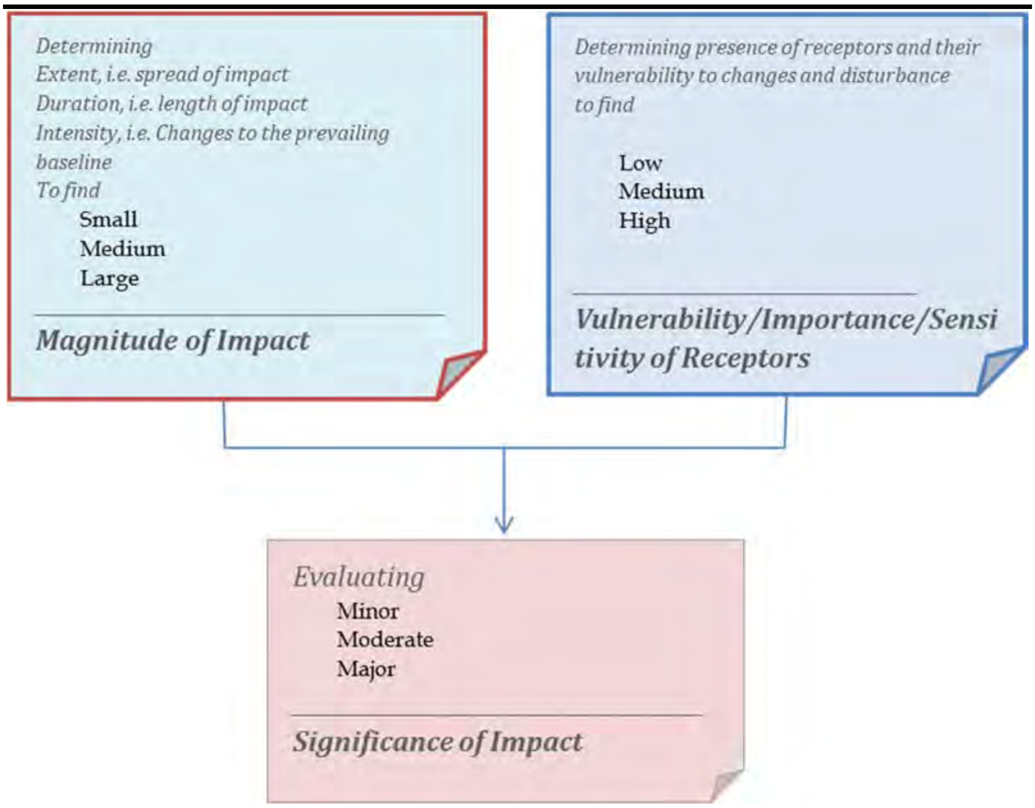
Following types of impacts could be there due to a development project:

a. Direct, Impacts that result from a direct interaction between the project and a resource/ receptor

b. Indirect, Impacts that follow on from the direct interactions between the project and its environment as a result of subsequent interactions within the environment

c. Induced. Impacts that result from other activities (which are not part of the project) that happen as a consequence of the Project.

Figure 5.2 Assessing Significance of an Impact due to proposed project related activities



Determining Magnitude of an impact

Magnitude, i.e. severity of an impact or degree of change caused by a project activity is a function of one or more of the following characteristics:

- Intensity: Degree of damage that may be caused to the environmental components concerned.
- Extent: The extent refers to spatial or geographical extent of impact due to proposed project and related activities.
- Duration: The duration of an impact is to be determined whether it would be temporary, short term, long term or permanent.

Criteria have been defined for each of these key elements and classified based on the level of impacts on the environmental component. Viz. Low, Moderate and High based on the criteria, presented in ***Table 5.1*** below:

Table 5.1 Impact Prediction Criteria

Impact Elements	Criteria	Ranking

Impact Elements	Criteria	Ranking
Intensity	• Irreversible damage to natural environment and effect on other components • Impact on sensitive natural areas and protected species in natural habitat and large scale felling • Use of scarce natural resource with competing users • Destruction of landform or diversion of channel • Serious injury, loss of life and total destruction of property • Large population affected and total loss of livelihood • Destruction of the social infrastructure (roads, bridge water sources), cultural properties • Cultural Conflict with Community	High
	• Reversible damage to natural environment and direct impact on human health • Impact on natural vegetated areas and unprotected species in natural habitat and undergrowth • Occasional exceedance of benchmark emission/ effluent discharge limit; • Affects a portion of population and may bring about a change in abundance and / or distribution over one or more generations, but does not threaten the integrity of that population or any population depend on it • Minor injury damage to property • Large number population affected and partial loss of livelihood • Damage of the social infrastructure (roads, bridge water sources), cultural Properties • Commercial conflict with community	Medium
	• Reversible damage to natural environment and indirect impact to human health • Slight changes in background levels well within acceptable norms. Emission/ discharges are well within benchmark discharge limits; • Impact on non-forest vegetation/ plantation area and limited felling • Affects a specific group of localised individuals within a population -one generation or less, but does not affect other trophic levels or the population itself; • Small population affected and partial loss of livelihood; • Minor modification of landscape or temporary diversion • Inconvenience to community for use of the social infrastructure (roads, bridge water sources), cultural properties	Low
Extent	• When impact/ risk on environment due to proposed project extends beyond 10 km of study area.	National
	• When impact due to the proposed project related activities is restricted within 10 km radius of the proposed project site	Regional
	• Impact discernible within 1.0 km in the immediate vicinity of the proposed project site	Local
Duration	• When impacting 1 years to 3 years; this is based on the understanding that there will be recovery of the affected environmental component to its best achievable pre-project state within 3 to 10 years	Long term

Impact Elements		Criteria	Ranking
	•	When impacts is likely to be restricted for a duration of less than 12months; this is based on understanding that there will be recovery of the affected environmental component to its best achievable pre-project state within 3 years	Short Term
	•	When impact lasts for a limited period of 6 month or less and ceases on completion of the activity or as a result of mitigation measures and natural recovery of resource or receptor	Temporary

Based on the above understanding extent, duration and intensity, magnitude of impact is assessed as per the Table 5.2.

Table 5.2 Assessing Magnitude of Impact

Extent	Duration	Intensity	Magnitude
Local	Medium	Low	Small
Local	Long	Low	
Regional	Short	Low	
Regional	Medium	Low	
Regional	Long	Low	
Local	Short	Medium	Medium
Local	Medium	Medium	
Local	Long	Medium	
Regional	Short	Medium	
Regional	Medium	Medium	
Regional	Long	Medium	
National	Short	Low	
National	Medium	Low	
National	Long	Low	
National	Short	Medium	
National	Medium	Medium	
National	Long	Medium	
Local	Short	High	
Local	Short	High	Large
Local	Medium	High	
Regional	Medium	High	
Regional	Short	High	
Local	Long	High	
National	Short	High	
National	Medium	High	
Regional	Long	High	
National	Long	High	

The above determined magnitude of small, medium or large have been evaluated based on definition as given in Table 5.2, which are used as guiding principles for assessing magnitude of impact on environments covering physical, socio-economic and biological resources/receptors.

Determining Sensitivity/ Importance/ Vulnerability of Receptor

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for an impact is to define the sensitivity/

vulnerability/ importance of the impacted resources/ receptor. There are a range of factors to be taken into account when defining the sensitivity/ vulnerability/ importance of the resource/ receptor, which may be phisical, biological, cultural or human as per the following understanding:

- Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, regional, national importance) are considered.
- Where the resources/ receptor is biological or cultural (for example, the riverine environment), its importance (for example local, regional or national importance) and its sensitivity to the specific type of impact are considered.
- Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered.

Definition as defined in ***Table 5.3*** has been adopted to determine sensitivity/ importance/ vulnerability of environmental resources or receptor.

Table 5.3 Sensitivity/Importance/ Vulnerability Criteria

Sensitivity	Criteria
High	• Existing physical environment quality is already under stress and /or the ecological resources it supports are very sensitive to change • Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the project and opportunities associated with it. • Some ecological receptors in the area are rare or endemic, under significant pressure and /or highly sensitive to changing environments. Species are valued nationally/ globally and listed as endangered or protected.
Medium	• Existing physical environment quality shows some sign of stress and /or supports ecological resources that could be sensitive to change in quality or physical disturbance • Some, but few areas of vulnerability; still retaining an ability to at least in part adapt to change brought by the project and opportunities associated with it. • Some ecological receptors have low abundance, restricted ranges, are currently under pressure or are slow to adapt to changing environments. Species are valued locally/ regionally and may be endemic. Endangered or protected
Low	• Existing physical environment quality is good and the ecological resources that it supports are not sensitive to disturbance • Human receptors are located away and are not likely to be affected due to the project related activities • Ecological receptors are abundant, common or widely disturbed and generally adaptable to changing environments. Species are not endangered or protected.

5.2.2 *Evaluating Significance of Impacts*

Once magnitude of impact and sensitivity/ vulnerability/ importance of resource/ receptor have been characterised, the significance was assigned for each impact. Impact significance is designated using the matrix shown in ***Figure 5.3.***

Figure 5.3 *Impact Significance*

		Sensitivity/Vulnerability/ Important Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	High
	Large	Moderate	High	High

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/ vulnerability/ importance designations that enter into the matrix. ***Box 5.1*** provides a context of what the various impact significance ratings imply.

Box 5.1 *Context of Impact Significances*

An impact of **minor** significance is one where a resource/ receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards/ guidelines.

An impact of **moderate** significance has an impact magnitude that is within applicable standards/guidelines, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of impact assessment is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

It is important to note that impact prediction and evaluation takes into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the impact assessment process).

5.2.3 *Identification of Mitigation and Enhancement Measures*

Once the significance of an impact has been characterised, the next step was to evaluate what mitigation and enhancement measures are warranted. For the purposes of this impact assessment, ERM adopted the following mitigation hierarchy:

- **Avoid at source, reduce at source:** avoiding or reducing at source through the design of the Project.
- **Abate on site:** add something to the design to abate the impact.
- **Abate at receptor:** if an impact cannot be abated on-site then control measures can be implemented off-site.
- **Repair or remedy:** some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, work camps or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures.
- **Compensate in kind, compensate through other means:** where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries, access, recreation and amenity space).

The priority in mitigation was to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

Management and Monitoring

The final stage in the Impact Assessment Process was the definition of the basic management and monitoring measures that are needed to identify whether:

a) impacts or their associated Project components remain in conformance with applicable standards/ guidelines; and
b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

5.3 INTERACTION MATRIX

The interaction matrix enables a methodical identification of the potential interactions each Project activity may have on the range of resources/receptors within the Area of Influence for the Project.

The completed Potential Interactions Matrix for Project activities and likely impacted resources/ receptors is presented in

Table 5.4. The matrix consists of a list of resources/receptors that could be affected against a list of activities for the proposed marine industrial cluster project. All potential interactions, regardless of probability of occurrence, are considered at this stage.

Table 5.4 Impact Identification Matrix

Sl. No.	Activity & Sub-Activity	Aspect	Physical Environment											Biological Environment									Socio-economic Environment						
			Aesthetics & Visual	Air Quality	Noise Quality	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground water resources	Ground water quality	Road & Transport	Terrestrial Habitat	Terrestrial Flora	Terrestrial Fauna	Aquatic Habitat	Aquatic Flora	Aquatic Fauna	Migratory species/Route & Corridor	Protected Habitat	Protected Species	Common property resources	Community Infrastructure	Livelihood & Occupation	Conflict with local people	Job & economic opportunity	Occupation health & safety	Community health & safety
A.	**Project Planning & Designing**																												
A.1	Land Purchase/ acquisition																												
A.1.1	Transferring of Govt. land for project	Loss of agricultural activity				X																			X				
A.1.2	Acquisition/ purchase of private land	Loss of agricultural activity				X																			X				
A.2	Local Procurement																												
A.2.1	Supply of supply construction material/ labour	Hiring of local contractor																								X	X		
A.3	Designing of cut & fill operation of ash dyke																												
A.3.1	Sourcing location of fill material for ash dyke	Location of borrow				X	X																						
A.4	Water Intake Pipeline laying plan	Water intake pipeline route finalization																						X		X			
A.5	Designing and planning of ash pond																												
A.5.1	Designing of laying material						X			X		X																	
A.5.2	Designing of collection and reuse of supernatant water									X																			
A.6	Selection of fuel	Ash and sulphur content of coal & sulphur content of LDO		X																									X
A.7	Designing of coal storage	Designing of coal storage		X						X																			
A.8	Natural Hazards (Flood & Earthquake)																												
	Designing of flood protection system for main plant & ash pond	Flooding /dyke brake					X			X						X	X	X					X						
A.9	Selection & planning for pollution control system	Selection & planning of pollution control system like (ESP, FGD, Low NOx burner)		X																									
B.	**Site Development & Construction of Plant**																												
B.1	Main plant site development & construction																												
B1.1	Excavation of soil for foundation	Fugitive emission	X																										X
B1.2	Transportation of equipment and machineries	Fugitive emission & emission from motor vehicles	X	X																								X	X
		Generation of Noise		X																								X	X
		Increase of road traffic											X												X				X
B1.3	Operation of machineries	Air emission		X																									X
		Noise generation			X																								

Sl. No.	Activity & Sub-Activity	Aspect	Physical Environment											Biological Environment									Socio-economic Environment						
			Aesthetics & Visual	Air Quality	Noise Quality	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground water resources	Ground water quality	Road & Transport	Terrestrial Habitat	Terrestrial Flora	Terrestrial Fauna	Aquatic Habitat	Aquatic Flora	Aquatic Fauna	Migratory species/Route & Corridor	Protected Habitat	Protected Species	Common property resources	Community Infrastructure	Livelihood & Occupation	Conflict with local people	Job & economic opportunity	Occupation health & safety	Community health & safety
B.2	Site development & construction of ash pond/dyke																												
B.2.1	Removal & storage of top soil	Loss of productive soil					X																						
		Fugitive emission	X	X																								X	X
		Erosion- runoff & air					X																						
B.2.2	Clearance of vegetation	Loss of vegetation												X	X														
B.2.3	Construction of ash dyke	Elevated dyke area						X																					
B.2.4	Operation of machineries	Air emission		X																								X	X
		Noise generation			X											X												X	X
B.2.5	Transport of material / soils/ machineries	Fugitive emission & emission from traffic		X																									X
		Generation of Noise			X																							X	X
		Increase of traffic																											
B.3	Construction of water intake facility																												
B.3.1	Removal & storage of top soil	Loss of productive soil					X																						
		Fugitive emission		X																									
		Erosion- runoff & air					X			X																			
B.3.2	Raising of land	Elevating of land						X																					
B.3.3	Operation of machineries	Air emission		X																									
		Noise generation			X																								
B.4	Storage of construction material & chemical	Haphazard storage	X				X			X		X																	
		Fugitive emission		X																									
		Runoff –open storage area								X								X	X										
		Spillage of chemical & oil					X			X		X						X	X				X						
B.5	Generation & disposal of construction waste	Haphazard storage																											
		Disposal in non-designated area	X																										
		Fugitive dust		X																								X	X
B.6	Power sourcing (operation of backup DG)	Air emission		X																									
		Noise emission			X																								X
B.7	Operation Labour camp & Site office	Generation of MSW & disposal	X			X						X																	
		Generation of domestic waste water & discharge							X			X						X											
		Use of ground water									X												X						
		Sourcing of food- locally																							++				
B.8	Operation of Batching & Bitumen plant	Air emission		X																								X	X
		Noise emission			X																							X	X
B.9	Sourcing of water	Use of ground water									X												X						
B.10	Sourcing of manpower	Engagement of outside people																							++	X			
		Engagement of local people																							++	X			

Sl. No.	Activity & Sub-Activity	Aspect	Physical Environment											Biological Environment									Socio-economic Environment						
			Aesthetics & Visual	Air Quality	Noise Quality	Land Use	Soil Quality	Local Drainage & Physiography	Surface Water Resources	Surface water quality	Ground water resources	Ground water quality	Road & Transport	Terrestrial Habitat	Terrestrial Flora	Terrestrial Fauna	Aquatic Habitat	Aquatic Flora	Aquatic Fauna	Migratory species/Route & Corridor	Protected Habitat	Protected Species	Common property resources	Community Infrastructure	Livelihood & Occupation	Conflict with local people	Job & economic opportunity	Occupation health & safety	Community health & safety
C.	**Operation of Power Plant & Associate facilities**																												
C.1	Physical presence of power plant		X					X																					
C.2	Physical presence of ash pond		X					X																					
C.3	Operation of boiler, turbine & generator	Noise generation		X												X												X	X
		Generation of boiler blow down water																											
C.4	Operation of stack	Emission flue gas		X			X								X													X	X
C.5	Operation of CHP																												
C.5.1	Unloading of coal	Fugitive emission		X																								X	X
		Noise generation			X																							X	X
C.5.2	Crushing of coal	Fugitive emission		X																								X	X
		Noise generation			X											X												X	X
C.5.3	Storage of coal	Fugitive emission		X																									
		Surface runoff					X			X							X	X	X										
C.5.6	Grinding of coal	Fugitive emission		X																								X	X
		Noise generation			X										X													X	X
C.5.7	Operation of coal conveyor	Fugitive emission		X																								X	X
		Noise generation			X																							X	X
C.6	Operation of water intake facility & treatment of water																												
C.6.1	Operation water intake pump	Withdrawal of water							X								X	X	X		X	X	X						
		Generation of noise			X																								
C.6.2	Pre-treatment of water	Generation of sludge & disposal					X					X																	
C.6.3	Treatment of water (potable & DM)	Generation of noise			X																							X	
		Generation of sludge					X					X																	
		Generation of waste water								X							X	X	X										
C.7	Operation of cooling tower	Generation of noise			X																							X	X
		Generation of blow down water								X							X	X	X										
C.8	Operation of ash handling unit	Fugitive emission		X																								X	X
		Noise generation			X																							X	X
C.9	Operation of Ash pond	Generation of supernatant water with leachate								X							X	X	X										
		Fugitive emission from dried ash pond area		X																									X
C.10	Operation of Residential township	Generation of MSW	X				X					X											X						
		Generation of domestic waste water								X		X											X						
		Use of potable water									X												X						
		Sourcing of food- locally																									++		

5.4 IMPACT ASSESSMENT & MITIGATION MEASURES

This section discusses the potential impacts of the project activities on the environmental resources/ receptors that stand to get affected adversely by during various phases of the project. The impact rankings for each activity – component interaction is based on the criteria set earlier and the resulting environmental significance with necessary justification has been recorded below for each set of impacts and the same has been represented in the evaluation matrices.

5.4.1 *Potential Impacts on Visual & Aesthetics*

Construction Phase

Site Development & Construction of Main Plant & Ash Pond

Impact Significance

The proposed main plant will be constructed within the existing site of Unit 8 & 9. The site is already developed for construction of Unit 8 & 9. Vegetation clearance or filling activity would not be required. However, some excavation of soil would be require for construction of main plant and associated facilities.

The proposed ash pond site is mostly Govt. land and private land, which is mostly used for agricultural purpose. The site has very limited vegetation of the bunds around plots of agricultural land. The construction of ash pond would require limited vegetation clearance and cut and fill operation.

The proposed water intake facility is also a Govt. land, presently being used for agricultural purpose and the site has no trees within the alignment of proposed pipeline route. The construction of water intake facility would require cut and fill operation.

The site development and construction activity will generate dust, which generally settles down on the adjacent areas within a short period due to its larger particulate size. This temporary dust generation and deposition on vegetation and houses from the construction activity have adverse impact on visual and aesthetic quality in and around the proposed activity. Such impact is likely to be experienced by the villagers inhabiting near the main plant site (Malhipur & Simariya) and ash pond area (Diara Maranchi). The proposed main plant site is located within the existing power plant site, have experienced in such activities. The proposed sites are located in the Medium sensitive area (landscape having limited vegetation cover and semi-urban in nature). The potential impact on Visual and aesthetics due to fugitive emission without mitigation major is considered to be **Moderate** significance.

Mitigation Measures

- Dust nuisance from the construction site will be suppressed through periodical water spraying at disturbance area;
- Construction material will be transported through covered truck/trailors.

Considering the above mentioned mitigation measures, potential impact on visual and aesthetics due to fugitive emission is considered to be **Minor** significance.

Evaluation of Impact Significance

Impact significance on visual and aesthetic due to fugitive emission is as shown in Table 5.5.

Table 5.5 Impact Significance on Visual & Aesthetic due to Fugitive Emission

Impact	*Visual & aesthetic impact due to fugitive emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Offsite Disposal of Municipal Solid Waste and Construction Waste

Impact Significance

The accommodation for the construction workers will be arranged in a temporary labour camp at the plant site/ adjacent area. Domestic waste generated from the camp sites would be stored temporarily within the labour camp area before final offsite disposal. Domestic waste water will be treated through septic tank and soak pit.

Construction waste will be stored within the construction site; recyclable materials will be recycled through water recycler and inert waste will be disposed outside the plant boundary. Disposal of waste in a non-designated site can lead to visual impacts and nuisance related to dust and odour.

Such impact is likely to be experienced by the villagers inhabiting near the main plant site (Malhipur & Simariya) and ash pond area (Diara Maranchi). The duration of the construction activity is short term in nature. The proposed sites are located in the Medium sensitive area (landscape having limited vegetation cover and semi-urban in nature). The potential impact on Visual and aesthetics due to storage and disposal of municipal waste from labour camp and construction waste without mitigation major is considered to be **Moderate** significance.

Mitigation Measures

- On completion of works (in phases) all temporary structures, surplus materials and wastes will be completely removed;
- Construction wastes temporarily stored at the sites will be transported to the designated disposal site/facility at regular intervals;
- Domestic solid wastes temporarily stored at the collection point within the labour camp and will be transported to designated solid waste disposal site at regular intervals.

Considering the above mentioned mitigation measures, potential impact on visual and aesthetics due storage and disposal of municipal waste from labour camp and construction waste is considered to be **Minor** significance.

Evaluation of Impact Significance

Impact significance on visual and aesthetic due to storage and disposal of municipal waste from labour camp and construction waste is as shown in Table 5.6.

Table 5.6 Impact Significance on Visual & Aesthetic due to storage and disposal of municipal waste from labour camp and construction waste

Impact	*Visual & aesthetic impact due to storage and disposal of municipal waste from labour camp and construction waste*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Potential Impacts on Visual & Aesthetics - Operational Phase

Physical Presence of Plant, Ash Pond and Associate Facility

Impact Significance

The physical presence of main plant, especially the elevated structures like boiler& turbine house, stack, coal silos, elevated coal conveyor, etc. will lead to adverse visual impact for residents of the area. As the proposed project site is a plan land, these elevated structures can be seen from 3 to 4 km from site. The study area has few large industries like existing power plant units of BTPS, Hindustan Fertiliser Plant, IOCL Oil refinery, with elevated structure and these can be seen from Malhipur, Simariya, Diara Maranchi, Mahna, Bihat, Jainagar villages; people are experienced on such type of visual and aesthetics of industries. It is proposed to develop a greenbelt around the main plant, and ash pond, which would provide visual screening. The physical presence of the main plant and its associated facilities would not cause any major adverse significant impacts on aesthetics of this region, which is already affected by prior industrial activity. The potential impact on Visual and aesthetics due to Unit #10 without mitigation major is considered to be of **Minor** significance.

Mitigation Measures

- Greenbelt development proposed in the plan need to be implemented along with the construction phase depending upon the availability of the area for sapling plantation.
- Periodic monitoring of greenbelt survival as well as plantation of new plants shall be carried out.
- Plantation shall be carried out in 2 to 3 tier.

Considering the above mentioned mitigation measures, potential impact on visual and aesthetics due plant operation is considered to be **Negligible** significance.

Evaluation of Impact Significance

Impact significance on visual and aesthetic due to physical presence of plant is as shown in Table 5.7.

Table 5.7 Impact Significance on Visual & Aesthetic due to Physical Presence of Plant

Impact	*Visual & aesthetic impact due to Physical Presence of Plant*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Operation of Coal Handling Plant

Impact Significance

Unloading of coal from coal rakes, transport of coal to coal crushing plant, crushing of coal and stacking of coal will generate coal dust, which lead to dust nuisance in the immediate vicinity of coal handling plant. The deposition of coal dust on vegetation and property would have some adverse visual impact. However, dust suppression measures in coal unloading site, crushing plant, storage of coal in silos, greenbelt along the main plant will minimize dust emission. This limited dust generation in coal handling plant will settle down on the adjacent areas within a short period due to its larger particulate size. Considering the project level control/mitigation measures (like storage of coal in the silos, covered coal conveyor, etc.) it is not expected to major adverse impact on aesthetics and visual quality of the project site and its vicinity. The potential impact on Visual and aesthetics due to operation of CHP with embedded control measures is considered to be of **Minor** significance.

Mitigation Measures

- Dust suppression measures through sprinklers;
- Greenbelt plantation around the CHP

Evaluation of Impact Significance

Impact significance on visual and aesthetic due to operation of CHP is as shown in Table 5.8.

Table 5.8 Impact Significance on Visual & Aesthetic due to operation of CHP

Impact	*Visual & aesthetic impact due to Operation of CHP*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Coal Combustion and Stack Emission

Impact Significance

The major visual impact from the power plant will be deposition of fly ash from the stack emission on the adjacent land and property. The Project will be having advanced air pollution control systems in place in order to comply with the air quality standards, which include ESP, taller stacks for better dispersion of pollutants. Stack emissions will also be monitored by Continuous Emission Monitoring System (CEMS). Greenbelt along the plant boundary as well as the area facing towards the National Highway is also planned as part of the Unit# 8 and #9 expansion as well as for Unit #10, to meet the regulatory requirement of more than 33% greenbelt area development. The routine emission of the stack will meet emission standards. Potential adverse aesthetic and visual impacts are not predicted to be significant during the normal operation of the plant and ESP and are considered to be of **Minor** significance.

Mitigation Measures

- The selection of coal to be based on calorific value and ash content.
- Installation and operation of high efficiency pollution control equipment to ensure maximum removal of flue gas air pollutants.
- Continuous emissions monitoring of flue gas

Evaluation of Impact Significance

Impact significance on visual and aesthetic due to combustion of fossil fuel and stack emission is as shown in Table 5.9.

Table 5.9 Impact Significance on Visual & Aesthetic due to Coal Combustion and Stack Emission

Impact	*Visual & aesthetic impact due to Coal Combustion and Stack Emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

5.4.2 *Potential Impact on Air Quality*

Air quality is a general term that provides a measure of the presence of air contaminants, including greenhouse gas (GHG), in the environment. Potential air contaminants from the proposed project include: particulate matter (PM), oxides of nitrogen (NOx), sulphur di-oxide (SO_2), carbon monoxide (CO), hydrocarbons (HCs), chlorofluorocarbons (CFCs) and air- borne inorganic particles such as fly ash, soot and other trace gases. Carbon dioxide, methane and chlorofluorocarbons are greenhouse gases. These emissions are considered to be responsible for heating up the atmosphere and producing a harmful global environment. Oxides of nitrogen and sulphur play an important role in atmospheric chemistry and are largely responsible for atmospheric acidity. Particulates and black carbon (soot) are of concern in addition to possible lung tissue irritation resulting from inhalation of soot particles the various organic chemicals are also known to be potential carcinogens. Major emission from the power plant project is stack emission during operation of plant. Other sources of emission are fugitive emission and some point source emission during construction & operational phase of the plant.

The ambient air quality of the study area (*Refer Section 4.4.3*) shows that area is under stress. The concentration of PM (PM_{10} and $PM_{2.5}$) was comparatively high. Therefore any significant emission from industrial activity may degrade the ambient air quality of the area. The sections below discuss the air quality impacts from stack emission separately.

Construction Phase

Site Development and Construction of Main Plant, Ash Pond & Associate Facility

<u>*Impact Significance*</u>
As discussed in *Section 5.4.1*, main plant will be constructed on existing site of 2 x 250 MW plant site, which is already developed, no further developmental activity would be required. The new ash pond for all the existing and proposed expansion will be constructed on Govt. land, currently used for agriculture purpose. New water intake facility of existing and proposed expansion unit will be construction on Govt. land, presently used for agriculture purpose and/or waste land along the national highway. For construction of ash pond and water intake facility would require cut & fill operation.

The fugitive emissions in form of dust are expected due to cut & fill of earth, loading, unloading and transport of fill material materials during the site development and construction of plant, ash pond and associate facilities. The potential for dust to be emitted during site preparation and construction activities is strongly dependent on the type of activities taking place, such as the movement of vehicles along the working width and their speed, soil stripping, cutting, back-filling and reinstatement. Wind speed and a particular wind direction may carry emitted particles towards receptors located in the adjacent villages like Malhipur, Simariya and Diara Maracnchi. Effects of dust emissions are heightened by dry weather and high wind speeds and effectively reduced to zero when soils and/or ambient conditions are wet. However, dust generated from the site development and construction activity will generally settles down on the adjacent areas (i.e. < 500 m from the source) within a short period due to its larger particle size. This temporary dust generation from the construction activities is not expected to significantly affect the ambient air quality of the study area.

The proposed sites are located in the Medium sensitive area (ambient air quality shows some sign of stress). The potential impact on ambient air quality due to fugitive emission without mitigation major is considered to be **Moderate** significance.

Mitigation Measures

- Dust generated from the construction site will be suppressed through periodical water spraying at disturbance area;
- On completion of works (in phases) all temporary structures, surplus materials and wastes will be completely removed;
- All vehicles used for transportation of loose and friable materials will not be loaded over the freeboard limit and will be covered.
- Water spraying will be done on the access roads to control re-entrained dust during dry season.

Considering the above mentioned mitigation measures, potential impact on ambient air quality due to fugitive emission is considered to be **Minor** significance.

Evaluation of Impact Significance

Impact significance on ambient air quality due to fugitive emission is as shown in Table 5.10**.**

Table 5.10 Impact Significance on Ambient Air Quality due to Fugitive Emissions from Site Development and Construction Activities

Impact	*Ambient air quality impact due to Fugitive Emissions from Site Development and Construction Activities*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operation of Machineries & Vehicles

Impact Significance

The construction of plant and associate facilities would involve operation of machineries and equipment, which are listed out in the Project Description Chapter. These are mainly diesel operated and also back up DG sets. The construction equipment and DG sets will emit fumes such as nitrogen oxides, SO_2, CO and hydrocarbons; this may cause health risk to the workers and local people, which is discussed under the occupational and community health hazard section (Section 5.4.12 and Section 5.4.13), respectively. The emissions are likely to disperse nearby areas such as Malhipur, Simariya and Diara Maracnchi, due to their proximity to project site as well as national highway.

The construction materials will be transported via road ways using heavy vehicles. Vehicular emissions have almost the same characteristics as DG set emissions, if they operate on diesel engines. The activities involving heavy vehicles will be particularly intense during site preparation and construction. However, their effects are highly localized and will principally affect the localities adjacent to the NH-31, road connecting site approach road to ash pond (from Simariya junction to Diara Maranchi). The potential impact on ambient air quality due to operation of machinery and vehicles without mitigation measures is considered to be **Moderate** significance.

Mitigation Measures
The level of emissions from these vehicles will be managed through appropriate maintenance schedule for all vehicles, correct engine tuning, etc.

- Equipment, machinery and vehicles having inbuilt pollution control devices will be considered as a measure for prevention of air pollution at source;
- The engines and exhaust systems of all vehicles and equipment used for the project will be maintained so that exhaust emissions are low and do not breach statutory limits set for that vehicle/equipment type.

Considering the above mentioned mitigation measures, potential impact on ambient air quality due to fugitive emission is considered to be **Minor** significance.

Evaluation of Impact Significance
Impact significance on visual and aesthetic due to fugitive emission is as shown in Table 5.11.

Table 5.11 Impact Significance on Ambient Air Quality due to Operation of Machineries and Vehicles

Impact	*Ambient air quality impact due to Operation of Machineries and Vehicles*			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Extent	Local	Regional	National	
Impact Duration	Temporary	Short-term	Long-term	Permanent

Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operational Phase

Operation of Coal Handling Plant

Impact Significance

Unloading of coal from coal rakes will generate coal dust, which lead to dust nuisance in the immediate of coal handling plant. However, fugitive emission from coal conveyor is likely to disperse in the immediate vicinity like Malhipur as well as the BTPS Township. The fugitive emissions are also anticipated from the coal handing site at coal sock yard and coal grinding unit at the main plant site. However, the incremental concentrations of these air pollutants in the form of dust and particulate matters resulting from handling of coal and from the grinding activity will be controlled by restricting such activities to any covered area and through use of bag filter at coal stack yard and coal grinding units. The designed emission level from these units is 50 mg/Nm^3. These emissions will also be dispersed in the adjacent area, and may have health impact to the workers, which is discussed under the Occupational health hazard section.

The mitigation measures like dust suppression measures in coal unloading site, crushing plant, storage of coal in silos, greenbelt along the main plant proposed in the project will minimize dust emission. This limited dust generation in coal handling plant will settle down on the adjacent areas within a short period due to its larger particulate size. Considering the project level control/mitigation measures, it is not expected to major adverse impact on ambient air quality of the project site and its vicinity. The potential impact on ambient air quality due to coal handling with embedded control measures is considered to be **Minor** significance.

Mitigation Measures

- Dust suppression measures through sprinklers;
- Greenbelt plantation around the CHP

Evaluation of Impact Significance

Impact significance on ambient air quality due to operation of CHP is as shown in Table 5.12.

Table 5.12 Impact Significance on Ambient Air Quality due to operation of CHP

Impact	*Ambient air quality impact due to Operation of CHP*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Transport and Handling of Other Raw Materials and Chemicals

Impact Significance

Major raw material for the TPP is coal and this will be transported through rakes. Only LDO and chemicals (such as Cl_2 and NH_3) will be transported through road. Vehicular emissions due to transport of other raw materials may have some impact on the transport route areas in its immediate vicinity.

Oil and chemical will transported in a closed container/ vehicles and these materials will be also stored in a closed area. However, during transportation and handling some spillage of oil and chemicals are expected. Due to this spillage, fumes of VOC from oil and lubricant and Cl_2 and NH_3 may get released into the local environment. This may create occupational health hazards for the workers in these areas; occupational health impact is discussed in the relevant section. Major release may accidentally occur in the storage area; this may have significant impact on ambient air quality as well as the risk to the workers and local people, which is discussed separately in risk analysis (Section 5.5). During normal operational cases any significant impact on ambient air quality is not envisaged and overall the impact will be **Minor** significance with embedded control measures in place.

Evaluation of Impact Significance

Impact significance on ambient air quality due to handling of LDO & chemical is as shown in Table 5.13.

Table 5.13 Impact Significance on Ambient Air Quality due to handling of LDO & chemicals

Impact	*Ambient air quality impact due to handling of LDO & chemicals*		
Impact Nature	Negative	Positive	Neutral
Impact Type	Direct	Indirect	Induced

Impact Extent	Local		Regional		National	
Impact Duration	Temporary	Short-term	Long-term	Permanent		
Impact Scale/ Intensity	Negligible	Low	Medium	High		
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large	
Resource/ Receptor Sensitivity	Low		**Medium**		High	
Impact Significance	**Without Mitigation Measures**					
	Negligible	**Minor**	Moderate	Major		
Residual Impact	**With Mitigation Measures**					
	Negligible	Minor	Moderate	Major		

Fly Ash & Bottom Ash Handling and Disposal

Impact Significance

It is proposed to use dry ash handling system. The dry fly ash will be transported to the end user through closed bulker and bottom ash will be disposed in the ash pond in high concentrated slurry form. However it is anticipated that the fugitive emission would result mainly during ash handling and from the ash pond during the dry season. Fugitive emission will be dispersed in the local environment, which may have impact on Malhipur, Simariya village. However, this localized increase of air pollutant from ash handling and transportation is not expected to have any significant impact on ambient air quality and overall the impact will be **Minor** significance with embedded control measures in place.

Mitigation Measures

- Reuse of fly ash will be implemented in accordance with the Fly Ash Utilization Plan;
- Peripheral green belt will be developed along ash pond area through formulation of a Green Belt Development Plan.

Evaluation of Impact Significance

Impact significance on ambient air quality due to handling of fly ash is as shown in Table 5.14.

Table 5.14 Impact Significance on Ambient Air Quality due to handling of fly ash

Impact	*Ambient air quality impact due to handling of fly ash*				
Impact Nature	Negative		Positive		Neutral
Impact Type	Direct		Indirect		Induced
Impact Extent	Local		Regional		National
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low		**Medium**		High
Impact Significance	**Without Mitigation Measures**				

	Negligible	**Minor**	Moderate	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	Minor	Moderate	Major

Coal Combustion and Stack Emission

The major source of air pollution from coal based thermal power plant is coal combustion and stack emission. The sections below discuss the air quality impacts from stack emission separately.

The emission from proposed 660 MW expansion unit will be discharged into the atmosphere through 275m height single flue stack. The primary pollutants emitted by the stack will comprise of PM, NOx, and SO_2. Combustion of coal in boiler typically happens at high temperatures resulting in generation of considerable amounts of NOx. The SO_2 concentration in emissions is dependent on the sulphur content in coal and particulate matter consists of un-burnt Carbon particles.

Barauni Thermal Power Station is currently having two units, which are currently under revamp, i.e. Unit 6 and 7 with power generation capacity of 110 MW each. In addition to that 2 units (Unit 8 and 9) are under commissioning with power generation capacity of 250 MW each. Proposed expansion project will be Unit 10 with power generation capacity of 660 MW. Since Unit 6, 7, 8 and 9 were not operational at the time of baseline data collection; hence the air quality impact prediction has been carried out for three scenarios, which are listed below:

- Scenario 1: Operation of Unit 10 and emissions from 275 m tall stack;
- Scenario 2: Operation of Unit 8 & 9 and emissions from 275 m tall stack (single stack for two units); and Operation of Unit 6 & 7 and emissions from 125 m tall stack (single stack for two units); and
- Scenario 3: Operation of Unit 6, 7, 8, 9 and 10 and emissions from three stacks (2 stacks of 275 m and 1 stack of 125 m height).

Emission Sources:

The emission sources during the operation of Unit 6, 7, 8, 9 and 10 will be one stack of height 125 m (connected with Unit 6 & 7) and two stacks of height 275 m each (one connected with Unit 8 & 9 and second connected with Unit 10). Emissions from each stack based on information available in the EIA study of Unit 8 & 9, and information provided by DPR consultant for Unit 10 are presented below. Information of Unit 6 & 7 was not available from the DPR consultant and BTPS and therefore, necessary assumptions in line with Unit 8 & 9 have been taken, which may need to be verified at the later stage with BTPS as per the revamp plan:

Table 5.15 Emission Parameters for the Power Plant

Stack	UTM Co-ordinates* (m)		Stack Height (m)*1	Stack Internal Diameter (m)	Flue Gas Exit Velocity (m/s)	Flue Gas Temperature (°K)	Emission Rate		
	Easting	Northing					PM g/s	SO2 (g/s)	NOx (g/s)
Stack 1 (Unit#10)[1]	401660	2808840	275	15.55	25	401	30.71	364.5	283.03
Stack 2 (Unit#8&9)[2]	401806	2808725	275	13.0	25	413	119.72	703.2	359.24
Stack 3 (Unit#6&7)[3]	401668	2809602	125	7.00	25	413	121.13	363.39	158.06

* UTM Zone - 45

[1] Source: DPR consultant

[2] Source: EIA study report of Unit 8 & 9.

[3] Source: Calculated based on fuel quality provided for Unit 8&9 and stack height calculation based on anticipated SO_2 emission from the stack

Criteria

The standards considered for assessment of potential impacts to air quality, are National Ambient Air Quality Standards (NAAQS) of India. The air quality impacts associated with the construction activities have been assessed qualitatively, using professional judgement and based on past experience from similar projects.

Prediction of Impacts

Impacts due to the operation of the plant were assessed by modelling projected emission rates (Table 5.15) using the AMS/EPA Regulatory Model (AERMOD). AERMOD is a modelling system consisting of three separate modules: AERMET, AERMAP and AERMOD. AERMET is a meteorological pre-processor and uses hourly surface observations, cloud cover, and upper air parameters from twice-daily vertical sampling of the atmosphere to create two output files consisting of surface and vertical profile data, respectively. The terrain pre-processor AERMAP uses DEM maps as well as user generated receptor grids. AERMAP's output file consists of the x, y locations of each receptor, mean sea level (MSL) elevation and hill profile parameters. The hill profile parameter is used in determining plume flow around elevated terrain.

Model Options: The AERMOD model was run with the following regulatory default options in this assessment:

- Stack-tip downwash;

1 Stack height has been calculated based on average SO2 emission rate of 237.44 kg/hr in case of use of HSD as fuel.

- Elevated terrain effects;
- Use of calms processing routine;
- Use of missing data processing routine; and
- No exponential decay

The area surrounding the Project site has one operational 150 MW SCGT of NWPGCL and scattered rural settlements in the surroundings. Based on this, the Project site and its surroundings have been considered as rural area, and therefore, the rural dispersion coefficient was used in the Model.

Meteorological Data: The input meteorological data for the AERMOD was generated using meteorological data collected during summer season (2015) at site.

Terrain Data: Terrain data for the AERMAP model were taken from the 90 m SRTM database, while land cover data was sourced from satellite imagery of the Project site and its surroundings.

Receptors: The receptor grid or network, defined the locations of predicted ground level concentrations (GLCs) used to assess compliance with the relevant standards or guidelines. The following comprehensive fine and coarse receptor network was used for this analysis:

- 100 m spaced receptors from the project boundary up to 10 km; and
- 10 Discrete Cartesian receptors located within the study area, where baseline monitoring was carried out during the study period.

This network used Cartesian (X, Y) receptors with UTM coordinates. Base elevation of all the receptors were found using terrain elevations interpolated from SRTM (~90 m) Digital Elevation Model (DEM) data. The discrete Cartesian receptor locations are shown in Figure 5.4 and details have been presented in Table 5.16:

Figure 5.4 Receptor Network and Emission Sources

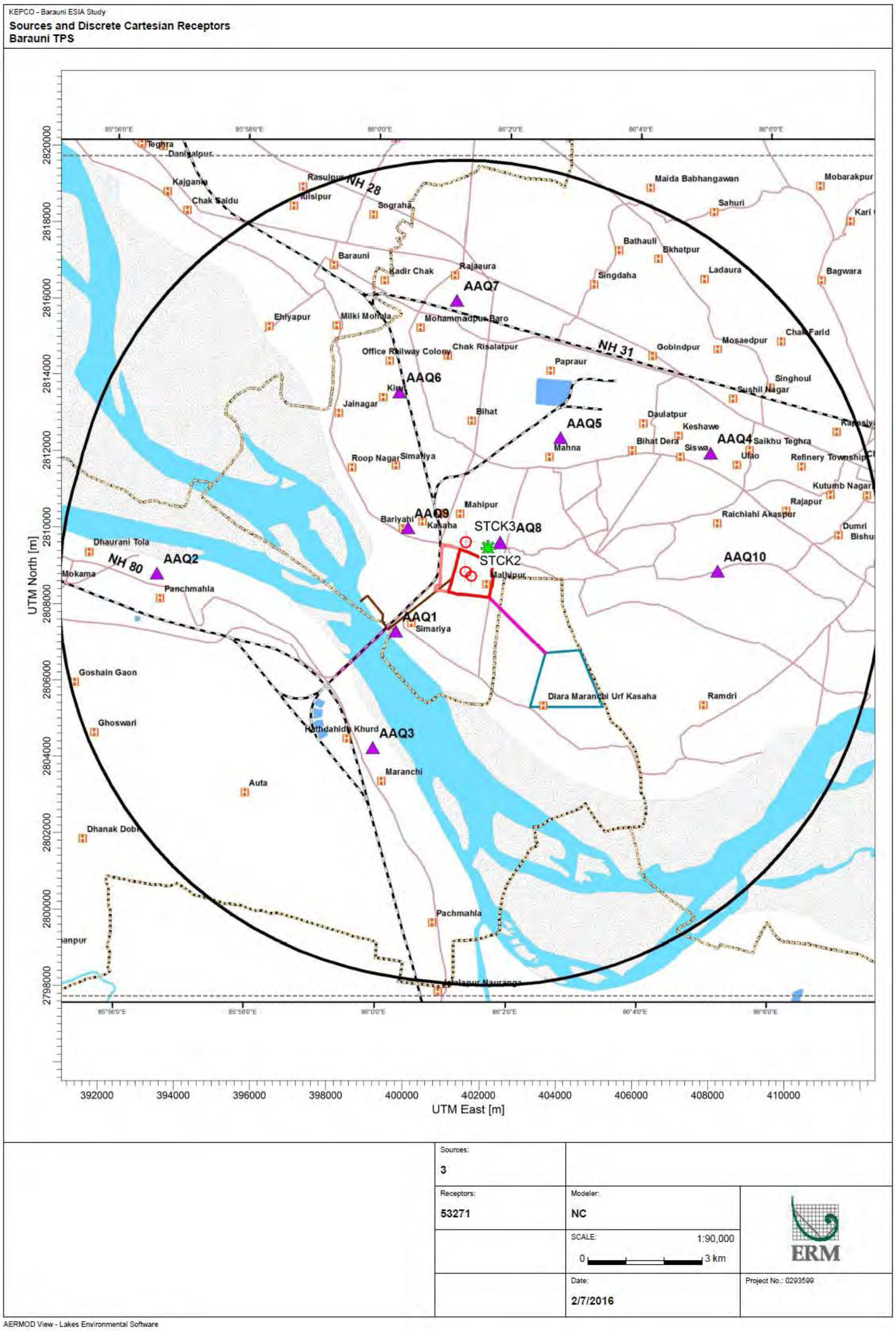


Table 5.16 Monitoring Locations with respect to the Project

Receptor	Receptor Name	Geographical Co-ordinate		Ground Elevation (m)	Distance from Project Boundary (km)	Direction from Project Boundary
		X (m E)	Y (m N)			
AAQ1	Simariya Ghat	399834	2807247	44.0	1.4	SW
AAQ2	Shikharichawk (Pachmahla)	393574	2808754	49.2	7.1	W
AAQ3	Maranchi	399231	2804188	48.3	4.4	S
AAQ4	Makardahi	408082	2811871	44.4	6.2	NE
AAQ5	Mahna	404145	2812258	47.8	3.6	NE
AAQ6	Kiul	399939	2813454	49.0	4	NW
AAQ7	Hajipur	401445	2815875	45.3	6.2	N
AAQ8	BTPS Colony	402551	2809545	47.5	0.05	NE
AAQ9	Baryahi	400154	2809924	48.8	0.9	NW
AAQ10	Akashpur	408265	2808798	47.7	5.8	E

* UTM Zone - 45

<u>*Modelling Results*</u>

Predicted maximum ground level concentrations within the study area with the three scenarios are presented in Table 5.19. It is evident that maximum incremental concentrations of PM_{10}, SO_2 and NOx due to the Project operations (i.e. stack emissions) will be 0.41µg/m^3, 4.88 µg/m^3 and 3.79 µg/m^3, respectively. The ground level concentrations due to the Project (maximum baseline concentration + predicted maximum concentration) in the study area will be well within the applicable NAAQS for PM_{10} at all the baseline monitoring locations, except at Hajipur (AAQ7) and BTPS Colony (AAQ8), where the maximum baseline concentrations were reported as 132 µg/m^3 and 122 µg/m^3, respectively. Out of these two locations, Hajipur is a major settlement in the study area and is more than 6 km away from the Project site, where as BTPS colony is next to the Project boundary. High level of PM10 concentrations are also attributed due to construction activities of Unit #8 and #9, which were ongoing at the time of monitoring. All the gaseous pollutants concentrations will be well within the applicable standards. Furthermore, it is evident that the project contribution for all the pollutants considered in the modelling study is < 25% of the applicable air quality standard. Considering this and already proposed high efficiency air pollution control systems and tall stack, the overall impact on air quality due to stack emissions will be of Minor in nature. However, it shall also be noted from Table 5.19 that the impact magnitude will change from small to medium in case of operation of all the units of BTPS (i.e. Unit # 6,7,8,9 and 10) and the impact on air quality due to stack emissions of all units will be of Moderate in nature.

<u>*Mitigation Measures*</u>

To ensure compliance with the air emission criteria for flue gas stack, the following measures will be implemented during operations:

- The use of continuous emission monitoring (CEM) equipment for the measurement of air emission levels in the exhaust stack. CEM will be undertaken for PM, NO_x, SO_2, CO and O_2;
- The stack will be provided with safe access to sampling points for CEM.
- Coal blending should be done in case of change in coal quality in order to meet the design requirements.

Evaluation of Impact Significance

Impact significance on ambient air quality due to stack emission from Unit 10 is as shown in Table 5.17.

Table 5.17 Impact Significance on Ambient Air Quality due to Stack Emission (Unit 10)

Impact	*Ambient air quality impact due to stack emissions (Unit 10)*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Impact significance on ambient air quality due to stack emissions from Unit #6, 7, 8, 9, and 10 is as shown in Table 5.18.

Table 5.18 Impact Significance on Ambient Air Quality due to Stack Emissions from all BTPS Units

Impact	*Ambient air quality impact due to stack emissions from all BTPS Units*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	

Residual Impact	With Mitigation Measures			
	Negligible	**Minor**	Moderate	Major

Table 5.19 Predicted Concentrations at Receptors due to Operation of Project in different scenarios

Scenario	Receptor	Receptor Name	Predicted 24 hourly Maximum Concentration (µg/m³)			Baseline 24 hourly Maximum Concentration (µg/m³)			24 hourly Maximum Concentration (µg/m³) (Predicted + Baseline)		
			PM_{10}	SO_2	NOx	PM_{10}	SO_2	NOx	PM_{10}	SO_2	NOx
Scenario 1: Operation of Unit # 10	Maximum GLC		0.41	4.88	3.79	132.00	11.20	43.20	132.41	16.08	46.99
	AAQ1	Simariya Ghat	0.35	4.20	3.26	92	9.2	38.5	92.35	13.40	41.76
	AAQ2	Shikharichawk (Pachmahla)	0.19	2.27	1.76	92	9.6	35.2	92.19	11.87	36.96
	AAQ3	Maranchi	0.26	3.07	2.39	95	10.2	35.2	95.26	13.27	37.59
	AAQ4	Makardahi	0.18	2.19	1.70	99	10.2	39.7	99.18	12.39	41.40
	AAQ5	Mahna	0.25	3.02	2.35	95	9.6	38.5	95.25	12.62	40.85
	AAQ6	Kiul	0.32	3.75	2.91	87	9.6	39.6	87.32	13.35	42.51
	AAQ7	Hajipur	0.28	3.27	2.54	132	11.2	41.2	132.28	14.47	43.74
	AAQ8	BTPS Colony	0.39	4.67	3.62	122	9.2	43.2	122.39	13.87	46.82
	AAQ9	Baryahi	0.36	4.32	3.37	87	9.5	32.2	87.36	13.82	35.57
	AAQ10	Akashpur	0.22	2.58	2.01	90	8.2	38.5	90.22	10.78	40.51
Scenario 2: Operation of Unit # 6, 7, 8 and 9	Maximum GLC		7.13	25.08	11.48	132.00	11.20	43.20	139.13	36.28	54.68
	AAQ1	Simariya Ghat	3.76	14.98	7.18	92.00	9.20	38.50	95.76	24.18	45.68
	AAQ2	Shikharichawk (Pachmahla)	2.13	8.59	4.08	92.00	9.60	35.20	94.13	18.19	39.28
	AAQ3	Maranchi	2.97	11.88	5.63	95.00	10.20	35.20	97.97	22.08	40.83
	AAQ4	Makardahi	1.93	7.96	3.82	99.00	10.20	39.70	100.93	18.16	43.52
	AAQ5	Mahna	3.87	14.56	6.79	95.00	9.60	38.50	98.87	24.16	45.29
	AAQ6	Kiul	3.85	15.48	7.34	87.00	9.60	39.60	90.85	25.08	46.94
	AAQ7	Hajipur	4.62	16.40	7.53	132.00	11.20	41.20	136.62	27.60	48.73
	AAQ8	BTPS Colony	5.14	20.02	9.42	122.00	9.20	43.20	127.14	29.22	52.62
	AAQ9	Baryahi	4.20	16.07	7.65	87.00	9.50	32.20	91.20	25.57	39.85

Scenario	Receptor	Receptor Name	Predicted 24 hourly Maximum Concentration (µg/m³)			Baseline 24 hourly Maximum Concentration (µg/m³)			24 hourly Maximum Concentration (µg/m³) (Predicted + Baseline)		
			PM_{10}	SO_2	NOx	PM_{10}	SO_2	NOx	PM_{10}	SO_2	NOx
	AAQ10	Akashpur	3.00	11.74	5.53	90.00	8.20	38.50	93.00	19.94	44.03
Scenario 3: Operation of Unit # 6, 7, 8, 9 and 10	Maximum GLC		7.41	28.59	14.46	132.00	11.20	43.20	139.41	39.79	57.66
	AAQ1	Simariya Ghat	4.07	19.14	10.45	92.00	9.20	38.50	96.07	28.34	48.95
	AAQ2	Shikharichawk (Pachmahla)	2.32	10.88	5.84	92.00	9.60	35.20	94.32	20.48	41.04
	AAQ3	Maranchi	3.23	14.96	8.02	95.00	10.20	35.20	98.23	25.16	43.22
	AAQ4	Makardahi	2.08	10.15	5.61	99.00	10.20	39.70	101.08	20.35	45.31
	AAQ5	Mahna	4.11	17.41	9.00	95.00	9.60	38.50	99.11	27.01	47.50
	AAQ6	Kiul	4.17	19.22	10.25	87.00	9.60	39.60	91.17	28.82	49.85
	AAQ7	Hajipur	4.80	18.97	9.88	132.00	11.20	41.20	136.80	30.17	51.08
	AAQ8	BTPS Colony	5.49	24.13	12.61	122.00	9.20	43.20	127.49	33.33	55.81
	AAQ9	Baryahi	4.29	20.41	11.02	87.00	9.50	32.20	91.29	29.91	43.22
	AAQ10	Akashpur	3.22	14.32	7.53	90.00	8.20	38.50	93.22	22.52	46.03
National Ambient Air Quality Standards (24 Hourly Average)									***100***	***80***	***80***

Figure 5.5 Isopleths of 24 Hourly Maximum PM Concentration due to Operation of Unit # 10

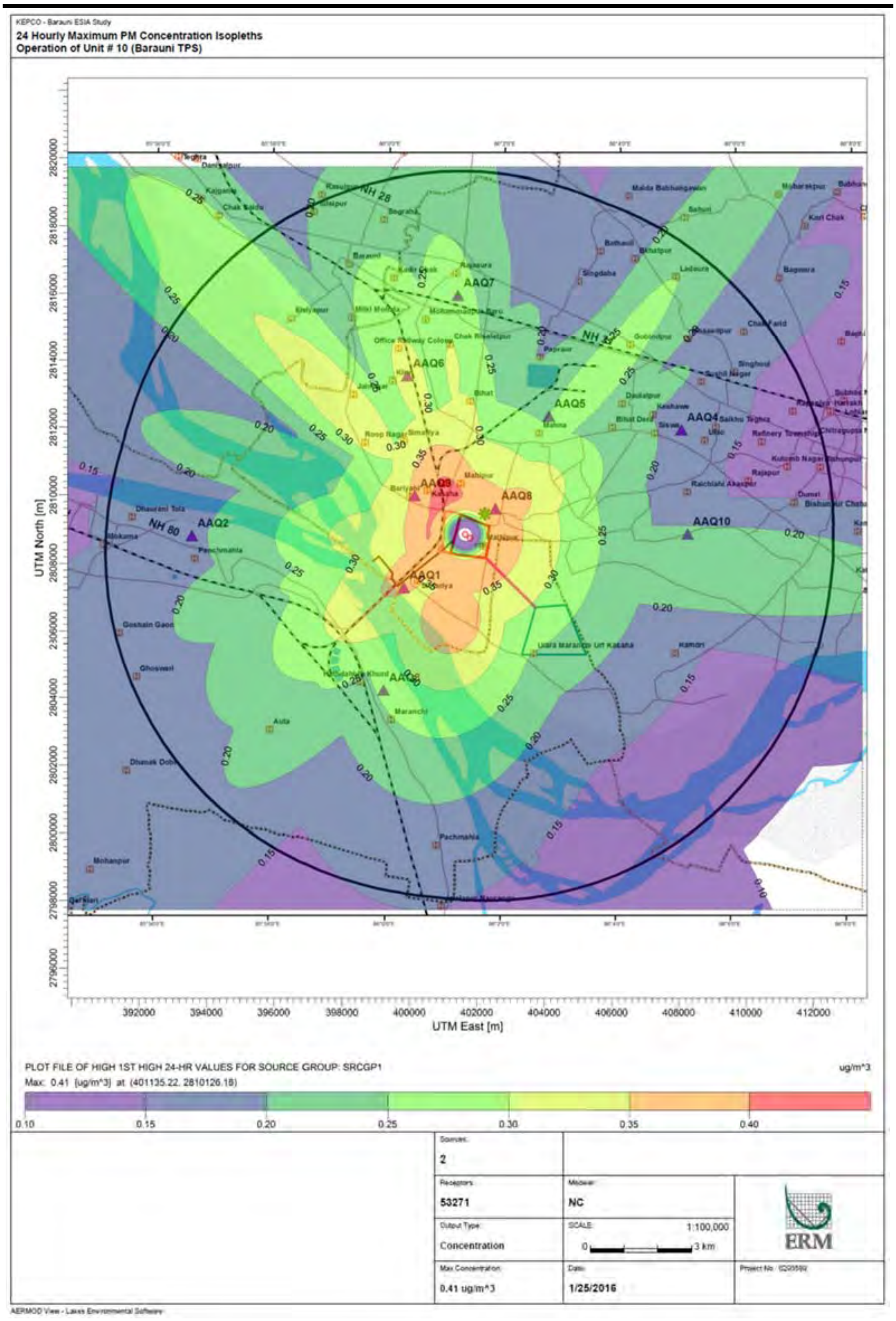
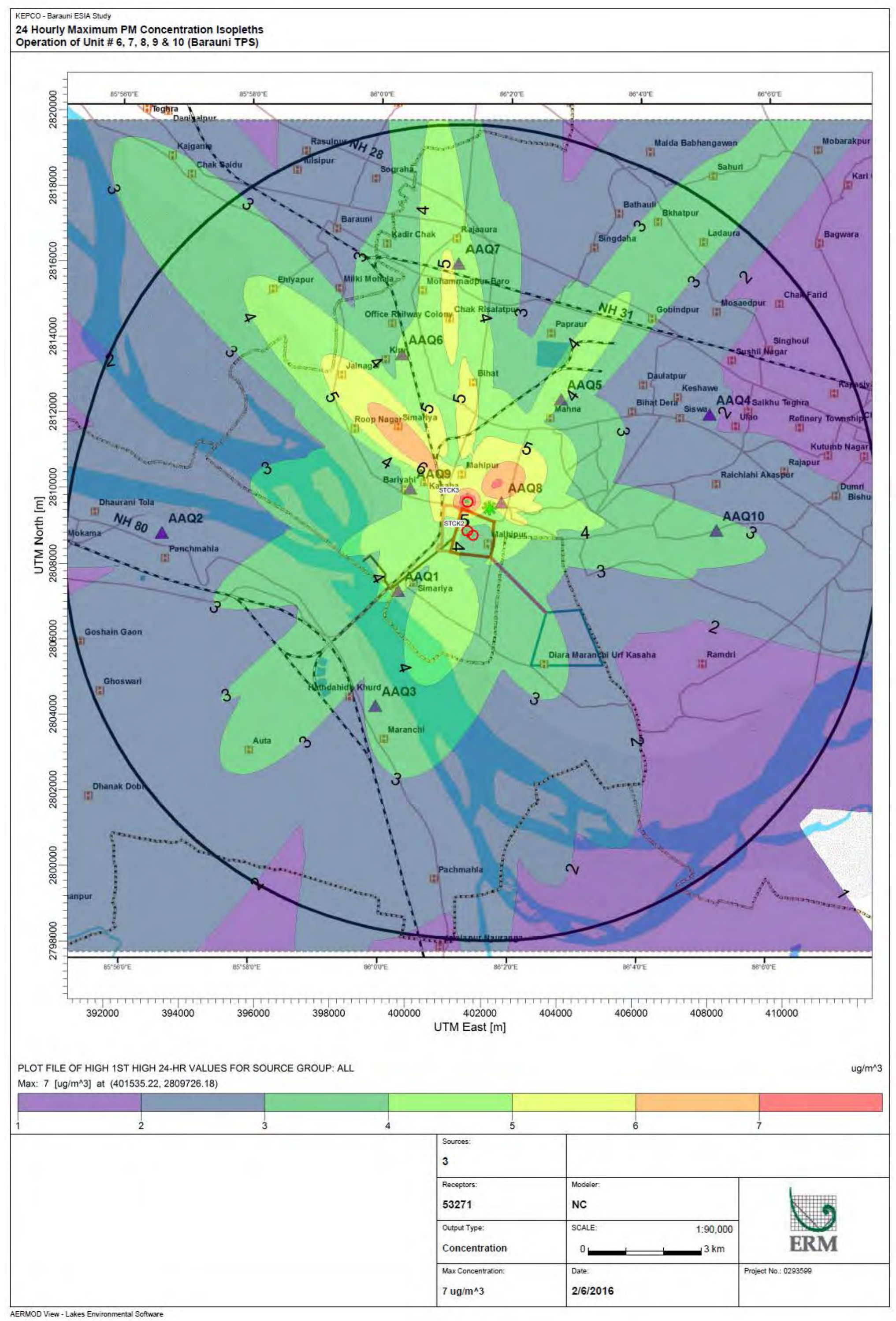


Figure 5.6 Isopleths of 24 Hourly Maximum PM Concentration due to Operation of Unit # 6, 7, 8, 9 and 10



Other isopleths are presented in **Annex 5.1** covering all the scenarios.

5.4.3 *Potential Impact on Noise Quality*

Construction Phase

Source of Impact

The potential sources of noise during the construction phase of the Project include equipment, machinery and transportation used for the construction activities. The heavy equipment used for the construction activities will be the major sources of noise. This will include piling and preparing concrete foundations for major plant and buildings. There is expected to be an increase in traffic and thereby in traffic noise impacts to receptors near the existing access road from the transportation of equipment, construction materials and workers. To minimise these impacts, only those vehicles meeting the applicable standards will be used. Construction works are expected to last for 52 months.

The detailed breakdown of activities is not available at this stage, and as the Contractor has not yet been appointed, no construction plant inventory is available at the time of assessment. Therefore, an assumed plant inventory is provided in Table 5.20. Assumptions have made regarding the type, number and Sound Power Levels (SPLs) of construction plant, based on similar projects and publicly available data. It has been assumed that only one of each type of plant will be on-site during any day or night period. Re-assessment of noise levels may be required if the actual plant inventory and SPL vary from the assumed list.

Table 5.20 Assumed Construction Equipment Sound Pressure Level Inventory

Construction Equipment	SPL, dB(A)
Bulldozer	115
Backhoe	96
Impact pile driver	101
Loaders	108
Vibratory roller	102
Fuel truck	104
Welding machine	101
Cranes	106
Dump truck	105
Grader	114
Fork lifts	112
Compressors	104
Generators	93

Source: The SPLs of the construction equipment have been taken from DEFRA Construction Noise database for prediction of noise on construction and open sites, July 2006 and ERM's internal database

Impact Significance

Although construction equipment and materials will be delivered by road/ rail, which will result in slight increase in heavy traffic movement and thereby in traffic noise impacts to receptors near the national highway. However, this increase will not be significant with respect to the existing traffic on the National Highway. Majority of the construction activities will be limited to the day time only. Noise impacts will be more predominant within 500 m of the activity areas. Considering the construction activity schedule and nature of construction, overall noise impact on nearby sensitive receptors with embedded controls in place will be of **Moderate** significance.

Mitigation Measures

The following mitigation measures will be implemented to minimise potential noise impacts during the construction phase in all periods:

- Normal working hours of the contractor will be between 06:00 and 21:00 hours from Monday to Sunday. If work needs to be undertaken outside these hours, it should be limited to activities that do not exceed the noise criteria at nearby noise sensitive receptors;
- Only well-maintained equipment will be operated on-site;
- Regular maintenance of equipment such as lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machinery and construction plant that may be in intermittent use (e.g. trucks) shall be shut down or throttled down during non-work periods;
- Low noise equipment shall be used as far as practicable;
- The number of equipment operating simultaneously shall be reduced as far as practicable;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable;
- Noisy plant (such as breakers and rollers) shall be located as far away from receptors as practicable.

Evaluation of Impact Significance

Impact significance on ambient noise levels due to construction activities is as shown in Table 5.21.

Table 5.21 Impact Significance on Noise from Construction Activities and Transportation of Man and Material

Impact	*Noise from Construction Activities and Transportation of Man and Material*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				

	Negligible	Minor	**Moderate**	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	**Minor**	Moderate	Major

Operation Phase

Sources of Impact

For coal based thermal power plant, the major noise sources during base load operation are the steam generator and auxiliaries (coal pulverisers/ mills, draft fans, mill reject compressor, air preheaters, ESP), steam turbine generator and the auxiliaries (condensate polishing units, condenser, condensate extraction pumps, vacuum pumps, motor and turbine driver boiler feed pumps, steam turbine and generator, HP/LP bypass valves, ACW pumps, CCW pumps, generator, generator transformer, ICT) and balance of plant (circulating water pumps, raw water transfer pumps, ash water make-up pumps, paddle feeder, crusher, air compressors, hydrogen generation plant, emergency DG and GIS switchyard). Most of these units will be having noise generation less than 90 dB, except the bypass valves, which will be having noise generation of the order of 105dB. The details of noise generation from these units including the details of building and wall design are presented in Figure 2.11.

Noise and vibration from the Project will be mitigated through engineering control and wherever possible high noise equipment will be enclosed in noise-proofed buildings that effectively contain the noise.

Receptors

In order to predict noise levels, a grid of 50 m x 50 m for the study area has been created. In addition to that noise level prediction due to the project operations was also carried out at 12 noise sensitive receptors, where baseline noise levels were monitored. All these 12 noise receptors with respect to noise generating sources and plant boundary have been shown in a topographic map in Figure 5.7.

Prediction of Impact

Methodology: The environmental noise prediction model SoundPLAN 7.2 was used for modelling noise emissions from the use of power plant equipment. The noise emission data of the major equipment/ machinery has been taken from the information provided by KEPCO (Figure 2.11). Operation of equipment with 100% usage scenario was modelled to cover the operation phase of the Project. As a conservative approach to the assessment, atmospheric absorption during sound transmission was not included in the assessment. In addition, to represent a worst-case scenario for the assessment, all equipment was assumed to be operating simultaneously. Attenuation due to already constructed boundary wall of the Plant boundary of Unit #8, 9 and 10 has been considered in the modelling.

Figure 5.7 Major noise generating sources and receptors

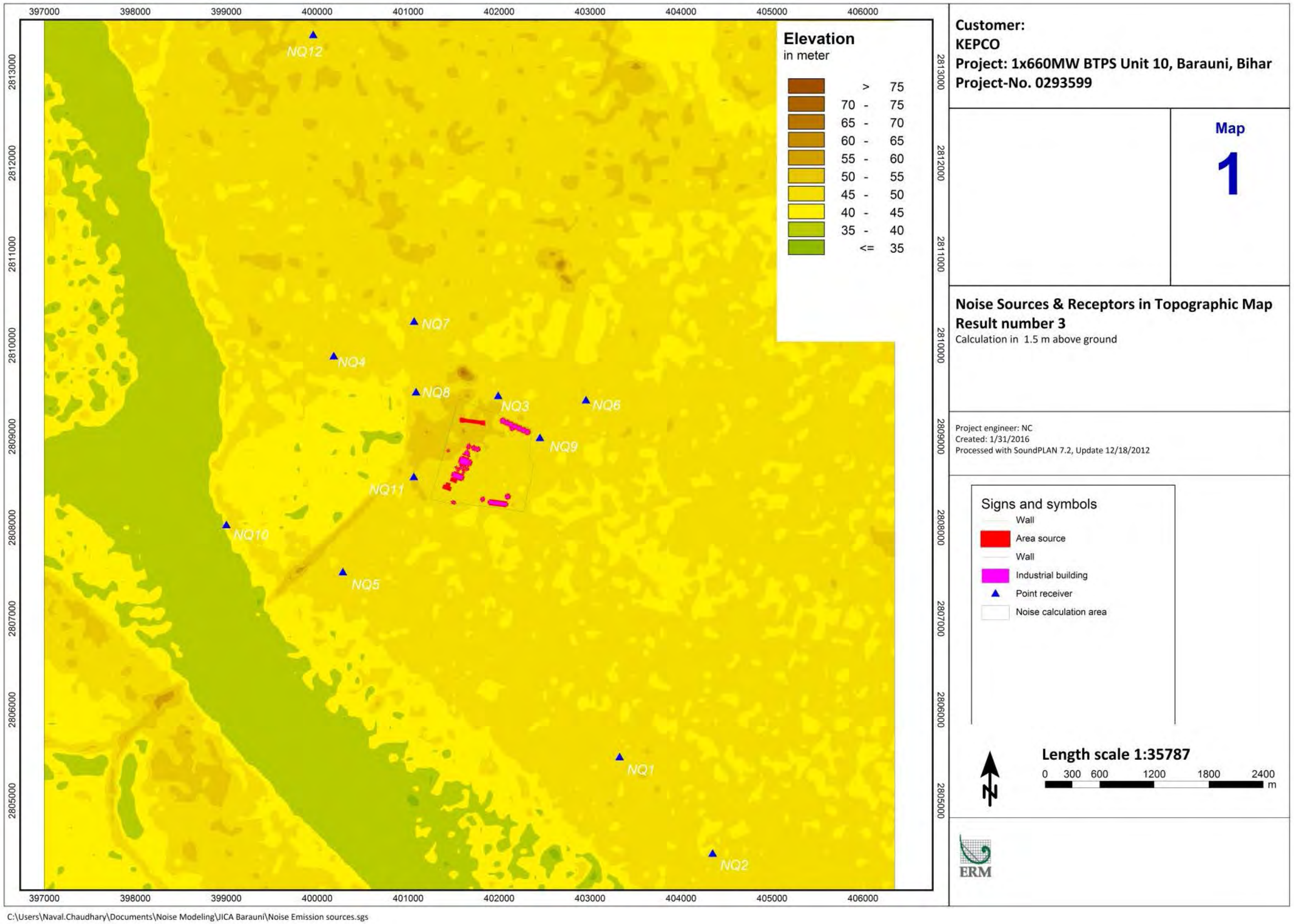
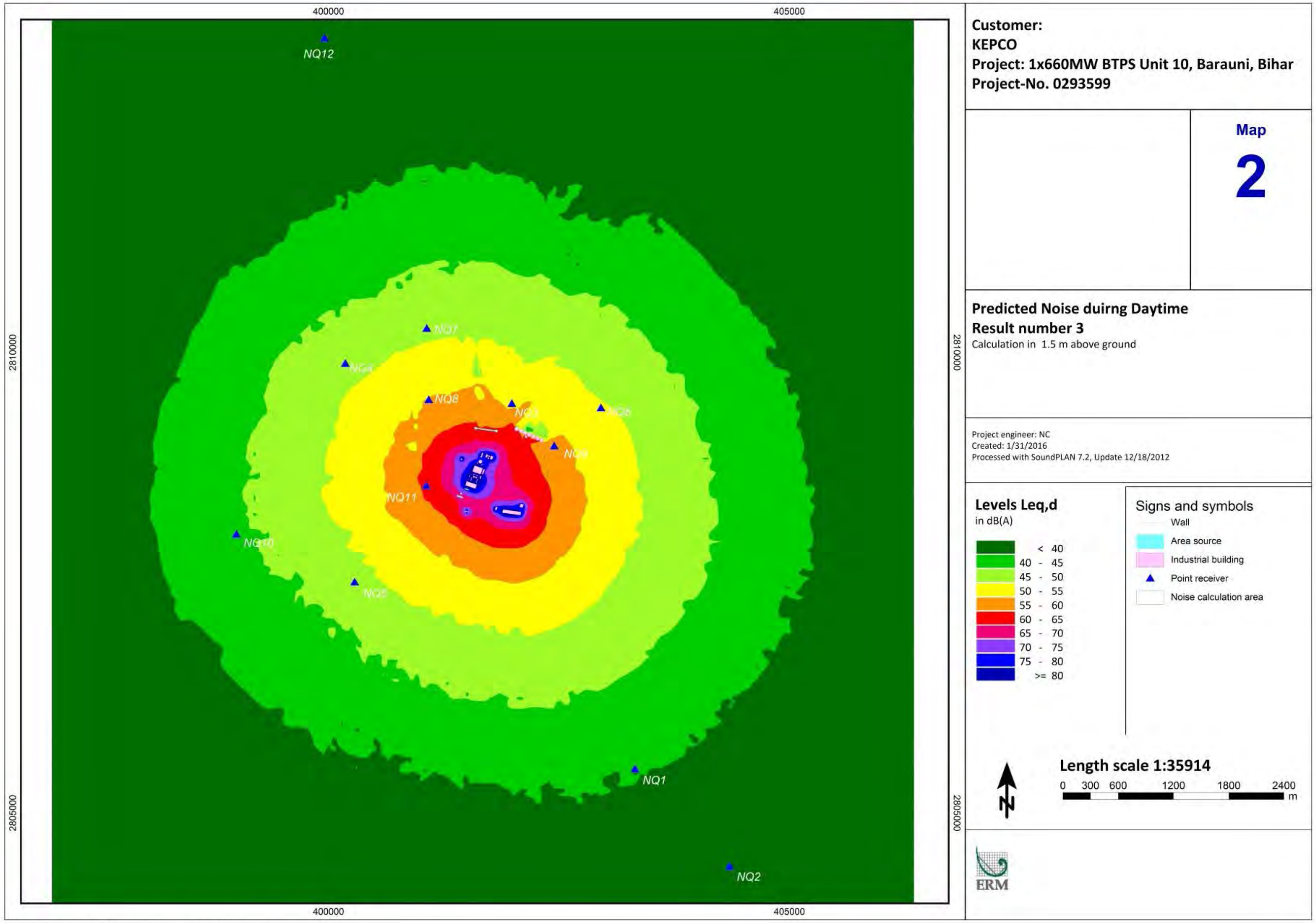


Table 5.22 Predicted Noise Levels at Noise Receptors during Operation Phase of the Project (worst case scenario)

Receptor Code	Landuse	Distance from Project Boundary (km)	Direction from Project Boundary	Baseline Sound Pressure Levels at Receptors, Leq (dBA)[1]		Predicted Sound Pressure Levels at Receptors, Leq (dBA)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard (dB(A)) as per Landuse	
				Leq_d*	Leq_n*	Leq_d	Leq_n	Leq_d	Leq_n	Day	Night
NQ1	住居	2.8	SE	54.6	43.8	39.5	39.3	54.7	45.1	*55*	*45*
NQ2	住居	4.1	SE	54.2	45.2	31.2	30.9	54.2	45.4	*55*	*45*
NQ3	住居	0.23	N	53.2	44.2	54.4	54.4	56.9	54.8	*55*	*45*
NQ4	住居	1	NW	54.1	43.2	48.5	48.5	55.2	49.6	*55*	*45*
NQ5	住居	1	SW	62.2	44.2	47.1	46.9	62.3	48.8	*55*	*45*
NQ6	住居	0.7	NE	57.5	45.2	50.4	50.4	58.3	51.5	*55*	*45*
NQ7	住居	0.8	N	57.5	46.6	48.3	48.3	58.0	50.5	*55*	*45*
NQ8	工業	0.02	N	58.5	46.6	55.2	55.2	60.2	55.8	*75*	*70*
NQ9	住居	0.09	E	52.5	42.2	56.3	56.3	57.8	56.5	*55*	*45*
NQ10	住居	1.9	SW	51.8	39.6	43.2	43	52.4	44.6	*55*	*45*
NQ11	工業	敷地境界	-	61.2	47.1	61.9	61.9	64.6	62.0	*75*	*70*
NQ12	住居	4	NE	53.2	45.2	29.4	29.4	53.2	45.3	*55*	*45*

Figure 5.8 Prediction of Noise Levels (daytime)



C:\Users\Naval.Chaudhary\Documents\Noise Modeling\JICA Barauni\Barauni Daytime.sgs

Predicted noise levels at 12 receptors (where baseline noise levels were also monitored) have been presented in Table 5.22. It is evident from the predicted results that in the worst case scenario, the nearest receptor (90 m from the eastern boundary of the Project site) will have a daytime and night time noise levels of 57.8 dB(A) and 56.5 dB(A), respectively, during the operation phase.

Impact Significance

It is evident from Table 5.22 that ambient noise levels due to operation of the project will be well within the applicable standard during day time at 6 receptors and night time at 3 receptors, out of total 12 receptors considered in the study. This is primarily due to already existing higher noise levels at the background due to the ongoing construction activities as well as proximity of highway. Considering the continuous operation of the plant, overall noise impact on nearby sensitive receptors with embedded controls in place will be of **Moderate** significance.

Mitigation Measures

To mitigate operational noise impacts the detailed design specifications will have the following measures in place:

- Selection of equipment with lower sound power levels (< 85 dB);
- Installation of mufflers on engine exhausts and compressor components;
- Installation of acoustic enclosures for equipment (e.g. turbine, compressor) casing radiating noise;
- Buildings will be designed with improved acoustic performance and sound insulation will be provided;
- Installation of acoustic barriers without gaps and with a continuous minimum surface density in order to minimize the transmission of sound through the barriers;
- Barriers will be located as close to the source, as far as practicable, to be effective;
- Installation of vibration isolation for mechanical equipment; and
- A noise analysis of all major plant components will be carried out during commissioning of the plant to ensure compliance with the specification and guaranteed performance as well as ambient noise levels at the receptors located in the surroundings.

Evaluation of Impact Significance

Impact significance on ambient noise levels due to plant operation is as shown in Table 5.23.

Table 5.23 Impact Significance on Noise from Plant Operations

Impact	*Noise from Plant Operations*			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Extent	Local	Regional	National	
Impact Duration	Temporary	Short-term	Long-term	Permanent

Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

5.4.4 *Potential Impacts on Land Use*

Major land use types of the study area (*Refer: Section 4.6.3- Land use*) can be classified as agricultural land (60.36%) followed by Ganga River (approximately 18%), settlement (15.67%), Industrial areas etc. (2.08%), vegetation (0.40%), road (0.55%), railway (0.23%). BTPS is an old plant and the plant has 561.583 acres of land. BTPS has 7 existing units, (5 units are already retired), residential colony. The reclaimed ash pond area of 370 acres has been utilised for construction of 2 x 250 MW units (Unit #9 and 10). The main plant of the proposed expansion will be constructed on existing site (*Refer: Section 2.3.1*). New ash pond and water intake system will be constructed for existing and proposed expansion unit. Impact on land use can only be envisaged due to construction of ash pond and water intake facility.

Construction Phase

Construction of Ash Pond & Water Intake Facility

Impact Significance

The land required for the ash pond/dyke and ash slurry pipeline is 290 acres and for water intake facility is 20 acres. The 290 acres of proposed ash pond area is Govt. land under Revenue Department. The land has already been transferred to BSPGCL for construction of ash pond. However, presently the land has been utilised for agricultural purposes.

The proposed water intake facility and water intake pipeline corridor will be constructed over 20 acres of land. The land identified for water intake facility is Railway land, presently used for agricultural purpose. Water intake pipeline is mostly passing through ROW of the existing road.

Therefore, construction of ash pond & slurry pipeline and water intake facility will permanently change the land use from agriculture to industrial land. Approximately, 310 acres agricultural land will be converted into industrial land, which is also insignificant compared to total agricultural land in the study area, i.e. about 0.6% only. The proposed land use changes will ultimately affect the livelihood of the land looser community, which is discussed in socio-economic section. In terms of sensitivity, majority of population are dependent on agricultural activity; there any significant changes of agricultural land use to non-agricultural purpose can be considered as medium significance.

It is estimated that capacity of the ash pond can accommodate ash generated from Unit No. 6, 7, 8, 9 and proposed expansion unit up to 16 years. Considering, 20 years life of plant additional ash dyke area would be required additional land. The adjacent land of proposed ash pond area is also used for agricultural purpose. If additional land acquired for the project, land use changes can be envisaged.

Evaluation of Impact Significance

Impact significance on land use due to construction of ash pond and water intake facility is as shown in Table 5.24**.**

Table 5.24 Impact Significance on Land use due to Construction of Ash Pond and Water Intake Facility

Impact	*Land use impact due construction of ash pond and water intake facility*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

5.4.5 Potential Impact on Soil Quality

Topsoil generally contains most of the nutrients and organisms that gives the soil a living character and productivity. Top soil may be impacted due to removal during site development and contamination during construction and operation of plant. However, it is to be noted here that the proposed project is coming up on a land parcel, which was earlier being used as ash pond for old units of BTPS and hence, the impact on soil quality is more prominent with respect to the activities outside the plant boundary, such as ash pond and water intake facility.

Construction Phase

Potential impact on soil quality is anticipated during site development and construction of plant is expected from ash pond and water intake facility area from stripping & storage of top soil and disposal of excavated debris/spoil.

Top soil stripping

<u>*Impact Significance*</u>

The proposed ash pond and water intake facility is located on agricultural land of Diara Maranchi and Simariya villages, top soil stripping could therefore possibly lead to the loss of soil fertility and increase in soil erosion. The soil in this region is generally characterized by low to moderate fertile. The soil samples analysed as part of the primary baseline monitoring also revealed the same as discussed in *Section 4.3.4*. The excavated top soil if not properly preserved and utilized for greenbelt purpose may have result in loss of the top soil (a very valuable resources) of the project site. The soil quality of the agricultural land is moderately fertile, this can be categorised as medium sensitive resource.

<u>*Mitigation Measures*</u>

- Properly stripping of top soil before construction activity
- Proper storage and stabilization of top soil will be ensured for future activities

<u>*Evaluation of Impact Significance*</u>

Impact significance on soil quality due to stripping of top soil is as shown in Table 5.25**.**

Table 5.25 Impact Significance on Soil Quality due to Stripping of Top Soil

Impact	*Soil quality impact due stripping of top soil*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Storage and disposal of excavated debris and borrow material

<u>*Impact Significance*</u>

A large volume of fill and quarry material will be required for construction of ash dyke and elevating water intake facility. Considerable amount of fill and quarry material from other areas will be brought in during construction stage (source of the same is currently unknown). If not sourced from proper areas, this may result in damage on the soil quality of quarry area. If such material is spilled or displaced during construction of ash pond and water intake facility on adjacent agricultural land, it can affect the soil characteristics of the surrounding agricultural land.

Excavation undertaken as part of project site preparation activities will be resulting in the generation of spoil/debris. The excavated material is planned to be reused as additional fill material along with borrow material to be sourced for the proposed project. If adequate care not taken in the proper storage and handling of such excavated soil and/or borrow material to prevent spillage of debris and borrow material to abutting agricultural land, soil quality may be affected.

The surface runoff from the construction site laden with construction materials such as sand, etc. tend to infiltrate and clog up inter granular spaces, which may alter the soil characteristics.

However with the project proponent planning to store the excavated spoil/debris and borrow material at only designated locations within the main plant area no significant impact to this regard is envisaged.

Mitigation Measures

- All construction activities will be restricted within the main plant boundary;
- Location of debris stockpiles to be selected based on local sensitivities;
- Proper reuse/disposal of debris will be ensured to prevent land degradation;
- Provision of adequate onsite surface run-off drainage;

Evaluation of Impact Significance

Impact significance on soil quality due to storage and disposal of debris and borrow material is as shown in Table 5.26**.**

Table 5.26 Impact Significance on Soil Quality due to storage and disposal of debris and borrow material

Impact	*Soil quality impact due storage and disposal of debris and borrow material*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				

	Negligible	**Minor**	Moderate	Major

Storage and handling of fuel and lubricants

Impact Significance

Contamination of soil can result from the project activities if certain operations like storage and handling of fuels are not managed efficiently. Accidental spillage of oil and lubricants, either during transportation or during handling, on open soil may contribute to soil contamination of construction site and adjoining village agricultural lands following surface run-off. However such impact is likely to occur only under exceptional circumstances and is not considered being of significance.

Mitigation Measures

- Provision of adequate onsite surface run-off drainage;
- Manage spills of fuel and lubricants on soil

Evaluation of Impact Significance

Impact significance on soil quality due to storage and disposal of debris and borrow material is as shown in Table 5.27**.**

Table 5.27 Impact Significance on Soil Quality due to Storage and handling of fuel and lubricants

Impact	*Soil quality impact due to Storage and handling of fuel and lubricants*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operational Phase

Impacts on soil quality during operational phase are generally envisaged from deposition of fugitive coal dust generated from coal handling plant. However the major soil quality impact is identified from the deposition of fly ash (characterized by toxic heavy metals) on nearby agricultural land during the operation of thermal power plant.

Coal transportation & operation of Coal Handling Plant

Impact Significance

The coal for the proposed project will be transported to main plant site through coal reak. It is anticipated coal dust will be generated from operation of coal crusher unit. These coal dusts will be deposited in the nearby area due to its larger particle size. Although any soil contamination to this regard is not established prolonged deposition of coal dust may affect soil fertility and crop productivity. Again the proposed coal handling plant is located on the western side of the plant, and there is no agricultural land adjacent to the proposed CHP. However considering the conveyor belt to be of enclosed type along with adequate dust extraction/dust suppression system to be implemented by the proponent at the transfer points, coal storage in silos and greenbelt around the plant, impact is not considered being of major significance.

Mitigation Measure

- Provision of adequate onsite surface run-off drainage in CHP and treatment facility.

Evaluation of Impact Significance

Impact significance on soil quality due to operation of CHP is as shown in Table 5.28**.**

Table 5.28 Impact Significance on Soil Quality due to operation of CHP

Impact	*Soil quality impact due to operation of CHP*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Flue gas emissions and fly ash storage & disposal

Impact Significance

As discussed under *section 2.5.3* under "Ash Handling & Disposal System" about 176 tons/hr of fly ash is estimated to be generated from combustion of non-coking coal during the operation of the proposed thermal power plant. The ash particles present in the flue gas will be arrested by electrostatic precipitators and collected in the ESP hoppers. The fly ash will then be pneumatically conveyed to the bag filter system for further removal prior to its transfer to fly ash silos. Although the ESP will be designed to operate at maximum operational efficiency (about 99.89%), some portion (0.11%) may find its way into the atmosphere through flue gases emission from chimney and get deposited on the surrounding land and vegetation depending on the prevalent micro-meteorological conditions. The maximum GLC for PM was predicted at a distance of 1km from the source (*section 5.4.2*). During dry season re-suspended ash generated from ash pond may also get deposited on adjacent village agricultural land. However such impacts are anticipated only during the dry months of the year and can be addressed through implementation of proper mitigation measures.

Study on assessment of heavy metals emissions from coal fired thermal power plants carried out by CPCB revealed the presence of heavy metals such as Hg, Pb, Cr, Co, Cd, Ni, Cu & Zn in both fly ash and bottom ash samples. Significant concentration of Hg, Pb, As, Cr, Cd, Ni, Cu & Zn were found in stack emissions which is attributed to the high surface area and atmospheric mobility of fly ash leading to its deposition over a wider area. The concentration of metals however could not be detected significantly in bottom ash samples. About 37 trace elements have been detected in fly ash with Cu, Ni, Pb, Co, Bi, Sb and Zn being identified as key toxic metals (Klein et al., 1975).

In order to understand the possible impact of fly ash on soil quality a study[1] was undertaken by Indian School of Mines through comparative analysis of soil samples collected from both contaminated and uncontaminated areas with respect to a thermal power station. The study indicated elevated concentration of heavy metals in the top soil (0-30cm) of contaminated areas which may affect the crop productivity due to their accumulation over longer periods at concentration above soil's normal requirement. The concentrations of toxic metals in top soil (0-30cm) of contaminated and uncontaminated samples analyzed have been presented in the Table 5.29 below for reference.

Table 5.29 Study Soil Analysis Results

Soil Type	**Depth (cm)**	**Parameter conc. (mg/kg)**						
		Cu	Ni	Pb	Co	Bi	Sb	Zn
Uncontaminated	0-30	5.6	40.0	18.6	9.6	Nil	Nil	45.0
Contaminated	0-30	18.6	143.4	93.8	79.0	1.4	Nil	153.8

Although the heavy metal content in the fly ash can be controlled through ESPs installed as part of the proposed project the proponent needs to adopt additional mitigation measures to achieve improved heavy metal removal efficiency. A peripheral green belt is also planned to be developed along the ash pond and plant area to prevent dispersion of fly ash beyond the project boundary. Hence considering the project design to enhance particulate

[1] "Impact of fly ash on soil quality around a thermal power station with reference to toxic elements" by Somesh Jana and Gurdeep Singh; Indian School of Mines, Centre of Mining Environment

removal and implementation of additional mitigation measures the impact is considered to be of moderate significance.

Evaluation of Impact Significance

Impact significance on soil quality due to coal combustion and stack emission is as shown in Table 5.30**.**

Table 5.30 Impact Significance on Soil Quality due to stack emission

Impact	*Soil quality impact due to stack emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

5.4.6 *Potential Impact on Topography & Drainage*

Topography refers to relief of the area and covers both vegetative and man-made features. Drainage refers to natural and man-made channels that carry the surface runoff. These may be altered due unplanned development activity. As discussed in *Section 5.4.1*, main plant site would not require further site development. However, it is proposed to construct a flood protection embankment towards southern and eastern side of the main plant. The proposed ash pond and water intake facility will be constructed on presently agricultural land, which have flood related problem.

Site Development & Construction of Main Plant

Impact Significance
The topography of the study area is low lying flat terrain (MSL 45m-32m) having a southerly to south-easterly slope. The study area is having a flat terrain sloping towards the River Ganges (*Section 4.3.1*). The existing main plant site is already elevated up to 45.5 m. The high flood level of the site is 43.22 m. It is proposed to construct 45.5 m flood protection dam. The Malhipur village is located adjacent to main plant site on eastern side. The runoff from the main plant site and Malhipur village drained into river on natural slope towards south and south-east. The flood protection embankment around 300 m from site will protect the village from flood but may create water logging problem is cross drainage structure not properly made.

Again rainfall of the study area is moderately high (*Refer Section 4.4.1*), the drainage of plant will be managed by a proper designing and constructing storm water drainage system to avoid any water logging. There is no drainage channel in the main plant site (*Refer Section 4.5.1*). Therefore; alteration of drainage channel is not envisaged. The site has no major problem related to local drainage; however, the site has flood related problem, this can be categorised as medium sensitivity.

Mitigation Measures

- Proper cross drainage structure along the flood protection bund;
- Proper storm water drainage system to avoid water logging in nearby village.

Evaluation of Impact Significance

Impact significance on topography local and drainage due to site elevation and flood protection embankment is as shown in Table 5.31.

Table 5.31 Impact Significance on Topography & Local Drainage due to Main Plant site development & Construction

Impact	*Topography & local drainage impact due topography change of main plant site*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Site Development & Construction of Ash Pond/Dyke and pipeline Corridor

Impact Significance

The proposed ash pond area is located outside the flood protection embankment. The elevation of the site is varies from 40.5 m (towards north) to 42.0 m (towards south). The general slope of the proposed ash pond is towards north. The high flood level of the site is 43.22 m. It is proposed to construct ash dyke of 18 m height (as per CEA guidelines). This embankment may disturb the local drainage due to physical presence of embankment. It is also proposed to construct an ash slurry pipeline corridor of 2.7 km from main plant to ash pond, north-west to south-east direction. The alignment of the ash slurry pipeline shows (*Refer: Figure 4.26- Drainage Map*) that corridor is also crossing a local *nala,* connecting river Ganga and passing through northern side. General slope of northern part of the ash pond and its surrounding area is towards north to south and southern part is towards south to north.

The construction of ash pond and ash slurry corridor may disturb local drainage and can causes temporary blockage of local drainage. However, culvert and cross drainage structure will be constructed over the local *nala* and along the ash slurry corridor to prevent any impedance to the present drainage pattern. If the drainage system is not properly designed, localised drainage system may disturb due to construction of ash pond and ash slurry pipeline.

Mitigation Measures

- Minor drainage channels along the ash slurry corridor will be maintained
- Design parameter will be followed for elevated structure of the main plant and its associated facilities.

Evaluation of Impact Significance

Impact significance on topography local and drainage due to site elevation and flood protection embankment is as shown in Table 5.32**.**

Table 5.32 Impact Significance on Topography & Local Drainage due to Ash Pond & Slurry Pipeline site development & Construction

Impact	*Topography & Local Drainage due to Ash Pond & Slurry Pipeline site development & Construction*				
Impact Nature	Negative	Positive		Neutral	
Impact Type	Direct	Indirect		Induced	
Impact Extent	Local	Regional		National	
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

5.4.7 *Potential Impact on Surface Water Resources*

Water Abstraction from River

Impact Significance

It is proposed to use the river water for existing and proposed expansion units. For existing and under construction unit, water requirement is 5097 m^3/hr and for proposed expansion unit, water requirement will be 2140 m^3/hr. Therefore after expansion total water requirement will be 7237 m^3/hr. BSPGCL has water withdrawal permission for 6116 m^3/hr and for lean season is 4077 m^3/hr. For proposed expansion unit BSPGCL need to take additional water withdrawal permission from Water Resource Department.

Other industries in this region are using ground water only. There is no competitive users like industry or irrigation in this portion of the river. The lean season flow of the river is 85,630 m^3/hr. After expansion, 8.5% of the total available river water will be withdrawn for power plant. From the available data, water is available for existing and proposed expansion unit.

However, at the same time a number of upcoming/expanding industries, municipal and irrigation users located further downstream of the off take point of BTPS at Simariya, has required the surface water. Considering this impact on surface water resource is moderate.

Mitigation Measures

- Usage of water will be optimized through adequate reuse/recycle of waste water.

Evaluation of Impact Significance

Impact significance on topography local and drainage due to site elevation and flood protection embankment is as shown in Table 5.33**.**

Table 5.33 Impact Significance on Surface Water Resources due to withdrawal of water

Impact	*Surface water resource impact due to withdrawal of water*				
Impact Nature	Negative	Positive		Neutral	
Impact Type	Direct	Indirect		Induced	
Impact Extent	Local	Regional		National	
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

5.4.8 *Potential Impact on Surface Water Quality*

Construction Phase

The impact on surface water quality during construction phase is anticipated mainly from discharge of surface run-off into local drainage channels during monsoon. With the domestic waste water generated from construction camps being treated in a combination of septic tanks and soak pits no impact on surface water quality is predicted during this phase.

Discharge of surface run-off

Impact Significance

As discussed in *Section 5.4.5* under "Impact on Soil Quality" top soil stripping during site preparation of proposed ash pond will be leading to increase in soil erosion. Hence during monsoon the surface run-off generated from the site area will be characterized high sediment load which will subsequently get discharged in the local natural drainage channel located north of the site. Such run-off discharge may lead to the alteration of flow rates and increase in suspended solids, which ultimately discharged into River Ganga. In addition to sediment load, the surface run-off may also characterized by contaminants viz. oil, lubricants etc. thereby leading to degradation of the water quality of the drainage channel.

The main plant area is already developed and there is no natural drainage channel in nearby area. The surface runoff from the main plant site will be discharged into the nearby agricultural land. The surface runoff from main plant site will not directly discharge into surface water body. It may also be noted that the discharge will be a temporary activity and will be experienced only during monsoon hence the impact is not considered to be of significance.

Mitigation Measures

- Soil erosion from top soil and debris stockpiles to be checked;
- Provision of adequate drainage and sediment control systems onsite;
- Fuel and lubricant storage areas will be properly maintained;
- Construction activities to be restricted during monsoon to the extent possible.

Evaluation of Impact Significance

Impact significance on surface water quality due to surface runoff from construction site is as shown in Table 5.34.

Table 5.34 Impact Significance on o surface water quality due to surface runoff from construction site

Impact	*Surface water quality impact due to surface runoff from construction site*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				

	Negligible	**Minor**	Moderate	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	Minor	Moderate	Major

Operational Phase

Wastewater Discharge

Impact Significance

Potential surface water quality impacts is not envisaged during operational phase taking into account that all waste water discharges will adequately treated by an "Effluent Treatment System" (ETP) designed for the proposed project (*refer section 2.7.3*) and subsequently reused. Surface water quality impact is however anticipated from discharge of surface run-off generated from coal pile and hazardous material storage area during monsoon. Again all such run-off will be channeled through storm water drains to a settling unit for removal suspended solids prior to its discharge to natural drainage channel. Thus considering the intermittent generation of surface run-off and its necessary treatment prior to its discharge the impact is not considered to be of significance.

Mitigation Measures

- All effluent discharge to surface waters will be complying with the CPCB Inland Water Discharge Standards and Effluent Standards of IFC Thermal Power Plant EHS Guidelines;
- Hazardous material storage areas will be properly maintained;
- Prevention and control of accidental spillage of hazardous chemicals;
- Reuse/recycle of treated waste water will be maximized wherever feasible;
- The effluent and sewage treatment system will effectively designed and maintained.

Evaluation of Impact Significance

Impact significance on surface water quality due to generation and discharge of waste water is as shown in Table 5.35.

Table 5.35 Impact Significance on o surface water quality due to generation and discharge of waste water

Impact	*Surface water quality impact due to generation and discharge of waste water*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		

Impact Significance	**Without Mitigation Measures**			
	Negligible	**Minor**	Moderate	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	Minor	Moderate	Major

5.4.9 *Potential Impact on Ground Water Quality*

Construction Phase

Domestic waste water generation

Impact Significance

The domestic waste water generated from the construction labor camp will be treated in a combination of septic tank and soak pit. It is estimated that about 56KLD of sewage is likely to be generated from labor camp considering a peak operational workforce of 500 personnel and per capita water consumption of 140 lpcd. With the site area sandy loam (*Refer section 4.3.4*), there lies a possible risk of contamination of sub-surface aquifer due to the increased percolation of sewage through sandy soil from the soak pit if not properly managed. Consumption of such contaminated water by the nearby village communities may lead to the water borne health problems viz. diarrhoea, cholera etc. The profiling of the health status of the project affected families during consultation process also revealed the prevalence of water borne diseases. Hence the impact is considered to be of medium significance and requires proper mitigation. The ground water quality of the study area is under stress have biological contamination; this can be categorised as medium sensitivity.

Mitigation Measures

- Waste water to be adequately treated before discharge;
- Periodic monitoring of ground water well in the region will be conducted.

Evaluation of Impact Significance

Impact significance on ground water quality due to generation of domestic waste water from labour camp is as shown in Table 5.36**.**

Table 5.36 Impact Significance on Ground Water Quality due to Operation of Labour camp

Impact	*Ground water quality impact due operation of labour camp*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		

Impact Significance	Without Mitigation Measures			
	Negligible	**Minor**	Moderate	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	Minor	Moderate	Major

Operational Phase

Operation of Ash pond generation of Leaching

<u>*Impact Significance*</u>

As discussed under *section 2.5.9* under "Ash Handling & Disposal System" the bottom ash (20 TPH) and unused fly ash generated is to be disposed in an ash pond through High Concentrated Slurry Disposal (HCSD) system. The ash pond area is planned to be developed in village agricultural land of Diara Maranchi having sandy loam in nature (*Section 4.3.4*).

The chemical composition of fly ash generated from pulverization of Indian coal is as follows SiO_2 (59.38%); Al_2O_3 (23.59%); Fe_2O_3 (6.11%); CaO (1.94%); MgO (0.97%); SO_3 (0.76%); alkalies (1.41%) unburnt S and moisture (3.74%) including toxic heavy metal[1] in detectable quantities viz. Hg, I; Cd, Ga, Sb, Se, Ti and V (1-10 mg/kg); As, Cr, La, Mo, Ni, Pb, Th, U and Zn (10-100 mg/kg); and B, Ba, Cu, Mn and Sr (100-1000 mg/kg). Hence possible contamination of ground water may arise from the leaching of heavy metals in ash pond effluent. Although no heavy metal contamination was observed in the study[2] undertaken on the leachate generated from ash pond disposal site by Indian School of Mines indicate no leaching for metals such as Cr, Ni, Co, Se, Al, Ag, As, B, Ba, V, Sb, Mo and Hg which were found below detectable limits (0.001mg/l) reflecting their occurrence related mainly to sulphidic associations (Keakinen et al., 1975; Klien et at., 1975). Continuous leaching was however observed for the alkali metals viz. calcium (18-46 mg/l) and magnesium (10-19 mg/l) while for Fe, Pb, Cu, Zn and Mn leaching was observed to be of intermittent nature. The pH value of the leachate analyzed was also found to be within the pH range (6.5-8.5) prescribed[3] for ash pond effluent. The coal ash so evaluated in the study was therefore found to be environmentally benign and can be engineered for their bulk utilization particularly for reclamation of mined out and low lying areas.

However in addition to the presence of heavy metal in the leachate the contamination of ground water will also be governed by the hydraulic conductivity of the underlying geological strata, depth of sub-surface aquifer and ground water flow in the region. Considering the feed coal for the proposed project to be of Indian origin characterized by low sulfur content

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[1] Naik H K, Fly Ash: Its material characteristics, environmental implications and utilization strategies in India, January 2006

[2] "Environmental Evaluation of Coal Ash from Chandrapura Thermal Power Station of Damodar Valley Corporation by G.Singh and S.Kumar; Indian School of Mines, Centre of Mining Environment

[3] G.S.R. 742(E), dt. 30th Aug; 1990

(0.05%) the occurrence of trace metals in the resultant coal ash and subsequently in the ash pond leachate is anticipated to be low. It is also proposed to provide HDPE liner system as integrated in the project design by the proponent no significant impact on the ground water quality is envisaged. Considering the project level control measures, impact on ground water quality will be minor.

Mitigation Measures

- The ash pond effluent will conform to the CPCB Thermal Power Plant – Standard for Liquid Effluents.
- Ash pond to be adequately designed to prevent ground water contamination from migration of ash pond leachate.
- Periodic monitoring of ground water well in the region will be conducted.

Evaluation of Impact Significance

Impact significance on ground water quality due to generation of domestic waste water from labour camp is as shown in Table 5.37.

Table 5.37 Impact Significance on Ground Water Quality due to Leachate generation from ash pond

Impact	*Ground water quality impact due Leachate generation from ash pond*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

5.4.10 Potential Impact on Biological Environment

Construction Phase

Terrestrial Flora & Floral habitat due construction of Ash Pond & Water Intake Facility

Impact Significance

The proposed main plant site is planned on industrial land which is already developed for industrial purpose. The proposed ash pond and water intake facility will be constructed on agricultural land, which very limited vegetation, mostly on the plot boundary. The floral survey results shows that

Acacia, Neem, Banyan trees are most dominant species in the proposed project site; those are common to the site.

The review of the ecological conditions at site revealed no flora or floral assemblages that are unique to the site or are listed as protected or threatened species. There is no protected forest or declared critical habitat in the study area. The site development would require clearing of limited number of indigenous vegetation. The proposed greenbelt development plan with indigenous plant species will help to re-establish the population of indigenous plant species. Considering this, impact on flora and floral habitat due to site development and construction of ash pond and water intake facility is considered to be Negligible.

<u>*Evaluation of Impact Significance*</u>
Impact significance on terrestrial flora and floral habitat due to side development and construction of ash pond and water intake facility is as shown in Table 5.38**.**

Table 5.38 Impact Significance on terrestrial flora due to construction of ash pond and water intake facility

Impact	*Terrestrial flora impact due construction of ash pond and water intake facility*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	**Low**	Medium	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Terrestrial Fauna & Faunal habitat due construction of Ash Pond & Water Intake Facility

<u>*Impact Significance*</u>
The ecological survey result shows that proposed project site and its immediate vicinity has no demarcated ecological habitat (National Park, Biosphere Reserve, Wildlife Sanctuary). However, Important Bird Area-Mokama Tal is located approximately 3.5 km from the plant. Small mammals (mongoose, squirrel, and rodents) and local and migratory birds are reported in the study area. During the construction phase, these faunal populations may avoid the working area due temporary disturbance. It is expected that these population will again comeback to the site and after development of

greenbelt and afforestation. The construction activity is not expected to have any significant impact on terrestrial habitat.

Evaluation of Impact Significance

Impact significance on terrestrial fauna and faunal due to side development and construction of ash pond and water intake facility is as shown in Table 5.39**.**

Table 5.39 Impact Significance on terrestrial fauna due to construction of ash pond and water intake facility

Impact	*Terrestrial fauna impact due construction of ash pond and water intake facility*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	**Low**	Medium	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Operational Phase

Impact on Aquatic Ecology due to Sourcing of Water

Impact Significance

The water for proposed plant will be sourced from the Ganga river. The downstream of the river has Dolphin Sanctuary, which is approximately 70 km from the proposed water intake facility. It is estimated that, 8.5% of the total available water will be withdrawn for plant. It may not have significant impact on minimum ecological flow of the river or Dolphin habitat.

Evaluation of Impact Significance

Impact significance on aquatic ecology due to abstraction of surface water is as shown in Table 5.41**.**

Table 5.40 Impact Significance on aquatic ecology due to water abstraction

Impact	*Aquatic fauna impact due to surface water abstraction*			
Impact Nature	Negative	Positive	Neutral	
Impact Type	Direct	Indirect	Induced	
Impact Extent	Local	Regional	National	
Impact Duration	Temporary	Short-term	Long-term	Permanent

Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Impact on Terrestrial Vegetation due to Stack Emission

Impact Significance

The impacts on vegetation due to the operation of thermal power plants mainly occur from deposition of air pollutants in form of particulates. The fly ash particles depending upon their size and weight settle down at varying distances and on soil surfaces in the prevailing wind direction. Foliar deposition of high concentration of fly ash can interrupt gaseous exchange through stomatal clogging thereby affecting plant growth.

For this present project the emission of particulates from the stack would be maintained at 50 mg/Nm^3 through efficient functioning of the ESP. Furthermore emission of fly ash through the tall stack will result in wide distribution of particulates leading to low ground level concentrations. Such concentrations of fly ash in the air are not likely to induce any change in the plant growth in the wildlife habitat. The operation of plant is not expected to have any significant impact on terrestrial flora.

Mitigation Measures

- Fugitive dust emissions during coal transportation by conveyor system will be regulated;
- Reduction in flue gas particulate matter through necessary equipment design modification and retrofits.

Evaluation of Impact Significance

Impact significance on terrestrial flora and fauna due to stack emission is as shown in Table 5.41.

Table 5.41 Impact Significance on terrestrial ecology due to stack emission

Impact	*Terrestrial ecological impact due stack emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor	**Low**	Medium	High		

Sensitivity				
Impact Significance	**Without Mitigation Measures**			
	Negligible	**Minor**	Moderate	Major
Residual Impact	**With Mitigation Measures**			
	Negligible	Minor	Moderate	Major

Waste Water Generation & Discharge

The waste water from the power plant will be treated and reused for various purposes like ash handling, watering in the greenbelt & plantation area. The discharge of plant effluent into the river is very unlikely as the proposed plant is designed as zero discharge. Therefore, contamination of river ecosystem and impact on plankton and aquatic animals will be very unlikely.

5.4.11 *Potential Impact on Socio-economic Environment*

Context for identification of Social Impacts

The socio-economic impacts to the surrounding areas on account of capacity expansion of 1×660 MW thermal power plant are described with the following understanding:

- The expansion project will not require additional land (as informed) for the main power plant and other project components except ash dyke and ash pipeline.
- The ash dyke and ash pipeline are shared facilities – to be shared by Units 8, 9 & 10.
- The project area is not located in a Schedule V area and is not dominated by tribal or indigenous population. The proportion of Scheduled Caste and Scheduled Tribe is small in the study area.
- The immediate vicinity of the project area is not remote in terms of access to the nearest urban centres of Barauni (less than 10 km to the north west of power plant) as well as Begusarai (nearly 10 km to the east of the power plant). There has been major industrial development in Barauni constituting one of the largest refineries in Bihar, thermal power plant, fertilizer plant etc.

Compilation of the potential Socio-Economic Impacts

With this background and description of the socio-economic context, the likely social impacts from the existing thermal power plant and its expansion project are categorized as follows:

a) Livelihood impacts in the ash dyke area
b) Displacement/Resettlement impacts - 10 houses in the ash pipeline area
c) Temporary obstruction to shops in Simariya Ghat due to laying down the water pipeline and during periodical maintenance
d) Labour Influx

e) Impact on community health and safety
f) Employment generation

Impact Identification and Mitigation

For the assessment of social impacts, the sensitivity and magnitude criteria outlined in ***Table 5.42*** and ***Table 5.43*** respectively have been used.
The social impacts associated with the construction, operations and decommissioning stages have been assessed qualitatively and in some cases quantitatively (subject to availability of data), using professional judgement and based on past experience from similar projects.

Table 5.42 Impact Magnitude for Local Communities

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 5.43 Receptor Sensitivity for Local Communities

Category	
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

Livelihood and land based Impacts in the Ash Dyke Area

<u>*Context – Impact Source*</u>

The receptors for impacts on livelihood and land include the local community undertaking agricultural cultivation in the ash dyke area and residing adjacent to the proposed ash pond. These include:

- families dependent on the land for cultivation as cultivators;
- families dependent on the land and working as agricultural labourers;
- families residing inside or in the adjacent area to the ash dyke; and

- families with any other asset (fruit trees, bore wells, huts etc.) inside the proposed ash dyke area

The construction of ash dyke in the proposed land will directly impact the livelihood sustenance and the income source for most of the families. However, the Supreme Court case (SLP 37969/2013) resolution proves that no rights accrue over this land parcel (ash dyke area) by the local community[1]. It is retained as government land. However people have been cultivating in that area for over 3-4 decades and have been residing in the adjacent areas. Some of them have also been depositing rent towards the cultivated land and the receipts were identified by the administration till few years back. Although formal rights of use or cultivation have not been identified by the land administration, the families (over 100) have been cultivating and are dependent on this land. Hence, if the land parcel is diverted for industrial use, this may lead to loss of livelihood and vulnerability of such families dependent on the land. At present, there is insufficient information in terms of the magnitude/extent of dependence of these families and the extent of vulnerability it will lead to.

Embedded/In Built Control

BSPGCL is still to take a final decision on the status of the claim which presently has not been recognized by Supreme Court.

Additional Mitigation Measures
In addition to the embedded measures, the following risk mitigation measures are suggested to minimize the impacts of livelihood impacts:

- BSPGCL/BTPS will need to comply with the JICA standards as part of which the impacts are to be avoided or minimized and the remaining impacts need to be compensated adequately. The project will also comply with OP 4.12 Resettlement Plan of the World Bank as part of which the measures against livelihood impacts are captured and a RAP will be prepared which will guide the entitlements for the various categories of the impact.
- The receptors will be identified either through the formal process by the land authorities (if the private claims are identified by the Supreme Court) or by BSPGCL. After initial identification, an entitlement matrix will be prepared for all the PAPs.
- As part of the stakeholder engagement and information disclosure process, the community will be provided with an understanding of the project activities and the process of compensation and livelihood restoration etc.

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[1] The claimants after the judgement still have the option of going for curative petition in Supreme Court. The next step by the claimants is still not known as on 30th January 2016.

- The proponent will put in place a grievance mechanism to allow for the community members to report any concern or grievance pertaining to the project activities.
- The project proponent will also undertake community development initiatives (for instance, strengthen social infrastructure/services etc.) through the project lifecycle to support communities in the livelihood restoration process.

Residual Impact Assessment

The assessment of the residual impacts on livelihood is given below. The significance of impact will be reduced to **moderate** on implementation of mitigation measures.

Table 5.44 Impact Significance on Livelihood Impacts in the Ash Dyke Area

Impact	*Livelihood Impacts in the ash dyke area*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	Medium	**Large**
Resource/ Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	Moderate	**Major**	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	

Displacement/Resettlement Impacts - Displacement of 10 houses in the ash pipeline area

Context – Impact Source

The receptors for impacts on displacement/resettlement impacts include the local community residing in the ash pipeline area. It was reported that nearly 10 houses will be displaced and this would require acquiring additional private land of 0.2 acres for a new resettlement site.

Embedded/In Built Control

BTPS is in the process of identifying a new resettlement site. It is also seeking help from the land acquisition department in Patna District to identify a new site and to support in the resettlement process. The cash compensation will be much above the circle rate (land rate fixed by the government).

Additional Mitigation Measures

- In addition, for livelihood restoration, the JICA/World Bank standards of resettlement plan and restoration process will be complied with.

- As part of the stakeholder engagement process, the project proponent will involve the affected families in the identification process of the new resettlement site and a site similar to the existing site, not too far will be selected.
- As part of the engagement process, the proponent shall undertake adequate information disclosure pertaining to the timelines of the construction of the ash pipeline, while allowing them for sufficient relocation time and settlement time at the new site.
- The proponent will put in place a grievance mechanism to allow for the affected members to report any concern or grievance pertaining to the resettlement process.
- In addition to land/house compensation, the proponent will also support the families in livelihood restoration to a level better than their previous standard of living – through community development initiatives etc.

<u>Residual Impact Assessment</u>

The assessment of the residual impacts due to displacement/ resettlement in ash pipeline area is given below. The significance of impact will be reduced to **minor** on implementation of mitigation measures.

Table 5.45 Impact Significance on Displacement/Resettlement Impacts

Impact	*Impact of Displacement/Resettlement in ash pipeline area*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Temporary obstruction in Simariya Ghat due to water pipeline and during periodical maintenance

<u>Context – Impact Source</u>

As reported by BTPS, the water pipeline length is reported to be 3 kms approx. This involves laying of 4 underground pipelines of 650 mm and 600 mm diameter for 2 each crossing through guide bund and also laying of 33 kV underground electrical cables crossing near Railway land near Rajendra Pool Railway Station. The receptors include the families and shop keepers in Simariya ghat who will be facing temporary inconvenience while the water pipeline is being laid.

BTPS is in the process of laying down the water pipeline. A section of the pipeline passes through the Simariya ghat area where there are several shops and in front of the main temple. Perhaps about 500 metres section passes through the *ghat* area. There will be temporary obstruction to the shops as the soil will be dug. These shops are in the form of temporary wooden structures and hence the water pipeline will only be an obstruction for a brief time period during the pre-construction phase and perhaps later at during operation/maintenance phase on a periodical basis. These shops are mainly meant to sell items used for religious ceremonies and rituals being practiced in the temple.

Embedded/In Built Control

The water pipeline involves obtaining the right of way permission and not land acquisition/purchase etc. BTPS aims to undertake the same within a brief period of time to reduce any inconvenience that may be caused.

Additional Mitigation Measures

- The proponent will provide adequate information pertaining to the timeline of the activity (laying of water pipeline) prior to the beginning and ensure preparedness of the community for the same.
- The proponent will discuss the grievance mechanism and the platform through which community concerns can be raised, if any.
- The proponent will ensure that any loss caused to the property of the families while laying the water pipeline, needs to be adequately compensated.

Residual Impact Assessment

The assessment of the residual impacts in Simariya Ghat due to water pipeline and during periodical maintenance is given below. The significance of impact will be reduced to **negligible** on implementation of mitigation measures.

Table 5.46 Temporary Inconvenience due to water pipeline

Impact	*Water pipeline construction and periodic maintenance*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Labour Influx/In-Migration and Management

Context – Impact Source

The project will employ skilled, semi-skilled and unskilled workers during the construction and operation phase, which will include contractual and regular employees and local and migrant workers. The project is likely to hire over 1000 workers during various phases of the construction period. The preference is to mainly hire locals; however migrant workers will be hired particularly for semi-skilled and skilled work. The regular skilled workers are likely to be comprised of migrant workers, from different districts and states in the country, depending upon the need for technical expertise.

There is a labour accommodation facility inside the power plant area which is currently occupied with workers engaged in the construction of units 8 & 9. It was reported that this space would be adequate for the labourers engaged in unit 10. Some of the contract labourers engaged at present may continue to be retained for unit 10 as well. The remaining labourers will be residing in nearby villages on self- accommodation.

Embedded/In Built Control

BTPS is already in the process of managing contractors and the labourers – those engaged in the construction phase of units 8 & 9. It was reported that they closely monitor the accommodation facilities, payment of wages and comply with the requisite regulatory requirements.

Additional Mitigation Measures

The following additional mitigation measures are suggested in order to ensure compliance with labour laws/provisions as per the industry best practices:

- The proponent will put in place a contractor management plan and labour management plan to incorporate aspects such as contractor selection and evaluation, labour compliance with respect to the legal specifications and ensuring good labour working conditions, timely payment of wages and other benefits etc.
- The labour accommodation facility for regular employees should be constructed to meet the requirements of the applicable reference framework in terms of space per worker, water and sanitation facilities, first aid, lighting and ventilation etc. and regular monitoring should be undertaken to ensure compliance through the project lifecycle.
- The proponent should develop a systematic monitoring and auditing mechanism for monitoring the contractors and sub-contractors with respect to compliance to the applicable reference framework, in terms of resources, migrant workers, child labour and forced labour, health and safety, payment of wages etc.
- Strengthening security personnel around labour camps in order to maintain adequate law and order and avoid any possible tensions between the migrant workforce and host community.

- Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work activities.

Residual Impact Assessment

The assessment of the residual impacts on labour influx and management are given below. The significance of impact will be reduced to minor on implementation of mitigation measures.

Table 5.47 Impact Significance on Labour Influx and Management

Impact	*Labour In-migration and management*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Community Health and Safety

Context

The construction phase activities include: construction of the main power plant, construction of the ash dyke and the ash pipeline, laying of the underground water pipeline, connecting the switchyard with the transmission lines and road widening etc. Such construction phase activities involve movement of material and personnel that may result in impacts on the health and safety of the community. The movement may also result in damage to human life or livestock due to accidents.

The receptors for impacts on community health and safety include the local community within the study area and more specifically:

- The residents surrounding the ash dyke area and ash pipeline area which will witness heavy vehicular movement mainly during the construction phase
- The residents/families surrounding the road connecting the power plant to the ash dyke. There is an unpaved path at present and the same will be made concrete and widened by BTPS, as reported. The layout has not been finalized yet and the receptors may vary.

- The families residing in and around the proposed transmission line.

According to the IFC EHS guidelines, the main risks include structural safety of project infrastructure, life and fire safety, public accessibility and management of emergency situations.

Embedded/ In Built Control

The project will identify personnel responsible for the monitoring of the project activities and also the health and safety aspects of each of the activities.

Additional Mitigation Measures

In addition to the embedded measures, the following risk mitigation measures are suggested to minimize the risks/hazards of construction activities onsite:

- As part of the stakeholder engagement and information disclosure process, the community will be provided with an understanding of the activities to be undertaken and the precautions taken for safety.
- As part of stakeholder engagement, the project will also propagate health awareness amongst the community, including setting up of health camps etc.
- The traffic movement for the project in the area will be regulated to ensure road and pedestrian (including livestock) safety
- Put in place a grievance mechanism to allow for the community members to report any concern or grievance related to project activities

Residual Impact Assessment

The assessment of the residual impacts on community health and safety are given below. The significance of impact will be reduced to minor on implementation of mitigation measures.

Table 5.48 Impact Significance on Community Health and Safety

Impact	*Community health and safety during the construction phase*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Economic Opportunities

<u>*Context – Impact Source*</u>
The receptors for economic opportunities include the local community members in the study area who may be able to avail of additional economic opportunities. While the direct impact will be in the form of additional jobs at the local level, the indirect impacts may be in the form of hotels, shops, drivers, training of skilled workforce etc. during the project lifecycle and particularly during the construction phase triggered by the power plant expansion. During the operations phase, the employment opportunities will be reduced and restricted mainly to the security personnel, housekeeping staff at the site office and any contractual workers required for maintenance activities.

However, it is to be noted that the opportunities may be limited as the power plant has been operational for a long period of time and several hotels/shops are existing in the areas surrounding the power plant and in Barauni.

<u>*Additional Recommendation Measures*</u>
The project is recommended to have the following additional mitigation measures in place:

- Depending upon the skill requirement, the local community should be given preference for employment, especially in semi-skilled and unskilled work
- The sourcing of local labour wherever possible should be made obligatory for the sub-contractors and in all major procurement activities

5.4.12 *Potential Impact on Occupational Health*

Construction Phase

Occupational health and safety impacts during construction phase are anticipated primarily from operation of construction machineries/equipment during site preparation and operation of labour camps for housing of onsite workers.

Operation of construction machineries/equipment during site preparation

<u>*Impact Significance*</u>
During construction phase impact on occupational health and safety of contractor workers is anticipated from exposure to high noise generated from operation of heavy machineries /equipments and fugitive dust generated from material stockpiles, cut and fill operations and vehicular movement along unpaved roads. It is estimated that about 500 workers will be deployed by project contractors. Continuous exposure of workers to high noise levels and fugitive dust may lead to adverse health impacts viz. headache, asthma, allergy, hearing loss etc. Details on noise and fugitive dust emitting sources during construction phase have been provided in section 5.4.2. Also

considering the temporary nature of the construction phase activities, intermittent operation of machineries/equipments, and provision of proper PPEs for the workers no significant occupation health impacts are envisaged.

Mitigation Measures

- Provision of proper PPEs for the contractor workers onsite;
- Exposure of workers operating in near high noise generating sources will be reduced to the extent possible;
- Health surveillance of contractor workforce will be conducted
- Occupational health and safety of contractor workforce will be assured through the formulation of an "Occupational Health & Safety Management Plan".

Evaluation of Impact Significance

Impact significance on occupational health & safety due to Operation of construction machineries/equipment is as shown in Table 5.49**.**

Table 5.49 Impact Significance on occupational health & safety due to Operation of construction machineries/equipment

Impact	*Occupational health & safety impact due to Operation of construction machineries/equipment*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operation of contractor labour camps

Impact Significance

The project workforce will be housed in labour camp located within the main plant area and Diara Marachi village for ash pond. The labour camps generally constructed of tin structure with brick tile roof resulting in high temperature within the rooms during summer months. As the labour camps are temporary in nature, lack of proper ventilation and sleeping bed/cot and expected high occupancy. The electricity will be made available for lighting and sanitation facilities in the camp. If, common canteen facility not provided, the workers will cook their food in their rooms, which will lead to unsafe conditions. Thus taking into account the condition of labour camps the occupational health and safety impact on the residing workforce is considered to be significant and requires necessary mitigation measures.

Mitigation Measures

- Adequate provision of healthy living conditions will be ensured in the contractor labour camps in consistent with the occupational health and safety requirement of IFC Performance 2: Labour & Working Conditions and National Policy on Safety, Health & Environment at Work Place.

Evaluation of Impact Significance

Impact significance on occupational health & safety due to operation of labour camp is as shown in Table 5.50**.**

Table 5.50 Impact Significance on occupational health & safety due to Operation of labour camp

Impact	*Occupational health & safety impact due to operation of labour camp*				
Impact Nature	Negative	Positive		Neutral	
Impact Type	Direct	Indirect		Induced	
Impact Extent	Local	Regional		National	
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operational Phase

Operation of boilers, turbine generator and auxiliaries

Impact Significance

Occupational health and safety impact during operational phase is anticipated from exposure of project personnel to high noise levels generated from operation of boilers, turbine generators, pulverizers, fans and ductwork, pumps and compressors and cooling towers. As discussed in section 5.4.3, noise levels from the major equipment/ machinery will be < 90 dB(A) excluding the HP/LP Safety Valves. Though it is below the prescribed standard i.e. 90 dB(A)[1] but prolonged exposure to this levels may be sufficient to create a chronic health hazard problem viz. physiological change and stress. Personnel operating near F.D. fans, there is a fair chance of exposure to >90

[1] 90 decibels for 8hrs/day is threshold limit/values for non-impulsive noise prescribed by the American Conference of Governmental Industrial Hygienists

dB(A) noise. i.e., beyond the prescribed standard leading to noise induced hearing loss (NIHL). However NIHL occurs only from prolonged exposure to high noise levels between 90 and 105 dB(A) (McCunney and Meyer 2007) with risk of NIHL being perceived at about 85 dB(A), for an 8-hour day, over a 40-year career[1]. However considering appropriate noise control measures will be adopted to this regard by the proponent with respect to the equipment design and retrofits and provision of PPEs the impact is considered to be of low significance. Health impacts are also envisaged from exposure of personnel to heat during operation and maintenance of boilers, pipes and related hot equipments. With the project power house building design taking into account installation of a supply/exhaust ventilation system with evaporative cooling no significant impact to this regard is predicted.

Mitigation measures

- Provision of proper PPEs and maintenance of workplace condition in compliance with specific provision of the Factories Act 1948 and occupational health and safety requirements of IFC EHS Guidelines for Thermal Power Plants.
- Prolonged exposure of personnel operating in near high noise generating areas will be reduced to the extent possible;
- Health surveillance will be conducted of personnel working in the aforesaid areas.
- Periodic inspection and audits will be conducted

Evaluation of Impact Significance

Impact significance on occupational health & safety due to operation of BTG is as shown in Table 5.51.

Table 5.51 Impact Significance on occupational health & safety due to Operation of BTG

Impact	*Occupational health & safety impact due to operation of BTG*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

[1] OSHA, 1983 and NIOSH, 1998

Storage and handling of coal and fly ash

Impact Significance

Occupational health impacts may arise due to continuous exposure of project personnel to fugitive dust generated from transportation, storage and handling of coal. Operation of crusher unit, coal conveyor system and stockpiles has been identified as the principal fugitive dust emitting source for the proposed project. According to the OSHA's "Occupational Safety and Health Guideline for Coal Dust" continuous exposure of workers to coal dust may lead health hazards such as pneumoconiosis, bronchitis and emphysema. The current permissible exposure limit (PEL) for respirable fraction of coal dust prescribed by OSHA is 10 mg/Nm^3. The coal will be transported by an enclosed conveyor system and proper ventilation will be provided in the coal handling plant to avoid any dust nuisance. Further the proponent will adopt necessary control measures through implementation of dust suppression system and provision of proper PPEs viz. nose masks, safety goggles etc to the workers operating in the aforesaid areas to prevent and/or mitigate any adverse health related impacts. Hence any possible occupational health impact from exposure to such fugitive dust is not likely to be of major significance.

Exposure to fugitive dust generated from removal of ash from ESP hoppers, pneumatic transfer to ash silos, preparation of ash slurries etc may cause respiratory problems among workers involved in their storage and handling. However no potential health effects were recorded among workers continuously exposed to such fly ash due as part of their routine activities[1]. The American Conference of Governmental Health Hygienists (ACGIH) has recommended an allowable coal ash exposure concentration of 10mg/Nm^3 although no health effects have been perceived at or below this concentration even under continuous workday exposure[2]. Further considering the provision of proper PPEs the impact is considered to be of moderate significance.

Mitigation Measures

- All potential occupational health hazards will be identified
- Dust control measures will be implemented near coal and fly ash handling areas.
- Provision of proper PPEs and maintenance of workplace condition in compliance with specific provision of the Factories Act 1948 and occupational health and safety requirements of IFC EHS Guidelines for Thermal Power Plants.
- Prolonged exposure of personnel operating in near dust generating areas will be reduced to the extent possible;

[1] Fly Ash Exposure in Coal Fired Power Plants, EPRI, TR-102576, August 1993

[2] "Threshold limit values for Chemical Substances and Physical Agents, Biological Exposure Indices". American Conference of Governmental Health Hygienists - ACGIH, OH, p.35, 1997

- Health surveillance will be conducted of personnel working in the aforesaid areas.
- Periodic inspection and audits will be conducted.

Evaluation of Impact Significance

Impact significance on occupational health & safety due to emission from plant is as shown in Table 5.52.

Table 5.52 Impact Significance on occupational health & safety due to emission from plant

Impact	*Occupational health & safety impact due to emission from plant*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

5.4.13 Potential Impact on Public Health

Construction Phase

Site preparatory activities and vehicular movement

Impact Significance

As discussed earlier in section 5.4.2 under "Impact on Air Quality" community health impacts during construction phase is anticipated primarily from exposure to fugitive dust generated during site preparatory activities viz. clearing and grading operations, material/debris stockpiles and vehicular movement along unpaved village roads. Depending on the prevalent meteorological conditions the inhabitants **of** Diara Maranchi, Simaryia, Malhipur village (particularly those residing along village roads) are likely to be most affected by such fugitive emissions leading to potential health impacts viz. respiratory problems, eye irritation, asthma etc. Also taking into account the construction activities to be temporary in nature and dust suppression to be undertaken along unpaved roads by the proponent the community health impacts are not considered to be of significance.

Again with site approach road to ash pond and water intake facility is also being utilized by the Diara Maranchi, Simaryia villagers, the plying of project vehicles on the same road during material transportation is likely to pose community safety risks. However considering the movement of vehicles only during construction phase and necessary road safety measures to be adopted the impact is not considered to be of significance.

As discussed in section 5.4.3 high levels of noise is likely to be generated from operation of construction machineries & DG sets and vehicular movement. Sound pressure level of 80 dB(A) is recorded at a radial distance of 200m without any control. At this noise level the village inhabitants of Diara Maranchi, Simaryia, Malhipur is likely to experience some discomfort in the form of annoyance, task and speech interference with no noise induced hearing loss being anticipated. Thus given the temporary nature of activities, intermittent operation of machineries/DG sets and equipment engineering control the impact is considered to have minor significance.

Mitigation Measures

- Siting of construction machineries/equipment will be done based on local sensitivities;
- Dust control measures will be implemented along site approach road;
- Community safety risks posed by vehicular movement on site approach road will be mitigated in accordance with "Road Safety & Traffic Management Plan".

Evaluation of Impact Significance

Impact significance on Public health & safety due to operation of construction machineries/equipment is as shown in Table 5.53.

Table 5.53 Impact Significance on Public health & safety due to Operation of construction machineries/equipment

Impact	*Public health & safety impact due to Operation of construction machineries/equipment*				
Impact Nature	Negative	Positive		Neutral	
Impact Type	Direct	Indirect		Induced	
Impact Extent	Local	Regional		National	
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Scale/ Intensity	Negligible	Low		Medium	High
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor		**Moderate**	Major
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**		Moderate	Major

Disposal of domestic solid waste & waste water

Impact Significance

Domestic solid waste viz. food waste and recyclables (paper, plastic, wood etc) will be generated from contractor labour colonies and project office onsite. Unplanned dumping/littering of such waste may lead to development of unhygienic conditions village resulting prevalence of vector borne diseases in the abutting villages of Diara Maranchi, Simaryia, Malhipur. Although domestic solid waste generated from the project office will be properly managed through authorized waste handling agencies, littering and open pit burning of waste will be restricted. Considering the short term nature of the construction phase the impact is likely to be less significant if adequate waste management measures are adopted and implemented by the proponent.

As discussed earlier in the section 5.4.7, the treatment of sewage generated from labour camps in a combination of septic tank and soak pit may lead to possible ground water contamination under exceptional circumstances. Since the residents of Diara Maranchi, Simaryia, Malhipur – the project area villages are primarily dependent on the ground water it could lead to water borne diseases viz. diarrhoea, cholera etc. among them. Although such impact is unlikely however considering the severity of the impact appropriate mitigation measures need to be adopted to prevent any possible community health problems.

Mitigation Measures

- Domestic waste generated from labour colonies will be properly managed;
- Spread/transmission of communicable diseases from influx of contractor workforce will be mitigated.

Evaluation of Impact Significance

Impact significance on Public health & safety due to disposal and solid waste and sewage from construction site is as shown in Table 5.54**.**

Table 5.54 Impact Significance on Public health & safety due to disposal of domestic waste and waste water

Impact	*Public health & safety impact due to disposal of domestic waste and waste water*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	Minor	**Moderate**	Major	
Residual Impact	**With Mitigation Measures**				

	Negligible	**Minor**	Moderate	Major

Operational Phase

Flue gas emissions from chimney

Impact Significance

As already discussed in section 5.4.2 under "Impact on Air Quality" flue gas emissions from chimney is likely to result in the increase in ambient level of air pollutants like SPM, NOx, SOx, CO including trace heavy metals. The project area village population is already experiencing health related problems due to emissions from operational industries of the Barauni industrial area. Thus in the absence of adequate control at source the emission from the proposed project is likely to contribute further to the degradation of ambient air quality thereby leading to potential community health problems. However with the project design taking into account the installation of high efficiency ESP (99.99%) and development of peripheral green belt the impact is considered to be minor significant.

Evaluation of Impact Significance

Impact significance on Public health & safety due to flue gas emission is as shown in Table 5.55.

Table 5.55 Impact Significance on Public health & safety due to flue gas emission

Impact	*Public health & safety impact due to flue gas emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	

Operation of boilers, turbine generator and auxiliaries

Impact Significance

Continuous operation of boiler, turbine generator and auxiliaries, fans, pumps, compressors etc. may lead to the generation of high noise levels. With noise generating equipments housed in sound proof enclosures/building and considering the attenuation of noise with distance the possible health impacts on abutting village inhabitants of Malhipur, Simaryia are not anticipated. However such impact appears to be unlikely with the project design taking into account the development of green belt as an acoustic barrier and installation of proper engineering controls hence the impact is envisaged being of Minor significance.

Evaluation of Impact Significance

Impact significance on Public health & safety due operation of BTG is as shown in Table 5.56.

Table 5.56 Impact Significance on Public health & safety due to operation of BTG

Impact	*Public health & safety impact due operation of BTG*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

Leaching of ash pond effluent

Impact Significance

As discussed in section 5.4.7 under "Impact on Ground Water Quality" the fly ash is characterized by the presence of trace heavy metals hence their disposal in ash pond through HCSD may lead to contamination of ground water aquifers from possible migration of ash pond leachate containing heavy metals. Although such impact appears to be unlikely as established by studies and review of ash pond design (considering the provision of an impermeable liner) it is anticipated to occur only under exceptional circumstances viz. damage to liner structure. With the village population in the project area primarily dependent on the ground water resource to meet their drinking water demand such aquifer contamination may lead to potential community health impacts. Depending on the hydrogeological regime the impact may be experienced by nearby villages located near the ash pond area. Hence the impact is considered to be of significance and need to be mitigated accordingly.

Evaluation of Impact Significance

Impact significance on Public health & safety due operation of ash pond is as shown in Table 5.57.

Table 5.57 Impact Significance on Public health & safety due to operation of Ash pond

Impact	*Public health & safety impact due to flue gas emission*				
Impact Nature	Negative	Positive	Neutral		
Impact Type	Direct	Indirect	Induced		
Impact Extent	Local	Regional	National		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Scale/ Intensity	Negligible	Low	Medium	High	
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Resource/ Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	**Without Mitigation Measures**				
	Negligible	**Minor**	Moderate	Major	
Residual Impact	**With Mitigation Measures**				
	Negligible	Minor	Moderate	Major	

5.5 RISK ASSESSMENT & EMERGENCY PLAN

5.5.1 *Objective of the Quantitative Risk Assessment (QRA)*

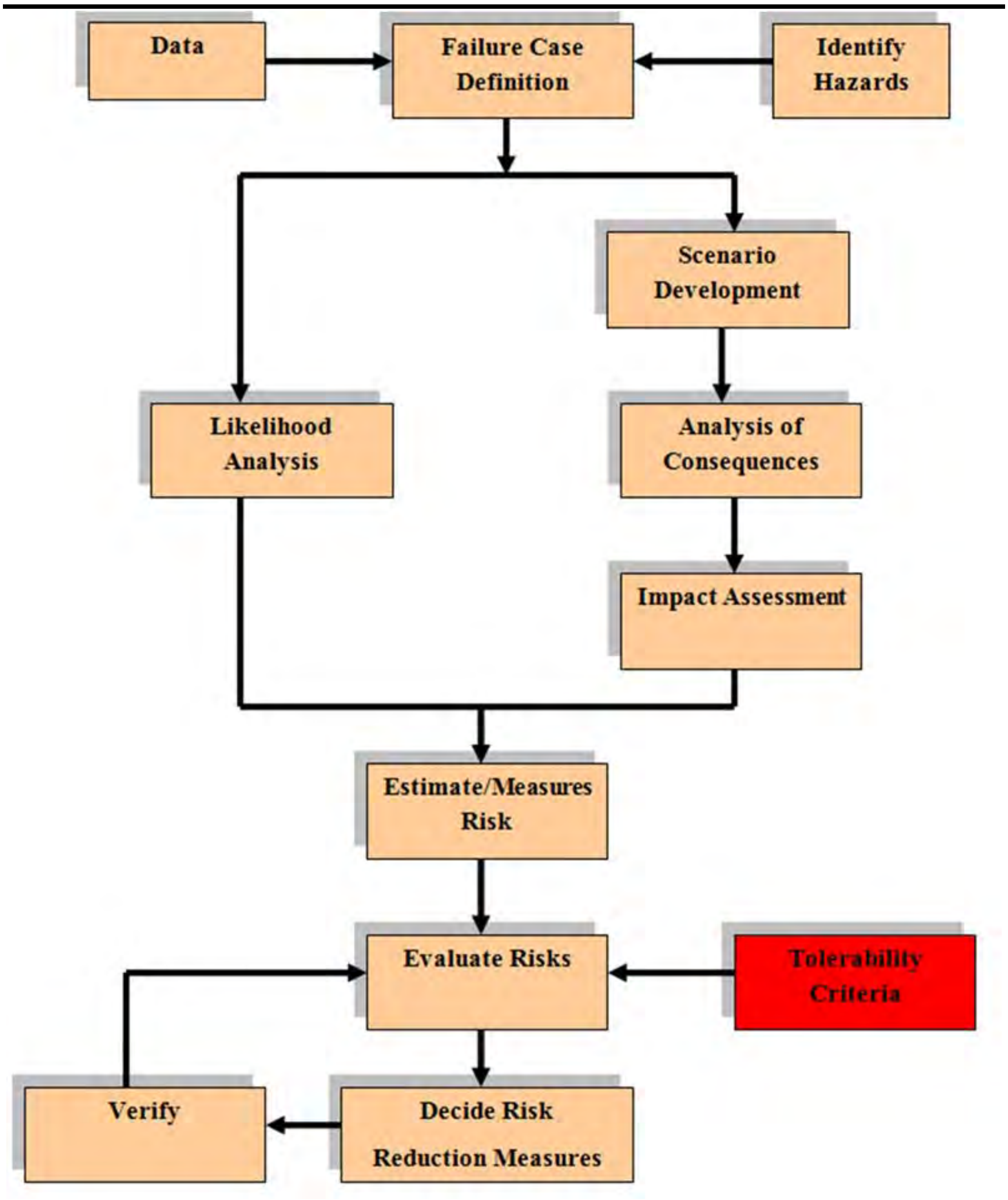
The overall objective of this QRA is to address the identification, analysis and subsequent assessment of major hazards associated with the proposed power plant operation, and make judgment on the tolerability of risks to personnel associated with these hazards and the public. The QRA will be evaluated which in turn becomes an important input in determining the requirements for any remedial measures. Review could cover:

- BSPGCL HSE Policy, Standards and Design Criteria;
- The source of hazards;
- Events which are capable to cause major accidents;
- Analysis of the consequence and their effects on employees and the public;
- Evaluation of individual and social risk;
- Measures to prevent, control and minimize likely consequences;
- Emergency procedures and emergency system.

5.5.2 *Risk Assessment Methodology*

Scenario that could result in major hazards will be identified and evaluated using semi-Quantitative Risk Assessment (QRA). This technique is used to establish the expected frequency of such incidents and their consequences. For the purposes of this assessment, criteria for risk ranking methodology based on frequency and consequence has been developed based on specific criteria set for this project. The overall approach is summarized in the Figure 5.9.

Figure 5.9 Quantitative Risk Assessment Methodology



5.5.3 *Hazard Identification*

The first step in any risk assessment is to identify all hazards. Hazard identification for the purposes of this QRA comprised of a review of the project and associated activity related information provided by BSPGCL. Taking into account the applicability of different risk aspects in context of the coal based thermal power operation to be undertaken in the BTPS, Barauni, main hazards of the proposed power plant area are:

- Toxic fumes from process chemicals
    - Chlorine Cylinder Leak
    - Ammonia Storage Tank Leak
- Fires & Thermal Radiation
    - Jet fires

- Bund and Pool Fires
- Vapour Cloud Explosion Consequences
  - Un-Confined gas explosions
  - Boiling Liquid Expanding Vapour Explosion

Hazardous Substances Stored on Site

The summary of potentially hazardous materials stored on site is given below in Table 5.58. The storage capacity data provided the BSPGCL on expected 1 month's consumption.

Table 5.58 Potential Hazardous Materials Storage at Site

Sl. No	Hazardous Material	Storage capacity
1.	Hydrogen gas	Information yet to receive from DPR consultant
2.	Chlorine gas	
3.	Ammonia	
4.	LDO	

Likelihood Analysis

The analysis of frequencies of occurrences for the key hazards that has been listed out is important to assess the likelihood of such hazards to actually unfold during the lifecycle of the project. With relevance to the risk assessment study of the proposed thermal plant project, major information sources viz. statistical data, historical records were considered during the frequency analysis of the major identified risks.

Based on the range of probabilities arrived at for different potential hazards that may be encountered during the proposed TPP operation, the following criteria for likelihood rankings have been drawn up:

Table 5.59 Likelihood Categories and Criteria

Frequency	Category Ranking	Criteria Definition
Frequent	4	Incidents may occur on annual basis (or more often)
Occasional	3	Incident may occur on several times during facility life
Seldom	2	Incident may occur once during facility life
Unlikely	1	Given current practices and procedures, incident is not likely to occur at this facility

Consequence Analysis

In parallel with the frequency analysis, hazard prediction / consequence analysis exercise assesses the resulting effects if the accidents occur and their likely impact on project personnel, infrastructure and environment. In relation to the proposed project, the estimation of the consequences for each possible event has been based either on accident experience, consequence modelling or professional judgment, as appropriate.

Overall, the consequence analysis takes into account the following aspects:

- Magnitude and severity of the environment;
- Impact on power plant structure or on BTPS personnel;
- Impact on community in the study area;
- Corporate image of BSPGCL.

The following criteria for consequence rankings have been drawn up in context of the possible consequences of the risk events that may occur during operation of TPP.

Table 5.60 ***Consequence Categories and Criteria***

Consequence	Category Ranking	Criteria Definition
Major	4	• **Personnel-** fatality or permanently disabling injury. • **Community-** one or more severe injuries • **Environmental-** event having serious on-site or off-site impact; results in on-site agency involvement and a major fine • **Facility-** major or total destruction to process area(s)
Serious	3	• **Personnel-** one or more severe injuries • **Community-** one or more minor injuries • **Environmental-** event having significant on-site or off-site impact and requiring prompt agency and Corporate notification. • **Facility-** major damage to process area(s)
Minor	2	• **Personnel-** single injury, not severe, possible lost time • **Community-** odour or noise complaint from the public • **Environmental-** event which results in Agency reporting or permit violation. • **Facility-** some equipment damage
Negligible	1	• **Personnel-** minor or no injury, no lost time • **Community-** no, hazard, or annoyance to the public; no injury no public complaint. • **Environmental-** environmental event with no Agency reporting or Permit violation. • **Facility-** minimum equipment damage

Risk evaluation

Based on ranking of consequence and likelihood, each identified hazard has been evaluated based on the consequences and frequencies criteria. The significance of the risk is expressed as the product of likelihood and the consequence of the risk event, expressed as follows:

Significance = Likelihood X Consequence

The figure below illustrates all possible product results for the four frequency and consequence categories and the Table 7.4 assigns risk significance criteria in the scale of 1-5 and will be used for delineation of risk reduction and mitigation measures in the EMP and for framing emergency management action plans as a part of the risk assessment study.

Figure 5.10 Risk Matrix and Hazard Significance

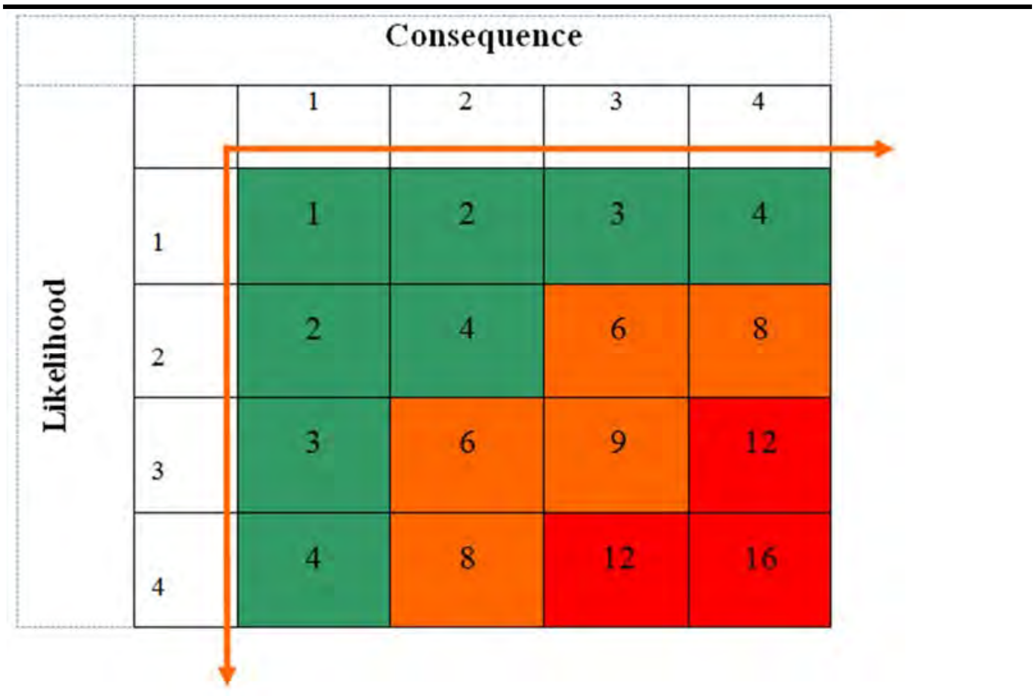


Table 5.61 Risk Categories and Significance Criteria

Risk	Risk Score (Consequence X Likelihood	Criteria Definition
Low	5 - 9>	The level of risk is broadly acceptable and no specific control measures are required.
Moderate	5 - 9	The level of risk can be tolerable only once a structured review of risk-reduction measures has been carried out
High	< 10	The level of risk is not acceptable and risk control measures are required to move the risk figure to the previous regions

5.5.4 *Risk Assessment of Identified Project Hazards*

As discussed in the potential hazards section, the risks that may arise from the operation of TPP and related activities can be categorized into three major categories. This section presents a systematic evaluation of the major risks for the proposed TPP operation. As the specific information related to storage capacity of chemicals is not available to our end, risk assessment study can not be taken up. Same will be updated after receiving the information.

5.5.5 *Emergency Response Plan*

Leaving aside earthquake, cyclone, flood and sabotage, the possible emergencies that can arise in the power plant due to operations and storages and handling of the fuels and gases are:

- Explosion in boilers, turbo generators, transformers and hydrogen plant
- Heavy leakage and subsequent fire in the fuel oil handling area and storage tanks
- Large fires involving the coal stockyard and coal handling areas
- Accidental release of ash slurry
- Chlorine leakage in the water treatment plant
- Accidental fire due to some other reasons such as electrical short circuit.

The materials handled at the proposed installation are inflammable and reactive substances; the following measures are suggested as risk mitigation measures.

- It should be ensured that combustible materials such as oiled rags, wooden supports, oil buckets etc. are not kept in the storage and process areas as well as road tankers loading/unloading sites where there is maximum possibility of presence of flammable hydrocarbons in large quantities, to reduce the probability of secondary fires..
- Hydrocarbon, smoke and fire detectors should be suitably located and linked to fire fighting system to reduce the response time and ensure safe dispersal of vapours before ignition can occur.
- Tank cooling provisions, particularly upper sections of the tank must be ensured to prevent explosion and tank tire. Foam for arresting roof fires must be started immediately.
- Pool fires resulting from tanker/pump/pipeline leakage are dangerous since the liquid pool becomes unconfined. Training in fire fighting, escape action, operation of emergency switches etc. is vital.
- Pump loading line failures also have possibility of causing major damage. Strict inspection, maintenance and well laid down operation procedures are essential for preventing escalation of such incidents.
- Emergency procedures should be well rehearsed to achieve state of readiness.

The Disaster Management Plan is discussed in EMP

6 ANALYSIS OF ALTERNATIVES

6.1 WITH & WITHOUT PROJECT ALTERNATIVES

A "no-project scenario" was first examined.

Without the project, power shortages would result in the region and projected power generation target would be difficult to meet. This may cause blackouts, work stoppages, increases in pollution resulting from the use of small generators, reduced economic growth, increased poverty, and complete social inconvenience.

Without the project, opportunity would be lost for 1000 jobs for 4 years of construction, 500 permanent jobs during operation, and indirect jobs and business opportunities that the project would create. The substantial increase in local taxes and revenues, including the direct and indirect local benefits expected to accrue as a result of the project, would also be foregone. The "no-project scenario" is therefore not an attractive alternative.

6.2 ALTERNATIVE PROJECT LOCATIONS

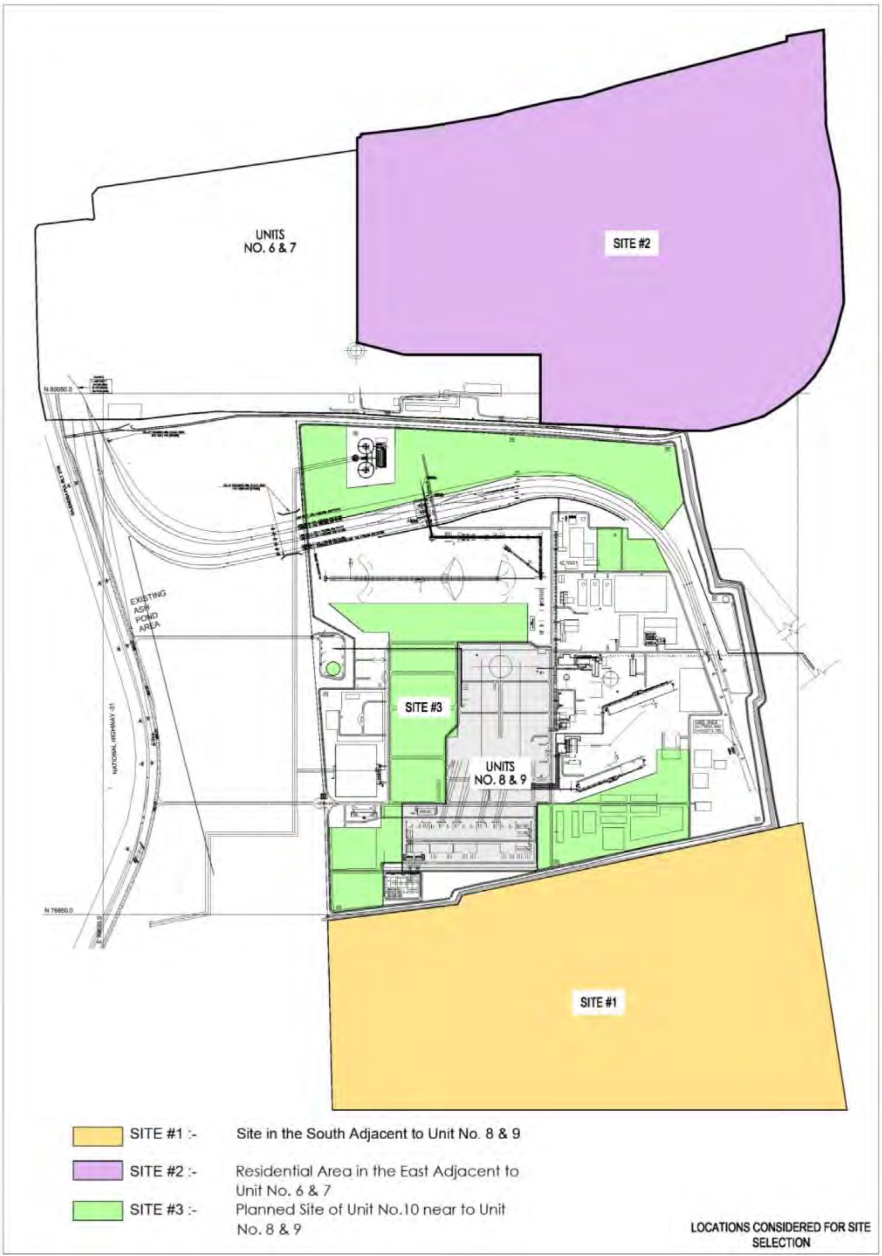
The selection of a suitable site for the establishment of Unit No. 10 depends primarily on availability of the following basic inputs:

- Land: Suitable & adequate land for constructing the various plant facilities
- Accessibility: Road, railway, seaport, airport for the transportation of plant and machinery
- Fuel: Availability and proximity to fuel source for supply of the Domestic Coal, and LDO
- Water: Availability and proximity to the source, i.e. the Ganga River
- Power: Availability and proximity of power grid for the evacuation of generated power as well as withdrawal of start-up power
- Environmental aspects: Does not affect any sensitive environments around the vicinity of the BTPS site.

6.2.1 Site Selection

Based on the preliminary survey three sites were examined for the installation of the Unit No. 10. The areas where these construction sites can be located at BTPS are shown in Figure 6.1**.**

Figure 6.1 Alternative Site Location Map



The advantages & disadvantages of all the three (3) potential sites as shown in Figure 6.1is discussed in Table 6.1.

Table 6.1 Evaluation of Three Alternative Sites

Alternate Sites	Advantage	Disadvantage

Alternate Sites	Advantage	Disadvantage
Site #1 (South side Adjacent to Unit No. 8 & 9)	• Large land area is available • Layout planning with adequate access for O&M is possible. • There is no need for existing plant/equipment removal. • The plant and facilities relative location and arrangement can be optimized. • No need to apply special facilities to mitigate lack of space. • Future expansion is possible.	• Acquisition of additional land is required by BSPGCL. • Additional railway siding is required for this area. • Private land acquisition is very difficult.
Site # 2 (Residential Area in the East Adjacent to Unit No. 6 & 7)	• Large land area is available. • Layout planning with adequate access for O&M is possible. • There is no need for existing plant/equipment removal. • The plant and facilities relative location and arrangement can be optimized.	• Removal and leveling of residential buildings is required. • Rehabilitation of people living in the residential colony. • Additional railway siding is required for this area.
Site #3 (Previously planned Site of Unit No.10 (1x 250 MW) near to Unit No. 8 & 9)	• No need for equipment or residential colony removal / demolishing. • No need to acquire additional land. • Existing railway siding can be used. • No worries for rehabilitation of people living in the residential colony.	• Limited space for plant layout planning so special facilities such as coal silos have to be applied.

The evaluation of three alternate sites as shown in above Table 6.1, Site # 3 is selected considering the advantages mainly on account of no need to acquire land, no demolishing work and no rehabilitation of peoples.

The Site # 3 land will be used for locating the main plant facility inclusive of Boiler, ESP, Chimney, Steam Turbine, Transformer Yard and GIS Switchyard for the Unit No. 10. However, BOP like CHP, AHP, WTP and ETP will be located within the plant area based on space availability.

6.2.2 *Land Availability*

The land requirement for the construction of Unit No. 10 and its availability is presented in Table 6.2.

Table 6.2 Land Availability for Unit 10

Component	Area (Acre)	Current Status
Main Plant	84	Existing land Owned by BSPGCL
Ash Pond & Slurry Pipeline (common for Unit No. 6 to 10)	290	Mix of government and private land. The land is under the process of possession of BSPGCL for Unit No. 8 & 9 Government land.

Component	Area (Acre)	Current Status
Water Intake Facility (common for Unit No. 6 to 10)	20	Approximately seventeen (17) acres of land is under the possession of BSPGCL as required for onshore intake water facility and balance three (3) acres of land for ROW for intake water pipeline of Unit No. 10 is additionally required.

From above, it may be concluded that the land available is suitable and generally adequate for the Unit No. 10 with all the auxiliaries and accessories.

6.3 TECHNICAL ALTERNATIVES

6.3.1 *Cooling Water Systems*

The water cooled Condenser is proposed to be used for the Unit No. 10 similar to Unit No. 6 to 9. The water cooled Condenser has the advantage of higher plant efficiency and less land area requirement as compared to Air Cooled Condenser (ACC). Since, in this project land area is very limited, ACC option is ruled out.

The cooling in case of water cooled Condenser is achieved either through a once-through Cooling Water System or a CCW System employing IDCTs.

Table 6.3 Comparative Analysis of Cooling System

Once Through Cooling Water System	Closed Cooling Water (CCW) System
• The surface water directly supplied to the Condenser directly for cooling. The hot cooling water is then discharged back into the river simply and temperature rise limited to 7°C. • Large amount of cooling water required. • Large capacity pumping system required thereby increasing the auxiliary power consumption. • The environmental effect especially effect of the temperature rise of river water on aquatic life is a prime concern. • Cooling Tower and pre-treated water (i.e. clarified water) from the WTP is not necessary.	• Pre-treated surface water is pumped by Circulating Water Pumps from the Cooling Tower outlet to the Condenser where it picks up heat from the condensing steam and the hot water is led to the Cooling Tower where it is cooled by the ambient air flowing through the Cooling Tower by Induced Draft (ID) Fans. • The temperature rise of the cooling water in this system can be in the range of 9~10 °C • Make-up water to the cooling system is required on continuous basis due to evaporation loss • The make-up water has to be pre-treated (i.e. clarified water) in the WTP to reduce the concentration of impurities in the system, and dosing of chemicals are also required

Considering the above mentioned advantages of CCW, it is proposed to use CCW system for Unit 10. Two types of CCW system are available; these are Induced Draft Cooling Tower (IDCT) and Natural Draft Cooling Tower (NDCT). The comparative analysis is given in Table 6.4.

Table 6.4 Comparative Analysis of IDCT & NDCT

Description	NDCT	IDCT
Land / Space requirement (Acres)	3	2
Differential Auxiliary Power Consumption (kW)	0	2500
Installation Cost	More	Less
Operating Cost	Less	More

Although, NDCT is a better choice due to lower operating cost, but considering lesser (rectangular) space requirement, lesser construction time and better performance in case of changing ambient conditions, IDCT is recommended to adopt for the Unit No. 10.

6.3.2 Ash Disposal System

Unused dry fly ash cannot be disposed directly to ash pond. Ash should be disposed in the form of slurry. There are two types of slurry system- High Concentration (HCSD) & Lean Slurry Disposal System (LSD). The comparative analysis is provided in Table 6.5.

Table 6.5 Comparison between HCSD & LSD

Item	HCSD System	LSD System
Slurry Concentration (Ash to Water Ratio)	High (60:40)	(30:70; in fly Ash case) & (25:75 in Bottom Ash Case)
Maximum particle size can handle	5 - 6 mm	20-25 cm
Slurry Disposal Distance	Long Distance can be covered. Single Pump can generate pressure more than 100 Kg/cm^2.	Low. As even series of pumps cannot exceed a certain pressure limit.
Water Consumption	Very low	Very high
Power Consumption	Low	High
Ash Dyke Area Requirement	Low	Very High
Recovery Water System	No Recovery Water	Yes
Installation Cost	High	Low

Conventional Lean Slurry Disposal System and Ash Water Recovery System have limitations / disadvantages on account of higher amount of water wastage / contamination, ground water pollution, potential for ash pond collapse, vast land required for ash dykes, higher costs for ash pond construction and higher power consumption. These limitations have led to the adoption of new environment friendly ash disposal technologies such as HCSD systems where less water consumption and less ash disposal area requirements are major advantages.

Accordingly, based on above mentioned major advantages, HCSD is considered in the design of ash handling system of proposed Unit No. 10

7 ENVIRONMENTAL MONITORING PROGRAMME

7.1 INTRODUCTION

The environmental monitoring programme is an important process of any management plan of the development project. The environmental monitoring will be required for the construction and operational phases of the Project. The environmental and social monitoring helps to:

- assess the changes in environmental conditions,
- monitor the effective implementation of mitigation measures,
- measure deteriorations of environmental quality for further preventive action(s).

The following monitoring programs are to be carried out at project in order to meet the above objectives:

- Ambient Air Quality;
- Ambient Noise;
- Wastewater;
- Soil Quality;
- Sediment Quality
- Greenbelt;
- Social parameters;
- HSE Audits; and
- Inspection of Prevention and Control Measures.

The site will carry out monitoring, the details of which are provided in subsequent sections. The monitoring framework proposes both internal and external monitoring. The aspects to be covered include the following:

7.2 INTERNAL MONITORING

Internal monitoring focuses on measuring and reporting progress of implementing EMP activities. The HSE Officer will be responsible for internal monitoring parameters.

For social parameters internal monitoring tasks will be undertaken by the CSR Team and include the following:

- Review grievance records and check that grievance logs are being correctly completed and maintained;
- Selection of a random sample of grievances and follow up with the complainants that appropriate corrective actions have been taken and that outcomes are satisfactory;

- Preparation of brief six monthly progress and compliance reports for BSL Management and external monitoring.

7.3 EXTERNAL MONITORING

BSPGCL will hire an external agency to conduct monitoring and produce half yearly and annual reports for emissions data and wastewater discharges for submission to the Bihar State Pollution Control Board. The Project will submit an environmental monitoring report to BSPCB every six months, summarizing status of compliance of conditions of Environmental Clearance (EC), Consent to Establish (CTE) and Consent to Operate (CTO) together with EMP implementation. This report shall present monitoring data and findings, describe any significant events or incidents that occurred, and indicate how these events were managed. BSPGCL will also ensure disclosure of compliance on its website as per the requirement of MoEF&CC.

7.3.1 *Monitoring Schedule and Parameters*

To evaluate the effectiveness of environmental management programme, regular monitoring of the important environmental parameters will be taken up. The specific monitoring program carried out during construction and operation phases along with the frequency of monitoring and the responsibility are referenced in Table 7.1.

Table 7.1 Proposed Monitoring Requirements for the Proposed Project

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
A.	Construction Phase			
A1	Air emissions from vehicles and machineries	CO, HC based on emission factors % of vehicles possessing valid PUCC Certificates	Exhausts	Quarterly during construction phase
A2	Dust generated from site clearance/levelling	Visual observation of dust generation	Site & approach road	Daily during site preparation
A3	Noise emissions from vehicles and machineries	Noise pressure level in dB(A) Compliance with CPCB noise limits specified for DG sets Check for valid certificates of Type Approval and also valid certificates of Conformity of Production for equipment particularly DG sets.	Near noise sources (1m)	Quarterly during site preparation
A4	Gaseous pollutant emissions from DG Set	Pollutant concentrations in gaseous emissions and maintenance parameters (air, fuel filters & air-fuel ratio) of DG sets influencing air emissions	DG Stack	Quarterly during construction phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
		Emission rates of PM, NOx, SOx, CO, HC based on emission factors		
A5.	Sourcing of water	Volume of water sourced and consumed	Sourcing and usage areas	Daily during construction phase
A6.	Fugitive emissions from handling and storage of raw materials	Visual observation	Material stockpiles	Daily during construction phase
A7.	Community health and safety	Complaints registered by the local communities No. of. Accidents	Grievance Records Safety Records	Monthly during construction phase
A8.	Occupational health and safety	Health surveillance of workers Sanitation status of labour camps and canteen Potable nature of drinking water viz. coliform, pH, TSS, Residual chlorine Usage of proper PPEs Safety performance indicators viz. LTIs. Near misses, fatalities etc	Medical records Labor camp maintenance records Drinking water storage tanks Construction site	Monthly during construction phase Daily during construction phase
A9	Green Belt Development	No of saplings planted % of total plant area covered under green belt	Green belt area	Monthly during construction phase
A10	Disposal of sewage	Visual observation of leaks, overflows etc Odour	Septic tank and soak pits	Daily during construction phase
A11	Surface run-off discharge	Visual observation of water logging due to drainage disruption CPCB Inland Water Discharge Parameters	Areas abutting construction site Discharge point	One representative storm event every year
A12	Domestic waste generation, storage, handling and disposal	Quantity of waste generated and recycled Visual observation of waste segregation and storage conditions viz. usage of labelled and covered bins, insect repellents etc. Awareness level of onsite workers	Waste generating areas viz. canteen, labour camps etc Workers involved in waste handling and storage	Weekly during construction phase
A13	Hazardous chemicals and waste storage, handling and disposal	Quantity of fuel consumed Visual observation of fuel and chemical storage conditions viz. presence of spill kits, drip trays, fire extinguisher, display of MSDS etc,	Chemical and fuel storage and consumption areas Hazardous waste storage areas Workers involved	Daily during construction phase Weekly during construction phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
		Quantity of waste oil and other hazardous waste generated and recycled to registered recyclers Awareness level of onsite workers	in waste handling and storage	
B.	**Operational Phase**			
B1.	Electrostatic Precipitator Performance	Visual observation of flue gas emission viz. color Monitoring of flue gas air pollutants viz. SPM, CO, CO_2, NOx, SO_2 etc to ensure compliance CPCB Thermal Power Plant Emission Standards (only SPM) Maintenance parameter check as per supplier manual Cases of ESP malfunction	Flue gas stack Flue gas emissions ESP Maintenance Records	Daily during operational phase Daily during operational phase As per supplier's manual
B2.	Sewage Treatment Plant Performance	Volume of sewage generated and reused Raw sewage monitoring parameters viz. pH, Suspended Solids, Oil & Grease, BOD, COD Treated sewage (prior to reuse/disposal) monitoring parameters in compliance with IS 2470 standards Maintenance parameters as per supplier manual	STP Performance Records Raw water inlet STP outlet STP Maintenance Records	Daily during operational phase Monthly during operational phase As per suppliers manual
B3.	Effluent Treatment Plant Performance	Volume of liquid effluent generated, treated and reused Raw effluent parameters as referred in the CPCB Thermal Power Plant – Standards for liquid Effluents Treated effluent parameters as referred in the CPCB Thermal Power Plant – Standards for liquid Effluents Maintenance parameters as per supplier manual	ETP Performance Records Raw effluent inlet Treated effluent storage and reuse areas ETP Maintenance Records	Daily during operational phase Monthly during operational phase As per supplier's manual
B4.	Green Belt Development	% of species survival	Green belt area	Monthly during operational phase
B5.	Disposal/reuse of sewage sludge	Volume of sludge generated and reused Sludge chemical characteristics to assess	STP Performance Record Sludge drying bed	Daily during operational phase Monthly during operational phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
		reusability for green belt development		
B6.	Fugitive emissions from operation of coal conveyor , crusher and storage stockpiles	Visual observation of dust generated Water sprinkling details viz. frequency and quantity. Maintenance parameter check to ensure proper operation of dust suppression/dust extraction system	Coal handling plant and conveyors Maintenance Records	Daily during operational phase Weekly during operational phase As per supplier's manual
B7.	Fugitive emission from fly ash handling and disposal	Visual observation of dust generated Volume of fly ash and bottom ash generated and disposed/reused Water sprinkling details viz. frequency and quantity. Maintenance parameter check to ensure proper operation of dust suppression/dust extraction system	Ash pond and fly ash handling area Maintenance Records	Daily during operational phase As per supplier's manual
B8.	Noise generated from operation of crusher, coal conveyor and main plant units	Noise pressure level in dB(A) Maintenance parameter check with respect to equipment noise attenuation and control	Near noise sources (5m) Noise generating equipment	Weekly during operational phase As per supplier manual
B9	Water sourcing and consumption	Volume of water sourced and consumed	Water usage areas	Daily during operational phase
B10	Surface run-off discharge	Visual observation of water logging due to any possible drainage disruption CPCB Inland Water Discharge Parameters	Areas abutting plant site Discharge point	One representative storm event every year
B11.	Domestic waste generation, storage, handling and disposal	Quantity of waste generated and recycled Visual observation of waste segregation and storage conditions viz. usage of labelled and covered bins, insect repellents etc. Awareness level of operational workforce	Waste generating areas viz. canteen, labour camps etc Workforce involved in waste handling and storage	Daily during operational phase
B12.	Hazardous chemicals and waste storage, handling and disposal	Visual observation of chemical storage conditions viz. presence of spill kits, drip trays, fire extinguisher, display of	Chemical and fuel storage and consumption areas Hazardous waste	Daily during operational phase Weekly during operational phase

EPI No.	Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period & Frequency
		MSDS etc Quantity of waste oil and other hazardous waste generated and recycled to registered recyclers Awareness level of operational workforce	storage areas Workforce involved in waste handling and storage	
B13	Community health and safety	Complaints registered by the local communities No. of. Accidents	Grievance Records Safety Records	Monthly during operational phase
B14.	Occupational health and safety	Health surveillance of workers Sanitation status of onsite office building and canteen	Medical records Office building maintenance records	Monthly during operational phase
		Potable nature of drinking water viz. coliform, pH, TSS, Residual chlorine	Drinking water storage tank	Daily during operational phase
		Usage of proper PPEs Safety performance indicators viz. LTIs. Near misses, fatalities etc	Operational sites	

Table 7.2 Environmental Quality Monitoring

EQI No.	Environmental Quality Indicator (EQI)	Monitoring Parameter	Location	Period & Frequency
A.	**Construction Phase**			
A1	Ambient Air Quality	Measurement of PM_{10}, $PM_{2.5}$, SOx, NOx, CO	Nearest receptor	Quarterly during construction phase
A2	Ambient Noise quality	Measurement of Noise Pressure Level in dB(A)	Nearest receptor viz. villages, schools	Monthly during construction phase
A3	Surface water Quality	Parameters as per CPCB Use-class	River Ganga	Quarterly during construction phase
A4	Ground water quality	Depth of ground water table IS 10500 parameters	At withdrawal source	Quarterly during construction phase
A5	Soil Quality	Soil fertility parameters viz. NPK, pH, SAR, Water holding capacity, Conductivity, Organic Carbon	Abutting village agricultural land	Quarterly during construction phase
B.	**Operational Phase**			
B1	Ambient Air Quality	Measurement of PM_{10}, $PM_{2.5}$, SOx, NOx, CO, CO_2, heavy metals viz. Hg, Ni	Nearest receptor	Monthly during operational phase
B2	Ambient Noise quality	Measurement of Noise Pressure Level in dB(A)	Nearest receptor viz. villages,	Monthly during operational phase

EQI No.	Environmental Quality Indicator (EQI)	Monitoring Parameter	Location	Period & Frequency
			schools	
B3	Surface water Quality	Parameters as per CPCB Use-class	River Ganga	Quarterly during operational phase
B4	Ground water quality	Depth of ground water table in ash pond area IS 10500 parameters	Nearby villages in ash pond area	Monthly during operational phase
B5	Soil Quality	Soil fertility parameters viz. NPK, pH, SAR, Water holding capacity, Conductivity, Organic Carbon including heavy metals	Abutting village agricultural land	Monthly during construction phase

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 INTRODUCTION

The Environmental Management Plan (EMP) is required to minimise impact of adverse environmental impacts by implementing suggested mitigation measures with suggested timelines and responsibilities during the Project life cycle.

The EMP covers management program for mitigation measures suggested to counter likely impact from proposed expansion and associated activities. Monitoring measures are suggested for effective implementation of the mitigation measures in addition to the mitigation measures already implemented as part of the Project. It also addresses the management program to minimise adverse impacts identified from the associated activity such as coal resource use, handling & storage of resources, material transportation etc.

The EMP addresses the potential impacts from the construction, operation phases of proposed expansion unit of BTPS. The proposed EMP will be required to ensure effective management of the potential impacts through following implementation aspects:

- Prevention and control measures to be implemented along with its time of implementation during the project;
- Roles and responsibilities for implementation; and
- Monitoring activities in terms of inspection, measurement etc.

The environmental monitoring will help in assessing the changes in environmental conditions by monitoring the effective implementation of mitigation measures, and measuring deteriorations in environmental quality for further preventive actions.

EMP includes four major elements:

- Commitment and Policy: BSPGCL will strive to provide and implement the Environmental Management Plan;
- Planning: This includes identification of environmental impacts, legal requirements and setting environmental objectives.
- Implementation: This comprises of resources available for the project, accountability of contractors, documentation of measures to be taken; and
- Measurement & Evaluation: This includes monitoring, corrective actions and record keeping.

8.2 PLANNING

Various components of planning for the proposed expansion Project will include as per the following sub sections.

8.2.1 Organization, Roles and Responsibilities

Role of BSPGCL

BSPGCL will have ultimate responsibility for implementing the provisions of the EMP. This role will include the contractor involved in the construction of plant, monitoring of contractor performance as well as development of mechanisms for dealing with environmental problems.

Role of BSPGCL Contractors

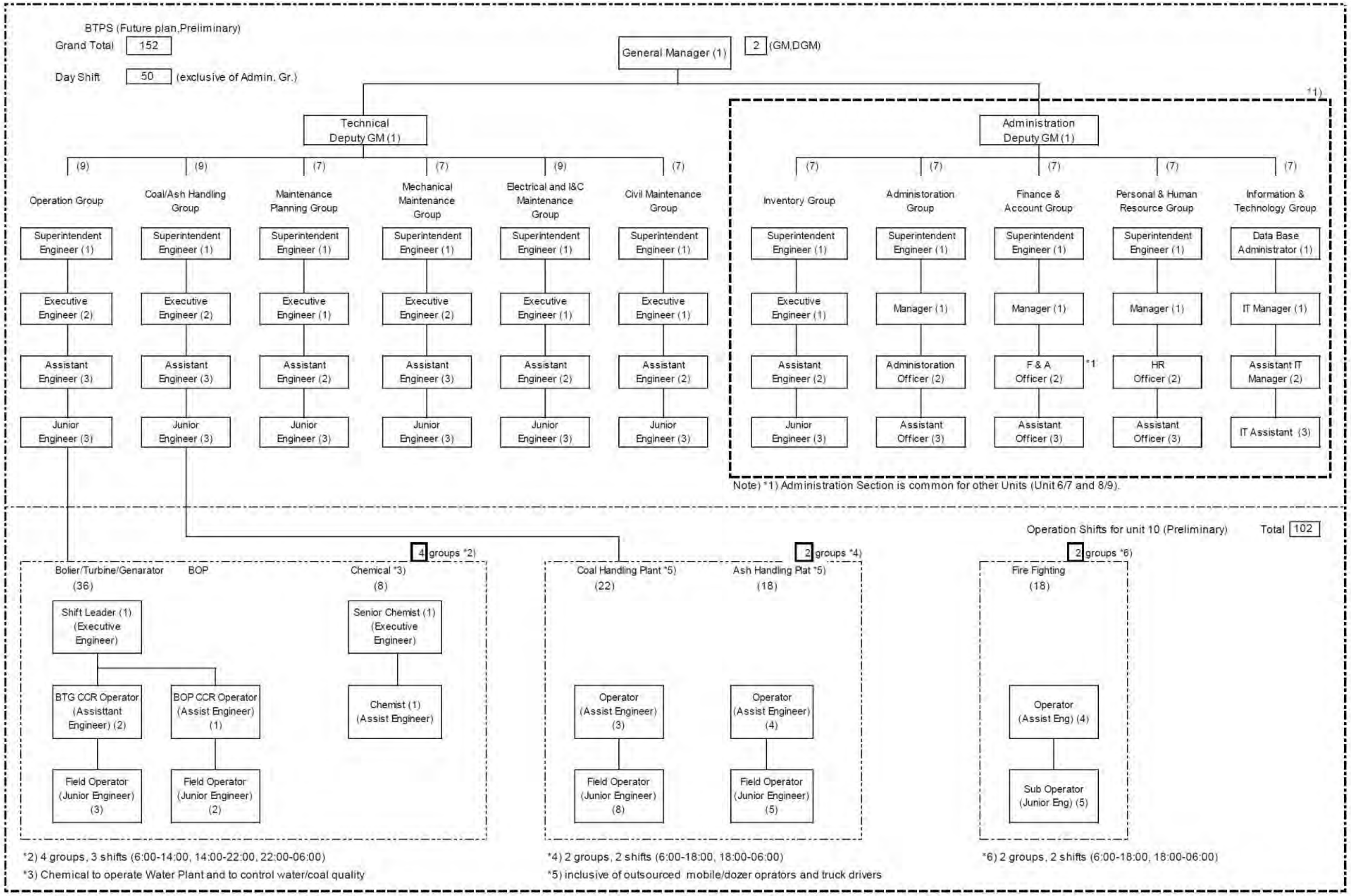
BSPGCL management will be responsible for the performance of all it's contractors and ensuring that all BSPGCL commitments in the EIA are translated into contractors' requirements and that these requirements are implemented to the full intent and extent of BSPGCL commitment.

Contractors will be responsible for implementation of, or adherence to, all the mitigation measures outlined in the EIA. All contractors will be required to comply with the provisions of the EMP and with any environmental and other codes of conduct required by BSPGCL. BSPGCL will require all contractors to introduce regular environmental inspection and reporting to the concerned departments to enable monitoring their performance.

Inspection, Monitoring and Audit

Inspection and monitoring of the environmental impacts of the Project activities will increase the effectiveness of EMP. Through the process of inspection and auditing, BSPGCL will ensure that the conditions stipulated in EC, Consent for Establishment, Consent to Operate and storage of petroleum products etc. are complied with. It is proposed that the audit will be conducted by Audit Team (comprising of Contractor and BSPGCL) for implementation of management system. The entire process of inspections and audits will be documented and inspection and audit findings will be implemented by jointly by contractor and BSPGCL.

Figure 8.1 ***BSPGCL Organisational Structure***



Monitoring, Reporting and Documentation

BSPGCL will develop a well-documented reporting requirement for the all stages of the Project with delegated personal to meet the reporting requirements and timely submission of all compliance reports.

BSPGCL will hire an external agency to conduct monitoring for air emissions and domestic wastewater quality for submission to BPCB/MoEF&CC.

Records of all of the monitoring activities will be maintained and will be available for review as required by BPCB/MoEF&CC.

Annual environmental report known as 'Environmental Statement' as per Form V of EPA Rules, 1986, Six monthly compliance report as per EC of MoEF&CC, compliance reports as per CTE/CTO etc. will be submitted to the regulatory agencies. HSE Manager will be the responsible person for ensuring that communication with regulatory agencies is maintained as per the requirement.

Internal Monitoring, Reporting and Communication

Internal monitoring will focus on measuring and reporting progress of implementing EMP activities. The HSE Manager will be responsible for internal monitoring. Inspection and audits finding along with their improvement program will be regularly reported to the senior management for their consideration.

Documentation

Documentation is an important step in implementing EMP. BSPGCL will establish a well documentation and record keeping system to ensure recording and updating of documents per the requirements specified in existing EMP. Responsibilities will be assigned to relevant personnel for ensuring that the EMP documentation system is maintained and that document control is ensured through access by and distribution to, identified personnel in form of the following:

- Master Environment Management System document;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;
- Training records;
- Monitoring reports;
- Auditing reports; and
- Complaints register and issues attended/closed

All the above documentation system will be maintained as per the requirement of BPCB/MoEF&CC and other relevant regulatory authority.

EMP Review & Amendments

The EMP would be reviewed periodically to update it addressing any changes in the organisation, process or regulatory requirements.

8.2.2 Implementation

The implementation of EMP mainly comprises of resources available for the project, accountability of contractors and documentation of measures to be taken. BSPGCL's Health Safety and Environment Department has the overall mandate for coordination of the actions required for environmental mitigation and management and monitoring the progress of the proposed management plans and various action plans to be implemented for the project. The department will have following functions:

- Preparation of required EMS documents;
- Ensuring availability of resources and appropriate institutional arrangements for implementation of EMP;
- Selection of appropriate MoEF&CC approved monitoring agency for carrying out monitoring and analysis;
- Co-ordinating with monitoring agency in collection and analysis of water, air and soil samples, water samples, monitoring of noise levels within and outside the work zone;
- Implementation of the health and safety measures;
- Conducting routine medical checkups of workers;
- Green belt development;
- Co-ordination of the environment related activities within BSPGCL;
- Collection of the statistics of health of workers;
- Awareness and implementing safety programmes;
- Providing job specific training;
- Compliance of regulatory requirements;
- Carrying out environmental audits;
- Monitoring the progress of implementation of EMP; and
- Reviewing and updating the EMP as and when required for its effective implementation.

8.2.3 Action Plans under EMP

Environmental Management Plans have been prepared based on the outcome of Environmental Impact Assessment study. These EMPs apply to project activities of BSPGCL. The commitments made in these plans are applicable to BSPGCL and its contractor personnel. The principal purpose of formulating this EMP is to ensure commitments made in the EIA report are translated into ongoing actions.

Objectives

The objectives of the EMPs are to:

- Describe the approach and procedures that will be adopted in execution of the project;
- Achieve the intended objectives of the proposed project and mitigation measures thereby reducing the environmental impacts to the levels predicted in the EIA;
- Ensure obligation with the project's legal, regulatory and policy obligations.

Various action plans developed under EMP for implementation during construction and operation phases are given below:

- Air quality management plan
- Noise quality management plan
- Surface water and ground water protection & management
- Waste water management plan
- Solid waste management plan
- Storm water management plan
- Top soil management plan
- Road safety and traffic management plan
- Greenbelt plan
- Occupational health & safety management plan
- Disaster management plan
- Social management plan

8.3 *ENVIRONMENT MANAGEMENT PLAN*

The Environment Management Plan furthers detail out the mitigation measures to be taken by BSPGCL and the Contractors during the construction and operational phase of the project. The environmental control measures proposed in the project description chapter (Chapter 2) and mitigation measures are presented in the impact assessment chapter. The EMP's that will be put into place consist of those during construction and operating stages of the project and includes the elements given below:

8.3.1 *Designing & Planning*

Proper site planning and plant design can result in preventive mitigation measures that may considerably reduce impacts arising out of the proposed project. The Design Consultant -Kyushu Electric Power Co., INC. – Japan has been working in close cooperation with the BSPGCL's planning and designing team to look at preventive options early in the project life cycle based on various techno-physical studies. This will ensure that the need for "end-of-the-pipe" solutions is minimized, to the extent possible. Some of the proposed control measures that already considered in the project are discussed below.

Physical Presence of Main Plant

The main plant site was selected within the existing plant area of BTPS, considering three alternative sites (*Refer section 6.2- Alternative study*), to avoid the procuring/acquiring agricultural land for industrial purpose. The design team has proposed to use coal silos for storage of coal, use of common facilities like, coal siding, water intake facility, residential colony with its existing units to optimise the land requirement.

Physical Presence of Ash Pond and Water Intake Facility

The proposed expansion unit will use the new ash pond and water intake facility, planned for Unit. No. 6, 7, 8 & 9. Both the ash pond and water intake facility is located Govt. land. However, the identified lands are currently being used for agricultural purpose, for the BSPGCL is the process of giving proper compensation to the users.

The ash pond was selected as per MoEF&CC guidelines for selection of ash pond; i.e. not in the flood plain, 500 m away from river. The capacity of the ash pond is approximately 16 years, considering disposal of bottom ash and 100 utilization of fly ash after 4th year of plant operation. The life of the units (existing and proposed) varies from 20 to 25 years. Therefore Design and Planning team shall consider the identifying the additional land for ash pond to minimise the impact on acquiring agricultural land.

Ash Pond Design

Ash pond area is located on sandy loam soil, and ground water level is shallow. Therefore leachate from the ash pond may contaminate the ground water. To prevent that, the Design and Planning team has already considered providing HDPE liner system in ash pond.

The plant will be operated in zero discharge modes. The supernatant water from ash pond will be collected in overflow lagoon and same will recirculate back to plant for use in ash disposal system. This will not only prevent contamination of natural water bodies within the vicinity of plant, but also help in reducing the fresh water requirement for the Unit No. 10.

Water Intake Pipeline

The water intake well is proposed to construct in up stream of Simariya ghat, which is approximately 3.5 km from ghat. The Simariya village and number of shops in the ghat is located in between water intake facility and plant. To avoid the potential displacement of shops, the alignment of the pipeline has been finalised.

Selection of Fuel and Pollution Control Devices

Presently, the proposed expansion unit has no coal linkage. The probable sources of coal are either Indian coal or imported coal. The Indian coal has high ash content and low sulphur; whereas, imported coal from Indonesia or Australia has low ash content and high sulphur. The design team has consider to use Indian coal, accordingly, designed the ESP and ash pond.

The predicted value of PM, NOx, SO2 from proposed expansion unit and comparing against the standard for IFC EHS guidelines – for non-degraded air-shed (NDA), degraded air-shed (DA) and the draft norms for coal based thermal power plant as prescribed by MoEF (Table 8.1). The baseline study shows that, the air-shed is non-degraded. The predicted emission after control measures is higher compared to MoEF&CC draft norms as well as IFC EHS Guidelines. The design should consider the MoEF&CC's draft norms for designing plant emission.

Table 8.1 Emission Standards Comparison with Predicted Values

Pollutant	**IFC EHS Guidelines – Solid Fuels (Plant ≥ 600 MWth)**		**MoEF&CC Draft Norms**	**Predicted Values for 1 x 660 MW, Unit No. 10**	
	NDA (mg/Nm^3)	DA (mg/Nm^3)	**Unit after Jan 1, 2017** (mg/Nm^3)	Design Coal (mg/Nm^3)	Worst Coal (mg/Nm^3)
SO_2	250-850	200	100	605	625
NOx	510	200	100	500	485
PM	50	30	30	50	50

Natural Disasters (Flood and Earth Quake)

The main plant area, ash pond area and water intake system are located outside the flood protection embankment. The design team has considered the HFL for developing the sites. It is proposed to construction a flood protection bund along the eastern and southern portion of the main plant, to protect the plant from flooding and also, mixing of various pollutant from the plant. Design team also planned to construct ash dyke height considering soil load bearing capacity, flood level, etc.

8.3.2 *Air Quality Management Plan*

The air pollutants from the proposed project will be in the form of gases like Sulphur dioxide (SO_2), Nitrogen oxide (NOx) and Particulate Matter (PM). Air Pollution control facilities would be provided to control the atmospheric emissions. The measures suggested during the different project phases are:

Construction Phase

Dust Suppression Measures

- All vehicles delivering material to the site shall be covered to avoid material spillage. While unloading materials, fall height shall be kept low to minimize fugitive dust generation.

- All dumpers carrying construction material shall be covered for preventing spillage on roads.
- Application of adequate amount of water / dust suppressants on all construction roads / sites using a dedicated water truck or through installation of water sprinklers or any other suitable methods, to control fugitive dust. The frequency of watering should be pre-decided based on site conditions.
- Strict control of speed limit (use of speed breakers) on haul roads to minimise dust entrainment.
- All construction material storage piles shall be covered and watered as appropriate to minimize generation of dust.

Regular Maintenance of Vehicle and Machineries

- All vehicles utilized in transportation of raw materials and personnel will have valid Pollution under Control Certificate (PUCC). Vehicular exhaust will be complying with the CPCB specified emission norms for heavy diesel vehicles.

Monitoring

Periodic monitoring of ambient air quality near sensitive receptors as specified in the Environmental Monitoring Program (Chapter 6) will be undertaken to ensure compliance with regulatory standards.

Procedural Changes to Construction Activities

Material Production - The transport of materials such as concrete and asphalt to construction sites generate significant amounts of road dust, especially for ash pond site that is relatively far from material manufacturers. Haulage of materials can be eliminated by setting up temporary portable concrete plants and/or asphalt plants at construction sites.

Idling Time Reduction - Construction equipment are commonly left idling while the operators are on break or waiting for the completion of another task. Emissions from idling equipment tend to be high, since catalytic converters cool down, thus reducing the efficiency of hydrocarbon and carbon monoxide oxidation. Existing idling control technologies, which automatically shut the engine off after a pre-set time can reduce emissions, without intervention from the operators.

Improved Maintenance - Recognizing that significant emission reductions can be achieved through regular equipment maintenance, contractors should be asked to provide maintenance records for their fleet as part of the contract bid and at regular intervals throughout the life of the contract.

Reduction of On-site Construction Time - Rapid on-site construction would reduce the duration of traffic interference and therefore, reduce emissions from traffic delay. Off-site fabrication of structural components can also enhance the quality of work, as the production takes place in controlled settings and external factors such as weather and traffic do not interfere.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager–Projects.

Operation Phase

Control Measures –proposed in plant designing

- For restricting the particulate matter emission within present 50 mg/Nm^3 and proposed 30 mg/Nm^3 (as per Draft emission standard for new power plant- Draft Notification April 2015), electrostatic precipitator (ESP) of required efficiency will be installed.
- Fly ash handling system is designed to collect fly ash in dry form in silos using pressure type pneumatic system. The fly ash collected at air preheater hoppers, duct hoppers, back-pass hoppers, ESP hoppers and stack hopper will be gravity fed into individual transmitter vessels provided below each hopper and conveyed to fly ash silos with the help of compressed air through transport piping. The conveying air will be vented by vent fan through bag filters mounted on top of the silos in order to limit the dust concentration in the vented air below 50 mg/Nm^3.
- Appropriate technology will be adopted to meet the new emission standard of 100 mg/ Nm^3 for SO_2 (December 2015).
- Low NOx burner and appropriate technology will be adopted to reduce NOx formation and also assure that NOx formed satisfies the new emission standard of 100 mg/ Nm^3 (Dec. 2015).
- Dust nuisance due to coal handling would be minimised by providing suitable dust suppression/ extraction systems at screen house, crusher house, junction towers and coal unloading area for the coal stockyard. The dust extraction system would be provided with ventilation system having bag filters to trap the dust in the bunkers.

Dust Suppression Measures

- Dust suppression techniques shall be practiced to control fugitive emissions. This shall include water sprinkling along the existing paved roads to bring down the dust levels (It is pertinent to mention in this regard that access roads to the project site are already asphalted)
- A plan for Green belt development and afforestation will be implemented in allocated spaces within the project site. Trees with high foliage density and large leaf areas are very effective in dry deposition of particulates.

Regular Maintenance of Vehicle and Machineries

The preventive maintenance program and appropriate operational control procedures will be developed for all machineries and equipment which can result in air emissions. Through the program and procedures, it will also to be ensured that engines and exhaust systems of all supply vehicle and equipment used for the project will be maintained so that exhaust emissions are low and with the standard. Routine maintenance will be of high standard to ensure that such emissions are minimized.

<u>*Monitoring*</u>

- Monitoring of the stack emissions for PM, SO_2 and NOx will be carried out once in a month to meet the statutory requirements.

- Periodic monitoring of ambient air quality near sensitive receptors as specified in the Environmental Monitoring Program (Chapter 6) will be undertaken to ensure compliance with regulatory standards.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager–Operation.

8.3.3 Noise Quality Management Plan

The major sources of noise during the construction stage will be the vehicles carting equipment and raw materials, operation of heavy construction equipment such as earth movers, concrete mixers, piling equipment, etc. and also running of DG sets. On the other hand during the operation stage the noise sources will pre dominantly be plant units such as boilers, turbines, crushers, cooling towers, etc. The measures suggested to control noise during different project phases are:

Construction Phase

<u>*Noise Abatement*</u>

- All vehicle and construction equipment shall be fitted with exhaust silencers. Damaged silencers shall be promptly replaced by the contractor.
- All construction equipment particularly DG sets, shall adhere to stipulated noise standards.
- Contractor shall ensure that noise levels near residential areas are within the daytime and night time noise standards as specified in MoEF Noise Rules, 2000.
- Noisy operations such as any on-site fabrication and piling work shall be limited to daytime hours
- Construction equipment such as portable power generators should be provided with noise shields or barriers

<u>*Monitoring*</u>

- Periodic monitoring of ambient noise quality near sensitive receptors as specified in the Environmental Monitoring Program will be undertaken to ensure compliance with regulatory standards.
- Periodic work place noise will be monitored in all the noise generating sources.

Provision of PPE

- Personnel deployed near high noise generating areas will be equipped with proper PPEs (ear plugs etc.) and subjected to rotation.
- Periodic health surveillance programs to be organized to monitor the health of workers.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager– Projects.

Operation Phase

The predominant noise levels will be confined to the work zones in the plant. Ambient noise levels are not likely to be affected due to the proposed project because of the proposed green belt development program and also due to attenuation due to physical barriers (building enclosures, compound walls, etc.)

Control Measures- Planned in designing

- The use of damping materials for work places like Boiler house, Furnace etc;
- Inlet and outlet mufflers should be provided which are easy to design and construct;
- All the openings like covers, partitions should be acoustically sealed;
- Reflected noise should be reduced by the use of absorbing material on roofs and walls;

Operation & Maintenance

- Operation and maintenance to keep noise levels low on relevant equipment such as raw material conveyor belts

Provision of PPE

- Isolation of noisy equipment from working personnel;
- In some areas where due to technological process, it is not feasible to bring down the noise level within acceptable limits, personnel working in these areas shall be provided with noise reduction aid such as ear muffler and also the duration of exposure of the personnel will be limited as per the norms.

Monitoring

- Periodic monitoring of ambient noise quality near sensitive receptors as specified in the Environmental Monitoring Program will be undertaken to ensure compliance with regulatory standards.
- Periodic work place noise will be monitored in all the noise generating sources.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager–Projects.

8.3.4 *Surface & Ground Water Protection & Management*

Necessary mitigation measures need to be adopted and implemented by BSPGCL to prevent and control impact on surface and ground water that may result from project related activities during both construction and operation phase.

Construction Phase

The following measures shall be adopted during the construction phase:

- The sourcing of ground water for drinking and construction activities will be avoided during this phase.
- Cutting and filling operation will be carried out in accordance to site contour to prevent normal drainage disruption
- Provision of alternate drainage will be implemented to prevent disruption of natural drainage pattern.
- The surface runoff from the construction sites will be channelized to sedimentation tank, clear water will be discharged into the natural drainage channel.
- Surface run-off discharges to natural drainage channels will be complying with CPCB Inland Water Discharge Standards.

Operational Phase

The following measures need to be taken during operational phase:

- Provision of impermeable liner for ash pond to prevent contamination of ground water by ash pond leachate.
- Periodic monitoring of ground water quality of villages abutting the ash pond area in accordance with the Environmental Monitoring Program (*Refer Environment Monitoring Program*) to check ground water contamination by ash pond leachate, if any by comparing with baseline data
- The effluents viz. cooling tower blowdown, boiler blowdown, oil separated water generated during operational phase will be adequately treated in accordance with CPCB Thermal Power Plant Industry Standards and Effluent Guidelines – IFC EHS for Thermal Power Plants and reused to the extent possible. Details for specific effluent treatment and disposal measures have been discussed under waste management section in this Chapter.
- Surface run-off will be channelled through separate onsite drainage system to prevent mixing with effluent prior to its discharge to natural drainage channels and nearby agricultural field.
- Rain water harvesting shall be adopted to maximize water reuse and ensure ground water recharging. Central Ground Water

Authority/Board shall be consulted for finalization of appropriate rain water harvesting technology.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager–Projects.

8.3.5 *Waste Water Management Plan*

Construction Phase

To prevent degradation and maintain the quality of the water source, adequate control measures should be provided to check the surface run-off, as well as uncontrolled flow of water into any water body. The following management measures are suggested to protect the water quality during the construction phase

- Implementation of necessary drainage facilities, inclusive of catch-pits or sedimentation basins for the drainage of construction wastewater, prior to discharge.
- The construction site should be provided with sufficient and suitable toilet facilities for workers to maintain proper standards of hygiene. These facilities would be connected to a septic tank and maintained to prevent wastewater from entering the water bodies.
- Provision of secondary containment in oil/fuel storage areas. All such storages should be on impervious flooring.

Operation Phase

The major process and non-process effluents generated during operational phase include:

- Cooling tower blow down
- Boiler blow down
- DM Plant Regeneration Waste
- Filtration unit backwash
- Oil water effluent
- Coal Handling Plant Surface Run-off
- Ash Pond Supernatant
- Domestic Waste Water viz. Sewage
- Ash Pond Leachate

Management of effluent streams

Cooling Tower & Boiler Blow-down – The cooling tower blow down and the boiler blow down will constitute major portion of the effluents generated during the operation phase. These effluents shall be treated in Effluent Treatment Plant (ETP) before reuse/discharge. Major portion of the cooling tower blow down will be either reused/recycled for varied purposes viz. dust extraction/dust suppression at coal handling plant, preparation of bottom ash slurry for ash pond disposal and fire fighting activities. The remaining of the blow down water will be discharged into guard pond installed to serve as an equalization unit for all treated/untreated effluents. The guard pond will be located suitable location within the main plant and will be designed to store 24hrs project effluent discharge. Similar to cooling tower blow down, boiler blow down generated from process operation will be directed into the guard pond following treatment in ETP through boiler blow down drain pit to be reused for onsite dust suppression and green belt development.

DM Plant Regeneration Waste - Acidic and alkaline waste water generated following regeneration of DM plant ion exchangers will be led through acid/alkali resistant tile lined trenches and collected in neutralization pit. Drain and overflow of DM water storage tank, chemical tanks etc. and floor washings of the water treatment facility will also be drained through such trenches to the neutralization pit. After necessary pH correction at the neutralization pit the effluent will be pumped to the guard pond for storage and reuse for green belt development, dust suppression/dust extraction and other non-potable non-process purposes.

Filtration Unit Backwash - Waste water is likely to be generated from backwashing of filtration units of DM plant, potable water treatment plant and side stream filtration (SSF) system. The SSF reject shall be transferred to the bottom ash slurry pump and subsequently reused in the preparation of ash slurry for High Concentrated Slurry Disposal (HCSD) in ash pond. The backwash from DM and potable treatment plant shall be collected in designated waste pits, treated in ETP and pumped back to the raw water pre-treatment unit supply line for reuse.

Oil Water Effluent – Oily water effluent is generated from fuel oil storage area, BTG building and transformer yard shall be initially collected in an oily waste retention pit. The collected effluent shall be screened through an oil water separator (corrugated plate interceptor) for removal of oil. The treated water shall be collected in a retention pit and subsequently reused as make-up water for the ash water sump. The sludge from the retention pit shall be disposed at the ash pond through bottom ash slurry pump. The oil so collected shall be adequately stored in closed containers and sold to authorized waste oil recyclers located in Barauni.

Ash Pond Supernatant - Ash pond supernatant shall be recovered from the bottom ash pond by a recovery system and treated in a clarifier. The sludge generated from the clarifier shall be recycled back to the bottom ash pond for disposal while the treated water shall be supplied to the ash water sump to serve as make-up water for high concentrated slurry disposal of bottom ash and unused fly ash.

Domestic Waste Water – Domestic Waste Water likely to be generated from kitchens, canteens of the labour colony will be treated through septic tank and soak pit or through the STP. In case of STP, treated water will be reused to watering in greenbelt area.

Coal Handling Plant Surface Run-off - Run-off from coal handling plant will be channelled through storm water drains to a settling unit for suspended solids removal. Part of the clear water would be returned to the ash handling system while the remaining will be led to the Guard Pond. However generation of surface run-off is of intermittent nature and is likely to occur only during monsoon. A storm water management plan shall be prepared in this regard to effectively manage the storm water from the main plant site and the coal handling plant.

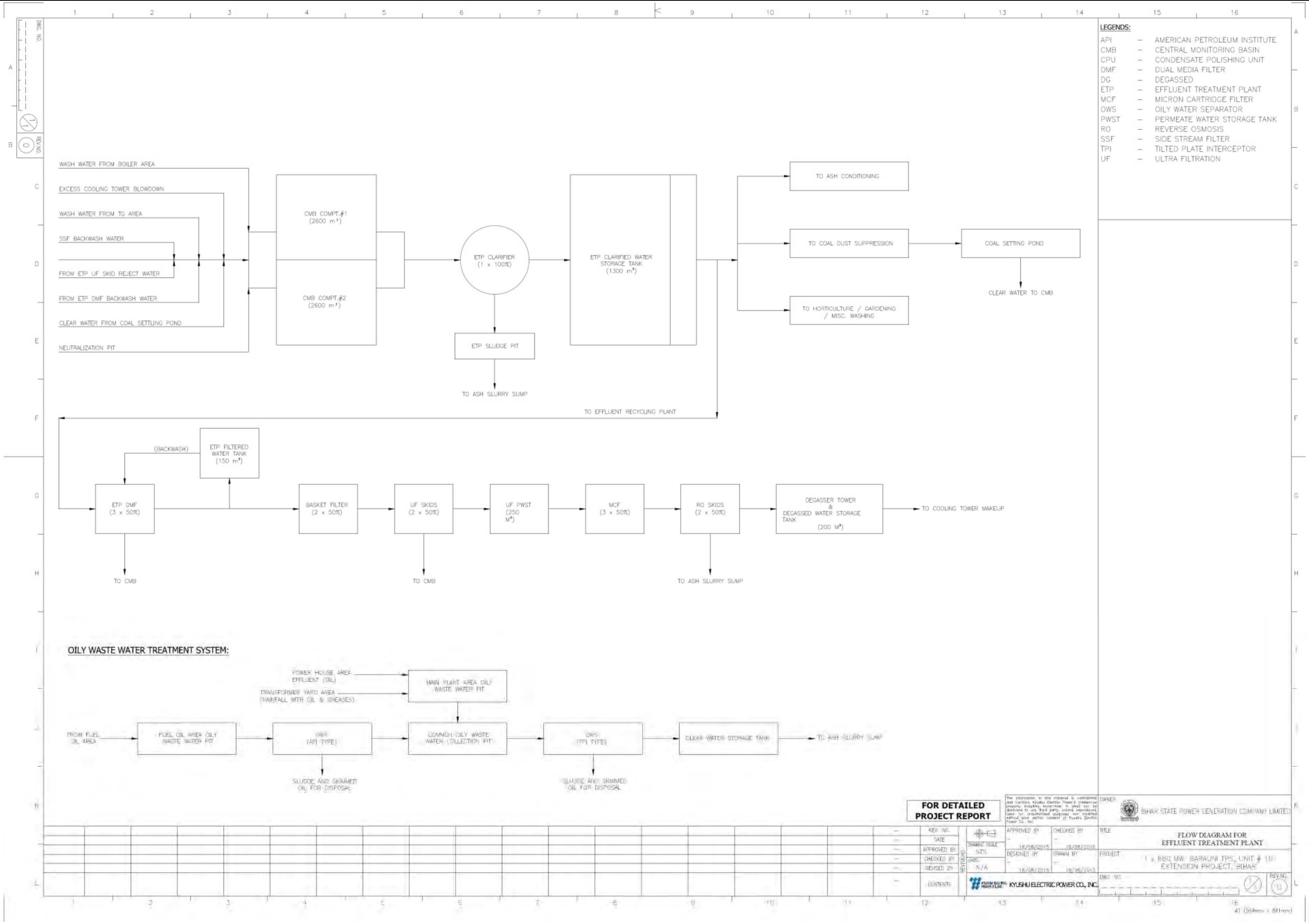
The overall effluent treatment and disposal process is schematically represented in Figure 8.2.

Monitoring

- Daily records of generation/reuse/disposal of ETP and STP treated waste water will be maintained. Treated waste water will be reused to the maximum extent possible.
- Effluent discharges if any during monsoon will be complying with the CPCB Thermal Power Plant – Standards for liquid Effluents and Effluent Standards of IFC Thermal Power Plant EHS Guidelines.
- Periodic preventive maintenance of ETP and STP will be performed as per supplier manual.
- Mercury and other heavy metals will be continuously monitored in the effluent emanating from the ash pond
- Periodic monitoring of surface water quality in River Ganga as specified in the Environmental Monitoring Program will be undertaken.
- Treated and untreated water will be periodically monitored to meet the regulatory standard.

The HSE Manager of the site will be responsible for implementing the plan during the operational phase under the guidance of General Manager–Projects

Figure 8.2 Schematic Representation of the Effluent Treatment and Disposal Process



8.3.6 *Solid Waste Management Plan*

This waste management plan identifies the wastes that are likely to be generated during the construction and operation of the proposed 1 x 660 MW Thermal Power Plant and documents cradle to grave waste management practices to be employed for their collection, storage, treatment and/or disposal.

Specifically, the waste covered by this WMP includes the following sources.

- Construction and commissioning of main plant and the associated facilities (main plant, ash pond, and water intake facility).
- Operation of main plant and the associated facilities throughout the project life-cycle.
- Temporary accommodation during construction and permanent accommodation during operation phase for the workers.
- Other operations like equipment maintenance, road construction, site preparation etc.
- Operation and maintenance of infrastructures both during construction and operation phase.

WMP is intended to serve as a guideline for the project proponent & the contractor(s) to manage wastes effectively during construction and operation phase. The contractor(s) shall prepare their own WMP in compliance with this WMP and implement the same during the construction phase. BSPGCL shall implement the WMP throughout the operational phase.

The WMP describes how wastes will be managed during the construction and operation phase of the project and how the project will:

- Minimize the potential to cause harm to human health and the environment.
- Comply with Indian Environmental Regulation.
- Reduce operational costs and any potential liabilities which may arise from waste handling operations.

Construction Phase

- A waste inventory of various waste streams generated will be prepared and periodically updated.
- The excavated material generated will be reused for site filling and levelling operation to the maximum extent possible.
- The scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers.
- Food waste and recyclables viz. paper, plastic, glass etc will be properly segregated and stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through waste handling agency.

- Hazardous waste viz. waste oil etc. will be collected and stored in paved and bunded area and subsequently sold to authorized recyclers. Necessary manifest for the same will be maintained.

Operational Phase

Process Waste
The solid wastes and Hazardous wastes likely to be generated during operation phase are fly ash & bottom ash, clari- flocculator sludge, STP sludge; hydrocarbon wastes; non-hazardous solid wastes, miscellaneous hazardous wastes and biodegradable solid waste (refer section 2.7.3. for details).

Bottom Ash – The bottom ash generated during the plant operation will be disposed to the designated ash pond by High Concentrated Slurry Disposal (HCSD) System. The bottom ash will be disposed in the ash pond in slurry form reusing the treated effluent (cooling water blow-down). Mercury and other heavy metals (As, Cr, Pb, etc) will be monitoring in the bottom ash.

Fly Ash - The fly ash which constitutes the major portion of the ash generated during operational phase will be reused for various purposes like raw material in cement plant and brick manufacturing units and captive coal mines, road embankment construction etc. No ash will be disposed in the low lying areas and adequate safety measures will be adopted to prevent the breach of ash dyke. A fly ash utilization plan shall be prepared by the proponent in this regards following the feasibility assessment of the above mentioned reusability options. About 100% utilization of fly ash is required to be achieved within 4th year of operation.

Clariflocculator Sludge – The clari-flocculator sludge generated from ETP during the operational phase will be treated in a centrifuge and will be disposed as solid cake into the ash pond. The treatment of the sludge will be carried out at regular interval depending on the rate of generation of clari-flocculator sludge.

STP Sludge – The STP sludge (solid cake) following dewatering will be dried and reused for green belt development due to its high N, P, K values.

Hazardous Wastes
Hazardous wastes generated within the plant site should be stored separately in specially designed and constructed containers. Appropriate leak proof containers should be used for storage of wastes. Best practices for storage and handling of hazardous waste include following steps:

- Adequate Storage Facility;
- Adequate isolation of hazardous waste storage area;
- Adequate protection of storage area such as roofing;
- Adequate sign boards of "HAZARDOUS WASTE" at storage site;
- Adequate illumination;
- Proper Drainage System.

The recyclable hazardous waste generated during the operational phase (e.g. waste and used Oil etc.) will be recycled to an offsite BSPCB authorized waste/used oil recycler.

Non-hazardous Wastes

Non-hazardous wastes include scrap tires from site vehicles, miscellaneous scrap including glass, plastic and metal and domestic and administrative solid wastes from staff cafeteria, offices and process areas. Dedicated storage area for non-hazardous wastes will be allocated. The following management and handling measures are suggested:

- Bio-degradable wastes should be composted on site and used as manure as far as practicable
- All non-biodegradable waste collected from administration and other process areas should be segregated into individual fractions such as glass, plastics, scrap metal, etc., and sent for recycling/ use where practical.
- All remaining non-saleable/non-recyclable material should be sent to municipal disposal sites at regular intervals

8.3.7 *Top Soil Management*

Topsoil is generally defined as the top, fertile layer of material on the land surface which is capable of supporting plant growth. It contains the seed bank and is therefore an essential component of the re-vegetation program. Maintenance of topsoil quality, particularly its structure and the integrity of its seed bank, is vital to both bio-restoration work and erosion control.

At the commencement of site preparation activities (ash pond and water intake facility), the topsoil of the land acquired for the project will be carefully stripped to its full depth and stored separately. Topsoil will not be stripped from areas that will only be used for storing topsoil. Topsoil will be stored where it will not be compacted by vehicles or contaminated and will be stored in a manner that will minimizes its loss and/or degradation. Topsoil will not be mixed with subsoil or any other inert material during construction activity.

Subsequently, the Topsoil will be stored in a stockpile within the site premises in a heap not more than 2m high with side slopes < 45°, drained with open ditches. The surface of the stockpile will be lightly compacted to reduce rainfall penetration but not enough to promote anaerobic conditions.

Alternatively the stockpiles shall be enclosed by use of appropriate sediment filtration devices in the form of silt fence or straw barriers. Under no circumstances will topsoil be used as padding material.

After the completion of site development and construction work, top soil will be overlaid into the plantation area.

Proper disposal of the excavated fill material shall be carried out. No excavated material shall be disposed on fertile agriculture land or close to any water channel/ water body.

8.3.8 Storm Water Management

This section outlines prevention and possible control, methods to ensure that storm water is not contaminated with processes, raw materials, loading and unloading activities. The goal of storm water control is to reduce contaminant loadings to the maximum extent practicable. Storm water discharges include but are not limited to discharges from drainage areas, material handling sites, raw material storage sites, etc. These discharges can occur during the construction and operation phases of the project. Storm water management measures suggested both for the construction and operation phases are described below:

Construction Phase

- Wash off from the oil/grease handling area or workshop shall be drained through impervious drains. Clarifiers or oil/water separators shall be constructed and effluent should be treated appropriately before release.
- All stacking and loading areas should be provided with proper drains equipped with baffles to prevent run off from the site to enter any water body.
- All drainage shall be provided with silt traps to prevent silt from entering water bodies
- All exposed surfaces shall be flattened to prevent erosion due to rapid runoff.

Operation Phase

The following criteria are a guide to minimize impairment of storm water:

- Separation of all storm water discharges within the site that do not come into contact with raw material, material handling sites, storage sites and wastes;
- Separation of all storm water discharges associated with employee parking lots, administration buildings and landscaped areas that are not mixed with storm water associated with plant activities;
- Separation of waste water channels leading to respective treatment units.

These measures can be classified into two major categories: the first category includes measures that that are low in cost such as good housekeeping, employee training and spill prevention procedure; the second category includes management practices that provide a second line defence such as containment, mitigation and treatment. Measures suggested for storm water pollution prevention are:

- Identifying where any of the following activities may be exposed to precipitation or surface runoff
  - Storage or disposal of wastes such as spent solvents and baths, sand, slag and liquid storage tanks and drums;
  - Processing areas including pollution control equipment (e.g., baghouses);
  - Storage areas of raw material such as coal, limestone, etc.
  - Accumulation of significant amounts of particulate matter could occur from such sources as furnace or oven emissions.
- Preventing exposure of materials and activities such as material handling equipment, plant machineries, raw materials and wastes by installing storm resistant shelters.
- *Create an Inventory of Exposed Material* - An inventory of materials handled at the site that potentially may be exposed to precipitation or runoff and also listing out areas where deposition of particulate matter from process air emissions or losses during material handling activities are possible.
- *Good Housekeeping Measures* - As part of good housekeeping program, a cleaning and maintenance program for all impervious areas of the facility where particulate matter, dust, or debris may accumulate, especially areas where material loading and unloading, storage, handling, and processing occur; and the paving of areas where vehicle traffic or material storage occur but where vegetative or other stabilization methods are not practicable (instituting a sweeping program in these areas too).
- For unstabilized areas where sweeping is not practicable, using storm water management devices such as sediment traps, vegetative buffer strips, filter fabric fence, sediment filtering boom, gravel outlet protection, or other equivalent measures that effectively trap or remove sediment.
- *Spills Prevention and Control* – Installation of secondary containment and dykes in fuel/oil storage facilities to minimize spills. Prepare and implement spill response plans, particularly for fuel, chemical and oil storage areas.

Monitoring and Inspection

Following the commissioning of the works, a proactive monitoring program may be initiated to assess the effectiveness of the preventative measures and to ensure proper response and preparation for immediate remedial measures if required:

- *Inspections* - Conduct periodic inspections and address all potential sources of pollutants, including air pollution control equipment for any signs of corrosion and leaks; process and material handling equipment (e.g., conveyors, cranes, and vehicles) for leaks, drips, or the potential loss of material; and material storage areas (e.g., piles, bins, or hoppers for storing coal, limestone, scrap, as well as chemicals stored in tanks and drums) for signs of material losses due to wind or storm water runoff.

- *Sampling and analysis* - Collect and analyze samples for at least one representative storm events from storm water outlets from the different plant areas (i.e. process, storage, loading and unloading of any raw material, ash disposal area, etc.) to determine the contaminants found in storm water. Some of parameters that can be analysed are suspended solids, iron and oil and grease.
- Measure the daily rainfall and monthly total rainfall, estimate the total area drained by each sewer, as well as the total area of impervious surfaces on the site, including paved areas and building roofs.
- Estimate the volume of storm water discharged, during representative storm events, using methods based on rainfall, drainage areas and runoff coefficients or based on calculated flow rates. Assess the accuracy of the methods used.

8.3.9 Road Safety & Traffic Management Plan

The plan encompasses the addressal of community safety related impacts that may arise from the increased vehicular traffic due to movement of heavy equipment/machineries and vehicles along the site access and approach roads particularly during construction phase. The plan will be regularly updated by the contractor with the project progress and as vehicle movement requirements are identified in detail.

During Construction Phase

The following mitigation measures will be implemented during this phase:

- Project vehicular movement will be restricted to defined access routes.
- Proper signage will be displayed at important traffic junctions along the vehicular access routes to be used by construction phase traffic. The signage will serve to prevent any diversion from designated routes and ensure proper speed limits are maintained near residential areas.
- Any road diversions and closures will be informed in advance to the project vehicles accessing the above route. Usage of horns by project vehicles will be restricted near sensitive receptors viz. schools, settlements etc.
- Traffic flows will be timed wherever practicable during period of increased commuter movement in the day.
- Temporary parking facilities shall be provided within the work areas and the construction sites to avoid road congestion.
- Clear signs, flagmen & signal will be set up where necessary in discussion with Gram Panchayat and relevant authorities' viz. police department, fire department etc.
- Movement of vehicular traffic will be restricted during night time. A Journey Management Plan will be formulated for the construction

phase traffic to enforce night driving restrictions and to establish vehicular speed limits.

- Vehicular movement to be controlled near sensitive locations viz. schools, colleges, hospitals identified along designated vehicular transportation routes.
- Routine maintenance of project vehicles will be ensured to prevent any abnormal emissions and high noise generation.
- Adequate training on traffic and road safety operations will be imparted to the drivers of project vehicles. Road safety awareness programs will be organized in coordination with local authorities to sensitize target groups viz. school children, commuters on traffic safety rules and signage.

8.3.10 Greenbelt Development Plant

Comprehensive afforestation is imperative for restoring eco-dynamics. The afforestation activities not only serve as foreground and background landscape features resulting in harmonizing and amalgamating the physical structures of thermal power projects with the surrounding environment, but also contribute to the overall improvement in the environment. In addition to this plants have an in-built mechanism to absorb a wide variety of pollutants.

The greenbelt development plan aims at overall improvement in the environmental conditions of the region. The main objectives of the plan are: prevention of land degradation due to activities during construction phase; enhancing the forest cover for increasing the biodiversity of the region; providing aesthetic value to the project area; enhancing the ecological equilibrium of the area; and to attenuate dust emission and noise during construction.

Area Allocated

A detailed survey was conducted with respect to existing vegetation types, vegetation diversity, etc. in the project area for development of greenbelt around project components. The greenbelt plan has been formulated considering the parameters such as climate, soil types etc.

In the present case an area of around 104 acres (28% of the total main plant area) and 27.6 acres (9.5% of the ash pond area) has been allocated within the site for development of the Green Belt.

Selection of Species

The selection of tree species suitable for plantation at the industry shall be governed by guiding factors as stated below:

- Selection of the plant species to be done on the basis of their adaptability to the existing geographical conditions and the vegetation composition of the forest type of the region.

- During the development of the green belt within the project area, special attention would be given to species having nitrogen fixing capability, ornamental values, and species of very fast growth with good canopy cover.
- The tree should be tolerant to air pollutants present in the area, especially fly ash.
- The tree should be able to grow and thrive on soil of the area, be evergreen, inhabitant, having minimum of leaf fall.
- Plants with more than 10 m height, fair amount of canopy cover shall be preferred so that these plants can effectively reduce the pollution load as well as provide maximum amount of shade.
- Since the tree trunks are normally devoid of foliage (up to 3 m), it would be appropriate to have shrubs in front of such trees to give coverage to such portions.
- The tree should possess extensive foliar area to provide maximum impinging surface for continued efficient adsorption and absorption of pollutants.
- The tree should be fast growing and indigenous and should maintain ecological, land and hydrological balance of the region.
- It is also recommended to plant some trees which are sensible to air pollution so that they will work as indicator of air pollution in future.

The species are recommended for Green belt development given in Table 8.2.

Table 8.2 Suitable Plant Species for Greenbelt

Sl. No.	Plant Species	Type and suitable site
1	*Adina corodifolia*	Deciduous, suitable on open areas and near flares
2	*Aegle marmelos*	Deciduous, good for green belts
3	*Anogeissus latifolia*	Deciduous, Suitable for green belts
4	*Azadirachta indica*	Evergreen, suitable for green belts along the boundary and outside office
5	*Bauhinia variegate*	Deciduous, good for green belts in garden and as a second row avenue tree
6	*Boswellia serrata*	Deciduous suitable on green belt on willow soils
7	*Butea monosperma*	Deciduous for green belt and as a second row avenue tree
8	*Careva aroborea*	Deciduous, good for green belts
9	*Carrisa Carandas*	Semi evergreen large bushy shrub good as a hedge to protect against noise.
10	*Cassia fistula*	Deciduous, good ornamental tree in green belts.
11	*Cassia siamea*	Evergreen, good as an avenue tree
12	*Cedrela toona*	Deciduous, good in open spaces, in green belts and along ponds
13	*Ficus bengalensis*	Deciduous, widely spaced avenue tree (15 m apart)
14	*Ficus religios*	Deciduous, widely spaced avenue tree also as a single tree in isolated sites
15	*Maduca indica*	Deciduous, good for green belts
16	*Saraca indica*	Evergreen tree good on road sides within campus
17	*Terminalia catappa*	Large Deciduous tree
18	*Terminalia arjuna*	Evergreen tree for road sides and for green belts
19	*Putranjiva roxburghii*	Evergreen tree for road sides and for green belts

Source of Saplings and Plantation Requirements

The desired saplings for plantation will be obtained from the nearest Forest Department Nursery. Necessary steps to be taken for better results are as follows:

- One/two years old seedlings will be planted for plantation
- Regular weeding, clearing and hawing of seedlings and application of oil cakes will be carried out to boost up the growth.

Spacing and Pit Size: The spacing and pit size would be varying according to the choice of species and compatibility of various species to grow together in a niche. Small spread would be planted at a distance of 2.5m x 2.5m apart, while tall varieties with spread would be planted at a spacing of 3m x 3m. The pit size would be 30cm x 30cm x 30cm for cylindrical whereas for the broadleaf species the size of 45cm x 45cm x 45cm need to be adopted. Approximately 1600 saplings will be planted per hectare of land.

Pit Preparation: Adequate quantity of soil and manure mixture @ 4:1 is necessary for each pit. The soil mixture is to be filled in each pit and watered well to form a puddle before the actual transplantation.

Fencing and Closure: A minimum block plantation would be undertaken by providing barbed wire fencing including watch and ward for assuring protection from biotic interference.

The Planting Scheme

Available space within the proposed project site will be utilized for greenbelt development. For the purpose of pollution attenuation, the green belt shall be developed in three tiers as stated below:

First Tier – Consists of shrub species having good levels of air pollution tolerance limits which is referred to as Tolerance zone.

- Broken or interrupted: Trees shall be planted in between the shrub species at regular intervals in the first tier. The branching pattern and canopy formation of these species is not uniform.
- Drooping canopy: Trees shall be planted in between the shrubs in the first tier. The branches and leaves of these species droop downwards e.g. *Polyalthia longifloia*.

Second Tier - consists of trees having fast growth potential with conical canopy identified as Dispersion Zone.

- Rotund type: The shape of the crown is more or less rounded; branches and leaves are closely arranged e.g. *Mimusops elengi*. These tree species are suitable for the second and third tiers.
- Flat topped canopy: The branches of the crown are uniformly shaped flat-topped crown and the spread of the crown is wide to cover a large

area e.g. *Cassia fistula*. These tree species are suitable for the second and third tiers.

Third Tier - Trees having hairy leaves with thick and round canopy referred to as the Absorption Zone.

- Cylindrical type: The branches and leaves form a close network and give the longitudinal spread e.g. *Dalbergia* sp. These tree species are appropriate in between the trees in the third tier.
- Chimney type: The branches give the appearance of long chimney. These tree species are used for the outer rows of the third tier.
- Conical type: The growth of main stem and horizontal branches appear in the form of a cone. e.g. *Casuarina* sp. These tree species are suitable in the peripheral rows of the third tier.

8.3.11 Occupational Health & Safety Management Plan

The occupational health & safety (OHS) plan is formulated to address the key occupational health and safety related concerns of contractor workers and site personnel during both construction and operational phase. The plan will also be serving as a reference document for finalization of safety procedures with respect to construction and operational activities. The mitigation measures to be implemented both during construction and operational phase have been discussed below:

- The onsite workers shall be provided with proper personal protective equipment (PPEs) i.e. safety shoes & goggle, helmet, coverall, gloves, ear plugs, safety harness in case working at height etc during construction related activities to ensure health and safety of the workers at workplace.
- The contractor workers during construction phase will be housed in labour camps with provision of cooking fuel, sanitation facilities, potable water supply and medical health care centre.
- First aid and onsite sanitation arrangements will be made for drivers and other contractor workers during construction phase.
- Periodic health surveillance will be undertaken for personnel operating near high noise generating equipment viz. turbines, compressors etc. The audiometric records will be maintained for treatment for hearing loss if any
- All high noise generating areas and equipment will be identified and rotation of workers/site personnel including provision of proper PPEs for those operating in such areas
- Adequate light and ventilation shall be provided for the workers working in confined spaces.
- Passageways for pedestrians and vehicles within and outside buildings should be segregated and provide for easy, safe, and appropriate access
- Equipment and installations requiring servicing, inspection, and/or cleaning should have unobstructed, unrestricted, and ready access

- Hand, knee and foot railings should be installed on stairs, fixed ladders, platforms, permanent and interim floor openings, loading bays, ramps, etc.
- Provision of first-aid kits at all work areas onsite. Appropriately equipped first-aid stations should be easily accessible throughout the place of work
- Eye-wash stations will be provided close to all workstations where immediate flushing with water is the recommended first-aid response
- Safety signage and posters will be displayed at strategic locations within the site. Hazardous areas (electrical rooms, compressor rooms, etc.), installations, materials, safety measures, and emergency exits, etc. should be marked appropriately.
- Monitoring weather forecasts for outdoor work to provide advance warning of extreme weather and scheduling work accordingly
- Providing temporary shelters onsite for protection of workers against extreme weather condition during working activities or for use as rest areas.
- Provisions should be made to provide OHS orientation training to all new employees to ensure they are apprised of the basic site rules of work at / on the site and of personal protection and preventing injury to fellow employees.
- Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. Any site-specific hazard or colour coding in use should be thoroughly reviewed as part of orientation training. Establishment of procedures and systems for reporting and recording occupational accidents and diseases. All reported occupational accidents, occupational diseases together with near misses should be investigated with the assistance of a person knowledgeable/competent in occupational safety.

8.3.12 Disaster Management Plan

The disaster management plan gives a broad idea of the detailed emergency preparedness in case of an accident. The detailed emergency preparedness plan should be prepared on commissioning of the plant with the help of staffs working at the plant.

The Emergency Management Plan envisages the need for providing appropriate action so as to minimize loss of life/property and for restoration of normalcy within the minimum time in event of any emergency. Adequate manpower, training and infrastructure shall achieve this. An appropriate fire protection system is also developed to meet any emergency.

The emergencies are classified as construction hazard, natural hazard and operational hazard. During the construction time good construction practice and safety requirement should be enforced by the contractor at site. The construction manager can be the coordinator for the emergency management.

Depending on the severity of the injury/ disaster outside medical help can be obtained. Before commencement of the work the hospital facilities should be identified and the address and phone numbers to be available to the contractor as well as the construction manager. During natural hazard the emergency plan to be implemented with the help and guidance from the district collector, who is the coordinator for such activity. During operation, the plant manager becomes the coordinator for the emergency activity and the emergency cell will be acting in accordance with the disaster management plan (DMP).

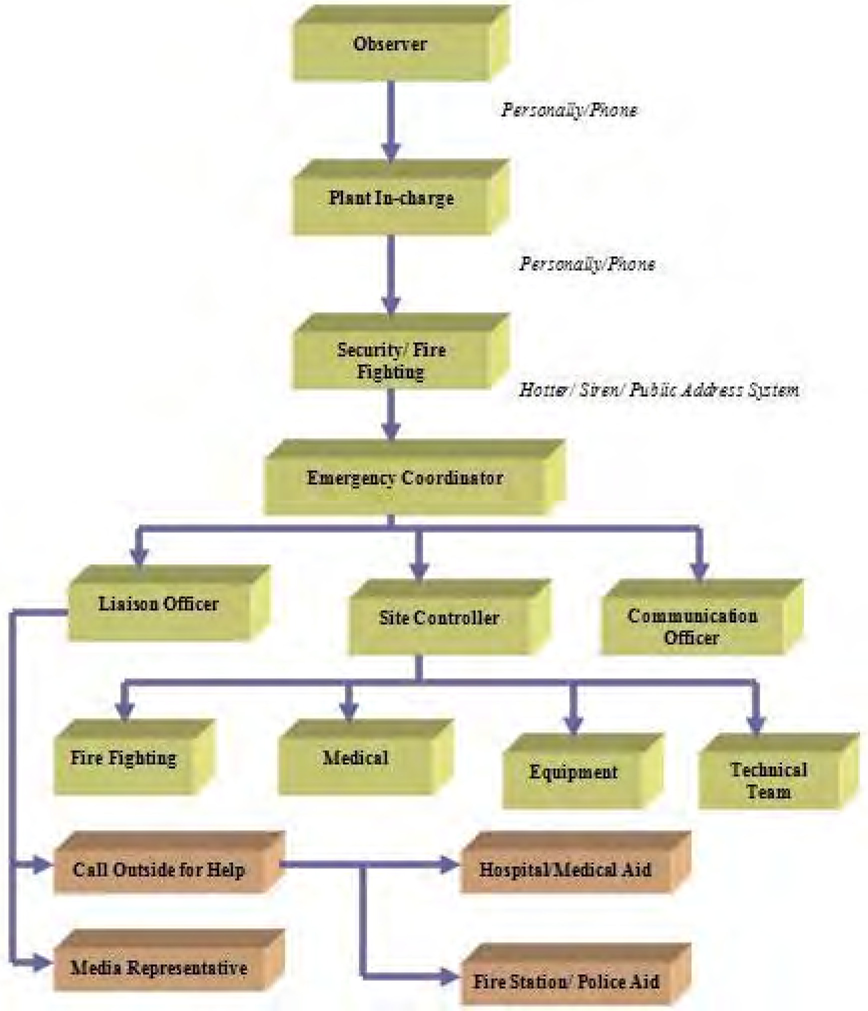
The following important elements in the disaster management plan (DMP) are suggested to effectively achieve the objectives of emergency planning:

- Reliable and early detection of an emergency i.e. flood, fire etc, and careful planning.
- The command, co-ordination, and response organization structure along with efficient trained personnel.
- The availability of resources for handling emergencies.
- Appropriate emergency response actions.
- Effective notification and communication facilities.
- Regular review and updating of the DMP
- Proper training of the concerned personnel.

Sequence of Action

In order to handle disaster/emergency situations, an organizational chart entrusting responsibility to various plant personnel has been prepared along with their specific roles during an emergency. The possible composition of the management team is given in Figure 8.3.

Figure 8.3 Disaster Management Team



Infrastructure

Following infrastructure & operational systems should be provided to meet emergencies.

- First aid boxes
- Gas masks
- Telephone line with STD facility
- Emergency lighting system
- Stretchers
- Transport facility
- Fire-fighting machinery
- Fire-tenders
- Ambulance
- Assembly Points

Assembly points are to be set up furthest from the location of likely hazardous events, where pre-designated persons would assemble in case of emergency. The location near to the entrance gate is one of the safest places. This can be the assembly point.

Communication System

Different types of alarms to differentiate types of emergencies should be provided. In case of failure of siren, placards of various colours should be used to indicate the situations. If everything fails, a messenger should be used for sending the information and the various placards mentioned would also be used.

Alarms should be followed by announcement over Public Address System. In case of failure of alarm system, communication should be by telephone operator who will make announcement in plant through Public Address System, which should be installed. Walkie-talkie and paging systems using predetermined codes of communication are very useful during emergency.

Warning System and Control

The control centres shall be located at an area of minimum risk or vulnerability in premises concerned, taking into account the wind direction, areas which might be affected by fire/explosion, toxic releases etc.

Emergency & Medical Services

This includes fire -fighting system, first aid center, hospital etc. Alternate sources of power supply for operating fire -pumps, communication with local bodies, fire -brigade etc. should also be clearly identified. Adequate number of external and internal telephone connections should be installed. The proponent is also required to provide first aid attendants for the facility as well as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital.

Fire Protection System

The fire protection system for the proposed plant is to consist of:

- Hydrant system for all the vulnerable areas of the plant.
- Portable carbon-dioxide extinguishers for the control room.
- Portable hand appliances of suitable types/ capacities for extinguishing small fires in selected areas of the plant.

BSPGCL will consider the level of local fire fighting capacity and whether equipment is available for use at the facility in the event of a major emergency or natural disaster. If insufficient capacity is available, fire fighting capacity should be acquired that may include pumps, water supplies, trucks, and training for personnel.

The emergency plan will have the key personnel of the organization and responsibilities assigned to them in case of an emergency and their telephone numbers. These telephone numbers and persons will be finalized after commissioning of the plant.

Training & Updating

The DMP requires maintenance, review, and updating to account for changes in equipment, personnel, and facilities. Training programs and practice exercises provide for testing systems to ensure an adequate level of emergency preparedness. The training programs will developed to identify training needs based on the roles and responsibilities, capabilities and requirements of personnel in an emergency. In addition a training plan will also be formulated to address needs particularly for fire -fighting, spill response and evacuation.

8.4 BUDGETARY PROVISIONS FOR EMP IMPLEMENTATION

Adequate budgetary provision has been made by the BSPGCL for execution of environmental management plan. The budget will give overall investment on the environmental safeguards and recurring expenditure for successful monitoring and implementation of control measures. The EMP budget has been prepared considering the 3 years construction phase. The operational phase budget is for 5 years; after completion of 5 year operational period the budget will be revised and funds will be allocated for the project.

8.5 ENVIRONMENT MANAGEMENT MATRIX

The environmental mitigation measures and plans are presented in form of a matrix according to the sequential flow of activities in the project life cycle. The matrix focuses on strategies to be adopted for safe guard of the environment from possible impacts resulting out of the project activities (Refer Table 8.3).

Table 8.3 Environmental Management Matrix

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
A.	Design & Planning								
A.1	Physical presence of main plant	A.1.1	Procurement of land parcel for main plant	Potential impact on land use change (agriculture to industrial)	The design team has identified the main plant within the existing plant of BTPS	Section 8.3.1	Design Team	BSPGCL	Not required, as using existing land
A.2	Physical presence of ash pond and water intake facility	A.2.1	Procurement of land parcel for ash pond and water intake facility	Potential impact on land use change (agriculture to industrial)	The design team has planning to accommodate the ash in the proposed ash pond for Unit. No. 6 to 9. BSPGCL had identified the Govt. land for setting up the ash pond and water intake facility.	Section 8.3.1	Design Team	BSPGCL	Govt. of Bihar
				Potential impact on livelihood and occupation	The identified land for ash pond and water intake facility is currently being used for agriculture purpose. BSPGCL will properly compensate the land users as per Govt. procedure	Section 8.3.1	Design Team	BSPGCL	Govt. of Bihar
		A.2.2	Changes in topography & local drainage	Potential to impact on local drainage	Site preparation planning designing takes into account of topography, slope, cross drainage	Section 8.3.1	Design Team	BSPGCL	Govt. of Bihar
A.3	Designing of Ash pond & Ash slurry pipeline	A.3.1	Sourcing of cut & fill material	Potential adverse impact on land use & soil quality	Project execution team shall identify the Govt. approved quarry for sourcing of fill & cut materials	Section 8.3.1	Contractor	BSPGCL	BSPGCL
		A.3.2	Liner system	Potential adverse impact on ground water quality	HDPE liner system will be provided in ash pond	Section 8.3.1	Design Team	BSPGCL	BSPGCL
A.4	Water intake pipeline layout	A.4.1	Water intake pipeline layout	Relocation and rehabilitation of shops/	Pipeline alignment has considered the finalising the	Section 8.3.1	Design Team	BSPGCL	BSPGCL

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
				houses	layout to minimise the disturbance of existing structures like shops, houses and IOCL pipeline				
A.5	Selection of fuel and pollution control system	A.5.1	Ash and sulphur content in coal and sulphur content in LDO	Potential impact on ambient air quality	Indian coal with 44.6% ash content and 0.3% S content has be considered for designing of pollution control system. Design team shall consider ESP efficiency rate to meet the new fly ash emission standard of 30 mg/Nm³ Design team made provision of FGD space to meet the SO_2 emission standard; the team shall consider to meet new SO_2 emission standard of 100 mg/Nm³. The low NOx burner has been planned to control emission of NOx; team shall consider to meet new NOx emission standard of mg/Nm³.	Section 8.3.1	Design Team	BSPGCL	BSPGCL
A.6	Natural disaster (Flood & Earth quake)	A.6.1	Flooding of main plant and washout of fuel and chemical	Potential impact on surface water, soil, etc.	Design team made provision of flood protection bunds around (east & south) main plant. Design team has considered the ash dyke height above the HFL	Section 8.3.1	Design Team	BSPGCL	BSPGCL
A.7	Plant water system		Sourcing of	Potential impact on	Designing of CCW system.	Section	Design Team	BSPGCL	BSPGCL

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
			surface water from River Ganga	competitive users, especially during lean season	Designing the plant in zero discharge system The new unit has planned to achieve 3.2 m^3/MWh. The design team shall consider to meet the water consumption 2.5 m^3/MWh as per draft Notification	8.3.1			
A.8	Procurement of Machinery and Equipment		Preferential procurement of equipment/machinery with lower potential to pollute	Potential adverse impact to air quality because of gaseous pollutants	All equipment and machinery procured will have inbuilt pollution control device to reduce potential air pollution	Section 8.3.1	Contractor	BSPGCL	BSPGCL
				Potential adverse impact to noise quality in the surroundings	All equipment and machinery procured will have provisions for reduction of noise emissions at source.				
B.	Construction Phase								
B.1	Construction of main plant, ash pond and water intake facility	B.1.1	Stripping of top soil (ash pond & water intake facility)	Impact on soil quality	Stripping of top soil and properly stored for future use-plantation	Section 8.3.7 Top soil mgt. plan	Contractor	BSPGCL	Contractor
		B.1.2	Fugitive emission of dust from site during dry weather	Temporary impact on air quality due to increase in PM levels during site construction phase	Water sprinkling will be done on the access roads to control re-entrained dust during site preparation and construction	Section 8.3.2: Air quality mgt. plan	Contractor	BSPGCL	Contractor
		B.1.3	Emission of gaseous pollutants from vehicle and machineries	Temporary impact on air quality during site development & construction phase	Preventive maintenance of machinery to be undertaken as per manufacturers schedule	Section 8.3.2: Air quality mgt. plan	Contractor	BSPGCL	Contractor
		B.1.4	Noise emission from the vehicles	Temporary noise impact on residence of Malhipur	Restriction on all noise generating operations to	Section 8.3.3:	Contractor	BSPGCL	Contractor

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
			& machineries	village	daytime Vehicle & machinery would have appropriate engineering controls at source	Noise quality Mgt. plan			
B.2	Storage & Handling of Materials & Spoils	B.2.1	Emission of fugitive dust from loading & unloading operation	Temporary impact on air quality especially PM	All loading and unloading activities to be carried out as close as possible to the storage facilities. Proper handling of materials to ensure minimal emission of dust.	Section 8.3.2: Air quality mgt. plan	Contractor	BSPGCL	Contractor
		B.2.2	Accidental spillage of oil & chemicals	Potential contamination surface water body resulting impact on water quality	All spills to be reported and & contained to prevent entry of spilled chemicals/fuels to any surface water body or drainage channel	Section 8.3.4: Surface & Ground water mgt. plan	Contractor	BSPGCL	Contractor
				Potential impact on soil quality	All spills to be reported and remedial measures to be taken for clean up of the spill.	Section 8.3.7: Soil quality mgt. plan	Contractor	BSPGCL	Contractor
B.3	Transport of Materials, Spoils and Machinery		Emission of gaseous pollutants from vehicle during transportation of materials, spoils and machinery	Temporary deterioration on air quality along transport route		Section 8.3.2: Air quality mgt. plan	Contractor	BSPGCL	Contractor
			Fugitive dust emission & re-entrainment during material transportation	Temporary impact on air quality at the vicinity of the project site	Dry, unpaved areas and roads to be sprinkled with water to prevent fugitive emission. Vehicle transporting material will not be over loaded.	Section 8.3.2: Air quality mgt. plan	Contractor	BSPGCL	Contractor

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
					Covering of loose materials during transportation				
			Noise emission during transport of materials, spoils and machinery	Temporary deterioration in ambient noise along the transportation route	Preventive maintenance of vehicles to be undertaken as & when required All vehicular movements for hauling materials to be undertaken during daytime only	Section 8.3.3: Noise quality Mgt. plan	Contractor	BSPGCL	Contractor
			Increase of traffic density on site access road due to transport of materials, spoils and machinery	Safety concerns for the school children adjacent school and habitants abutting the road	Safety related awareness will be created among the school children & teacher Restriction of vehicular movement during certain periods when vulnerability is more	Section 8.3.9: Road & Traffic mgt.	Contractor	BSPGCL	Contractor
B.4	Discharge of surface runoff	B.4.1	Discharge treated surface runoff into the surface water body	Contamination of surface water resulting deterioration of surface water quality	All runoff water from the construction sites will be channelized into sedimentation tanks; after treatment will be discharged into the surface water body.	Section 8.3.4: Surface & ground water mgt.	Contractor	BSPGCL	Contractor
B.5	Operation of Labour camps	B.5.1	Generation of MSW & disposal in undesignated site	Contamination of soil	Solid wastes will be temporarily stored in the labour camp and disposed in the municipal dumping ground.	Section 8.3.6: Solid waste mgt. plan	Contractor	BSPGCL	Contractor
			Generation of sewage, treatment & disposal	Potential impact on soil receiving surface water & ground water	Sewage will be treated through septic tank and soak pit.	Section 8.3.5: Waste water mgt. plan	Contractor	BSPGCL	Contractor
C.	Operation of Plant								

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
C.1	Operation of CHP	C.1.1	Fugitive emission	Potential impact on air quality at the vicinity of the plant	Dust suppression measures through water sprinkling. Crushing unit with bag filter	Section 8.3.2: Air quality mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
		C.1.2	Generation of noise	Deterioration of ambient noise level around the plant	Control of noise level through plant design. Greenbelt around plant	Section 8.3.3: Noise quality Mgt. plan & Section 8.3.10: Greenbelt mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.2	Operation of BTG	C.2.1	Generation of noise	Deterioration of ambient noise level around the plant. Potential impact on occupational health	Engineering control measures- building design Provision of PPE to workers	Section 8.3.3: Noise quality Mgt. plan & Section 8.3.11: occupational health mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.3	Operation of stack	C.3.1	Emission particulate matter & gaseous pollutants	Potential impact on ambient air quality in the air shed	Engineering control measures like ESP	Section 8.3.2: Air quality mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.4	Operation of Ash handling system	C.4.1	Fugitive emission	Potential impact on ambient air quality	Dry ash collection system in ash silos and pneumatic collection system.	Section 8.3.2: Air quality mgt. plan. Section 8.3.6: Solid waste mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.5	Operation of Ash pond	C.5.1	Disposal in ash	Potential to contaminate	Effective liner system in ash	Sec. 3.10.5:	BSPGCL	HSE, BSPGCL	BSPGCL

	Activity		Aspect	Impact	Mitigation Measures	EMP Ref.	Responsibility	Supervision	Source of Fund
			pond	the ground water.	pond. Collection of supernatant ash pond water and reuse in ash handling system.	waste water mgt. plan			
C.6	Operation of SW treatment plant, DM plant, cooling tower	C.6.1	Generation of plant effluent	Potential to contaminate the ground water and receiving surface water.	Treatment of plant effluent through ETP, reuse of treated water.	Section 8.3.5: waste water mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.7	Surface runoff from plant area	C.7.1	Discharge of contaminated surface water	Potential to contaminate the receiving soil and surface water	Treatment of runoff water through oil trap and sedimentation tank and discharge in drainage channel, meeting the discharge std,	Section 8.3.8: Storm water mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
C.8	Operation of residential colony	C.8.1	Generation of MSW	Contamination of soil	Solid wastes will be temporarily stored in the residential colony and disposed in the municipal dumping ground.	Section 8.3.6: Solid waste mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL
		C.8.2	Generation of sewage	Potential impact on soil receiving surface water & ground water	Sewage will be treated through septic tank and soak pit.	Section 8.3.5: Waste water mgt. plan	BSPGCL	HSE, BSPGCL	BSPGCL

9 SUMMERY & CONCLUSION

The GoI has planned a mission "POWER TO ALL BY 2019". Growth in economy and population has resulted in rise in the growth rate for demand of power. The GoI, through the Ministry of Power and Bihar state, is targeting to secure a supply capacity of about 5,243 MW until 2015-2016, to achieve its declared mission of 'power to all' and annual growth rate as of 9-10%. In order to reduce the duration for setting up of the new power station, Bihar State Power Generation Company Ltd. (BSPGCL) has planned the extension of existing Barauni Thermal Power Station. The proposed expansion of 1 x 660 MW super critical coal based thermal power plant has been planned taking into consideration all the laws, rules, codes of practices.

The environmental consideration also planned for the proposed supercritical coal fired thermal power plant; these are as follows:

- Superior thermal efficiency;
- Better heat rate, low fuel consumption, even though fragmentally high initial cost;
- Commendable performance record of the above sets in India & abroad; and
- Reduction in emission like, CO_2, SOx, NOx, SPM with application of supercritical technology.

The project is planned over an area of 680 acres of land. Of the total land required for the project, 370 acres of main plant land is under the possession of BSPGCL. The land (290 acres) identified for proposed ash pond is Government land under Land and Revenue Department. The estimate water requirement for the proposed expansion unit (1 x 660 MW) is about 2140 m^3/ hr (21 cusec) and will be sourced from River Ganga which is approximately 3.5 km from the plant. The annual coal requirement will be about 3.5 MTPA and domestic coal will be utilised.

This ESIA was focused on interactions between the Project activities and various resources/receptors that could result in significant impacts. Table 9.1presents the outcomes of the comprehensive assessment of identified impacts as a result of the various phases of the Project.

Table 9.1 Impact Assessment Summary

Impact Description	Impact Nature	Significance of Impact	
		Without Mitigation Measures	With Mitigation Measures
Construction Phase			
Visual & Aesthetic	Negative	Moderate	Minor
Air Quality	Negative	Moderate	Minor
Noise quality	Negative	Moderate	Minor
Land use	Negative	Minor	Negligible
Soil quality	Negative	Moderate	Minor

Impact Description	Impact Nature	Significance of Impact	
		Without Mitigation Measures	With Mitigation Measures
Topography & drainage	Negative	Moderate	Minor
Surface water quality	Negative	Minor	Negligible
Ground water quality	Negative	Minor	Negligible
Biological environment – terrestrial ecosystem	Negative	Negligible	Negligible
Livelihood and land based Impacts in the Ash Dyke Area	Negative	Major	Moderate
Displacement and resettlement impacts in the ash pipeline area	Negaltive	Moderate	Minor
Obstruction due to pipeline construction at Simriya ghat	Negative	Moderate	Minor
Labour Influx/ In-migration	Negative	Moderate	Minor
Community Health and Safety	Negative	Moderate	Minor
Economic opportunity	Positive	-	
Occupational Health and Safety	Negative	Moderate	Minor
Public Health	Negative	Moderate	Minor
Operational Phase			
Visual & Aesthetic	Negative	Minor	Negligible
Air Quality (fugitive emission)	Negative	Minor	Negligible
Air Quality (stack emission – Unit # 10)	Negative	Minor	Negligible
Air Quality (stack emissions – Unit # 6, 7, 8, 9 and 10	Negative	Moderate	Minor
Noise quality	Negative	Moderate	Minor
Soil quality	Negative	Minor	Negligible
Surface water resources	Negative	Moderate	Minor
Surface water quality	Negative	Minor	Negligible
Ground water quality	Negative	Minor	Negligible
Biological environment – terrestrial ecosystem	Negative	Minor	Negligible
Biological environment –aquatic ecosystem	Negative	Minor	Negligible
Occupational Health and Safety	Negative	Moderate	Minor
Community Health and Safety	Negative	Moderate	Minor
Job & economic opportunity	Positive	-	-

It is evident from the above table that most of the impacts during construction and operation phase are of minor to moderate impact significance with already embedded mitigation/ control measures adopted in the project. However, one major significance impact is linked with the livelihood loss due to construction of ash dyke/ pond for the proposed project (which will also cater the requirement of Unit 6, 7, 8 and 9). Proper mitigation measures will be taken during construction and operational phase to minimise the impact. The industrial development in the area will bring job and business opportunity for the locals and promote economic development in the region as a whole.

However, in spite of the earnest attempt of BSPGCL to develop the project in a sustainable environmental and social manner, some issues like livelihood loss, cultural conflict of the migratory workforce with the locals, impact on ambient air quality and community health due stack emission could occur. However, BSPGCL will strive to minimize the impacts by proper monitoring and surveillance of the project both during construction and operational phases in line with the Environmental Clearance Guidelines provided by MoEF&CC and also consistent with industry best practices.

Power plant is a strategically important industry which helps developing nations such as India drive industrial growth and economic development. The industry has the potential to attract direct and indirect investments, generate employment, and promote industrial growth in the region.

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Annex 2.1

Copy of EC for 2 x 250 MW Unit

J-13012/143/2008-IA.II (T)
Government of India
Ministry of Environment & Forests

Paryavaran Bhawan
CGO Complex, Lodi Road
New Delhi-110003

Dated: 8th May, 2014

To

M/s Bihar State Power Generation Company Ltd.,
(Department of Project & Design),
Vidyut Bhawan, Bailey Road,
Patna - 800001.

Telefax: 0612-2504984.

Sub: **2x250 MW Barauni (Extension) Thermal Power Project at Village Barauni, Districts Begusarai & Patna, Bihar by M/s Bihar State Power Generation Company Ltd. – reg. Environmental Clearance.**

Sir,

The undersigned is directed to refer to your letters dated 29.10.2013, 27.11.2013, 05.12.2013, 31.12.2013, 29.01.2014 and 03.02.2014 on the subject mentioned above. The Ministry of Environment & Forests has examined the application.

2. It is noted that the proposal is for setting up of 2x250 MW Barauni (Extension) Thermal Power Project at Village Barauni, District Begusarai & Patna, Bihar. The total project area for the proposed extension project is 624 acres of which the plant area (including green belt), the ash pond area (including green belt) and area for support facilities is 314 acres, 290 acres and 20 acres respectively. A similar philosophy as that of Pragati –I & II in Delhi, Anpara –D in U.P. and Ennore SEZ in Tamil Nadu regarding power plant construction on old ash ponds would be followed where in the entire ash lying at the project site would be compacted and retained at the same location covered with a suitably layer of good soil. There would be no displacement of ash from the existing ash pond area. The plant site co-ordinates are Latitude 25º23'13.5" N to 25º23'54" N & Longitude 86º01'05.1" E to 86º01'46.3" E and the ash pond co-ordinates are Latitude 25º21'54.05" N to 25º22'27.11" N & Longitude 86º02'26.4" E to 86º03'21.21" E. There are no National Parks, Wildlife Sanctuaries, Biosphere/Elephant/Tiger Reserves, Heritage sites within 10 km of the project site.

3. Tapering coal linkage from Eastern Coalfields Limited (ECL) of GCV grade of G10 and above coal (ash content, sulphur content and GCV are in the range of 12.1 - 40.1%, 0.2 – 0.6 %, and 4,750 – 6,725 Kcal/Kg) was accorded till the allocated coal block (Urma Paharitola) becomes operational. The water requirement is estimated to be 2530 m^3/h, which will be met from River Ganga flowing at a distance of about 3 km. Water Resources Department, Govt. of Bihar has accorded permission for 60 cusecs of water drawl for the existing as well as the proposed units. CWC has approved 45 cusecs of water for the proposed TPP for the lean season i.e. January to May. Public hearing/public consultation was conducted by the Bihar State Pollution Control Board on 08.07.2011 and 11.11.2011 in Districts Begusarai and Patna respectively. The project cost is around Rs. 3,666 crores.

4. The proposal has been considered in accordance with the provisions of the EIA Notification issued by the Ministry of Environment & Forests vide S.O. 1533 (E), dated September 14, 2006.

5. Based on the information submitted by you and presentations made by you and your consultant viz. M/s Bhagavathi Ana Labs Limited, Hyderabad, before the Expert Appraisal Committee (Thermal Power) in its 8th and 11th meetings held during January 9-10, 2014 and February 13-14, 2014 respectively, the Ministry of Environment and Forests hereby accords environmental clearance to the above project under the provisions of EIA Notification dated September 14, 2006, subject to the compliance of the following Specific and General conditions:

A. Specific Conditions:

(i) Vision document specifying prospective plan for the site shall be formulated and submitted to the Regional Office of the Ministry within **six months**.

(ii) Harnessing solar power within the premises of the plant particularly at available roof tops shall be undertaken and status of implementation shall be submitted periodically to the Regional Office of the Ministry.

(iii) Sulphur and ash contents in the coal to be used in the project shall not exceed 0.6 % and 40.1 % respectively at any given time. In case of variation of coal quality at any point of time, fresh reference shall be made to the Ministry for suitable amendments to environmental clearance condition (s) wherever necessary.

(iv) A stack of 275 m height shall be provided with continuous online monitoring equipments for SOx, NOx and $PM_{2.5}$ & PM_{10}. Exit velocity of flue gases shall not be less than 22 m/sec. Mercury emissions from stack shall also be monitored on periodic basis.

(v) High Efficiency Electrostatic Precipitators (ESPs) shall be installed to ensure that particulate emission from the proposed plant does not exceed 50 mg/Nm^3.

(vi) Adequate dust extraction system such as cyclones/ bag filters and water spray system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.

(vii) Fly ash shall not be used for agricultural purpose. No mine void filling will be undertaken as an option for ash utilization without adequate lining of mine with suitable media such that no leachate shall take place at any point of time. In case, the option of mine void filling is to be adopted, prior detailed study of soil characteristics of the mine area shall be undertaken from an institute of repute and adequate clay lining shall be ascertained by the State Pollution Control Board and implementation done in close co-ordination with the State Pollution Control Board.

(viii) Fly ash shall be collected in dry form and storage facility (silos) shall be provided. Unutilized fly ash shall be disposed off in the ash pond in the form of slurry form. Mercury and other heavy metals (As, Hg, Cr, Pb etc.) will be monitored in the bottom ash as also in the effluents emanating from the existing ash pond. No ash shall be disposed off in low lying area.

(ix) Ash pond shall be lined with HDPE/LDPE lining or any other suitable impermeable media such that no leachate takes place at any point of time. *A strong embankment shall be constructed around the ash dyke and TPP to prevent the flood waters entering into the site. The stability of these embankments shall be assessed by reputed institutes like CWPRS, Pune and the recommendations of the institute shall accordingly be implemented.*

(x) Fugitive emission of fly ash (dry or wet) shall be controlled such that no agricultural or non-agricultural land is affected. Damage to any land shall be mitigated and suitable compensation provided in consultation with the local Panchayat.

(xi) A long term study of radio activity and heavy metals contents on coal to be used shall be carried out through a reputed institute and results thereof analyzed every two year and reported along with monitoring reports. Thereafter mechanism for an in-built continuous monitoring for radio activity and heavy metals in coal and fly ash (including bottom ash) shall be put in place.

(xii) No water bodies including natural drainage system in the area shall be disturbed due to activities associated with the setting up / operation of the power plant.

(xiii) COC of atleast 5.0 shall be adopted.

(xiv) A well designed rain water harvesting system shall be put in place within six months, which shall comprise of rain water collection from the built up and open area in the plant premises and detailed record kept of quantity of water collected and its use. Action plan and road map for implementation shall be submitted to the Regional Office of Ministry.

(xv) Hydrogeology of the area shall be reviewed annually from an institute/ organization of repute to assess impact of surface water and ground regime (especially around ash dyke). In case any deterioration is observed specific mitigation measures shall be undertaken and reports/ data of water quality monitored regularly and maintained shall be submitted to the Regional Office of the Ministry.

(xvi) Monitoring of surface water quantity and quality shall also be regularly conducted and records maintained. The monitored data shall be submitted to the Ministry regularly. Further, monitoring points shall be located between the plant and drainage in the direction of flow of ground water and records maintained. Monitoring for heavy metals in ground water shall be undertaken.

(xvii) Wastewater generated from the plant shall be treated before discharge to comply limits prescribed by the SPCB/CPCB.

(xviii) No discharge in the River is permitted except if the quality of the effluent is of the same quality or better as that of River.

(xix) Additional soil for leveling of the proposed site shall be generated within the sites (to the extent possible) so that natural drainage system of the area is protected and improved.

(xx) Green Belt consisting of three tiers of plantations of native species around plant and at least 50 m width shall be raised. Wherever 50 m width is not feasible a 20 m width shall be raised and adequate justification shall be submitted to the Ministry. Tree density shall not be less than 2500 per ha with survival rate not less than 80 %.

(xxi) The project proponent shall also adequately contribute in the development of the neighbouring villages. Special package with implementation schedule for free potable drinking water supply in the nearby villages and schools shall be undertaken in a time bound manner.

(xxii) As committed, an amount of Rs 21.996 Crores as one time capital investment shall be earmarked for activities to be taken up under CSR during construction phase of the Project. Recurring expenditure for CSR thereafter shall be Rs 3.66 Crores per annum or as per CSR guidelines of Govt. of India, whichever is more till the life of the plant.

(xxiii) For proper and periodic monitoring of CSR activities, a CSR committee or a Social Audit committee or a suitable credible external agency shall be appointed. CSR activities shall also be evaluated by an independent eternal agency. This evaluation shall be both concurrent and final.

(xxiv) CSR schemes identified based on need based assessment shall be implemented in consultation with the village Panchayat and the District Administration starting from the development of project itself. As part of CSR prior identification of local employable youth and eventual employment in the project after imparting relevant training shall be also undertaken. Company shall provide separate budget for community development activities and income generating programmes.

(xxv) An Environmental Cell comprising of at least one expert in environmental science / engineering, occupational health and social scientist, shall be created preferably at the project site itself and shall be headed by an officer of appropriate superiority and qualification. It shall be ensured that the Head of the Cell shall directly report to the head of the organization who would be accountable for implementation of environmental regulations and social impact improvement/mitigation measures.

B. General Conditions:

(i) The treated effluents conforming to the prescribed standards only shall be re-circulated and reused within the plant. Arrangements shall be made that effluents and storm water do not get mixed.

(ii) A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising greenbelt/plantation.

(iii) Adequate safety measures shall be provided in the plant area to check/minimize spontaneous fires in coal yard, especially during summer season. Copy of these measures with full details along with location plant layout shall be submitted to the Ministry as well as to the Regional Office of the Ministry.

(iv) Storage facilities for auxiliary liquid fuel such as LDO/ HFO/LSHS shall be made in the plant area in consultation with Department of Explosives, Nagpur. Disaster Management Plan shall be prepared to meet any eventuality in case of an accident taking place due to storage of oil.

(v) First Aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.

(vi) Noise levels emanating from turbines shall be so controlled such that the noise in the work zone shall be limited to 85 dB(A) from source. For people working in the high noise area, requisite personal protective equipment like earplugs/ear muffs etc. shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc shall be periodically examined to maintain audiometric record and for treatment for any hearing loss including shifting to non noisy/less noisy areas.

(vii) Regular monitoring of ambient air ground level concentration of SO_2, NOx, $PM_{2.5}$ & PM_{10} and Hg shall be carried out in the impact zone and records maintained. If at any stage these levels are found to exceed the prescribed limits, necessary control measures shall be provided immediately. The location of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB. Periodic reports shall be submitted to the Regional Office of this Ministry. The data shall also be put on the website of the company.

(viii) Provision shall be made for the housing of construction labour (as applicable) within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.

(ix) The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned within seven days from the date of this clearance letter, informing that the project has been accorded environmental clearance and copies of clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the Ministry of Environment and Forests at http://envfor.nic.in.

(x) A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parisad / Municipal Corporation, urban local Body and the Local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.

(xi) The proponent shall upload the status of compliance of the stipulated environmental clearance conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MOEF, the respective Zonal Office of CPCB and the SPCB. The criteria pollutant levels namely; SPM, RSPM ($PM_{2.5}$ & PM_{10}), SO_2, NO_x (ambient levels as well as stack emissions) shall be displayed at a convenient location near the main gate of the company in the public domain.

(xii) The environment statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of environmental clearance conditions and shall also be sent to the respective Regional Offices of the Ministry by e-mail.

(xiii) **The project proponent shall submit six monthly reports on the status of the implementation of the stipulated environmental safeguards to the Ministry of Environment and Forests, its Regional Office, Central Pollution Control Board and State Pollution Control Board. The project proponent shall upload the status of compliance of the environmental clearance conditions on their website and update the same periodically and simultaneously send the same by e-mail to the Regional Office, Ministry of Environment and Forests.**

(xiv) Regional Office of the Ministry of Environment & Forests will monitor the implementation of the stipulated conditions. A complete set of documents including Environmental Impact Assessment Report and Environment Management Plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring. Project proponent will up-load the compliance status in their website and up-date the same from time to time at least six monthly basis. **Criteria pollutants levels including NO_x (from stack & ambient air) shall be displayed at the main gate of the power plant.**

(xv) Separate funds shall be allocated for implementation of environmental protection measures along with item-wise break-up. These cost shall be included as part of the project cost. The funds earmarked for the environment protection measures shall not be diverted for other purposes and year-wise expenditure should be reported to the Ministry.

(xvi) The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and final approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant.

(xvii) Full cooperation shall be extended to the Scientists/Officers from the Ministry / Regional Office of the Ministry / CPCB/ SPCB who would be monitoring the compliance of environmental status.

6. The Ministry of Environment and Forests reserves the right to revoke the clearance if conditions stipulated are not implemented to the satisfaction of the Ministry. The Ministry may also impose additional environmental conditions or modify the existing ones, if necessary.

7. The environmental clearance accorded **shall be valid for a period of 5 years** from the date of issue of this letter to start operations by the power plant.

8. Concealing factual data or submission of false/fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of Environment (Protection) Act, 1986.

9. In case of any deviation or alteration in the project proposed including coal transportation system from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of the condition(s) imposed and to add additional environmental protection measures required, if any.

10. The above stipulations would be enforced among others under the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and rules there under, Hazardous Wastes (Management, Handling & Transboundary Movement) Rules, 2008 and its amendments, the Public Liability Insurance Act, 1991 and its amendments.

11. Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.

Yours faithfully,

(Dr. Saroj)
Director

Copy to:

1. The Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi 110001.
2. The Chairman, Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi-110066.
3. The Chairman, Central Pollution Control Board, Parivesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi- 110032.
4. The Secretary (Environment), Forests and Environment Department, Government of Bihar.
5. The Chairman, Bihar State Pollution Control Board, Beltron Bhawan, Shastri Nagar, Jawahar Lal Nehru Marg, Patna, Bihar - 800023
6. The Chief Conservator of Forests, Ministry of Environment and Forests, Regional Office (EZ), A/3, Chandersekhapur, Bhubaneswar – 751023.
7. The District Collector, Begusarai District, Govt. of Bihar.
8. The District Collector, Patna District, Govt. of Bihar.
9. Guard file.

(Dr. Saroj)
Director

Annex 2.2:

Letter from Water Resource Department, Govt. of Bihar

(23)

बिहार सरकार

जल संसाधन विभाग

पत्रांक-मो0 4 कार्य पी0 230/99 ... /पटना, दिनांक 18.6.07

प्रेषक,

ई0 श्याम नन्दन प्रसाद
संयुक्त सचिव (अभियंत्रण)

सेवा में,

श्री स्वपन मुखर्जी,
अध्यक्ष,
बिहार राज्य विद्युत बोर्ड,
विद्युत भवन, बेली रोड, पटना ।

विषय:- बरौनी थर्मल पावर, बेगुसराय के लिए गंगा नदी से 60 घनसेक जल लेने के राज्य सरकार की अनुमति के संबंध में।

प्रसंग:- आपका पत्रांक 29/प्रोजेक्ट-4038/06-496 दिनांक 6.6.2007

महाशय,

निदेशानुसार उपर्युक्त विषयक प्रासंगिक पत्र से प्राप्त प्रस्ताव के आलोक में बरौनी थर्मल पावर स्टेशन, बेगुसराय के विस्तारिकरण 2x250 MW के लिए गंगा नदी से 60 घनसेक जल की आपूर्ति लेने के संबंध में निम्नलिखित शर्तों के अधीन राज्य सरकार की स्वीकृति संसूचित की जाती है:-

1. इस जलापूर्ति के लिए बी0एस0ई0बी0 को राज्य सरकार के जल संसाधन विभाग के संग विधिवत एकरारनामा करना होगा । गंगा से जलापूर्ति लेने के एवज में विद्युत बोर्ड द्वारा जल संसाधन विभाग को प्रतिवर्ष 6.375 करोड़ देनी होगी ।

2. गंगा नदी से जलापूर्ति लेने हेतु डिलिभरी व्यवस्था निर्माण पर विभाग की पूर्वानुमति बी0एस0ई0बी0 को लेनी होगी ।

3. गंगा नदी से औद्योगिक आवश्यकता हेतु जल की आपूर्ति लेने पर बी0एस0ई0बी0 को वर्त्तमान में चालू दर अथवा भविष्य में होने वाले पुनरीक्षण के अनुसार दर पर बी0एस0ई0बी0 को जल संसाधन विभाग को शुल्क का भुगतान करना होगा ।

विश्वासभाजन,

(श्याम नन्दन प्रसाद)
संयुक्त सचिव (अभियंत्रण)

5696/U
21/6/07

CE (G)
26
2/6

2315/M (Tra-1)
22-6-07

683/C.E.(Gen.)
22/6

ESE-2 (P&D)
ESE-1 (P&D)
25.6.07

EEK-2 (P&D)
25.6.07

Annex 2.3

Letter from Central Water Commission

140 A

M (G)
CE (P&O)

No. 7/2/2BH()/2003-IP(N)/ 535-37
CENTRAL WATER COMMISSION
IRRIGATION PLANING (NORTH) DTE.

204 (S) Sewa Bhawan
R.K. Puram, New Delhi
Dated 23/08/2010

To

The Principal Secretary,
Water Resources Department,
Govt. of Bihar,
Sinchai Bhawan,
PATNA - 800015

Sub: Barauni Thermal Power Station existing units (2x50 MW + 2x110 MW) & 2x250 MW extension Project clearance of water availability Reg.

Ref: State Govt. Letter No. Mo-4-Woks-P-230/99 PartIII/1301 dated 18.8.2010

Sir,

Kindly refer to the letter cited on the above subject regarding water availability for Barauni Thermal Power Station (2x50 MW + 2x110 MW) & 2x250 MW extension Project. It is mentioned in the letter under reference that 45 cusec of water required for the above Thermal Power Project would be provided by the Govt. of Bihar through river Ganga, out of the water available in Eastern Gandak Canal System, during lean period, within its present utilization. In this regard, it may be noted that approval for withdrawal of 45 cusec for Muzaffarpur Thermal Power Project from the same system has already been conveyed vide this office letter no. 7/2/2BH(5)/2003-IP(N)/88-92 dated 19.2.2010

6095/Ch.
01/09/10

716/CE(P&D)
01/09/10

In this context, it is to mention that from the TAC Note of (Feb 2004) of project report of Eastern Gandak Canal System, Bihar, it is seen that the main canal was originally constructed for carrying 15645 cusec (443 cumec) of water. It is also stated in the TAC note that canal is not able to carry more than 7000 cusec (198 cumec). The project is conceived for restoration of the canal network to its original shape so that the irrigation potential is restored back to its original value of 6.62 lakh ha. against the area of 2.25 lakh ha. getting irrigation (annual irrigation).

In case Govt. of Bihar proposes to withdraw 45 cusecs of water from Eastern Gandak Canal System to use in Barauni Thermal Power Plant, the irrigation use from

Thermal Power

EJE(P&D)-II

Eastern Gandak Canal has to be reduced to the extent of 90 cusec including 45 cusec for Muzaffarpur Thermal Power Project. Bihar Govt. may keep this aspect in view

Subject to above stipulation, I am directed to convey the approval of Central Water Commission for the allocation of 45 cusec of water for Barauni Thermal Power Plant during the lean period (January to May).

However, the details of utilization of water from Eastern Gandak Canal System including the above project may be furnished for reference and record.

Yours faithfully,

Director, IP (N)

Copy to

1. Chief Engineer (PAO) for information and future reference. This may be reflected in the TAC note as and when the revised proposal of ERM of Eastern Gandak Canal is considered.
2. Additional General Manager – Incharge (Engg. Services) NTPC Ltd., Engineering office complex, A-8A, Sector-24, Noida-201301(U.P.)

Annex 2.4

Quality of Raw Water from River Ganga (Units mg/L)

	The Ganges [15]	The Ganges (from DCPL report)	World	Japan	The Kiso (Japan)
pH	7.63 ~ 8.9	8	-	-	-
Turbidity	≒ 1,000	702	-	-	-
Calcium Ion / Hardness, $CaCO_3$	108	76	15.0	8.8	6.4
Magnesium Ion / Hardness, $CaCO_3$	45.8	32	4.1	1.9	0.9
Sodium Ion / Hardness, $CaCO_3$	45.78	24	6.3	6.7	5.6
Potassium Ion	10	-	2.3	1.2	1.0
Hydrogen Carbonate Ion	120.36	-	58.4	31.0	16.9
Chloride Ion, Cl	59.22	10	7.9	5.8	4.7
Sulphate Ion	30	-	-	-	-
Dissolved Silica, SiO2	10	7.9	13.1	19.0	10.7
Iron	0.19	-	-	-	-
Total Hardness, $CaCO_3$	-	108	-	-	-
M-alkalinity (HCO_3), $CaCO_3$	-	104	-	-	-
P-alkalinity, as $CaCO_3$	-	0	-	-	-
Total dissolved Solids	-	130	-	-	-
Dissolved Oxygen, O	-	-	-	-	-

Annex 3.1

Ambient Noise Quality Standard

Area Code	Category of Area	Limiting Value	
		Day Time	Night Time
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone	50	40

Note:

- Daytime is reckoned in between 6 am and 9 pm.
- Nighttime is reckoned in between 9 pm and 6 am.
- Silence zone is defined as areas up to 100 meters around such premises as hospitals, education institutions and courts. Silence zone are to be declared by the competent Authority.

Annex 3.2

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA, USA)

Total Time of Exposure per Day in Hours (Continuous or Short term Exposure)	**Sound Pressure Level in dB(A)**
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115
Never	>115

[*Note: No exposure in excess of 115 dB(A) is to be permitted.*
For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.]

Annex 3.3

Emission Standard for Diesel Engines

<table>
<tr><td colspan="2" rowspan="2">Parameters</td><td rowspan="2">Area Category</td><td rowspan="2">Engine Rating</td><td colspan="3">Generator sets commissioning date</td></tr>
<tr><td>Before 1.7.03</td><td>Between 1.7.03 and 1.9.05</td><td>On or after 1.7.05</td></tr>
<tr><td colspan="2" rowspan="4">NOx (as NO_2) (at 15% O_2), dry basis, in ppmv</td><td>A</td><td>Up to 75 MW</td><td rowspan="2">1100</td><td rowspan="2">970</td><td rowspan="2">710</td></tr>
<tr><td>B</td><td>Up to 50 MW</td></tr>
<tr><td>A</td><td>More than 75 MW</td><td rowspan="2">1100</td><td rowspan="2">710</td><td rowspan="2">360</td></tr>
<tr><td>B</td><td>More than 150 MW</td></tr>
<tr><td colspan="2">NMHC (as C) (at 15% O_2), mg/Nm^3</td><td>Both A & B</td><td></td><td>150</td><td>100</td><td>100</td></tr>
<tr><td rowspan="2">PM (at 15% O_2), mg/Nm^3</td><td>Diesel fuels- HSD & LDO</td><td>Both A & B</td><td></td><td>75</td><td>75</td><td>75</td></tr>
<tr><td>Furnace Oils- LSHS & FO</td><td>Both A & B</td><td></td><td>150</td><td>100</td><td>100</td></tr>
<tr><td colspan="2">CO (at 15% O_2), mg/Nm^3</td><td>Both A & B</td><td></td><td>150</td><td>150</td><td>150</td></tr>
<tr><td colspan="2" rowspan="2">Sulphur content in fuel</td><td>A</td><td></td><td><2%</td><td><2%</td><td><2%</td></tr>
<tr><td>B</td><td></td><td><4%</td><td><4%</td><td><4%</td></tr>
<tr><td colspan="2">Fuel specification</td><td>For A only</td><td>Up to 5MW</td><td colspan="3">Only diesel fuels (HSD, LDO) shall be used</td></tr>
<tr><td colspan="2">Stack height (for generator sets commissioned after 1.7.03)</td><td colspan="5">Stack height shall be maximum of the following, in meter:
(i) 14 $Q^{0.3}$, Q = Total SO_2 emission from the plant in kg/hr
(ii) Minimum 6m, above the building height where generator set is installed
(iii) 30m</td></tr>
</table>

[Source: G.S.R. 498 (E), MoEF Notification, 9th July 2002]

[Category A: Areas within the municipal limits of towns/cities having population more than 10 lakhs and also up o 5km beyond the municipal limits of such to towns /cities.

Category B: Areas not covered by category A]

Annex 3.4:

General Standard for Discharge of Environmental Pollutants

S. No.	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/ coastal areas
1	Colour and odour	See 6 of Annexure-1I		See 6 of Annexure-1I	See 6 of Annexure-1I
2	Suspended solids mg/l, max.	100	600	200	(a) For process waste water (b) For cooling water effluent 10 per cent above total suspended matter of influent.
3	Particle size of suspended solids	shall pass 850 micron IS Sieve	-	-	(a) Floatable solids, solidsmax. 3 mm (b) Settleable solids, max 856 microns
4	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5	Temperature	shall not exceed 5°C above the receiving water temperature			shall not exceed 5°C above the receiving water temperature
6	Oil and grease, mg/l max,	10	20	10	20
7	Total residual chlorine, mg/l max	1.0	-	-	1.0
8	Ammonical nitrogen (as N),mg/l, max.	50	50	-	50
9	Total kjeldahl nitrogen (as N);mg/l, max. mg/l, max.	100	-	-	100
10	Free ammonia (as NH_3), mg/l,max.	5.0	-	-	5.0
11	Biochemical oxygen demand (3 days at 27°C), mg/l, max.	30	350	100	100
12	Chemical oxygen demand, mg/l, max.	250	-	-	250
13	Arsenic(as As).	0.2	0.2	0.2	0.2
14	Mercury (As Hg), mg/l, max.	0.01	0.01	-	0.01
15	Lead (as Pb) mg/l, max	0.1	1.0	-	2.0
16	Cadmium (as Cd) mg/l, max	2.0	1.0	-	2.0
17	Hexavalent chro-mium (as Cr + 6),mg/l, max.	0.1	2.0	-	1.0

18	Total chromium (as Cr) mg/l, max.	2.0	2.0	-	2.0
19	Copper (as Cu)mg/l, max.	3.0	3.0	-	3.0
20	Zinc (as Zn) mg/l, max.	5.0	15	-	15
21	Selenium (as Se)	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/l, max.	3.0	3.0	-	5.0
23	Cyanide (as CN) mg/l, max.	0.2	2.0	0.2	0.2
24	Fluoride (as F) mg/l, max.	2.0	15	-	15
25	Dissolved phos- phates (as P),mg/l, max.	5.0	-	-	-
26	Sulphide (as S) mg/l, max.	2.0	-	-	5.0
27	Phenolic compounds (as C6H50H)mg/l, max.	1.0	5.0	-	5.0
28	Radioactive materials: (a) Alpha emitters micro curie mg/l, max. (b)Beta emittersmicro curie mg/l	10 -7 10 -6	10 -7 10 -6	10 -8 10 -7	10 -7 10 -6
29	Bio-assay test	90% suivival of fish after 96 hours in 100% effluent	90% suivival of fish after 96 hours in 100% effluen	90% suivival of fish after 96 hours in 100% effluen	90% suivival of fish after 96 hours in 100% effluen
30	Manganese	2 mg/l	2 mg/l	-	2 mg/l
31	Iron (as Fe)	3mg/l	3mg/l	-	3mg/l
32	Vanadium (as V)	0.2mg/l	0.2mg/l	-	0.2mg/l
33	Nitrate Nitrogen	10 mg/l	-	-	20 mg/l

Annex 3.5:

Surface Water Use Quality Standard

Designated-Best-Use	**Class of Water**	**Criteria**
Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms OrganismMPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
Outdoor bathing (Organised)	B	• Total Coliforms Organism MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms Organism MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • Electrical Conductivity at 25oC micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Annex 3.6:

Effluent Discharge Standard for Power Plant

Sl. No.	Pollutants	Concentration
A.	**Condenser Cooling Water (once through cooling system)**	
1.	pH	6.5-8.5
2.	Temperature	No more than 10°C than the intake water temperature
3.	Free available chlorine	0.5 mg/l
B.	**Boiler blow down**	
1.	Suspended solids	100 mg/l
2.	Oil & Grease	20 mg/l
3.	Copper (Total)	1.0 mg/l
4.	Iron (Total)	1.0 mg/l
C.	**Cooling tower blow down**	
1.	Free available chlorine	0.5 mg/l
2.	Zinc	1.0 mg/l
3.	Chromium	0.2 mg/l
4.	Phosphate	5.0 mg/l
5.	Other corrosion inhibiting materials	Limits to be established on case by case basis
D.	**Ash pond effluent**	
1.	pH	6.5-8.5
2.	Suspended solids	100 mg/l
3.	Oil & grease	20 mg/l

Annex 4.1

Primary Meteorological Data

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-11-2015 12:00	4.0	288.0	34.5	65.5	0.0	566
4-11-2015 13:00	5.0	275.0	36.6	58.5	0.0	785
4-11-2015 14:00	2.2	245.0	38.5	54.5	0.0	958
4-11-2015 15:00	2.2	220.0	39.6	48.8	0.0	855
4-11-2015 16:00	2.5	285.0	38.5	46.5	0.0	842
4-11-2015 17:00	1.2	285.0	36.6	45.0	0.0	125
4-11-2015 18:00	3.3	285.0	35.5	65.5	0.0	65
4-11-2015 19:00	2.5	356.0	34.2	74.7	0.0	15
4-11-2015 20:00	2.5	285.0	32.2	78.8	0.0	0
4-11-2015 21:00	1.2	258.0	30.2	75.7	0.0	0
4-11-2015 22:00	1.2	245.0	30.2	74.7	0.0	0
4-11-2015 23:00	6.6	202.0	30.2	76.5	0.0	0
4-12-2015 0:00	5.2	205.0	27.5	81.2	0.0	0
4-12-2015 1:00	5.2	256.0	27.5	81.5	0.0	0
4-12-2015 2:00	5.2	245.0	26.6	84.8	0.0	0
4-12-2015 3:00	0.0	262.0	26.6	85.8	0.0	0
4-12-2015 4:00	0.0	202.0	24.5	86.8	0.0	0
4-12-2015 5:00	0.0	202.0	25.5	85.8	0.0	0
4-12-2015 6:00	0.0	202.0	25.5	84.8	0.0	25
4-12-2015 7:00	0.0	202.0	26.6	81.0	0.0	155
4-12-2015 8:00	0.0	202.0	28.5	80.2	0.0	288
4-12-2015 9:00	0.0	202.0	29.6	74.2	0.0	455
4-12-2015 10:00	0.0	202.0	30.2	72.2	0.0	688
4-12-2015 11:00	5.5	320.0	35.2	65.5	0.0	845
4-12-2015 12:00	5.6	302.0	35.2	51.5	0.0	955
4-12-2015 13:00	2.3	302.0	40.2	48.5	0.0	915
4-12-2015 14:00	2.2	252.0	39.6	48.5	0.0	925
4-12-2015 15:00	2.2	252.0	39.3	46.5	0.0	755
4-12-2015 16:00	0.0	252.0	38.5	45.5	0.0	655
4-12-2015 17:00	0.0	25.0	37.5	45.5	0.0	455
4-12-2015 18:00	0.0	220.0	36.6	52.5	0.0	155
4-12-2015 19:00	0.0	222.0	34.2	65.5	0.0	42
4-12-2015 20:00	1.2	220.0	32.2	62.5	0.0	0
4-12-2015 21:00	1.2	252.0	32.2	72.2	0.0	0
4-12-2015 22:00	1.5	185.0	30.2	70.2	0.0	0
4-12-2015 23:00	1.5	185.0	30.2	81.2	0.0	0
4-13-2015 0:00	0.8	156.0	29.5	82.2	0.0	0
4-13-2015 1:00	0.0	156.0	28.5	80.2	0.0	0
4-13-2015 2:00	0.0	156.0	27.5	81.2	0.0	0
4-13-2015 3:00	0.9	156.0	26.6	82.2	0.0	0
4-13-2015 4:00	1.5	156.0	26.6	83.2	0.0	0
4-13-2015 5:00	1.6	152.0	25.5	81.2	0.0	0
4-13-2015 6:00	1.2	152.0	25.5	75.5	0.0	24
4-13-2015 7:00	1.8	152.0	25.5	76.5	0.0	152
4-13-2015 8:00	3.2	152.0	26.0	70.2	0.0	202
4-13-2015 9:00	1.6	152.0	28.5	75.5	0.0	355
4-13-2015 10:00	1.5	132.0	29.0	65.5	0.0	422

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-13-2015 11:00	3.2	132.0	30.0	58.5	0.0	755
4-13-2015 12:00	1.2	123.0	35.2	54.5	0.0	802
4-13-2015 13:00	1.2	125.0	36.0	41.0	0.0	899
4-13-2015 14:00	1.4	125.0	38.0	40.2	0.0	895
4-13-2015 15:00	1.4	125.0	36.6	45.3	0.0	954
4-13-2015 16:00	1.1	350.0	37.5	45.0	0.0	588
4-13-2015 17:00	0.8	350.0	31.2	46.0	0.0	422
4-13-2015 18:00	0.6	350.0	32.2	52.0	0.0	155
4-13-2015 19:00	0.0	354.0	32.0	57.1	0.0	42
4-13-2015 20:00	5.2	270.0	30.0	60.0	0.0	3
4-13-2015 21:00	0.6	360.0	28.5	63.6	0.0	0
4-13-2015 22:00	1.2	270.0	27.0	75.5	0.0	0
4-13-2015 23:00	1.2	352.0	26.5	81.0	0.0	0
4-14-2015 0:00	2.0	350.0	25.1	81.2	0.0	0
4-14-2015 1:00	2.2	322.0	24.5	75.5	0.0	0
4-14-2015 2:00	1.3	351.0	24.2	78.8	0.0	0
4-14-2015 3:00	0.0	270.0	24.2	79.9	0.0	0
4-14-2015 4:00	0.0	360.0	24.1	75.4	0.0	0
4-14-2015 5:00	0.5	351.0	23.4	80.5	0.0	0
4-14-2015 6:00	0.1	352.0	23.3	81.1	0.0	12
4-14-2015 7:00	0.0	360.0	23.2	79.3	0.0	45
4-14-2015 8:00	0.0	360.0	25.5	75.4	0.0	255
4-14-2015 9:00	0.0	270.0	28.5	68.2	0.0	188
4-14-2015 10:00	0.0	270.0	28.5	56.1	0.0	655
4-14-2015 11:00	0.0	349.0	30.3	48.5	0.0	588
4-14-2015 12:00	0.0	325.0	36.0	45.5	0.0	788
4-14-2015 13:00	0.0	256.0	36.6	45.2	0.0	885
4-14-2015 14:00	0.1	353.0	38.5	41.5	0.0	748
4-14-2015 15:00	2.2	351.0	35.5	38.6	0.0	655
4-14-2015 16:00	2.2	351.0	34.3	46.6	0.0	452
4-14-2015 17:00	2.2	350.0	34.6	42.5	0.0	210
4-14-2015 18:00	0.1	350.0	33.5	58.4	0.0	52
4-14-2015 19:00	0.1	349.0	32.1	65.0	0.0	0
4-14-2015 20:00	0.0	256.0	31.5	70.2	0.0	0
4-14-2015 21:00	0.0	265.0	30.5	75.5	0.0	0
4-14-2015 22:00	0.2	352.0	29.0	78.8	0.0	0
4-14-2015 23:00	0.0	360.0	28.2	81.2	0.0	0
4-15-2015 0:00	0.0	360.0	28.2	80.2	0.0	0
4-15-2015 1:00	0.7	350.0	27.4	81.2	0.0	0
4-15-2015 2:00	0.1	351.0	26.0	84.5	0.0	0
4-15-2015 3:00	0.0	256.0	26.2	88.8	0.0	0
4-15-2015 4:00	0.0	256.0	26.4	89.9	0.0	0
4-15-2015 5:00	0.0	256.0	26.2	82.2	0.0	0
4-15-2015 6:00	0.2	252.0	26.0	81.2	0.0	12
4-15-2015 7:00	0.0	252.0	25.2	75.5	0.0	54
4-15-2015 8:00	0.0	252.0	28.5	69.2	0.0	188
4-15-2015 9:00	0.0	252.0	29.6	70.0	0.0	352

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-15-2015 10:00	0.0	252.0	30.2	68.5	0.0	545
4-15-2015 11:00	0.0	256.0	35.2	67.0	0.0	845
4-15-2015 12:00	0.0	256.0	38.6	57.0	0.0	825
4-15-2015 13:00	2.0	256.0	39.6	51.2	0.0	845
4-15-2015 14:00	4.0	256.0	40.2	46.5	0.0	955
4-15-2015 15:00	7.0	275.0	38.5	51.2	0.0	455
4-15-2015 16:00	6.0	225.0	35.5	48.5	0.0	405
4-15-2015 17:00	5.0	86.0	32.2	52.5	0.0	252
4-15-2015 18:00	8.0	310.0	30.2	56.6	0.0	122
4-15-2015 19:00	6.0	299.0	31.2	58.5	0.0	42
4-15-2015 20:00	6.0	299.0	30.2	52.2	0.0	0
4-15-2015 21:00	4.0	306.0	30.2	62.2	0.0	0
4-15-2015 22:00	3.0	272.0	28.5	62.5	0.0	0
4-15-2015 23:00	5.0	310.0	27.5	75.5	0.0	0
4-16-2015 0:00	7.0	255.0	26.6	80.2	0.0	0
4-16-2015 1:00	2.0	293.0	26.5	75.0	0.0	0
4-16-2015 2:00	1.0	327.0	25.5	78.5	0.0	0
4-16-2015 3:00	2.0	297.0	25.5	78.5	0.0	0
4-16-2015 4:00	0.2	251.0	24.5	81.2	0.0	0
4-16-2015 5:00	0.0	280.0	25.5	81.2	0.0	0
4-16-2015 6:00	3.0	273.0	26.0	81.2	0.0	0
4-16-2015 7:00	5.0	279.0	25.5	75.7	0.0	21
4-16-2015 8:00	3.0	320.0	25.5	75.5	0.0	122
4-16-2015 9:00	2.0	256.0	26.6	85.5	0.0	355
4-16-2015 10:00	0.6	279.0	28.5	66.6	0.0	455
4-16-2015 11:00	0.4	285.0	30.3	65.5	0.0	758
4-16-2015 12:00	0.4	285.0	34.5	58.5	0.0	845
4-16-2015 13:00	0.4	285.0	36.6	52.5	0.0	925
4-16-2015 14:00	4.0	285.0	39.6	48.5	0.0	754
4-16-2015 15:00	3.0	295.0	38.5	45.5	0.0	685
4-16-2015 16:00	0.2	292.0	38.5	46.5	0.0	542
4-16-2015 17:00	3.0	273.0	36.0	48.5	0.0	425
4-16-2015 18:00	2.0	292.0	36.3	68.5	0.0	222
4-16-2015 19:00	7.0	292.0	35.3	75.5	0.0	15
4-16-2015 20:00	8.0	292.0	34.0	75.7	0.0	0
4-16-2015 21:00	6.0	186.0	32.2	84.2	0.0	0
4-16-2015 22:00	9.0	262.0	32.2	81.2	0.0	0
4-16-2015 23:00	8.0	286.0	30.2	85.5	0.0	0
4-17-2015 0:00	10.0	228.0	30.0	86.6	0.0	0
4-17-2015 1:00	6.0	285.0	28.2	80.2	0.0	0
4-17-2015 2:00	0.6	235.0	27.5	81.2	0.0	0
4-17-2015 3:00	0.6	300.0	26.6	75.0	0.0	0
4-17-2015 4:00	0.4	316.0	25.5	74.0	0.0	0
4-17-2015 5:00	0.0	312.0	25.5	71.2	0.0	0
4-17-2015 6:00	0.4	336.0	28.5	75.5	0.0	20
4-17-2015 7:00	0.0	319.0	29.6	78.8	0.0	45
4-17-2015 8:00	0.8	319.0	30.2	75.5	0.0	265

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-17-2015 9:00	0.6	319.0	35.5	65.5	0.0	455
4-17-2015 10:00	0.4	319.0	36.6	58.8	0.0	854
4-17-2015 11:00	0.4	319.0	38.5	54.5	0.0	788
4-17-2015 12:00	0.4	319.0	39.6	48.5	0.0	955
4-17-2015 13:00	2.0	319.0	42.2	46.5	0.0	788
4-17-2015 14:00	4.0	168.0	41.2	48.5	0.0	465
4-17-2015 15:00	4.0	168.0	38.5	42.5	0.0	545
4-17-2015 16:00	6.0	168.0	37.5	46.5	0.0	232
4-17-2015 17:00	4.0	168.0	37.5	45.5	0.0	152
4-17-2015 18:00	5.0	182.0	36.6	65.5	0.0	55
4-17-2015 19:00	3.0	182.0	35.3	68.8	0.0	2
4-17-2015 20:00	4.0	182.0	35.2	75.5	0.0	0
4-17-2015 21:00	3.0	153.0	32.2	78.8	0.0	0
4-17-2015 22:00	5.0	208.0	31.2	85.5	0.0	0
4-17-2015 23:00	7.0	196.0	30.2	83.8	0.0	0
4-18-2015 0:00	0.2	249.0	28.2	89.5	0.0	0
4-18-2015 1:00	0.4	183.0	28.5	78.8	0.0	0
4-18-2015 2:00	1.0	262.0	27.5	75.0	0.0	0
4-18-2015 3:00	0.4	230.0	27.5	78.0	0.0	0
4-18-2015 4:00	0.4	208.0	26.6	79.9	0.0	0
4-18-2015 5:00	3.0	241.0	26.6	80.2	0.0	0
4-18-2015 6:00	0.0	210.0	28.8	72.2	0.0	11
4-18-2015 7:00	0.6	196.0	29.6	72.2	0.0	42
4-18-2015 8:00	0.0	204.0	30.2	75.0	0.0	54
4-18-2015 9:00	0.6	240.0	34.0	71.2	0.0	155
4-18-2015 10:00	0.0	333.0	35.5	65.5	0.0	188
4-18-2015 11:00	0.4	199.0	36.6	58.5	0.0	255
4-18-2015 12:00	0.0	199.0	38.2	55.2	0.0	455
4-18-2015 13:00	0.4	87.0	39.3	48.5	0.0	625
4-18-2015 14:00	4.0	258.0	38.8	46.2	0.0	758
4-18-2015 15:00	3.0	300.0	37.5	45.5	0.0	788
4-18-2015 16:00	5.0	240.0	35.5	52.2	0.0	552
4-18-2015 17:00	5.0	324.0	35.0	58.5	0.0	232
4-18-2015 18:00	4.0	328.0	34.2	45.5	0.0	152
4-18-2015 19:00	3.0	280.0	32.2	46.5	0.0	15
4-18-2015 20:00	3.0	235.0	32.2	68.5	0.0	0
4-18-2015 21:00	6.0	275.0	30.2	68.0	0.0	0
4-18-2015 22:00	9.0	275.0	29.2	75.5	0.0	0
4-18-2015 23:00	4.0	265.0	28.2	71.2	0.0	0
4-19-2015 0:00	3.0	272.0	28.5	75.5	0.0	0
4-19-2015 1:00	9.0	230.0	27.5	72.2	0.0	0
4-19-2015 2:00	8.0	268.0	26.6	81.5	0.0	0
4-19-2015 3:00	0.4	320.0	25.3	82.2	0.0	0
4-19-2015 4:00	0.4	324.0	25.5	85.2	0.0	0
4-19-2015 5:00	0.4	293.0	26.6	86.6	0.0	0
4-19-2015 6:00	0.0	296.0	28.8	85.5	0.0	25
4-19-2015 7:00	0.4	288.0	29.0	71.2	0.0	152

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-19-2015 8:00	0.0	307.0	30.2	68.5	0.0	262
4-19-2015 9:00	0.4	319.0	31.2	68.5	0.0	352
4-19-2015 10:00	0.4	313.0	32.2	62.5	0.0	455
4-19-2015 11:00	0.0	319.0	33.3	65.2	0.0	652
4-19-2015 12:00	0.8	333.0	36.3	58.5	0.0	758
4-19-2015 13:00	3.0	72.0	39.0	54.5	0.0	805
4-19-2015 14:00	8.0	72.0	39.6	58.5	0.0	878
4-19-2015 15:00	8.0	101.0	41.0	59.5	0.0	785
4-19-2015 16:00	4.0	172.0	38.5	48.5	0.0	625
4-19-2015 17:00	9.0	259.0	35.0	45.5	0.0	255
4-19-2015 18:00	9.0	208.0	36.6	42.5	0.0	85
4-19-2015 19:00	11.0	225.0	36.3	46.5	0.0	42
4-19-2015 20:00	9.0	256.0	34.0	58.5	0.0	0
4-19-2015 21:00	4.0	189.0	32.0	52.5	0.0	0
4-19-2015 22:00	4.0	201.0	32.3	65.5	0.0	0
4-19-2015 23:00	4.0	201.0	35.2	65.5	0.0	0
4-20-2015 0:00	0.6	201.0	30.2	68.5	0.0	0
4-20-2015 1:00	0.6	175.0	28.9	78.8	0.0	0
4-20-2015 2:00	0.4	168.0	27.5	72.2	0.0	0
4-20-2015 3:00	0.4	211.0	27.2	84.5	0.0	0
4-20-2015 4:00	0.0	145.0	26.6	82.5	0.0	0
4-20-2015 5:00	0.4	97.0	26.6	89.6	0.0	0
4-20-2015 6:00	0.0	84.0	25.5	85.5	0.0	11
4-20-2015 7:00	0.4	87.0	28.5	72.2	0.0	85
4-20-2015 8:00	0.4	72.0	29.0	70.2	0.0	155
4-20-2015 9:00	0.0	96.0	31.2	65.5	0.0	285
4-20-2015 10:00	0.4	330.0	32.2	56.5	0.0	355
4-20-2015 11:00	0.0	350.0	32.2	52.5	0.0	455
4-20-2015 12:00	0.4	83.0	36.3	51.2	0.0	755
4-20-2015 13:00	3.0	56.0	35.5	54.5	0.0	805
4-20-2015 14:00	8.0	69.0	39.6	56.5	0.0	815
4-20-2015 15:00	8.0	72.0	38.5	52.5	0.0	878
4-20-2015 16:00	9.0	231.0	35.5	53.2	0.0	425
4-20-2015 17:00	4.0	331.0	34.5	56.6	0.0	322
4-20-2015 18:00	2.0	57.0	33.2	58.5	0.0	122
4-20-2015 19:00	2.5	72.0	32.2	58.5	0.0	44
4-20-2015 20:00	2.2	53.0	31.2	65.5	0.0	5
4-20-2015 21:00	6.0	56.0	30.2	62.5	0.0	0
4-20-2015 22:00	4.0	19.0	30.2	75.5	0.0	0
4-20-2015 23:00	1.0	74.0	29.2	75.5	0.0	0
4-21-2015 0:00	0.0	76.0	28.2	80.2	0.0	0
4-21-2015 1:00	0.4	86.0	29.2	75.5	0.0	0
4-21-2015 2:00	3.0	86.0	27.2	76.5	0.0	0
4-21-2015 3:00	0.0	2.0	25.2	82.5	0.0	0
4-21-2015 4:00	0.6	2.0	26.2	84.5	0.0	0
4-21-2015 5:00	0.0	1.0	25.2	81.2	0.0	0
4-21-2015 6:00	1.0	1.0	25.2	82.2	0.0	8

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
4-21-2015 7:00	0.0	314.0	27.5	75.5	0.0	15
4-21-2015 8:00	0.4	282.0	28.2	76.5	0.0	125
4-21-2015 9:00	0.4	4.0	30.2	75.2	0.0	288
4-21-2015 10:00	0.6	354.0	32.2	65.5	0.0	425
4-21-2015 11:00	0.0	262.0	35.2	62.2	0.0	625
4-21-2015 12:00	3.0	222.0	36.3	62.2	0.0	788
4-21-2015 13:00	4.0	225.0	39.3	56.6	0.0	825
4-21-2015 14:00	3.0	214.0	37.5	52.2	0.0	754
4-21-2015 15:00	3.0	340.0	35.2	55.5	0.0	956
4-21-2015 16:00	6.0	343.0	36.3	57.5	0.0	455
4-21-2015 17:00	8.0	308.0	32.2	51.5	0.0	202
4-21-2015 18:00	8.0	280.0	33.0	52.2	0.0	120
4-21-2015 19:00	6.0	208.0	32.2	55.5	0.0	52
4-21-2015 20:00	4.0	179.0	31.2	65.5	0.0	0
4-21-2015 21:00	8.0	278.0	30.2	75.5	0.0	0
4-21-2015 22:00	8.0	344.0	27.5	70.2	0.0	0
4-21-2015 23:00	3.0	275.0	25.5	84.5	0.0	0
4-22-2015 0:00	4.0	248.0	26.6	81.2	0.0	0
4-22-2015 1:00	3.0	282.0	25.5	81.2	0.0	0
4-22-2015 2:00	5.0	254.0	26.2	81.2	0.0	0
4-22-2015 3:00	0.4	310.0	25.5	82.2	0.0	0
4-22-2015 4:00	0.4	314.0	25.2	86.6	0.0	0
4-22-2015 5:00	0.4	289.0	25.2	80.2	0.0	0
4-22-2015 6:00	0.4	290.0	26.6	81.2	0.0	12
4-22-2015 7:00	3.0	282.0	28.5	80.2	0.0	121
4-22-2015 8:00	0.8	285.0	29.3	72.5	0.0	211
4-22-2015 9:00	0.0	247.0	30.2	72.2	0.0	266
4-22-2015 10:00	0.0	212.0	32.2	65.5	0.0	455
4-22-2015 11:00	0.0	275.0	31.2	55.5	0.0	625
4-22-2015 12:00	0.0	275.0	35.5	58.0	0.0	725
4-22-2015 13:00	4.0	275.0	36.6	52.5	0.0	825
4-22-2015 14:00	3.0	343.0	39.6	54.5	0.0	811
4-22-2015 15:00	5.0	225.0	38.6	50.2	0.0	899
4-22-2015 16:00	3.0	227.0	35.3	52.5	0.0	425
4-22-2015 17:00	3.0	228.0	35.3	48.5	0.0	322
4-22-2015 18:00	4.0	235.0	34.3	45.5	0.0	125
4-22-2015 19:00	3.0	168.0	32.2	52.5	0.0	42
4-22-2015 20:00	2.0	190.0	32.2	65.5	0.0	0
4-22-2015 21:00	3.0	166.0	30.2	70.2	0.0	0
4-22-2015 22:00	6.0	183.0	30.2	70.2	0.0	0
4-22-2015 23:00	9.0	235.0	30.2	72.2	0.0	0
4-23-2015 0:00	8.0	155.0	28.5	72.2	0.0	0
4-23-2015 1:00	4.0	279.0	29.6	81.2	0.0	0
4-23-2015 2:00	5.0	310.0	26.6	81.2	0.0	0
4-23-2015 3:00	0.4	300.0	25.5	80.2	0.0	0
4-23-2015 4:00	0.8	300.0	25.5	82.2	0.0	0
4-23-2015 5:00	0.8	338.0	25.0	86.6	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-23-2015 6:00	0.8	295.0	26.2	80.2	0.0	15
4-23-2015 7:00	0.6	321.0	27.5	85.5	0.0	51
4-23-2015 8:00	0.4	302.0	27.5	81.2	0.0	85
4-23-2015 9:00	0.0	229.0	28.5	80.0	0.0	155
4-23-2015 10:00	0.0	303.0	29.3	70.2	0.0	302
4-23-2015 11:00	0.0	282.0	32.2	58.5	0.0	455
4-23-2015 12:00	0.0	295.0	36.0	42.2	0.0	688
4-23-2015 13:00	4.0	333.0	41.2	32.2	0.0	758
4-23-2015 14:00	3.0	215.0	42.2	35.2	0.0	825
4-23-2015 15:00	4.0	227.0	40.0	35.2	0.0	815
4-23-2015 16:00	4.0	273.0	35.2	36.2	0.0	455
4-23-2015 17:00	3.0	231.0	38.5	35.2	0.0	302
4-23-2015 18:00	3.0	319.0	36.6	32.2	0.0	111
4-23-2015 19:00	3.0	186.0	31.2	51.2	0.0	54
4-23-2015 20:00	0.0	187.0	30.2	62.2	0.0	12
4-23-2015 21:00	3.0	176.0	30.2	65.0	0.0	0
4-23-2015 22:00	4.0	179.0	29.2	72.5	0.0	0
4-23-2015 23:00	3.0	228.0	28.5	75.5	0.0	0
4-24-2015 0:00	2.0	172.0	25.5	81.2	0.0	0
4-24-2015 1:00	4.0	252.0	26.6	75.5	0.0	0
4-24-2015 2:00	3.0	279.0	26.6	72.2	0.0	0
4-24-2015 3:00	0.0	327.0	25.0	85.5	0.0	0
4-24-2015 4:00	0.0	310.0	26.6	87.5	0.0	0
4-24-2015 5:00	0.0	309.0	27.5	80.2	0.0	0
4-24-2015 6:00	0.0	278.0	28.5	81.2	0.0	15
4-24-2015 7:00	0.8	282.0	28.5	80.2	0.0	85
4-24-2015 8:00	0.0	268.0	29.5	81.2	0.0	125
4-24-2015 9:00	0.0	333.0	30.2	70.5	0.0	255
4-24-2015 10:00	0.0	278.0	32.2	52.2	0.0	355
4-24-2015 11:00	0.0	278.0	31.2	58.5	0.0	455
4-24-2015 12:00	0.0	280.0	35.3	42.2	0.0	625
4-24-2015 13:00	1.0	286.0	38.5	35.5	0.0	725
4-24-2015 14:00	0.0	203.0	40.0	38.5	0.0	855
4-24-2015 15:00	6.0	357.0	41.2	35.2	0.0	955
4-24-2015 16:00	2.0	357.0	38.5	36.6	0.0	758
4-24-2015 17:00	3.0	312.0	34.2	35.2	0.0	422
4-24-2015 18:00	4.0	321.0	32.2	45.5	0.0	202
4-24-2015 19:00	8.0	236.0	32.2	42.2	0.0	85
4-24-2015 20:00	8.0	224.0	30.2	65.0	0.0	5
4-24-2015 21:00	8.0	176.0	31.2	68.0	0.0	0
4-24-2015 22:00	4.0	226.0	30.0	69.6	0.0	0
4-24-2015 23:00	2.0	224.0	29.9	68.5	0.0	0
4-25-2015 0:00	5.0	238.0	28.0	65.5	0.0	0
4-25-2015 1:00	3.0	131.0	29.9	65.5	0.0	0
4-25-2015 2:00	3.0	170.0	26.6	70.2	0.0	0
4-25-2015 3:00	3.0	286.0	26.6	72.2	0.0	0
4-25-2015 4:00	3.0	317.0	25.5	72.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-25-2015 5:00	0.8	317.0	26.2	75.5	0.0	0
4-25-2015 6:00	0.0	316.0	27.5	65.5	0.0	5
4-25-2015 7:00	0.0	314.0	28.5	58.0	0.0	85
4-25-2015 8:00	0.0	299.0	29.6	55.5	0.0	125
4-25-2015 9:00	0.4	224.0	30.2	54.5	0.0	255
4-25-2015 10:00	0.4	216.0	30.2	52.5	0.0	302
4-25-2015 11:00	0.8	326.0	35.3	54.5	0.0	455
4-25-2015 12:00	0.0	326.0	36.3	52.2	0.0	658
4-25-2015 13:00	2.0	350.0	36.3	48.5	0.0	788
4-25-2015 14:00	4.0	170.0	40.2	32.2	0.0	845
4-25-2015 15:00	6.0	184.0	42.2	28.6	0.0	925
4-25-2015 16:00	4.0	129.0	41.2	26.6	0.0	754
4-25-2015 17:00	3.0	124.0	36.6	35.2	0.0	625
4-25-2015 18:00	8.0	125.0	35.0	45.5	0.0	125
4-25-2015 19:00	9.0	202.0	34.2	45.5	0.0	8
4-25-2015 20:00	8.0	302.0	32.2	45.5	0.0	0
4-25-2015 21:00	4.0	302.0	32.2	56.6	0.0	0
4-25-2015 22:00	4.0	305.0	32.2	52.5	0.0	0
4-25-2015 23:00	5.0	302.0	30.2	68.5	0.0	0
4-26-2015 0:00	9.0	305.0	28.5	75.5	0.0	0
4-26-2015 1:00	11.0	352.0	29.5	72.5	0.0	0
4-26-2015 2:00	4.0	353.0	29.6	78.8.	0.0	0
4-26-2015 3:00	4.0	125.0	26.0	79.9	0.0	0
4-26-2015 4:00	3.0	126.0	28.5	81.5	0.0	0
4-26-2015 5:00	0.0	252.0	26.6	88.5	0.0	0
4-26-2015 6:00	0.0	125.0	26.6	85.5	0.0	21
4-26-2015 7:00	0.0	185.0	25.5	75.5	0.0	85
4-26-2015 8:00	0.0	158.0	28.5	72.2	0.0	155
4-26-2015 9:00	0.4	168.0	29.2	65.5	0.0	205
4-26-2015 10:00	0.0	165.0	30.2	62.2	0.0	355
4-26-2015 11:00	0.8	320.0	34.5	65.2	0.0	425
4-26-2015 12:00	0.0	252.0	35.0	58.5	0.0	625
4-26-2015 13:00	6.0	252.0	39.0	42.2	0.0	755
4-26-2015 14:00	3.0	242.0	40.2	41.2	0.0	855
4-26-2015 15:00	4.0	125.0	41.2	32.2	0.0	844
4-26-2015 16:00	3.0	125.0	39.0	35.3	0.0	444
4-26-2015 17:00	2.0	320.0	35.2	32.2	0.0	125
4-26-2015 18:00	4.0	252.0	36.6	32.2	0.0	56
4-26-2015 19:00	3.0	252.0	35.5	32.2	0.0	5
4-26-2015 20:00	5.0	252.0	32.2	35.5	0.0	0
4-26-2015 21:00	2.0	125.0	30.2	45.5	0.0	0
4-26-2015 22:00	0.0	125.0	28.5	52.5	0.0	0
4-26-2015 23:00	0.0	232.0	27.5	65.5	0.0	0
4-27-2015 0:00	0.0	202.0	26.6	80.2	0.0	0
4-27-2015 1:00	1.0	202.0	25.5	85.5	0.0	0
4-27-2015 2:00	2.0	302.0	26.6	85.2	0.0	0
4-27-2015 3:00	3.0	302.0	26.6	85.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
4-27-2015 4:00	8.0	305.0	28.5	85.5	0.0	0
4-27-2015 5:00	6.0	330.0	28.5	81.2	0.0	0
4-27-2015 6:00	0.0	332.0	27.0	75.5	0.0	12
4-27-2015 7:00	0.0	323.0	26.6	72.5	0.0	88
4-27-2015 8:00	5.0	322.0	28.2	65.5	0.0	155
4-27-2015 9:00	3.0	325.0	32.2	62.5	0.0	266
4-27-2015 10:00	6.0	325.0	31.2	62.2	0.0	355
4-27-2015 11:00	4.0	335.0	35.2	65.5	0.0	455
4-27-2015 12:00	1.0	256.0	38.5	42.2	0.0	688
4-27-2015 13:00	3.0	252.0	38.3	32.2	0.0	755
4-27-2015 14:00	3.0	202.0	39.0	35.2	0.0	845
4-27-2015 15:00	3.0	253.0	36.3	36.6	0.0	802
4-27-2015 16:00	3.0	256.0	36.3	45.5	0.0	788
4-27-2015 17:00	2.0	252.0	35.2	46.5	0.0	320
4-27-2015 18:00	3.0	202.0	35.2	55.5	0.0	122
4-27-2015 19:00	3.0	253.0	31.2	54.2	0.0	54
4-27-2015 20:00	4.0	222.0	31.2	65.5	0.0	5
4-27-2015 21:00	2.0	205.0	30.2	68.6	0.0	0
4-27-2015 22:00	0.0	227.0	29.0	69.6	0.0	0
4-27-2015 23:00	3.0	325.0	29.2	72.5	0.0	0
4-28-2015 0:00	6.0	228.0	28.5	75.5	0.0	0
4-28-2015 1:00	6.0	156.0	29.5	72.2	0.0	0
4-28-2015 2:00	4.0	242.0	27.5	84.5	0.0	0
4-28-2015 3:00	4.0	125.0	27.0	84.5	0.0	0
4-28-2015 4:00	0.0	225.0	26.2	84.5	0.0	0
4-28-2015 5:00	0.0	195.0	26.2	86.6	0.0	0
4-28-2015 6:00	0.4	235.0	28.5	75.5	0.0	8
4-28-2015 7:00	0.6	175.0	28.2	65.5	0.0	35
4-28-2015 8:00	0.0	325.0	29.2	66.6	0.0	125
4-28-2015 9:00	0.0	199.0	31.2	65.5	0.0	425
4-28-2015 10:00	0.0	58.0	30.2	62.5	0.0	655
4-28-2015 11:00	0.0	64.0	34.2	62.2	0.0	758
4-28-2015 12:00	0.0	16.0	35.2	58.5	0.0	855
4-28-2015 13:00	3.0	92.0	38.5	54.0	0.0	625
4-28-2015 14:00	3.0	225.0	40.2	45.5	0.0	788
4-28-2015 15:00	0.0	223.0	41.2	35.2	0.0	845
4-28-2015 16:00	3.0	265.0	38.5	36.2	0.0	785
4-28-2015 17:00	8.0	210.0	39.5	32.2	0.0	566
4-28-2015 18:00	3.0	228.0	32.2	35.5	0.0	255
4-28-2015 19:00	0.4	223.0	32.2	35.2	0.0	152
4-28-2015 20:00	4.0	156.0	30.2	45.5	0.0	5
4-28-2015 21:00	3.0	195.0	30.2	45.5	0.0	0
4-28-2015 22:00	3.0	156.0	29.2	42.2	0.0	0
4-28-2015 23:00	5.0	215.0	29.2	62.2	0.0	0
4-29-2015 0:00	0.4	225.0	28.5	64.5	0.0	0
4-29-2015 1:00	0.8	125.0	28.2	65.5	0.0	0
4-29-2015 2:00	0.0	86.0	28.2	65.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
4-29-2015 3:00	3.0	202.0	27.7	71.2	0.0	0
4-29-2015 4:00	0.0	265.0	27.2	72.2	0.0	0
4-29-2015 5:00	0.0	256.0	27.5	72.2	0.0	0
4-29-2015 6:00	0.0	125.0	28.5	75.2	0.0	5
4-29-2015 7:00	0.0	275.0	29.5	72.5	0.0	15
4-29-2015 8:00	0.0	125.0	29.5	68.6	0.0	12
4-29-2015 9:00	0.0	105.0	30.2	63.6	0.0	35
4-29-2015 10:00	0.0	205.0	32.2	65.5	0.0	452
4-29-2015 11:00	0.0	185.0	35.5	41.2	0.0	656
4-29-2015 12:00	0.0	136.0	39.9	35.5	0.0	688
4-29-2015 13:00	3.0	230.0	41.2	32.2	0.0	785
4-29-2015 14:00	4.0	215.0	39.6	32.2	0.0	866
4-29-2015 15:00	4.0	204.0	36.3	30.2	0.0	325
4-29-2015 16:00	3.0	250.0	36.3	42.2	0.0	458
4-29-2015 17:00	2.0	202.0	35.3	45.5	0.0	155
4-29-2015 18:00	3.0	210.0	32.2	55.2	0.0	266
4-29-2015 19:00	2.0	165.0	31.2	65.5	0.0	52
4-29-2015 20:00	3.0	96.0	30.2	68.6	0.0	0
4-29-2015 21:00	4.0	92.0	30.2	69.6	0.0	0
4-29-2015 22:00	4.0	193.0	29.5	65.5	0.0	0
4-29-2015 23:00	5.0	195.0	28.5	72.5	0.0	0
4-30-2015 0:00	3.0	256.0	28.5	75.5	0.0	0
4-30-2015 1:00	0.0	325.0	28.0	78.8	0.0	0
4-30-2015 2:00	0.4	190.0	27.5	82.5	0.0	0
4-30-2015 3:00	0.4	152.0	27.0	80.2	0.0	0
4-30-2015 4:00	4.0	194.0	27.2	72.5	0.0	0
4-30-2015 5:00	0.0	165.0	26.6	75.5	0.0	0
4-30-2015 6:00	0.0	185.0	26.6	76.5	0.0	2
4-30-2015 7:00	0.8	159.0	26.6	62.5	0.0	15
4-30-2015 8:00	0.6	194.0	28.5	65.5	0.0	25
4-30-2015 9:00	0.6	225.0	29.6	62.5	0.0	156
4-30-2015 10:00	0.6	247.0	30.2	62.2	0.0	652
4-30-2015 11:00	0.0	256.0	32.2	68.5	0.0	785
4-30-2015 12:00	0.0	235.0	36.6	42.2	0.0	455
4-30-2015 13:00	0.0	232.0	36.3	35.2	0.0	785
4-30-2015 14:00	5.0	243.0	40.2	26.6	0.0	744
4-30-2015 15:00	3.0	245.0	39.3	25.5	0.0	956
4-30-2015 16:00	6.0	231.0	38.5	35.2	0.0	541
4-30-2015 17:00	6.0	232.0	34.2	34.2	0.0	251
4-30-2015 18:00	6.0	239.0	30.2	45.5	0.0	125
4-30-2015 19:00	9.0	237.0	30.2	56.5	0.0	45
4-30-2015 20:00	6.0	239.0	29.5	65.5	0.0	5
4-30-2015 21:00	11.0	156.0	28.5	69.6	0.0	0
4-30-2015 22:00	9.0	249.0	28.5	69.6	0.0	0
4-30-2015 23:00	6.0	234.0	27.5	72.5	0.0	0
5-1-2015 0:00	8.0	289.0	27.2	72.2	0.0	0
5-1-2015 1:00	8.0	123.0	27.0	72.2	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-1-2015 2:00	3.0	96.0	26.6	75.5	0.0	0
5-1-2015 3:00	0.0	65.0	26.8	84.5	0.0	0
5-1-2015 4:00	0.0	29.0	26.8	84.5	0.0	0
5-1-2015 5:00	0.0	152.0	26.6	81.2	0.0	0
5-1-2015 6:00	0.8	205.0	27.5	84.5	0.0	5
5-1-2015 7:00	1.0	251.0	28.5	72.2	0.0	12
5-1-2015 8:00	1.0	95.0	29.2	71.0	0.0	22
5-1-2015 9:00	1.0	99.0	30.2	70.2	0.0	188
5-1-2015 10:00	0.4	156.0	31.2	62.0	0.0	565
5-1-2015 11:00	0.4	185.0	32.2	42.2	0.0	845
5-1-2015 12:00	0.2	224.0	34.5	35.5	0.0	699
5-1-2015 13:00	0.2	269.0	38.5	36.2	0.0	845
5-1-2015 14:00	0.2	356.0	42.2	25.0	0.0	845
5-1-2015 15:00	0.0	345.0	40.2	26.2	0.0	765
5-1-2015 16:00	8.0	356.0	41.2	23.0	0.0	625
5-1-2015 17:00	8.0	346.0	30.2	32.2	0.0	125
5-1-2015 18:00	8.0	355.0	30.2	45.5	0.0	130
5-1-2015 19:00	11.0	352.0	29.6	46.0	0.0	45
5-1-2015 20:00	6.0	348.0	29.8	62.2	0.0	3
5-1-2015 21:00	9.0	345.0	28.5	68.5	0.0	0
5-1-2015 22:00	9.0	344.0	27.5	78.0	0.0	0
5-1-2015 23:00	8.0	156.0	26.6	75.5	0.0	0
5-2-2015 0:00	8.0	158.0	26.6	81.2	0.0	0
5-2-2015 1:00	8.0	125.0	25.5	82.2	0.0	0
5-2-2015 2:00	0.0	305.0	25.0	88.5	0.0	0
5-2-2015 3:00	0.0	351.0	25.5	82.2	0.0	0
5-2-2015 4:00	0.0	356.0	24.5	86.5	0.0	0
5-2-2015 5:00	0.0	168.0	24.2	88.5	0.0	0
5-2-2015 6:00	0.0	256.0	25.2	75.0	0.0	55
5-2-2015 7:00	0.0	274.0	26.6	75.5	0.0	255
5-2-2015 8:00	0.4	344.0	28.8	65.5	0.0	186
5-2-2015 9:00	0.2	342.0	29.6	65.5	0.0	345
5-2-2015 10:00	0.2	265.0	30.2	65.5	0.0	525
5-2-2015 11:00	0.2	337.0	35.5	45.4	0.0	491
5-2-2015 12:00	0.0	236.0	36.6	42.2	0.0	855
5-2-2015 13:00	0.0	302.0	37.5	32.2	0.0	466
5-2-2015 14:00	0.0	256.0	38.5	26.6	0.0	952
5-2-2015 15:00	2.0	247.0	35.5	34.0	0.0	485
5-2-2015 16:00	0.0	320.0	32.3	48.5	0.0	156
5-2-2015 17:00	4.0	329.0	30.2	55.5	0.0	45
5-2-2015 18:00	6.0	268.0	30.2	52.2	0.0	8
5-2-2015 19:00	6.0	335.0	31.2	65.5	0.0	5
5-2-2015 20:00	6.0	156.0	28.2	69.6	0.0	0
5-2-2015 21:00	6.0	258.0	29.2	72.5	0.0	0
5-2-2015 22:00	9.0	260.0	28.8	72.2	0.0	0
5-2-2015 23:00	8.0	330.0	27.5	75.5	0.0	0
5-3-2015 0:00	3.0	201.0	26.6	76.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-3-2015 1:00	4.0	204.0	26.6	78.3	0.0	0
5-3-2015 2:00	5.0	338.0	26.6	79.5	0.0	0
5-3-2015 3:00	0.0	253.0	25.5	81.2	0.0	0
5-3-2015 4:00	0.0	231.0	25.5	82.2	0.0	0
5-3-2015 5:00	0.0	273.0	25.5	81.2	0.0	5
5-3-2015 6:00	0.0	228.0	27.5	78.5	0.0	22
5-3-2015 7:00	0.2	218.0	29.6	72.5	0.0	153
5-3-2015 8:00	0.0	279.0	28.5	68.5	0.0	369
5-3-2015 9:00	0.5	247.0	29.6	69.5	0.0	592
5-3-2015 10:00	0.0	256.0	30.2	62.2	0.0	773
5-3-2015 11:00	0.0	299.0	31.2	65.0	0.0	874
5-3-2015 12:00	0.0	289.0	35.2	55.5	0.0	680
5-3-2015 13:00	0.0	255.0	38.8	32.2	0.0	838
5-3-2015 14:00	0.0	249.0	39.3	35.2	0.0	652
5-3-2015 15:00	5.0	220.0	38.6	36.6	0.0	713
5-3-2015 16:00	3.0	249.0	38.8	35.2	0.0	483
5-3-2015 17:00	6.0	243.0	37.5	35.2	0.0	253
5-3-2015 18:00	4.0	357.0	35.5	26.6	0.0	73
5-3-2015 19:00	8.0	232.0	32.2	25.5	0.0	2
5-3-2015 20:00	8.0	259.0	31.2	65.5	0.0	0
5-3-2015 21:00	8.0	243.0	30.2	62.2	0.0	0
5-3-2015 22:00	8.0	242.0	29.6	62.2	0.0	0
5-3-2015 23:00	8.0	236.0	29.5	62.2	0.0	0
5-4-2015 0:00	4.0	212.0	28.5	62.0	0.0	0
5-4-2015 1:00	4.0	252.0	27.5	70.2	0.0	0
5-4-2015 2:00	5.0	299.0	26.6	71.2	0.0	0
5-4-2015 3:00	0.2	225.0	27.5	75.5	0.0	0
5-4-2015 4:00	3.0	258.0	26.6	75.5	0.0	0
5-4-2015 5:00	0.2	348.0	26.6	70.2	0.0	5
5-4-2015 6:00	0.2	232.0	27.5	70.2	0.0	23
5-4-2015 7:00	0.0	256.0	28.0	70.2	0.0	133
5-4-2015 8:00	0.0	279.0	29.0	68.5	0.0	267
5-4-2015 9:00	0.0	285.0	31.0	68.5	0.0	533
5-4-2015 10:00	0.0	279.0	35.2	55.2	0.0	676
5-4-2015 11:00	0.2	254.0	35.2	42.0	0.0	739
5-4-2015 12:00	0.0	268.0	36.6	32.2	0.0	770
5-4-2015 13:00	0.0	275.0	41.2	25.2	0.0	816
5-4-2015 14:00	0.0	327.0	41.2	26.6	0.0	726
5-4-2015 15:00	0.0	278.0	45.5	32.2	0.0	660
5-4-2015 16:00	3.0	309.0	36.6	30.2	0.0	467
5-4-2015 17:00	3.0	190.0	35.5	41.4	0.0	251
5-4-2015 18:00	6.0	290.0	34.5	54.8	0.0	77
5-4-2015 19:00	6.0	279.0	32.2	63.8	0.0	2
5-4-2015 20:00	6.0	286.0	32.2	69.2	0.0	0
5-4-2015 21:00	8.0	285.0	30.2	63.6	0.0	0
5-4-2015 22:00	11.0	360.0	31.2	72.9	0.0	0
5-4-2015 23:00	8.0	224.0	30.2	76.8	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-5-2015 0:00	6.0	254.0	29.4	72.5	0.0	0
5-5-2015 1:00	0.0	222.0	27.5	72.8	0.0	0
5-5-2015 2:00	0.0	297.0	26.3	72.7	0.0	0
5-5-2015 3:00	0.0	271.0	26.6	71.9	0.0	0
5-5-2015 4:00	5.0	206.0	27.2	73.3	0.0	0
5-5-2015 5:00	0.0	285.0	26.6	73.5	0.0	0
5-5-2015 6:00	0.0	248.0	28.5	63.5	0.0	23
5-5-2015 7:00	0.0	327.0	29.5	62.2	0.0	143
5-5-2015 8:00	0.0	297.0	30.2	52.5	0.0	343
5-5-2015 9:00	0.0	290.0	31.2	54.5	0.0	558
5-5-2015 10:00	0.0	288.0	32.2	52.5	0.0	742
5-5-2015 11:00	0.0	280.0	34.2	54.5	0.0	875
5-5-2015 12:00	6.0	302.0	35.2	48.5	0.0	960
5-5-2015 13:00	3.0	307.0	38.0	35.3	0.0	934
5-5-2015 14:00	3.0	214.0	40.0	32.2	0.0	773
5-5-2015 15:00	4.0	241.0	41.2	36.0	0.0	631
5-5-2015 16:00	6.0	162.0	39.0	26.2	0.0	453
5-5-2015 17:00	5.0	162.0	38.5	26.0	0.0	243
5-5-2015 18:00	3.0	271.0	35.2	42.2	0.0	75
5-5-2015 19:00	2.0	223.0	34.2	52.2	0.0	2
5-5-2015 20:00	8.0	294.0	30.2	62.2	0.0	0
5-5-2015 21:00	8.0	285.0	31.2	65.5	0.0	0
5-5-2015 22:00	8.0	348.0	30.2	72.2	0.0	0
5-5-2015 23:00	9.0	114.0	29.2	70.2	0.0	0
5-6-2015 0:00	8.0	160.0	28.5	72.2	0.0	0
5-6-2015 1:00	6.0	180.0	27.5	81.2	0.0	0
5-6-2015 2:00	3.0	283.0	27.5	84.5	0.0	0
5-6-2015 3:00	0.0	132.0	26.6	85.5	0.0	0
5-6-2015 4:00	0.0	245.0	26.5	84.5	0.0	0
5-6-2015 5:00	0.0	212.0	26.6	84.5	0.0	0
5-6-2015 6:00	0.0	162.0	26.2	88.5	0.0	26
5-6-2015 7:00	0.0	192.0	27.5	75.5	0.0	153
5-6-2015 8:00	0.0	250.0	28.8	65.5	0.0	347
5-6-2015 9:00	0.0	221.0	29.6	62.5	0.0	565
5-6-2015 10:00	0.0	231.0	31.2	62.2	0.0	748
5-6-2015 11:00	0.0	249.0	32.2	55.5	0.0	880
5-6-2015 12:00	0.0	351.0	33.3	50.2	0.0	939
5-6-2015 13:00	1.0	351.0	36.6	48.5	0.0	924
5-6-2015 14:00	4.0	264.0	38.5	42.0	0.0	859
5-6-2015 15:00	6.0	338.0	39.9	32.2	0.0	698
5-6-2015 16:00	3.0	225.0	34.5	25.2	0.0	480
5-6-2015 17:00	3.0	250.0	34.0	26.6	0.0	259
5-6-2015 18:00	3.0	245.0	32.2	35.2	0.0	89
5-6-2015 19:00	1.0	211.0	31.0	35.5	0.0	3
5-6-2015 20:00	1.0	228.0	30.2	45.5	0.0	0
5-6-2015 21:00	3.0	218.0	31.0	55.5	0.0	0
5-6-2015 22:00	8.0	266.0	30.2	62.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-6-2015 23:00	6.0	242.0	29.5	68.6	0.0	0
5-7-2015 0:00	6.0	293.0	28.5	72.5	0.0	0
5-7-2015 1:00	4.0	227.0	27.5	71.2	0.0	0
5-7-2015 2:00	4.0	168.0	27.5	71.2	0.0	0
5-7-2015 3:00	0.0	173.0	27.5	71.2	0.0	0
5-7-2015 4:00	0.0	183.0	26.6	72.2	0.0	0
5-7-2015 5:00	0.0	206.0	27.5	72.2	0.0	0
5-7-2015 6:00	0.0	249.0	28.5	75.5	0.0	29
5-7-2015 7:00	0.0	203.0	29.5	71.2	0.0	183
5-7-2015 8:00	0.0	180.0	28.5	65.5	0.0	388
5-7-2015 9:00	5.0	274.0	31.2	62.2	0.0	629
5-7-2015 10:00	0.0	278.0	30.2	58.5	0.0	826
5-7-2015 11:00	0.0	285.0	35.2	52.5	0.0	958
5-7-2015 12:00	0.0	314.0	36.6	54.5	0.0	992
5-7-2015 13:00	0.0	272.0	38.5	32.2	0.0	978
5-7-2015 14:00	6.0	279.0	39.6	26.6	0.0	873
5-7-2015 15:00	3.0	145.0	38.0	23.0	0.0	695
5-7-2015 16:00	3.0	324.0	37.5	35.2	0.0	504
5-7-2015 17:00	3.0	340.0	33.2	65.5	0.0	275
5-7-2015 18:00	3.0	215.0	32.2	68.5	0.0	83
5-7-2015 19:00	3.0	232.0	34.2	72.5	0.0	3
5-7-2015 20:00	3.0	241.0	31.1	75.5	0.0	0
5-7-2015 21:00	3.0	212.0	31.1	75.5	0.0	0
5-7-2015 22:00	0.0	158.0	31.9	71.2	0.0	0
5-7-2015 23:00	4.0	132.0	30.2	75.5	0.0	0
5-8-2015 0:00	6.0	142.0	28.8	80.2	0.0	0
5-8-2015 1:00	6.0	238.0	28.0	82.2	0.0	0
5-8-2015 2:00	4.0	284.0	29.5	85.5	0.0	0
5-8-2015 3:00	6.0	204.0	29.5	81.2	0.0	0
5-8-2015 4:00	0.0	216.0	24.2	80.2	0.0	0
5-8-2015 5:00	0.0	165.0	24.2	81.2	0.0	0
5-8-2015 6:00	0.0	138.0	26.7	75.5	0.0	34
5-8-2015 7:00	0.5	307.0	27.1	76.5	0.0	159
5-8-2015 8:00	0.6	238.0	28.8	75.5	0.0	346
5-8-2015 9:00	0.5	266.0	29.6	70.2	0.0	611
5-8-2015 10:00	0.0	244.0	31.2	55.5	0.0	775
5-8-2015 11:00	0.2	300.0	32.2	62.2	0.0	872
5-8-2015 12:00	0.3	235.0	34.2	42.2	0.0	918
5-8-2015 13:00	3.0	264.0	35.2	32.0	0.0	857
5-8-2015 14:00	4.0	194.0	41.2	28.0	0.0	757
5-8-2015 15:00	4.0	353.0	40.2	26.6	0.0	615
5-8-2015 16:00	3.0	183.0	38.5	35.2	0.0	437
5-8-2015 17:00	6.0	166.0	37.5	38.5	0.0	229
5-8-2015 18:00	4.0	119.0	34.2	45.5	0.0	60
5-8-2015 19:00	5.0	220.0	33.2	55.2	0.0	2
5-8-2015 20:00	3.0	354.0	31.2	51.2	0.0	0
5-8-2015 21:00	2.0	344.0	31.2	65.5	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-8-2015 22:00	4.0	242.0	31.2	65.5	0.0	0
5-8-2015 23:00	3.0	264.0	30.0	70.2	0.0	0
5-9-2015 0:00	3.0	211.0	30.2	71.2	0.0	0
5-9-2015 1:00	2.0	214.0	29.9	71.2	0.0	0
5-9-2015 2:00	5.0	132.0	28.8	75.5	0.0	0
5-9-2015 3:00	8.0	260.0	28.8	72.2	0.0	0
5-9-2015 4:00	7.0	251.0	28.5	81.2	0.0	0
5-9-2015 5:00	5.0	248.0	27.5	81.2	0.0	0
5-9-2015 6:00	0.0	182.0	27.7	80.2	0.0	25
5-9-2015 7:00	0.0	309.0	28.8	70.2	0.0	145
5-9-2015 8:00	0.0	279.0	29.9	70.2	0.0	337
5-9-2015 9:00	0.0	279.0	30.2	65.5	0.0	545
5-9-2015 10:00	0.0	289.0	33.2	65.5	0.0	730
5-9-2015 11:00	0.0	272.0	34.2	68.5	0.0	863
5-9-2015 12:00	0.0	290.0	35.5	68.5	0.0	934
5-9-2015 13:00	0.0	262.0	36.6	52.2	0.0	914
5-9-2015 14:00	4.0	278.0	39.6	42.2	0.0	819
5-9-2015 15:00	6.0	286.0	41.2	35.2	0.0	621
5-9-2015 16:00	4.0	286.0	40.2	25.5	0.0	401
5-9-2015 17:00	3.0	344.0	36.6	26.6	0.0	245
5-9-2015 18:00	3.0	354.0	35.5	32.2	0.0	81
5-9-2015 19:00	1.2	348.0	35.5	32.2	0.0	4
5-9-2015 20:00	3.0	309.0	33.3	45.5	0.0	0
5-9-2015 21:00	3.0	276.0	32.2	56.6	0.0	0
5-9-2015 22:00	4.0	265.0	31.2	68.8	0.0	0
5-9-2015 23:00	5.0	166.0	30.2	71.2	0.0	0
5-10-2015 0:00	2.0	138.0	29.9	72.2	0.0	0
5-10-2015 1:00	1.0	197.0	28.8	72.2	0.0	0
5-10-2015 2:00	0.0	208.0	27.2	73.2	0.0	0
5-10-2015 3:00	0.0	261.0	28.3	75.5	0.0	0
5-10-2015 4:00	0.0	299.0	26.6	84.0	0.0	0
5-10-2015 5:00	0.0	290.0	26.6	84.5	0.0	0
5-10-2015 6:00	0.0	316.0	27.5	84.5	0.0	26
5-10-2015 7:00	0.2	317.0	27.0	75.5	0.0	135
5-10-2015 8:00	0.5	312.0	28.5	71.0	0.0	303
5-10-2015 9:00	0.5	314.0	29.6	45.5	0.0	483
5-10-2015 10:00	0.6	321.0	31.2	42.0	0.0	632
5-10-2015 11:00	0.5	314.0	30.2	32.2	0.0	743
5-10-2015 12:00	0.6	271.0	35.5	28.5	0.0	786
5-10-2015 13:00	1.0	278.0	36.6	26.6	0.0	746
5-10-2015 14:00	4.0	278.0	38.5	25.0	0.0	637
5-10-2015 15:00	2.0	268.0	40.2	25.5	0.0	512
5-10-2015 16:00	3.0	358.0	39.6	35.2	0.0	353
5-10-2015 17:00	5.0	311.0	36.0	45.5	0.0	172
5-10-2015 18:00	1.2	343.0	35.5	42.0	0.0	49
5-10-2015 19:00	1.5	344.0	34.5	46.5	0.0	1
5-10-2015 20:00	0.8	249.0	32.3	50.2	0.0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-10-2015 21:00	0.6	348.0	30.2	68.6	0.0	0
5-10-2015 22:00	12.0	332.0	31.2	69.6	0.0	0
5-10-2015 23:00	1.0	338.0	29.6	75.5	0.0	0
5-11-2015 0:00	1.0	320.0	28.5	72.2	0.0	0
5-11-2015 1:00	0.0	276.0	28.8	71.2	0.0	0
5-11-2015 2:00	0.0	296.0	27.5	73.3	0.0	0
5-11-2015 3:00	0.3	232.0	27.5	75.5	0.0	0
5-11-2015 4:00	0.5	231.0	26.6	71.2	0.0	0
5-11-2015 5:00	0.0	316.0	27.5	78.7	0.0	0
5-11-2015 6:00	0.0	304.0	28.8	79.9	0.0	25
5-11-2015 7:00	0.0	323.0	29.3	70.2	0.0	120
5-11-2015 8:00	0.0	323.0	30.2	54.2	0.0	274
5-11-2015 9:00	0.0	307.0	31.2	45.5	0.0	484
5-11-2015 10:00	2.0	295.0	32.2	45.5	0.0	652
5-11-2015 11:00	0.2	323.0	33.3	35.2	0.0	754
5-11-2015 12:00	0.5	244.0	38.5	26.5	0.0	804
5-11-2015 13:00	0.3	207.0	40.2	25.5	0.0	846
5-11-2015 14:00	0.5	262.0	41.2	26.6	0.0	741
5-11-2015 15:00	0.6	222.0	40.2	29.6	0.0	596
5-11-2015 16:00	0.6	225.0	38.5	35.5	0.0	416
5-11-2015 17:00	1.2	214.0	39.6	35.2	0.0	219
5-11-2015 18:00	1.2	340.0	30.2	45.5	0.0	67
5-11-2015 19:00	1.2	343.0	30.2	42.2	0.0	3
5-11-2015 20:00	1.2	308.0	29.5	55.5	0.0	0
5-11-2015 21:00	5.0	280.0	28.8	52.2	0.0	0
5-11-2015 22:00	2.0	208.0	28.8	75.5	0.0	0
5-11-2015 23:00	2.0	179.0	27.7	72.2	0.0	0
5-12-2015 0:00	2.0	278.0	27.5	78.8	0.0	0
5-12-2015 1:00	2.0	344.0	26.6	75.0	0.0	0
5-12-2015 2:00	0.0	275.0	26.6	84.5	0.0	0
5-12-2015 3:00	0.0	248.0	26.8	81.2	0.0	0
5-12-2015 4:00	0.0	282.0	27.5	85.5	0.0	0
5-12-2015 5:00	1.2	254.0	27.5	86.5	0.0	0
5-12-2015 6:00	0.0	310.0	26.6	81.2	0.0	17
5-12-2015 7:00	1.0	314.0	27.5	70.2	0.0	61
5-12-2015 8:00	1.0	289.0	28.5	68.0	0.0	266
5-12-2015 9:00	2.0	290.0	29.9	52.2	0.0	492
5-12-2015 10:00	0.0	282.0	30.2	45.5	0.0	664
5-12-2015 11:00	0.0	285.0	31.2	42.2	0.0	784
5-12-2015 12:00	0.0	247.0	40.2	36.6	0.0	850
5-12-2015 13:00	0.0	212.0	41.2	35.2	0.0	864
5-12-2015 14:00	2.0	275.0	39.0	26.6	0.0	782
5-12-2015 15:00	2.0	275.0	38.5	28.0	0.0	638
5-12-2015 16:00	2.0	275.0	39.6	29.5	0.0	429
5-12-2015 17:00	2.0	343.0	38.8	42.0	0.0	229
5-12-2015 18:00	2.0	225.0	37.5	45.5	0.0	69
5-12-2015 19:00	25.0	227.0	32.2	50.2	0.0	3

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-12-2015 20:00	5.0	228.0	31.2	46.5	0.0	0
5-12-2015 21:00	4.0	235.0	30.2	52.0	0.0	0
5-12-2015 22:00	3.0	168.0	28.5	69.6	0.0	0
5-12-2015 23:00	5.5	190.0	29.6	68.6	0.0	0
5-13-2015 0:00	0.2	166.0	27.8	71.2	0.0	0
5-13-2015 1:00	0.6	183.0	27.6	71.2	0.0	0
5-13-2015 2:00	2.0	187.0	26.6	75.5	0.0	0
5-13-2015 3:00	2.0	195.0	26.6	75.5	0.0	0
5-13-2015 4:00	0.0	212.0	25.5	74.4	0.0	0
5-13-2015 5:00	0.0	256.0	25.5	77.4	0.0	0
5-13-2015 6:00	2.0	255.0	27.5	71.2	0.0	32
5-13-2015 7:00	0.0	255.0	26.6	71.2	0.0	124
5-13-2015 8:00	2.0	275.0	28.5	70.2	0.0	278
5-13-2015 9:00	1.2	275.0	31.2	69.6	0.0	467
5-13-2015 10:00	0.5	275.0	35.5	54.5	0.0	562
5-13-2015 11:00	0.6	275.0	36.6	56.0	0.0	755
5-13-2015 12:00	0.3	285.0	38.5	48.5	0.0	685
5-13-2015 13:00	0.0	270.0	40.2	35.2	0.0	807
5-13-2015 14:00	0.5	270.0	40.2	36.2	0.0	501
5-13-2015 15:00	2.0	270.0	39.1	26.6	0.0	482
5-13-2015 16:00	2.0	270.0	38.4	29.5	0.0	264
5-13-2015 17:00	2.0	270.0	37.3	28.5	0.0	131
5-13-2015 18:00	5.0	277.0	36.1	26.5	0.0	57
5-13-2015 19:00	5.0	270.0	35.1	34.5	0.0	0
5-13-2015 20:00	5.0	274.0	34.0	45.0	0.0	0
5-13-2015 21:00	5.0	275.0	32.2	52.2	0.0	0
5-13-2015 22:00	1.2	275.0	32.2	65.5	0.0	0
5-13-2015 23:00	1.2	278.0	31.2	66.5	0.0	0
5-14-2015 0:00	3.2	270.0	32.2	75.5	0.0	0
5-14-2015 1:00	5.2	281.0	30.2	81.2	0.0	0
5-14-2015 2:00	0.0	270.0	28.5	85.2	0.0	0
5-14-2015 3:00	4.5	271.0	29.5	86.1	0.0	0
5-14-2015 4:00	0.0	275.0	29.5	87.1	0.0	0
5-14-2015 5:00	1.5	275.0	27.5	86.0	0.0	0
5-14-2015 6:00	0.0	272.0	28.5	87.5	0.0	18
5-14-2015 7:00	0.0	262.0	29.6	88.0	0.0	102
5-14-2015 8:00	1.2	262.0	30.2	75.5	0.0	339
5-14-2015 9:00	1.2	262.0	31.2	52.5	0.0	423
5-14-2015 10:00	0.5	262.0	32.2	45.5	0.0	655
5-14-2015 11:00	0.3	256.0	35.2	42.2	0.0	767
5-14-2015 12:00	0.5	256.0	38.0	35.2	0.0	883
5-14-2015 13:00	1.2	256.0	39.6	32.2	0.0	889
5-14-2015 14:00	1.5	256.0	41.0	32.2	0.0	801
5-14-2015 15:00	1.3	256.0	41.2	29.6	0.0	609
5-14-2015 16:00	1.2	256.0	42.1	32.2	0.0	449
5-14-2015 17:00	5.0	256.0	39.6	45.5.	0.0	168
5-14-2015 18:00	2.0	253.0	38.5	51.2	0.0	91

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-14-2015 19:00	2.0	252.0	35.5	52.2	0.0	6
5-14-2015 20:00	2.2	270.0	32.2	62.2	0.0	0
5-14-2015 21:00	2.0	270.0	30.2	45.0	0.0	0
5-14-2015 22:00	2.3	275.0	28.5	52.2	0.0	0
5-14-2015 23:00	2.5	275.0	29.6	75.5	0.0	0
5-15-2015 0:00	3.2	275.0	27.5	72.2	0.0	0
5-15-2015 1:00	5.0	275.0	28.5	85.2	0.0	0
5-15-2015 2:00	2.0	270.0	27.5	85.5	0.0	0
5-15-2015 3:00	0.2	262.0	28.5	84.2	0.0	0
5-15-2015 4:00	0.2	270.0	28.5	85.5	0.0	0
5-15-2015 5:00	2.0	270.0	29.6	84.5	0.0	0
5-15-2015 6:00	2.2	270.0	28.5	84.5	0.0	29
5-15-2015 7:00	0.0	270.0	27.5	84.6	0.0	150
5-15-2015 8:00	1.2	272.0	29.6	85.0	0.0	339
5-15-2015 9:00	0.0	272.0	30.2	86.0	0.0	431
5-15-2015 10:00	0.0	275.0	32.2	81.4	0.0	273
5-15-2015 11:00	0.0	262.0	34.2	73.1	0.0	408
5-15-2015 12:00	1.2	265.0	38.5	64.2	0.0	552
5-15-2015 13:00	1.2	262.0	39.1	59.5	0.0	967
5-15-2015 14:00	0.0	275.0	40.2	45.0	0.0	886
5-15-2015 15:00	0.5	275.0	39.2	52.2	0.0	731
5-15-2015 16:00	0.8	270.0	39.4	35.2	0.0	474
5-15-2015 17:00	0.6	270.0	35.6	36.6	0.0	294
5-15-2015 18:00	1.2	270.0	36.6	32.2	0.0	98
5-15-2015 19:00	2.2	270.0	34.5	25.5	0.0	4
5-15-2015 20:00	0.2	275.0	35.0	26.6	0.0	0
5-15-2015 21:00	0.5	275.0	33.3	66.5	0.0	0
5-15-2015 22:00	4.5	278.0	32.2	72.3	0.0	0
5-15-2015 23:00	6.3	275.0	30.2	78.2	0.0	0
5-16-2015 0:00	2.0	275.0	30.2	81.3	0.0	0
5-16-2015 1:00	0.5	270.0	29.6	83.0	0.0	0
5-16-2015 2:00	0.5	270.0	28.5	84.5	0.0	0
5-16-2015 3:00	0.5	270.0	28.5	84.1	0.0	0
5-16-2015 4:00	2.0	262.0	28.5	85.3	0.0	0
5-16-2015 5:00	2.2	262.0	27.5	81.5	0.0	0
5-16-2015 6:00	0.2	262.0	28.5	86.3	0.0	34
5-16-2015 7:00	0.0	262.0	30.2	75.5	0.0	179
5-16-2015 8:00	0.0	262.0	30.2	72.0	0.0	383
5-16-2015 9:00	0.0	262.0	32.2	54.5	0.0	604
5-16-2015 10:00	1.0	262.0	35.3	45.5	0.0	794
5-16-2015 11:00	1.0	262.0	36.6	42.2	0.0	921
5-16-2015 12:00	0.5	262.0	39.6	36.6	0.0	954
5-16-2015 13:00	0.5	272.0	40.2	32.0	0.0	938
5-16-2015 14:00	0.8	272.0	39.6	29.6	0.0	831
5-16-2015 15:00	0.8	272.0	38.0	35.2	0.0	691
5-16-2015 16:00	1.2	282.0	38.5	32.2	0.0	502
5-16-2015 17:00	1.2	282.0	37.5	31.2	0.0	277

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-16-2015 18:00	0.5	282.0	35.2	45.5	0.0	90
5-16-2015 19:00	0.2	282.0	34.2	52.2	0.0	4
5-16-2015 20:00	1.2	282.0	32.2	60.2	0.0	0
5-16-2015 21:00	1.5	282.0	31.2	68.0	0.0	0
5-16-2015 22:00	1.5	282.0	31.2	72.2	0.0	0
5-16-2015 23:00	1.3	252.0	30.2	74.5	0.0	0
5-17-2015 0:00	0.5	252.0	29.5	75.5	0.0	0
5-17-2015 1:00	0.6	252.0	29.6	73.3	0.0	0
5-17-2015 2:00	0.6	252.0	28.5	75.0	0.0	0
5-17-2015 3:00	0.8	252.0	27.8	76.4	0.0	0
5-17-2015 4:00	0.0	252.0	28.5	60.5	0.0	0
5-17-2015 5:00	0.0	252.0	28.0	63.1	0.0	0
5-17-2015 6:00	0.0	252.0	29.6	60.2	0.0	32
5-17-2015 7:00	0.0	252.0	32.2	65.1	0.0	167
5-17-2015 8:00	0.0	270.0	31.2	67.3	0.0	349
5-17-2015 9:00	0.0	270.0	33.2	54.0	0.0	552
5-17-2015 10:00	1.5	270.0	34.5	62.1	0.0	739
5-17-2015 11:00	0.0	272.0	36.6	68.0	0.0	878
5-17-2015 12:00	1.2	250.0	38.5	54.5	0.0	923
5-17-2015 13:00	1.2	252.0	39.6	42.2	0.0	913
5-17-2015 14:00	0.5	252.0	40.2	43.2	0.0	838
5-17-2015 15:00	0.6	253.0	41.2	32.2	0.0	654
5-17-2015 16:00	0.6	253.0	38.5	29.4	0.0	466
5-17-2015 17:00	0.3	262.0	36.3	30.2	0.0	141
5-17-2015 18:00	0.3	270.0	35.3	28.5	0.0	57
5-17-2015 19:00	1.2	270.0	34.2	35.5	0.0	1
5-17-2015 20:00	0.0	270.0	32.3	42.2	0.0	0
5-17-2015 21:00	0.0	270.0	31.2	56.6	0.0	0
5-17-2015 22:00	0.0	270.0	30.2	65.5	0.0	0
5-17-2015 23:00	0.0	270.0	29.6	78.5	0.0	0
5-18-2015 0:00	5.2	270.0	29.2	75.0	0.0	0
5-18-2015 1:00	5.2	270.0	28.5	68.3	0.0	0
5-18-2015 2:00	2.3	270.0	27.5	75.5	0.0	0
5-18-2015 3:00	2.2	270.0	27.5	75.5	0.0	0
5-18-2015 4:00	1.2	275.0	27.5	78.5	0.0	0
5-18-2015 5:00	1.5	275.0	27.5	81.2	0.0	0
5-18-2015 6:00	1.2	275.0	29.6	65.5	0.0	39
5-18-2015 7:00	1.0	276.0	30.2	54.5	0.0	96
5-18-2015 8:00	0.5	270.0	32.2	41.2	0.0	251
5-18-2015 9:00	0.6	270.0	34.2	41.1	0.0	293
5-18-2015 10:00	0.5	270.0	33.3	32.2	0.0	754
5-18-2015 11:00	0.5	270.0	35.6	26.6	0.0	690
5-18-2015 12:00	0.5	285.0	36.6	38.5	0.0	801
5-18-2015 13:00	1.2	285.0	38.5	45.5	0.0	625
5-18-2015 14:00	1.3	285.0	39.6	51.2	0.0	523
5-18-2015 15:00	1.5	285.0	40.2	35.5	0.0	604
5-18-2015 16:00	0.5	282.0	36.6	32.2	0.0	506

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-18-2015 17:00	2.2	282.0	34.5	42.2	0.0	278
5-18-2015 18:00	2.2	263.0	32.2	59.5	0.0	96
5-18-2015 19:00	4.2	263.0	30.3	62.2	0.0	3
5-18-2015 20:00	3.2	230.0	29.5	75.7	0.0	0
5-18-2015 21:00	3.5	225.0	29.5	74.7	0.0	0
5-18-2015 22:00	3.5	255.0	28.5	72.5	0.0	0
5-18-2015 23:00	1.2	252.0	26.6	72.2	0.0	0
5-19-2015 0:00	1.2	252.0	27.5	71.2	0.0	0
5-19-2015 1:00	0.5	222.0	26.2	84.5	0.0	0
5-19-2015 2:00	0.6	220.0	26.6	81.8	0.0	0
5-19-2015 3:00	0.6	220.0	25.5	85.8	0.0	0
5-19-2015 4:00	0.5	220.0	26.2	85.0	0.0	0
5-19-2015 5:00	1.2	220.0	26.5	86.0	0.0	0
5-19-2015 6:00	1.2	200.0	26.5	85.0	0.0	21
5-19-2015 7:00	1.0	220.0	29.6	75.5	0.0	95
5-19-2015 8:00	0.0	220.0	30.2	72.2	0.0	149
5-19-2015 9:00	0.0	220.0	30.2	65.0	0.0	323
5-19-2015 10:00	0.3	220.0	31.2	68.0	0.0	296
5-19-2015 11:00	0.0	252.0	35.2	65.0	0.0	402
5-19-2015 12:00	0.0	262.0	36.6	52.2	0.0	513
5-19-2015 13:00	0.0	262.0	38.0	45.2	0.0	850
5-19-2015 14:00	0.0	262.0	40.2	36.6	0.0	538
5-19-2015 15:00	0.0	262.0	38.5	35.5	0.0	307
5-19-2015 16:00	0.0	262.0	39.6	32.2	0.0	164
5-19-2015 17:00	0.0	252.0	35.5	26.6	0.0	139
5-19-2015 18:00	1.2	252.0	35.5	28.5	0.0	55
5-19-2015 19:00	1.2	202.0	34.5	34.2	0.0	4
5-19-2015 20:00	1.2	188.0	28.5	32.2	0.0	0
5-19-2015 21:00	0.0	185.0	27.5	54.2	0.0	0
5-19-2015 22:00	0.0	185.0	27.5	65.5	0.0	0
5-19-2015 23:00	0.0	185.0	27.5	62.2	0.0	0
5-20-2015 0:00	0.0	185.0	26.5	75.5	0.0	0
5-20-2015 1:00	0.0	251.0	26.6	85.8	0.0	0
5-20-2015 2:00	0.0	252.0	26.5	85.5	0.0	0
5-20-2015 3:00	0.0	222.0	26.6	75.5	0.0	0
5-20-2015 4:00	0.0	225.0	26.8	75.5	0.0	0
5-20-2015 5:00	0.0	252.0	26.6	75.5	0.0	0
5-20-2015 6:00	0.0	252.0	27.5	76.6	0.0	51
5-20-2015 7:00	5.2	252.0	28.5	65.5	0.0	192
5-20-2015 8:00	2.3	252.0	29.5	68.5	0.0	416
5-20-2015 9:00	2.0	252.0	30.2	62.5	0.0	637
5-20-2015 10:00	2.0	220.0	32.2	62.2	0.0	822
5-20-2015 11:00	1.5	220.0	35.2	58.5	0.0	967
5-20-2015 12:00	1.6	202.0	36.6	35.5	0.0	873
5-20-2015 13:00	1.2	270.0	39.9	28.5	0.0	645
5-20-2015 14:00	1.0	270.0	41.2	32.2	0.0	895
5-20-2015 15:00	1.0	270.0	40.2	31.2	0.0	684

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-20-2015 16:00	2.0	270.0	36.6	35.2	0.0	523
5-20-2015 17:00	0.0	270.0	35.5	34.2	0.0	277
5-20-2015 18:00	0.0	250.0	32.3	35.2	0.0	93
5-20-2015 19:00	0.0	252.0	30.2	62.0	0.0	5
5-20-2015 20:00	0.0	252.0	31.2	62.2	0.0	0
5-20-2015 21:00	4.0	252.0	31.2	65.5	0.0	0
5-20-2015 22:00	0.0	212.0	30.2	65.5	0.0	0
5-20-2015 23:00	0.0	201.0	28.5	75.5	0.0	0
5-21-2015 0:00	0.0	201.0	28.5	74.5	0.0	0
5-21-2015 1:00	1	173	31.3	43.5	0	0
5-21-2015 2:00	1	168	30.6	44.6	0	0
5-21-2015 3:00	0	145	30.4	49.9	0	0
5-21-2015 4:00	1	163	29.8	54	0	0
5-21-2015 5:00	1	166	29.4	55.3	0	0
5-21-2015 6:00	1	168	29.2	54.9	0	22
5-21-2015 7:00	3	139	29.9	51.4	0	139
5-21-2015 8:00	6	131	30.9	44.6	0	373
5-21-2015 9:00	6	141	32.8	40	0	586
5-21-2015 10:00	8	162	35.1	34.1	0	701
5-21-2015 11:00	8	168	37.2	30	0	849
5-21-2015 12:00	8	183	38.3	28.3	0	892
5-21-2015 13:00	6	189	38.7	28.8	0	830
5-21-2015 14:00	8	196	38.3	28.8	0	756
5-21-2015 15:00	8	192	38.6	23.4	0	343
5-21-2015 16:00	8	199	38.7	27.6	0	271
5-21-2015 17:00	8	206	37.2	27.3	0	189
5-21-2015 18:00	4	197	35.8	32.6	0	134
5-21-2015 19:00	0	165	34.4	38.6	0	4
5-21-2015 20:00	0	172	33.2	38.7	0	0
5-21-2015 21:00	0	122	32.6	36	0	0
5-21-2015 22:00	0	159	31.8	40.3	0	0
5-21-2015 23:00	0	138	31.7	37.7	0	0
5-22-2015 0:00	0	151	31.6	41.3	0	0
5-22-2015 1:00	0	94	31	43.8	0	0
5-22-2015 2:00	0	53	30.6	45.6	0	0
5-22-2015 3:00	0	49	30.2	47.5	0	0
5-22-2015 4:00	0	45	29.6	49.8	0	0
5-22-2015 5:00	0	50	29.6	48.8	0	0
5-22-2015 6:00	1	73	29.4	50.6	0	31
5-22-2015 7:00	0	63	29.2	52.7	0	132
5-22-2015 8:00	0	80	29.9	51.2	0	323
5-22-2015 9:00	0	122	32.1	44	0	584
5-22-2015 10:00	0	179	33.9	38.3	0	765
5-22-2015 11:00	0	179	34.7	34	0	615
5-22-2015 12:00	1	169	35.7	30.1	0	773
5-22-2015 13:00	1	160	37.6	26	0	773
5-22-2015 14:00	1	165	37.7	26	0	637

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-22-2015 15:00	0	189	37.8	26.9	0	661
5-22-2015 16:00	0	135	37.4	27.3	0	518
5-22-2015 17:00	0	80	36.6	27.3	0	255
5-22-2015 18:00	0	66	35.8	33.5	0	87
5-22-2015 19:00	0	111	33.6	37.2	0	5
5-22-2015 20:00	0	141	32.3	41.5	0	0
5-22-2015 21:00	0	121	31.1	44.4	0	0
5-22-2015 22:00	0	74	30.3	47.7	0	0
5-22-2015 23:00	1	81	29.8	44.7	0	0
5-23-2015 0:00	1	100	30	47.5	0	0
5-23-2015 1:00	3	163	29.3	47.3	0	0
5-23-2015 2:00	0	240	28.7	52.1	0	0
5-23-2015 3:00	0	309	28.1	53.8	0	0
5-23-2015 4:00	0	276	27.6	54.5	0	0
5-23-2015 5:00	0	73	27.2	57.5	0	0
5-23-2015 6:00	0	169	27.4	56	0	33
5-23-2015 7:00	1	237	28	50.1	0	158
5-23-2015 8:00	0	238	30.8	41.8	0	362
5-23-2015 9:00	1	262	32.9	35	0	583
5-23-2015 10:00	1	276	34.5	33.2	0	734
5-23-2015 11:00	1	271	36.2	27.6	0	831
5-23-2015 12:00	0	210	37.4	26	0	803
5-23-2015 13:00	0	265	38.2	26.9	0	791
5-23-2015 14:00	0	271	38.7	20.8	0	776
5-23-2015 15:00	0	289	39.1	23	0	685
5-23-2015 16:00	0	254	38.6	19	0	507
5-23-2015 17:00	0	278	37.9	29.3	0	282
5-23-2015 18:00	4	297	36	34.4	0	97
5-23-2015 19:00	3	293	34.6	38.5	0	6
5-23-2015 20:00	0	279	33.4	44.4	0	0
5-23-2015 21:00	1	293	32.4	45.9	0	0
5-23-2015 22:00	1	309	31.6	46.6	0	0
5-23-2015 23:00	0	310	30.9	46	0	0
5-24-2015 0:00	0	314	30.4	47.1	0	0
5-24-2015 1:00	0	314	29.7	53.9	0	0
5-24-2015 2:00	0	316	29.1	56.9	0	0
5-24-2015 3:00	0	220	28.7	61.5	0	0
5-24-2015 4:00	0	312	28.4	65.3	0	0
5-24-2015 5:00	1	304	28.3	66.9	0	0
5-24-2015 6:00	3	220	28.3	69	0	40
5-24-2015 7:00	4	295	28.8	66.3	0	187
5-24-2015 8:00	4	256	30.3	62	0	393
5-24-2015 9:00	4	276	32.3	54.6	0	581
5-24-2015 10:00	4	175	33.6	56.5	0	736
5-24-2015 11:00	9	296	33.4	53.9	0	871
5-24-2015 12:00	6	190	34.7	45.5	0	941
5-24-2015 13:00	6	262	35.7	44.7	0	915

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-24-2015 14:00	8	190	35.8	43.4	0	814
5-24-2015 15:00	6	183	33.2	57.2	0	637
5-24-2015 16:00	4	210	29.1	49.4	0.2	442
5-24-2015 17:00	3	152	30.3	57.4	0	239
5-24-2015 18:00	0	105	30.4	53.8	0	83
5-24-2015 19:00	0	292	29.3	59	0	5
5-24-2015 20:00	0	205	28.6	61.7	0	0
5-24-2015 21:00	0	220	28.1	67.4	0	0
5-24-2015 22:00	1	220	28	66.5	0	0
5-24-2015 23:00	1	220	27.8	68.5	0	0
5-25-2015 0:00	1	299	27.4	71.5	0	0
5-25-2015 1:00	3	296	27.2	66.2	0	0
5-25-2015 2:00	3	175	27.1	66.7	0	0
5-25-2015 3:00	1	312	27.1	69.1	0	0
5-25-2015 4:00	1	295	26.8	72.3	0	0
5-25-2015 5:00	1	175	26.5	77.3	0	0
5-25-2015 6:00	4	220	26.6	78.1	0	38
5-25-2015 7:00	4	220	27.2	76.7	0	191
5-25-2015 8:00	6	265	28.6	69.6	0	413
5-25-2015 9:00	6	268	30.3	63.6	0	621
5-25-2015 10:00	6	262	32.1	58	0	795
5-25-2015 11:00	6	255	32.6	56.1	0	922
5-25-2015 12:00	4	261	33.7	52.9	0	972
5-25-2015 13:00	6	242	34.4	48.6	0	955
5-25-2015 14:00	3	237	35.3	42.7	0	847
5-25-2015 15:00	1	200	36.4	41.4	0	689
5-25-2015 16:00	1	173	36.6	39.7	0	465
5-25-2015 17:00	1	175	36	41.8	0	260
5-25-2015 18:00	3	175	35.3	44.4	0	91
5-25-2015 19:00	3	218	34.2	53.4	0	6
5-25-2015 20:00	4	286	32.7	55.6	0	0
5-25-2015 21:00	3	175	32.1	57.2	0	0
5-25-2015 22:00	3	206	31.4	60.3	0	0
5-25-2015 23:00	1	285	30.6	63.6	0	0
5-26-2015 0:00	1	310	30.3	64.8	0	0
5-26-2015 1:00	0	328	29.8	68	0	0
5-26-2015 2:00	0	205	29.4	70.7	0	0
5-26-2015 3:00	0	312	28.9	72.9	0	0
5-26-2015 4:00	0	175	28.6	75.5	0	0
5-26-2015 5:00	1	230	28.4	75.5	0	0
5-26-2015 6:00	0	200	28.2	75	0	36
5-26-2015 7:00	1	266	29.1	68.9	0	182
5-26-2015 8:00	0	296	31.9	56.2	0	396
5-26-2015 9:00	0	276	34.3	48.2	0	618
5-26-2015 10:00	0	261	36.1	44.7	0	782
5-26-2015 11:00	0	261	37.4	34.7	0	889
5-26-2015 12:00	0	218	38.6	33.9	0	969

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-26-2015 13:00	3	208	38.4	30.3	0	932
5-26-2015 14:00	3	214	38.7	32	0	829
5-26-2015 15:00	3	221	38.5	32.9	0	665
5-26-2015 16:00	3	221	38.1	34.4	0	449
5-26-2015 17:00	1	235	37.4	38	0	250
5-26-2015 18:00	0	247	36.8	42.3	0	89
5-26-2015 19:00	0	303	35.2	51.1	0	6
5-26-2015 20:00	1	220	34	55.5	0	0
5-26-2015 21:00	1	297	33	58.1	0	0
5-26-2015 22:00	0	175	32.2	59.2	0	0
5-26-2015 23:00	0	317	31.6	62	0	0
5-27-2015 0:00	1	312	31	64.6	0	0
5-27-2015 1:00	0	307	30.3	70.2	0	0
5-27-2015 2:00	0	313	29.6	74.1	0	0
5-27-2015 3:00	0	338	28.8	78	0	0
5-27-2015 4:00	0	343	28.3	81.6	0	0
5-27-2015 5:00	0	220	27.9	84.9	0	0
5-27-2015 6:00	0	53	28.1	78.4	0	41
5-27-2015 7:00	0	32	30.2	63	0	179
5-27-2015 8:00	0	107	33.6	44.9	0	373
5-27-2015 9:00	0	204	36.7	33	0	562
5-27-2015 10:00	0	224	38.9	27.4	0	749
5-27-2015 11:00	0	159	40	26	0	867
5-27-2015 12:00	0	224	41.6	26	0	917
5-27-2015 13:00	3	207	41	20.8	0	894
5-27-2015 14:00	4	186	41.4	19	0	804
5-27-2015 15:00	3	206	41.7	22.1	0	665
5-27-2015 16:00	1	224	40.9	27	0	452
5-27-2015 17:00	3	213	39.8	26	0	241
5-27-2015 18:00	0	220	38.9	26	0	86
5-27-2015 19:00	0	211	37.4	26	0	6
5-27-2015 20:00	0	204	35.8	32.8	0	0
5-27-2015 21:00	0	138	33.8	34.6	0	0
5-27-2015 22:00	0	69	32.6	42.3	0	0
5-27-2015 23:00	0	52	31.5	48.9	0	0
5-28-2015 0:00	0	49	30.4	47.1	0	0
5-28-2015 1:00	0	46	29.9	49.6	0	0
5-28-2015 2:00	0	91	30.1	40.4	0	0
5-28-2015 3:00	3	124	29.9	39.6	0	0
5-28-2015 4:00	0	132	29.3	29	0	0
5-28-2015 5:00	0	189	28.1	41.1	0	0
5-28-2015 6:00	0	173	26.9	47.6	0	23
5-28-2015 7:00	0	202	28.9	43.7	0	93
5-28-2015 8:00	0	135	33.1	26.2	0	274
5-28-2015 9:00	1	153	36.1	19	0	490
5-28-2015 10:00	4	186	38.2	19	0	674
5-28-2015 11:00	3	183	40.1	19	0	796

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
5-28-2015 12:00	4	186	42.1	13.8	0	863
5-28-2015 13:00	6	192	43.1	10.3	0	838
5-28-2015 14:00	9	186	43.9	8.5	0	753
5-28-2015 15:00	11	186	43.7	9.4	0	623
5-28-2015 16:00	6	196	43.2	12	0	446
5-28-2015 17:00	3	221	41.8	17.3	0	249
5-28-2015 18:00	0	228	40.2	19	0	87
5-28-2015 19:00	0	252	38.2	26	0	7
5-28-2015 20:00	0	248	35.9	28.6	0	0
5-28-2015 21:00	0	145	34.3	34	0	0
5-28-2015 22:00	0	145	32.9	35.2	0	0
5-28-2015 23:00	0	197	31.9	42	0	0
5-29-2015 0:00	0	207	31.1	46.3	0	0
5-29-2015 1:00	0	217	30.1	45.8	0	0
5-29-2015 2:00	0	230	29.3	52.6	0	0
5-29-2015 3:00	0	317	28.2	56.2	0	0
5-29-2015 4:00	0	316	27.4	60.6	0	0
5-29-2015 5:00	0	265	26.9	85	0	0
5-29-2015 6:00	0	292	26.8	85.5	0	42
5-29-2015 7:00	1	303	28.7	73.4	0	179
5-29-2015 8:00	0	309	31.5	56.3	0	365
5-29-2015 9:00	0	309	35.1	36.8	0	557
5-29-2015 10:00	0	268	38.1	32.9	0	712
5-29-2015 11:00	0	206	39.9	26	0	817
5-29-2015 12:00	0	245	42.5	14.7	0	880
5-29-2015 13:00	3	189	43.2	12.9	0	866
5-29-2015 14:00	4	190	43.3	19	0	788
5-29-2015 15:00	3	196	43.2	19	0	652
5-29-2015 16:00	1	206	42.5	19	0	473
5-29-2015 17:00	0	228	41.6	19	0	327
5-29-2015 18:00	0	227	40.6	27.6	0	141
5-29-2015 19:00	0	285	38.1	33.2	0	16
5-29-2015 20:00	0	175	36.4	37.5	0	0
5-29-2015 21:00	0	304	35	41.4	0	0
5-29-2015 22:00	0	310	33.9	49.4	0	0
5-29-2015 23:00	1	295	32.7	68.2	0	0
5-30-2015 0:00	4	206	31.5	71.6	0	0
5-30-2015 1:00	3	218	30.8	73.7	0	0
5-30-2015 2:00	3	218	30.2	73.6	0	0
5-30-2015 3:00	1	220	29.7	72.6	0	0
5-30-2015 4:00	1	297	28.9	72.3	0	0
5-30-2015 5:00	1	220	28.3	73.4	0	0
5-30-2015 6:00	3	295	27.6	72.8	0	45
5-30-2015 7:00	3	206	28.2	65.4	0	182
5-30-2015 8:00	3	220	29.8	59.2	0	375
5-30-2015 9:00	3	220	31.9	54.3	0	562
5-30-2015 10:00	3	286	33.8	50.4	0	736

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
5-30-2015 11:00	3	297	35.4	42.3	0	868
5-30-2015 12:00	1	272	37.5	35.3	0	920
5-30-2015 13:00	0	271	39.9	33.2	0	905
5-30-2015 14:00	1	206	39.8	34.1	0	822
5-30-2015 15:00	1	286	40.1	33.2	0	667
5-30-2015 16:00	4	202	39.3	42.8	0	475
5-30-2015 17:00	6	206	37.3	47.2	0	267
5-30-2015 18:00	6	292	35.3	51.9	0	94
5-30-2015 19:00	6	292	33.6	56.6	0	7
5-30-2015 20:00	8	285	32.1	61	0	0
5-30-2015 21:00	6	195	30.4	63.8	0	0
5-30-2015 22:00	8	292	29.4	67	0	0
5-30-2015 23:00	8	282	28.6	70.5	0	0
5-31-2015 0:00	8	299	27.9	73.5	0	0
5-31-2015 1:00	8	218	27.6	74.5	0	0
5-31-2015 2:00	6	175	27.3	76.2	0	0
5-31-2015 3:00	8	206	26.9	76.6	0	0
5-31-2015 4:00	6	286	26.5	77	0	0
5-31-2015 5:00	6	292	26.3	78.5	0	0
5-31-2015 6:00	4	297	26.2	77.6	0	50
5-31-2015 7:00	6	202	26.7	75.4	0	162
5-31-2015 8:00	8	295	27.9	68.6	0	357
5-31-2015 9:00	8	202	29.9	62.4	0	560
5-31-2015 10:00	6	273	31.8	57.2	0	742
5-31-2015 11:00	6	292	33.5	52.8	0	858
5-31-2015 12:00	6	276	34.8	48.9	0	891
5-31-2015 13:00	6	206	36	46	0	889
5-31-2015 14:00	4	206	36.7	44.5	0	786
5-31-2015 15:00	3	286	37.3	42.6	0	660
5-31-2015 16:00	4	206	37.3	42.7	0	467
5-31-2015 17:00	4	285	36.7	47.3	0	264
5-31-2015 18:00	6	292	35.6	53.1	0	96
5-31-2015 19:00	6	206	33.4	62.2	0	8
5-31-2015 20:00	6	220	31.9	65.5	0	0
5-31-2015 21:00	6	286	30.9	69.5	0	0
5-31-2015 22:00	6	297	30.1	71.6	0	0
5-31-2015 23:00	8	285	29.3	74.5	0	0
6-1-2015 0:00	6	220	28.8	75.4	0	0
6-1-2015 1:00	6	195	28.3	76.6	0	0
6-1-2015 2:00	4	285	28	76.7	0	0
6-1-2015 3:00	6	238	27.4	78.3	0	0
6-1-2015 4:00	6	256	27.1	78	0	0
6-1-2015 5:00	4	195	27	76.9	0	0
6-1-2015 6:00	4	195	26.8	75.6	0	40
6-1-2015 7:00	6	202	27.8	69.4	0	175
6-1-2015 8:00	8	282	29.1	58.4	0	363
6-1-2015 9:00	8	206	30.8	54.4	0	556

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-1-2015 10:00	8	175	32.4	50.8	0	726
6-1-2015 11:00	6	276	34	48	0	854
6-1-2015 12:00	6	268	34.9	45.1	0	907
6-1-2015 13:00	4	254	36	40.1	0	841
6-1-2015 14:00	4	255	36.8	38.8	0	776
6-1-2015 15:00	6	269	37.3	37	0	648
6-1-2015 16:00	4	264	37.2	37	0	475
6-1-2015 17:00	6	255	36.9	39	0	277
6-1-2015 18:00	6	273	36.2	42	0	98
6-1-2015 19:00	4	271	35	49.4	0	8
6-1-2015 20:00	6	292	33.4	56.3	0	0
6-1-2015 21:00	6	220	32.4	60.7	0	0
6-1-2015 22:00	8	286	31.2	60.7	0	0
6-1-2015 23:00	6	195	30.4	62.1	0	0
6-2-2015 0:00	6	175	29.8	66	0	0
6-2-2015 1:00	6	175	29.2	70	0	0
6-2-2015 2:00	4	303	28.8	73	0	0
6-2-2015 3:00	6	206	28.1	53.9	0	0
6-2-2015 4:00	8	285	24.8	70.4	0	0
6-2-2015 5:00	4	258	24.4	74.7	0	0
6-2-2015 6:00	6	220	24.5	68.4	0	23
6-2-2015 7:00	4	292	26	64.5	0	163
6-2-2015 8:00	3	282	27.2	52.9	0	361
6-2-2015 9:00	3	218	30.2	45.1	0	569
6-2-2015 10:00	4	268	32.5	42.4	0	756
6-2-2015 11:00	6	202	33.9	42.9	0	854
6-2-2015 12:00	6	272	34.8	40.3	0	905
6-2-2015 13:00	4	269	36.1	37	0	886
6-2-2015 14:00	6	202	36.9	37	0	797
6-2-2015 15:00	6	282	37.1	37	0	657
6-2-2015 16:00	8	218	36.9	40.3	0	476
6-2-2015 17:00	8	282	35.7	45	0	279
6-2-2015 18:00	8	286	34.4	50.9	0	102
6-2-2015 19:00	6	218	33	57	0	10
6-2-2015 20:00	6	285	32.1	59.6	0	0
6-2-2015 21:00	8	285	31.3	61.5	0	0
6-2-2015 22:00	6	276	30.6	64.5	0	0
6-2-2015 23:00	6	299	30	68.3	0	0
6-3-2015 0:00	4	296	29.4	71.4	0	0
6-3-2015 1:00	1	220	28.8	73.4	0	0
6-3-2015 2:00	1	299	28.2	75.7	0	0
6-3-2015 3:00	3	295	27.7	80.3	0	0
6-3-2015 4:00	8	292	27.2	79.8	0	0
6-3-2015 5:00	4	218	26.8	81	0	0
6-3-2015 6:00	6	218	26.9	77.2	0	40
6-3-2015 7:00	6	282	27.8	71.5	0	179
6-3-2015 8:00	6	220	29.3	64.6	0	395

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-3-2015 9:00	6	218	31.1	59.6	0	595
6-3-2015 10:00	4	202	33.4	51.7	0	770
6-3-2015 11:00	1	273	35.8	44.3	0	863
6-3-2015 12:00	1	175	37.2	41.3	0	919
6-3-2015 13:00	3	175	37.7	40.3	0	910
6-3-2015 14:00	3	175	37.8	39.6	0	855
6-3-2015 15:00	4	292	37.7	39.1	0	665
6-3-2015 16:00	3	206	37.5	39.4	0	493
6-3-2015 17:00	3	295	37.1	41.3	0	283
6-3-2015 18:00	3	299	36.1	44.7	0	105
6-3-2015 19:00	3	299	34.9	50.7	0	9
6-3-2015 20:00	3	220	33.8	56.5	0	0
6-3-2015 21:00	3	220	32.7	61.7	0	0
6-3-2015 22:00	4	286	31.9	66.4	0	0
6-3-2015 23:00	4	218	31	71.5	0	0
6-4-2015 0:00	3	195	30	76.3	0	0
6-4-2015 1:00	4	296	28.9	79.7	0	0
6-4-2015 2:00	3	220	28.6	80.4	0	0
6-4-2015 3:00	3	175	28.3	81.9	0	0
6-4-2015 4:00	3	220	28.1	82.9	0	0
6-4-2015 5:00	1	304	28	83.2	0	0
6-4-2015 6:00	3	220	28	82.3	0	48
6-4-2015 7:00	4	297	28.9	75.9	0	160
6-4-2015 8:00	4	218	30.7	68.5	0	344
6-4-2015 9:00	1	175	32.9	58.4	0	529
6-4-2015 10:00	1	285	35.3	50.7	0	696
6-4-2015 11:00	4	218	36.7	46.9	0	849
6-4-2015 12:00	1	285	38.3	40	0	892
6-4-2015 13:00	1	272	39.5	33	0	883
6-4-2015 14:00	4	272	39.8	38.2	0	776
6-4-2015 15:00	4	285	39.1	40.2	0	453
6-4-2015 16:00	6	285	38.3	43.6	0	24
6-4-2015 17:00	6	206	37.2	47.5	0	58
6-4-2015 18:00	6	282	35.5	52.6	0	72
6-4-2015 19:00	8	220	33.8	58.4	0	19
6-4-2015 20:00	8	195	32.4	61.7	0	0
6-4-2015 21:00	9	269	31.3	66.8	0	0
6-4-2015 22:00	8	195	30.4	69.7	0	0
6-4-2015 23:00	8	195	29.9	71.7	0	0
6-5-2015 0:00	8	286	29.5	73.5	0	0
6-5-2015 1:00	4	195	29.1	75.6	0	0
6-5-2015 2:00	4	296	28.7	77.2	0	0
6-5-2015 3:00	4	218	28.4	79.1	0	0
6-5-2015 4:00	3	297	28.1	81.4	0	0
6-5-2015 5:00	3	299	27.9	82.2	0	0
6-5-2015 6:00	6	206	27.8	77.3	0	22
6-5-2015 7:00	6	285	27.9	67.2	0	144

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-5-2015 8:00	6	218	29.7	60.2	0	364
6-5-2015 9:00	8	202	31.5	54	0	582
6-5-2015 10:00	8	285	32.7	53.2	0	754
6-5-2015 11:00	6	299	34.3	50.2	0	879
6-5-2015 12:00	6	202	35.1	48.8	0	947
6-5-2015 13:00	6	285	35.7	47.3	0	914
6-5-2015 14:00	6	265	35.8	49	0	824
6-5-2015 15:00	6	272	35.8	48.1	0	670
6-5-2015 16:00	6	175	35.5	50.4	0	478
6-5-2015 17:00	6	292	34.7	54.8	0	270
6-5-2015 18:00	6	206	33.4	60	0	94
6-5-2015 19:00	8	206	31.7	65.9	0	20
6-5-2015 20:00	6	202	30.4	69.8	0	0
6-5-2015 21:00	8	220	29.7	71	0	0
6-5-2015 22:00	6	220	29.2	73	0	0
6-5-2015 23:00	6	206	28.7	76.2	0	0
6-6-2015 0:00	6	206	28.3	78	0	0
6-6-2015 1:00	3	296	28.1	80	0	0
6-6-2015 2:00	4	286	27.7	81.5	0	0
6-6-2015 3:00	4	297	27.4	82.3	0	0
6-6-2015 4:00	4	220	27.2	83	0	0
6-6-2015 5:00	3	303	27.1	83.8	0	0
6-6-2015 6:00	3	276	27.1	83.9	0	39
6-6-2015 7:00	1	285	28.2	75.1	0	177
6-6-2015 8:00	1	204	30.9	61.7	0	376
6-6-2015 9:00	0	206	33.9	53.5	0	583
6-6-2015 10:00	0	206	36.4	44.7	0	761
6-6-2015 11:00	0	273	37.9	45.6	0	868
6-6-2015 12:00	1	248	38.3	42.7	0	897
6-6-2015 13:00	1	271	39.1	38.2	0	908
6-6-2015 14:00	0	261	40.3	32.6	0	821
6-6-2015 15:00	1	237	40.9	30.1	0	664
6-6-2015 16:00	0	258	41.1	27	0	491
6-6-2015 17:00	0	175	40.5	32.5	0	294
6-6-2015 18:00	0	206	39.1	38.8	0	148
6-6-2015 19:00	1	220	37.1	49.6	0	22
6-6-2015 20:00	4	299	35.3	58.4	0	0
6-6-2015 21:00	3	296	33.7	64.7	0	0
6-6-2015 22:00	6	292	32.6	67.7	0	0
6-6-2015 23:00	3	195	31.8	70.6	0	0
6-7-2015 0:00	1	292	31.2	75.1	0	0
6-7-2015 1:00	1	220	30.4	79.5	0	0
6-7-2015 2:00	1	206	29.8	82.5	0	0
6-7-2015 3:00	0	273	29.3	84.5	0	0
6-7-2015 4:00	0	190	29.3	84	0	0
6-7-2015 5:00	0	249	28.8	86	0	0
6-7-2015 6:00	0	175	28.8	83	0	41

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Directio n (Deg)	Temperatur e (Deg C)	Relative Humidit y (%)	Rain fall (mm)	Solar Radiatio n (wat/m2)
6-7-2015 7:00	0	297	29.8	77.7	0	180
6-7-2015 8:00	0	202	31.7	65.7	0	373
6-7-2015 9:00	0	286	33.9	54.7	0	578
6-7-2015 10:00	0	175	36.6	41.8	0	747
6-7-2015 11:00	0	265	39.3	32.7	0	830
6-7-2015 12:00	0	224	41.1	31.8	0	608
6-7-2015 13:00	1	216	41.5	31.5	0	479
6-7-2015 14:00	1	276	41.5	27	0	488
6-7-2015 15:00	1	285	41.4	27.9	0	583
6-7-2015 16:00	6	190	36	55	0.2	378
6-7-2015 17:00	4	211	30.9	45.6	2.5	131
6-7-2015 18:00	8	148	33.7	33.5	0.2	22
6-7-2015 19:00	1	136	30.9	56.5	0	0
6-7-2015 20:00	0	227	29.1	60.3	0	0
6-7-2015 21:00	0	264	28.8	59.1	0	0
6-7-2015 22:00	0	316	29.1	60.7	0	0
6-7-2015 23:00	0	190	28.6	61.7	0	0
6-8-2015 0:00	3	88	29.3	43.7	0	0
6-8-2015 1:00	0	187	29.4	55.1	0	0
6-8-2015 2:00	0	234	28.5	61.7	0	0
6-8-2015 3:00	0	202	28.3	59.2	0	0
6-8-2015 4:00	1	220	27.7	70.1	0	0
6-8-2015 5:00	0	296	27.2	71	0	0
6-8-2015 6:00	0	220	26.9	71.1	0	36
6-8-2015 7:00	0	317	27.9	63.4	0	196
6-8-2015 8:00	1	282	30.3	53.1	0	313
6-8-2015 9:00	0	73	33.6	45.7	0	465
6-8-2015 10:00	0	91	35.8	32.6	0	402
6-8-2015 11:00	1	190	37.9	27.6	0	721
6-8-2015 12:00	0	168	39.1	26	0	924
6-8-2015 13:00	0	189	40.2	26	0	920
6-8-2015 14:00	0	182	40.4	26	0	749
6-8-2015 15:00	0	152	41.1	22.5	0	331
6-8-2015 16:00	0	132	40.8	22.1	0	290
6-8-2015 17:00	0	110	40.3	26	0	69
6-8-2015 18:00	0	146	39.7	28.2	0	15
6-8-2015 19:00	0	202	37.6	34.7	0	0
6-8-2015 20:00	0	317	36.1	37.7	0	0
6-8-2015 21:00	0	326	34.9	42.2	0	0
6-8-2015 22:00	0	310	33.9	45.8	0	0
6-8-2015 23:00	1	310	33.1	54.8	0	0
6-9-2015 0:00	1	316	32.2	61.7	0	0
6-9-2015 1:00	0	101	31.4	55.1	0	0
6-9-2015 2:00	0	96	30.8	54.9	0	0
6-9-2015 3:00	0	42	30	58.3	0	0
6-9-2015 4:00	0	60	29.4	63	0	0
6-9-2015 5:00	0	338	29.1	62	0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-9-2015 6:00	0	314	28.8	62.6	0	40
6-9-2015 7:00	3	175	29.7	56.3	0	189
6-9-2015 8:00	4	202	31.4	50	0	392
6-9-2015 9:00	4	261	33.1	44.1	0	597
6-9-2015 10:00	3	232	35.2	38.5	0	775
6-9-2015 11:00	1	255	37.4	33.3	0	915
6-9-2015 12:00	1	259	38.7	31.1	0	961
6-9-2015 13:00	1	252	39.9	29.6	0	935
6-9-2015 14:00	1	282	40.2	28.1	0	829
6-9-2015 15:00	1	282	40.6	27	0	665
6-9-2015 16:00	1	202	40.6	27	0	476
6-9-2015 17:00	3	202	39.9	27.2	0	276
6-9-2015 18:00	3	190	39.3	29.5	0	89
6-9-2015 19:00	1	269	38.1	33.2	0	16
6-9-2015 20:00	1	238	36.8	34.1	0	0
6-9-2015 21:00	0	129	34.4	39.2	0	0
6-9-2015 22:00	3	177	33.1	43.9	0	0
6-9-2015 23:00	0	213	32.5	44.6	0	0
6-10-2015 0:00	0	228	32.4	47.1	0	0
6-10-2015 1:00	0	228	31.9	49.9	0	0
6-10-2015 2:00	0	216	31.2	56.7	0	0
6-10-2015 3:00	0	208	30.6	60.7	0	0
6-10-2015 4:00	0	208	30.1	58.7	0	0
6-10-2015 5:00	0	254	29.3	68	0	0
6-10-2015 6:00	0	320	29.2	66	0	44
6-10-2015 7:00	0	319	31.1	52.7	0	178
6-10-2015 8:00	0	251	33.5	43.9	0	371
6-10-2015 9:00	0	134	35.6	37.6	0	561
6-10-2015 10:00	0	138	37.7	34.3	0	740
6-10-2015 11:00	1	120	39.1	32.7	0	872
6-10-2015 12:00	0	197	39.9	32.5	0	927
6-10-2015 13:00	4	153	36.6	32.7	0	901
6-10-2015 14:00	1	200	37.9	32.9	0	789
6-10-2015 15:00	1	241	39.3	32	0	620
6-10-2015 16:00	0	218	39.5	30.8	0	443
6-10-2015 17:00	0	286	39.1	33.7	0	283
6-10-2015 18:00	0	204	37.4	41.9	0	107
6-10-2015 19:00	1	210	36.3	44.7	0	11
6-10-2015 20:00	0	241	35.7	47.7	0	0
6-10-2015 21:00	1	265	34.9	48.6	0	0
6-10-2015 22:00	0	271	34.6	51.7	0	0
6-10-2015 23:00	1	202	34.1	53.2	0	0
6-11-2015 0:00	0	276	33.2	57.7	0	0
6-11-2015 1:00	0	282	32.4	60.3	0	0
6-11-2015 2:00	0	296	31.7	54.8	0	0
6-11-2015 3:00	0	111	31.1	58.3	0	0
6-11-2015 4:00	0	50	30.9	63.3	0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-11-2015 5:00	0	79	30.6	55.4	0	0
6-11-2015 6:00	0	53	30.8	54.2	0	40
6-11-2015 7:00	0	32	32.6	46.7	0	191
6-11-2015 8:00	0	73	34	45.8	0	393
6-11-2015 9:00	1	80	35.4	42.9	0	591
6-11-2015 10:00	1	90	36.2	39.5	0	761
6-11-2015 11:00	1	129	37.7	32.4	0	887
6-11-2015 12:00	1	121	39.6	28.3	0	936
6-11-2015 13:00	1	170	40.9	27	0	935
6-11-2015 14:00	1	159	42.1	27	0	865
6-11-2015 15:00	3	144	40.3	29.1	0	705
6-11-2015 16:00	1	189	40.3	30.5	0	511
6-11-2015 17:00	4	132	36.8	39.2	0	295
6-11-2015 18:00	3	91	34.2	45.1	0	117
6-11-2015 19:00	1	56	32.4	47.6	0	12
6-11-2015 20:00	0	199	32.1	48.6	0	0
6-11-2015 21:00	0	53	31.8	50.4	0	0
6-11-2015 22:00	0	86	31.6	49.6	0	0
6-11-2015 23:00	0	74	31.2	50.4	0	0
6-12-2015 0:00	0	76	30.8	53.7	0	0
6-12-2015 1:00	0	129	30.4	55.4	0	0
6-12-2015 2:00	0	205	29.7	59.9	0	0
6-12-2015 3:00	0	320	29.2	61.2	0	0
6-12-2015 4:00	0	220	29.2	63.8	0	0
6-12-2015 5:00	0	220	28.8	64.6	0	0
6-12-2015 6:00	0	220	28.9	64.1	0	27
6-12-2015 7:00	0	231	30.9	51.3	0	160
6-12-2015 8:00	0	50	34.1	43	0	341
6-12-2015 9:00	1	88	36.2	35	0	539
6-12-2015 10:00	1	101	38.7	27.4	0	710
6-12-2015 11:00	3	145	40.7	19.9	0	839
6-12-2015 12:00	3	152	41.8	19	0	883
6-12-2015 13:00	3	173	42.6	19	0	878
6-12-2015 14:00	3	172	43.2	19	0	801
6-12-2015 15:00	3	187	43.3	19	0	643
6-12-2015 16:00	3	190	42.8	19	0	445
6-12-2015 17:00	1	186	42.3	19	0	247
6-12-2015 18:00	0	196	40.9	19	0	92
6-12-2015 19:00	0	201	39.4	19	0	12
6-12-2015 20:00	0	201	37.8	26	0	0
6-12-2015 21:00	0	201	36.1	28.7	0	0
6-12-2015 22:00	0	201	34.9	37.9	0	0
6-12-2015 23:00	0	74	33.9	42.2	0	0
6-13-2015 0:00	0	64	33.7	34	0	0
6-13-2015 1:00	0	183	32.8	38.4	0	0
6-13-2015 2:00	0	184	31.9	38.5	0	0
6-13-2015 3:00	0	264	30.7	42.7	0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-13-2015 4:00	0	202	29.8	56	0	0
6-13-2015 5:00	0	312	29.2	44.5	0	0
6-13-2015 6:00	0	97	29.9	41	0	35
6-13-2015 7:00	1	84	32.1	32.4	0	149
6-13-2015 8:00	3	87	35.3	27.1	0	333
6-13-2015 9:00	4	97	38.7	19	0	542
6-13-2015 10:00	4	138	40.8	19	0	715
6-13-2015 11:00	1	158	42.5	19	0	846
6-13-2015 12:00	3	135	43.3	19	0	876
6-13-2015 13:00	3	139	43.9	16.4	0	850
6-13-2015 14:00	3	138	44.2	16.4	0	767
6-13-2015 15:00	4	146	44.1	15.5	0	607
6-13-2015 16:00	4	145	43.4	16.4	0	413
6-13-2015 17:00	3	163	43.1	17.3	0	252
6-13-2015 18:00	1	182	41.9	19	0	104
6-13-2015 19:00	0	183	40.1	19	0	14
6-13-2015 20:00	0	247	38	34.7	0	0
6-13-2015 21:00	0	218	36.6	48.9	0	0
6-13-2015 22:00	0	295	35.6	55.1	0	0
6-13-2015 23:00	1	297	34.7	57.6	0	0
6-14-2015 0:00	1	271	33.7	62.6	0	0
6-14-2015 1:00	0	202	32.7	66	0	0
6-14-2015 2:00	0	269	31.7	70.3	0	0
6-14-2015 3:00	1	285	30.9	74.5	0	0
6-14-2015 4:00	0	206	30.3	77.4	0	0
6-14-2015 5:00	0	206	29.7	77.8	0	0
6-14-2015 6:00	0	40	29.6	75.9	0	33
6-14-2015 7:00	1	83	32.1	41.1	0	149
6-14-2015 8:00	1	101	35.4	32	0	303
6-14-2015 9:00	3	139	37.3	26	0	493
6-14-2015 10:00	3	158	39.9	19	0	667
6-14-2015 11:00	3	142	42.1	19	0	772
6-14-2015 12:00	6	107	43.7	17.3	0	886
6-14-2015 13:00	6	165	43.7	13.8	0	885
6-14-2015 14:00	8	166	44.1	12	0	795
6-14-2015 15:00	8	165	44.1	12	0	678
6-14-2015 16:00	6	162	43.8	12.9	0	474
6-14-2015 17:00	1	182	43.3	15.5	0	305
6-14-2015 18:00	0	210	42.1	19	0	150
6-14-2015 19:00	0	242	40.1	30.1	0	26
6-14-2015 20:00	1	220	38.1	38	0	0
6-14-2015 21:00	3	299	36.9	42.9	0	0
6-14-2015 22:00	3	303	36	48.3	0	0
6-14-2015 23:00	4	218	35	55.4	0	0
6-15-2015 0:00	1	218	33.9	60.8	0	0
6-15-2015 1:00	1	295	33	64.7	0	0
6-15-2015 2:00	1	218	32	69.9	0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-15-2015 3:00	1	292	31.2	72.1	0	0
6-15-2015 4:00	0	271	30.5	76.3	0	0
6-15-2015 5:00	0	264	30.1	78.1	0	0
6-15-2015 6:00	0	268	29.8	78.7	0	31
6-15-2015 7:00	0	218	30.9	67.7	0	145
6-15-2015 8:00	0	220	33.7	56.3	0	311
6-15-2015 9:00	0	271	36.9	44	0	513
6-15-2015 10:00	0	223	39	33.6	0	644
6-15-2015 11:00	1	201	40.7	32	0	824
6-15-2015 12:00	1	228	41.6	27.5	0	889
6-15-2015 13:00	1	245	42.7	27.1	0	876
6-15-2015 14:00	1	248	43.2	26	0	786
6-15-2015 15:00	0	256	43.3	27.2	0	654
6-15-2015 16:00	4	268	42.1	33.1	0	358
6-15-2015 17:00	4	276	40.7	34.7	0	234
6-15-2015 18:00	6	190	39.2	39.4	0	38
6-15-2015 19:00	6	202	37.9	44.9	0	0
6-15-2015 20:00	4	285	36.7	49	0	0
6-15-2015 21:00	4	272	35.9	53.8	0	0
6-15-2015 22:00	3	282	34.8	58.9	0	0
6-15-2015 23:00	4	206	33.7	62.3	0	0
6-16-2015 0:00	3	276	32.6	69.5	0	0
6-16-2015 1:00	3	202	31.6	71.1	0	0
6-16-2015 2:00	0	285	31.2	69.7	0	0
6-16-2015 3:00	0	206	30.9	56.4	0	0
6-16-2015 4:00	0	175	30.4	63.9	0	0
6-16-2015 5:00	0	202	29.9	67.5	0	0
6-16-2015 6:00	1	202	29.6	71.5	0	39
6-16-2015 7:00	4	202	30	63.3	0	126
6-16-2015 8:00	4	206	31.4	57	0	112
6-16-2015 9:00	3	282	32.8	49.3	0	198
6-16-2015 10:00	1	286	35.6	41.8	0	256
6-16-2015 11:00	0	264	38.2	35.1	0	645
6-16-2015 12:00	1	218	39.4	34.6	0	593
6-16-2015 13:00	3	285	39.6	37.6	0	809
6-16-2015 14:00	3	202	39.6	36.9	0	342
6-16-2015 15:00	4	276	39.6	40	0	288
6-16-2015 16:00	9	282	37.4	47.4	0	340
6-16-2015 17:00	9	271	35.8	51.3	0	184
6-16-2015 18:00	9	271	33.9	57.5	0	62
6-16-2015 19:00	9	206	31.6	63.4	0	6
6-16-2015 20:00	11	202	30.1	68.1	0	0
6-16-2015 21:00	9	286	29.5	70.1	0	0
6-16-2015 22:00	8	282	28.7	71.7	0	0
6-16-2015 23:00	9	286	28.1	72.5	0	0
6-17-2015 0:00	4	286	27.9	73.4	0	0
6-17-2015 1:00	3	271	27.9	73.7	0	0

Date (mm/dd/yy), time	Speed Wind (Km/hr)	Wind Direction (Deg)	Temperature (Deg C)	Relative Humidity (%)	Rain fall (mm)	Solar Radiation (wat/m2)
6-17-2015 2:00	6	276	27.7	74.7	0	0
6-17-2015 3:00	8	195	27.5	76.1	0	0
6-17-2015 4:00	6	206	27.1	77.3	0	0
6-17-2015 5:00	1	286	27.3	76	0	0
6-17-2015 6:00	1	285	27.4	71.6	0	31
6-17-2015 7:00	4	269	27.4	70.3	0	145
6-17-2015 8:00	6	175	28.1	63.9	0	262
6-17-2015 9:00	6	206	29.8	60.6	0	455
6-17-2015 10:00	6	190	31	56.5	0	515
6-17-2015 11:00	6	285	32.2	54.3	0	824
6-17-2015 12:00	4	272	32.7	54.8	0	785
6-17-2015 13:00	3	190	33.6	49.6	0	568
6-17-2015 14:00	1	202	35	47.7	0	754
6-17-2015 15:00	3	175	35.7	47.7	0	654
6-17-2015 16:00	6	276	34.6	53.2	0	358
6-17-2015 17:00	4	175	33.4	56.3	0	125
6-17-2015 18:00	6	276	31.7	64.4	0	40
6-17-2015 19:00	8	202	29.9	68.4	0	0
6-17-2015 20:00	8	282	29	71.9	0	0
6-17-2015 21:00	8	276	28.3	75	0	0
6-17-2015 22:00	4	206	27.9	75.4	0	0
6-17-2015 23:00	4	218	27.5	78.3	0	0
6-18-2015 0:00	3	296	27.6	76.6	0	0
6-18-2015 1:00	3	292	27.7	75.6	0	0
6-18-2015 2:00	3	190	27.7	76.4	0	0
6-18-2015 3:00	3	206	27.4	78.1	0	0
6-18-2015 4:00	3	285	27.2	79.7	0	0
6-18-2015 5:00	4	206	26.8	81.7	0	0
6-18-2015 6:00	3	195	26.7	80.5	0	23
6-18-2015 7:00	6	202	27.1	77	0	120
6-18-2015 8:00	6	218	28.1	72.2	0	199
6-18-2015 9:00	6	190	29.8	64.7	0	325
6-18-2015 10:00	8	202	30.9	59.8	0	425
6-18-2015 11:00	6	202	32.6	55.8	0	588
6-18-2015 12:00	4	195	34.6	46.9	0	488
6-18-2015 13:00	3	286	36.2	43.8	0	788
6-18-2015 14:00	3	190	37.2	41.5	0	402
6-18-2015 15:00	4	206	37.2	41.7	0	205
6-18-2015 16:00	6	202	36.4	49.1	0.5	302
6-18-2015 17:00	8	282	35	53	0	125
6-18-2015 18:00	6	295	33.4	56.5	0	41
6-18-2015 19:00	1	211	28.9	81.6	11.6	4

Annex 4.2

Ambient Air Quality Data

Location : Simriyaghat (AAQ-1)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	12/13.04.2015	77	38	8.5	29.6	20.2	36.6	0.32	0.05	6.65	<1.0	3.22	1.85	<2.0
2	16/17.04.2015	89	45	6.6	28.5	25.2	30.2	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
3	21/22.04.2015	92	55	7.5	36.0	26.6	28.5	0.88	<0.02	8.55	2.66	4.25	1.66	<2.0
4	24/25.04.2015	92	47	9.2	26.6	21.2	40.2	0.66	<0.02	7.55	<1.0	2.66	<0.4	<2.0
5	29/30.04.2015	85	42	7.6	27.5	18.6	47.5	0.33	0.02	5.60	<1.0	<2.08	<0.4	<2.0
6	02/03.05.2015	73	39	4.9	29.3	15.9	30.5	0.34	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
7	04/05.05.2015	89	43	6.2	32.4	22.5	41.6	0.42	0.03	7.21	<1.0	2.67	<0.4	<2.0
8	06/07.05.2015	68	36	4.3	28.6	18.7	32.5	0.31	<0.02	4.85	<1.0	<2.08	<0.4	<2.0
9	08/09.05.2016	74	39	5.2	27.5	18.6	33.6	0.48	<0.02	5.32	<1.0	2.56	1.41	<2.0
10	10/11.05.2015	69	36	6.3	30.2	17.3	29.6	0.56	<0.02	5.66	<1.0	<2.08	<0.4	<2.0
11	12/13.05.2015	78	40	4..5	25.3	19.5	24.8	0.47	0.02	6.37	<1.0	2.58	<0.4	<2.0
12	14/15.05.2015	80	43	6.2	36.4	21.4	36.9	0.52	0.03	8.54	3.66	3.05	<0.4	<2.0
13	17/18.05.2015	56	22	7.2	26.6	20.2	26.6	0.32	0.02	6.70	<1.0	<2.08	<0.4	<2.0
14	19/20.05.2015	78	35	6.9	18.5	16.6	25.5	0.25	0.02	5.55	<1.0	<2.08	<0.4	<2.0
15	21/22.05.2015	70	30	4.5	35.6	20.2	16.6	0.23	0.03	<4.0	4.52	5.66	1.88	<2.0
16	24/25.05.2015	68	29	5.3	38.5	24.2	20.3	0.31	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
17	26/27.05.2015	59	26	6.6	22.5	18.5	<19.62	0.28	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
18	28/29.05.2015	60	26	7.8	31.5	26.6	15.5	0.22	0.02	7.06	<1.0	<2.08	<0.4	<2.0
19	01/02.06.2015	73	39	4.9	29.3	15.9	30.5	0.34	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	03/04.06.2015	46	22	6.2	32.4	22.5	41.6	0.42	0.03	7.21	<1.0	2.67	<0.4	<2.0
21	05/06.06.2015	68	36	4.3	28.6	18.7	32.5	0.31	<0.02	4.85	<1.0	<2.08	<0.4	<2.0
22	07/08.06.2015	74	39	5.2	27.5	18.6	33.6	0.48	<0.02	5.32	<1.0	2.85	<0.4	<2.0
23	09/10.06.2015	69	36	6.3	30.2	17.3	29.6	0.56	<0.02	5.66	<1.0	<2.08	<0.4	<2.0
24	11/12.06.2015	78	40	4..5	25.3	19.5	24.8	0.47	0.02	6.37	<1.0	2.58	<0.4	<2.0

Location : Shikharichawk (Pach Mahala) Village (AAQ-2)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	12/13.04.2015	70	36	6.6	26.6	16.6	32.2	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
2	16/17.04.2015	85	45	8.5	20.2	25.2	36.6	0.26	0.02	4.55	3.66	2.89	<0.4	<2.0
3	21/22.04.2015	92	55	7.5	35.2	22.2	42.2	0.26	<0.02	<4.0	<1.0	2.66	1.85	<2.0
4	24/25.04.2015	60	35	6.2	23.8	14.8	34.5	0.35	<0.02	4.55	2.25	<2.08	<0.4	<2.0
5	29/30.04.2015	78	42	7.5	26.2	18.5	41.9	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
6	02/03.05.2015	72	38	5.6	24.3	16.3	33.6	0.34	0.02	5.37	2.04	<2.08	<0.4	<2.0
7	04/05.05.2015	69	36	4.5	22.7	12.6	28.7	0.28	<0.02	4.38	<1.0	<2.08	<0.4	<2.0
8	06/07.05.2015	82	43	6.4	34.6	19.5	44.8	0.47	0.04	8.32	2.57	3.63	<0.4	<2.0
9	08/09.05.2016	77	41	5.4	30.2	21.2	32.1	0.32	0.03	5.12	2.33	3.55	1.47	<2.0
10	10/11.05.2015	65	34	4.5	23.4	19.3	40.8	0.21	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
11	12/13.05.2015	77	42	5.2	29.3	14.0	35.7	0.25	0.02	5.39	<1.0	<2.08	<0.4	<2.0
12	14/15.05.2015	85	45	6.2	27.4	21.8	48.7	0.47	0.05	6.85	3.25	3.06	1.32	<2.0
13	17/18.05.2015	62	30	4.5	20.2	19.6	30.2	0.22	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
14	19/20.05.2015	78	36	6.2	18.5	18.5	33.3	0.36	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
15	21/22.05.2015	69	35	5.5	16.6	<10.0	<19.62	0.55	0.03	6.26	<1.0	<2.08	<0.4	<2.0
16	24/25.05.2015	55	36	9.6	26.6	<10.0	<19.62	0.62	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
17	26/27.05.2015	46	25	6.2	24.5	<10.0	<19.62	0.49	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
18	28/29.05.2015	72	38	7.5	22.2	<10.0	<19.62	0.26	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
19	01/02.06.2015	67	32	4.5	20.2	16.6	20.2	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	03/04.06.2015	58	25	6.2	32.2	15.5	<19.62	0.19	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	05/06.06.2015	75	38	5.5	26.2	20.2	28.5	0.16	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
22	07/08.06.2015	68	33	4.8	16.6	<10.0	35.5	0.20	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
23	10/11.06.2015	58	26	5.6	19.5	<10.0	<19.62	0.36	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
24	11/12.06.2015	49	22	6.3	23.2	<10.0	<19.62	0.25	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0

Location : Maranchi Village (AAQ-3)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	12/13.04.2015	48	20	6.6	28.5	16.6	42.2	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
2	16/17.04.2015	56	24	7.2	20.2	25.5	36.6	0.22	0.03	4.2	2.55	3.2	<0.4	<2.0
3	21/22.04.2015	88	42	8.2	23.2	23.2	32.2	0.88	<0.02	<4.0	3.22	4.55	<0.4	<2.0
4	24/25.04.2015	56	30	7.5	24.2	21.2	32.5	0.45	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
5	29/30.04.2015	80	48	8.6	28.5	18.5	40.2	0.36	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
6	02/03.05.2015	63	33	5.2	22.7	13.2	27.3	0.34	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
7	04/05.05.2015	57	30	4.0	23.4	11.4	23.6	0.27	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
8	06/07.05.2015	72	38	5.0	30.2	15.7	25.9	0.35	0.02	5.48	<1.0	<2.08	<0.4	<2.0
9	08/09.05.2016	52	29	7.5	24.7	16.5	30.2	0.56	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
10	10/11.05.2015	46	25	6.2	23.6	19.3	28.4	0.25	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
11	12/13.05.2015	58	31	5.3	20.8	12.7	27.5	0.37	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
12	14/15.05.2015	70	39	6.5	22.4	21.6	32.4	0.42	0.02	4.98	<1.0	<2.08	<0.4	<2.0
13	17/18.05.2015	62	37	6	25.2	16.5	25.5	0.16	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
14	19/20.05.2015	56	30	4.5	20.02	18.5	<19.62	0.55	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
15	21/22.05.2015	69	33	6.2	19.6	20.2	35.6	0.23	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
16	24/25.05.2015	75	38	5.5	30.2	22.2	<19.62	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
17	26/27.05.2015	46	20	8.5	26.6	<10.0	<19.62	0.22	<0.02	6.00	<1.0	<2.08	<0.4	<2.0
18	28/29.05.2015	59	26	6.6	21.2	<10.0	30.2	0.2	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
19	01/02.06.2015	54	26	6.6	20.2	22.2	42.2	0.22	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	03/04.06.2015	80	41	7.5	26.6	26.6	<19.62	0.18	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	05/06.06.2015	92	55	10.2	32.2	28.5	36.6	0.31	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
22	07/08.06.2015	95	56	9.6	35.2	24.2	<19.62	0.22	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
23	09/10.06.2015	77	38	5.5	31.2	20.2	20.2	0.19	<0.02	9.31	<1.0	<2.08	<0.4	<2.0
24	11/12.06.2015	56	29	4.3	26.7	14.8	21.3	0.14	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0

Location : Makardahi Village (AAQ-4)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	12/13.04.2015	62	34	6.6	26.6	18.5	30.2	0.25	<0.02	9.20	<1.0	<2.08	<0.4	<2.0
2	16/17.04.2015	99	55	6.2	30.2	20.2	26.6	0.19	0.02	11.99	5.2	2.66	<0.4	<2.0
3	21/22.04.2015	85	48	7.2	27.5	23.2	24.5	0.32	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
4	24/25.04.2015	58	28	6.3	22.2	18.7	36.3	0.38	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
5	29/30.04.2015	78	40	7.4	28.5	21.4	48.5	0.51	<0.02	6.85	4.52	3.56	2.85	<2.0
6	02/03.05.2015	69	36	4.6	25.3	14.3	30.5	0.31	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
7	03/04.05.2015	87	44	6.2	39.7	20.6	42.6	0.42	0.03	5.38	<1.0	3.21	<0.4	<2.0
8	05/06.05.2015	78	40	5.4	28.4	15.3	37.4	0.38	0.02	4.87	<1.0	<2.08	<0.4	<2.0
9	07/08.05.2015	90	48	6.5	36.9	21.6	46.5	0.33	0.05	7.28	<1.0	3.02	<0.4	<2.0
10	11/12.05.2015	56	29	7.9	29.6	20.2	28.5	0.28	<0.02	<4.0	<1.0	2.56	1.56	<2.0
11	13/14.05.2015	71	38	5.6	34.2	19.6	36.6	0.44	0.02	8.55	<1.0	<2.08	<0.4	<2.0
12	15/16.05.2015	65	34	5.0	27.5	17.5	25.3	0.25	<0.02	<4.0	<1.0	< 2.08	<0.4	<2.0
13	18/19.05.2015	87	44	6.6	20.8	<10.0	41.2	0.22	<0.02	8.80	<1.0	< 2.08	<0.4	<2.0
14	20/21.05.2015	71	37	7.5	29.6	20.2	30.2	0.16	<0.02	10.57	4.23	3.23	<0.4	<2.0
15	23/24.05.2015	58	30	7.2	30.2	23.2	55.2	0.33	0.02	6.64	4.25	2.36	1.62	<2.0
16	25/26.05.2015	67	27	8.5	33.3	25.2	31.2	0.42	<0.02	<4.0	<1.0	< 2.08	<0.4	<2.0
17	27/28.05.2015	78	37	7.9	30.2	22.2	34.2	0.32	<0.02	<4.0	<1.0	< 2.08	<0.4	<2.0
18	29/30.05.2015	71	38	10.2	36.6	<10.0	<19.62	0.26	0.02	<4.0	4.2	2.66	1.62	<2.0
19	31.05/01.06.2015	86	48	8.5	31.2	<10.0	<19.62	0.29	<0.02	<4.0	<1.0	< 2.08	<0.4	<2.0
20	02/03.06.2015	56	27	6.6	21.2	<10.0	26.6	0.25	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	04.05.06.2015	85	30	5.2	19.6	<10.0	28.5	0.32	0.02	5.22	3.22	2.66	1.26	<2.0
22	08/09.06.2015	88	45	10.2	15.5	<10.0	30.2	0.45	0.02	8.52	<1.0	4.52	1.66	<2.0
23	10/11.06.2015	70	34	8.5	34.2	24.2	<19.62	0.55	<0.02	<4.0	<1.0	<2.08	1.56	<2.0
24	12/13.06.2015	62	30	9.6	30.1	23.2	<19.62	0.34	<0.02	6.04	<1.0	<2.08	<0.4	<2.0

Location : Mahna Village (AAQ-5)														
		Concentration of Pollutants												
SL.No.	Date of Monitoring	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	11/12.04.2015	68	38	6.6	26.6	16.6	36.6	0.23	<0.02	7.55	<1.0	<2.08	<0.4	<2.0
2	14/15.04.2015	92	55	4.2	34.2	25.2	33.4	0.25	<0.02	5.80	4.5	3.60	1.50	<2.0
3	20/21.04.2015	78	39	9.6	38.5	22.8	42.5	0.56	0.02	6.66	<1.0	<2.08	<0.4	<2.0
4	23/24.04.2015	66	28	8.5	24.7	20.2	26.6	0.45	<0.02	<4.0	3.66	4.55	2.66	<2.0
5	27/28.04.2015	55	22	8.2	26.6	23.2	30.2	0.36	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
6	30.04/01.05.2015	72	38	7.5	26.6	18.5	36.6	0.22	0.02	<4.0	4.21	<2.08	1.99	<2.0
7	03/04.05.2015	73	39	5.0	27.3	17.5	29.6	0.28	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
8	05/06.05.2015	95	54	6.6	32.2	20.2	32.2	0.35	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
9	07/08.05.2015	75	48	5.5	35.5	25.2	28.5	0.45	<0.02	6.3	<1.0	<2.08	<0.4	<2.0
10	11/12.05.2015	60	37	6.2	28.5	20.2	40.2	0.26	0.05	<4.0	<1.0	<2.08	<0.4	<2.0
11	13/14.05.2015	56	27	7.5	29.6	24.2	51.2	0.36	0.02	4.0	3.66	2.66	1.85	<2.0
12	15/16.05.2015	82	40	6.6	30.2	14.4	35.2	0.21	0.05	4.0	<1.0	<2.08	<0.4	<2.0
13	18/19.05.2015	57	26	4.5	25.5	<10.0	26.3	0.16	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
14	20/21.05.2015	66	32	5.2	20.2	<10.0	23.2	0.28	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
15	23/24.05.2015	69	30	6.2	16.6	<10.0	25.5	0.44	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
16	25/26.05.2015	75	41	5.5	20.2	21.2	34.2	0.52	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
17	27/28.05.2015	85	45	4.8	36.6	25.3	25.2	0.36	<0.02	8.57	<1.0	<2.08	<0.4	<2.0
18	29/30.05.2015	48	22	6.2	23.2	<10.0	<19.62	0.26	0.02	8.29	<1.0	<2.08	<0.4	<2.0
19	31.05/01.06.2015	72	35	4.6	20.2	<10.0	<19.62	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	02/03.06.2015	66	31	5.6	30.2	16.6	25.5	0.26	0.02	5.87	<1.0	<2.08	<0.4	<2.0
21	04/05.06.2015	75	42	8.2	29.6	20.2	32.2	0.32	0.03	5.69	3.56	<2.08	<0.4	<2.0
22	08/09.06.2015	65	33	4.5	22.6	26.6	34.5	0.18	0.03	5.36	5.23	2.69	1.22	<2.0
23	10/11.06.2015	44	26	8.5	20.2	19.6	45.5	0.25	0.02	5.60	<1.0	<2.08	<0.4	<2.0
24	12/13.06.2015	68	35	9.6	31.2	<10.0	<19.62	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0

Location : Kiul Village (AAQ-6)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	11/12.04.2015	68	38	6.9	29.8	14.2	40.5	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
2	14/15.04.2015	56	30	5.5	26.6	17.5	36.6	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
3	20/21.04.2015	87	45	4.3	19.2	16.6	32.2	0.37	<0.02	7.54	4.52	<2.08	<0.4	<2.0
4	23/24.04.2015	62	36	6.6	20.2	12.2	25.5	0.20	<0.02	<4.0	3.25	4.25	<0.4	<2.0
5	27/28.04.2015	86	46	7.5	27.5	18.5	23.5	0.26	0.02	<4.0	<1.0	3.20	<0.4	<2.0
6	30.04/01.05.2015	45	23	8.5	32.2	20.2	31.2	0.40	<0.02	8.99	<1.0	<2.08	<0.4	<2.0
7	03/04.05.2015	65	37	7.0	30.2	14.9	51.2	0.47	0.05	5.39	2.66	<2.08	<0.4	<2.0
8	05/06.05.2015	58	26	8.6	26.6	20.2	46.6	0.45	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
9	07/08.05.2015	78	32	6.5	31.2	19.3	62.2	0.55	<0.02	<4.0	<1.0	<2.08	2.33	<2.0
10	11/12.05.2015	84	41	5.6	39.6	21.4	58.5	0.62	0.05	5.08	<1.0	2.88	<0.4	<2.0
11	13/14.05.2015	81	48	9.6	38.5	20.2	49.6	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
12	15/16.05.2015	65	39	8.2	28.6	18.3	35.5	0.25	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
13	18/19.05.2015	82	48	6.6	23.3	<10.0	<19.62	0.22	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
14	20/21.05.2015	65	30	5.5	20.2	20.2	36.6	0.16	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
15	23/24.05.2015	72	33	4.5	22.2	<10.0	45.5	0.35	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
16	25/26.05.2015	55	27	5.5	19.6	<10.0	<19.62	0.45	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
17	27/28.05.2015	49	28	5.5	20.2	21.2	<19.62	0.33	0.04	<4.0	<1.0	<2.08	<0.4	<2.0
18	29/30.05.2015	65	33	6.2	30.5	<10.0	<19.62	0.29	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
19	31.05/01.06.2015	72	38	4.5	32.2	19.5	58.5	0.46	0.02	6.79	<1.0	<2.08	<0.4	<2.0
20	02/03.06.2015	48	22	4.5	22.2	23.3	<19.62	0.23	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	04/05.06.2015	56	26	5.5	18.5	20.2	<19.62	0.55	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
22	08/09.06.2015	62	33	6.3	20.2	<10.0	<19.62	0.62	<0.02	<4.0	5.55	4.22	1.66	<2.0
23	10/11.06.2015	75	38	5.2	26.6	20.2	32.2	0.23	0.03	6.55	<1.0	2.88	<0.4	<2.0
24	12/13.06.2015	66	30	4.5	30.2	23.2	35.6	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0

Location : Hajipur Village (AAQ-7)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	13/14.04.2015	95	57	6.6	36.6	21.2	46.5	0.42	0.03	14.3	<1.0	<2.08	<0.4	<2.0
2	17/18.04.2015	118	70	8.5	34.2	26.3	32.2	0.32	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
3	19/20.04.2015	86	46	7.5	25.5	24.3	25.5	0.28	<0.02	5.13	<1.0	<2.08	<0.4	<2.0
4	22/23.04.2015	125	68	9.6	37.5	28.5	28.5	0.36	0.02	<4.0	<1.0	5.62	2.55	<2.0
5	28/29.04.2015	132	76	7.6	28.6	23.3	48.5	0.28	0.04	19.5	4.55	3.50	<0.4	<2.0
6	01/02.05.2015	125	55	9.6	32.2	18.3	37.5	0.42	<0.02	8.20	<1.0	<2.08	<0.4	<2.0
7	04/05.05.2015	89	48	7.5	36.6	20.4	25.6	0.55	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
8	06/07.05.2015	132	69	8.5	41.2	24.3	42.2	0.88	0.04	6.88	3.26	3.50	<0.4	<2.0
9	08/09.05.2015	95	45	10.2	34.2	21.7	35.8	0.75	0.06	<4.0	2.96	2.66	<0.4	<2.0
10	10/11.05.2015	78	32	11.2	30.2	25.5	45.5	0.96	<0.02	9.66	<1.0	4.55	3.22	<2.0
11	12/13.05.2015	98	52	8.3	38.7	17.3	33.5	0.67	0.04	7.35	<1.0	2.57	1.68	<2.0
12	14/15.05.2015	85	45	7.3	33.2	21.4	42.6	0.75	0.03	9.67	<1.0	<2.08	2.42	<2.0
13	17/18.05.2015	76	32	6.7	28.5	24.2	36.6	0.56	0.03	8.91	<1.0	<2.08	<0.4	<2.0
14	19/20.05.2015	112	64	8.5	26.6	20.2	62.2	0.45	0.02	9.43	4.2	<2.08	<0.4	<2.0
15	21/22.05.2015	105	57	6.6	30.2	16.6	40.2	0.26	0.03	6.21	<1.0	3.2	2.22	<2.0
16	24/25.05.2015	69	36	5.5	20.2	13.3	26.6	0.32	0.03	5.31	3.22	4.2	1.56	<2.0
17	26/27.05.2015	95	51	8.2	34.5	18.2	30.2	0.28	0.03	5.41	<1.0	<2.08	<0.4	<2.0
18	28/29.05.2015	88	40	7.0	30.2	20.2	28.2	0.44	0.03	<0.4	<1.0	<2.08	<0.4	<2.0
19	01/02.06.2015	89	41	6.6	21.2	15.6	36.6	0.26	0.03	6.00	<1.0	<2.08	<0.4	<2.0
20	03/04.06.2015	68	33	8.5	26.6	20.2	42.2	0.33	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	05/06.06.2015	78	29	7.2	19.6	15.5	56.6	0.45	<0.02	<4.0	3.26	1.52	<0.4	<2.0
22	07/08.06.2015	90	41	5.9	32.2	21.2	62.2	0.62	0.02	<4.0	2.96	2.66	<0.4	<2.0
23	09/10.06.2015	68	33	5.8	27.5	23.2	41.2	0.26	0.02	<4.0	<1.0	<2.08	1.25	<2.0
24	11/12.06.2015	88	46	6.2	29.6	18.5	29.6	0.23	0.00	<4.0	<1.0	<2.08	1.68	<2.0

Location : Barauni Thermal Colony (AAQ-8)														
SL. No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	11/12.04.2015	92	48	6.8	28.5	18.5	41.2	0.45	<0.02	4.06	4.55	<2.08	<0.4	<2.0
2	14/15.04.2015	66	27	6.6	26.6	20.2	36.6	0.63	0.02	5.32	<1.0	4.2	<0.4	<2.0
3	20/21.04.2015	70	30	7.2	30.2	13.3	52.5	0.55	<0.02	8.07	<1.0	<2.08	2.55	<2.0
4	23/24.04.2015	89	55	4.8	31.2	16.6	35.5	0.35	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
5	27/28.04.2015	80	34	5.8	35.5	24.5	52.5	0.32	<0.02	<4.0	<1.0	3.13	<0.4	<2.0
6	30/04-01/05.2015	72	33	7.5	22.3	20.2	39.5	0.24	<0.02	<4.0	<1.0	<2.08	1.32	<2.0
7	03/04.05.2015	75	35	6.6	32.2	27.4	48.35	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
8	05/06.05.2015	122	66	8.5	43.2	22.6	45.5	0.36	0.03	<4.0	2.65	4.55	2.62	<2.0
9	07/08.05.2015	66	30	7.5	22.7	18.3	28.5	0.25	<0.02	<4.0	5.6	<2.08	<0.4	<2.0
10	11/12.05.2015	82	48	5.2	28.5	15.5	55.5	0.28	0.04	5.20	<1.0	3.26	1.88	<2.0
11	13/14.05.2015	79	40	6.8	26.6	16.6	68.5	0.30	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
12	15/16.05.2015	92	48	7.0	30.7	22.3	45.9	0.41	0.02	6.37	<1.0	2.96	<0.4	<2.0
13	18/19.05.2015	70	35	8.2	26.6	19.6	42.2	0.32	<0.02	5.24	<1.0	<2.08	<0.4	<2.0
14	20/21.05.2015	59	30	7.5	20.2	17.5	<19.62	0.22	<0.02	8.54	<1.0	<2.08	<0.4	<2.0
15	23/24.05.2015	81	45	6.0	38.5	21.2	<19.62	0.26	<0.02	9.32	4.22	<2.08	<0.4	<2.0
16	25/26.05.2015	92	51	5.5	34.2	20.2	<19.62	0.32	0.02	8.58	<1.0	<2.08	<0.4	<2.0
17	27/28.05.2015	76	41	7.2	26.6	23.2	28.5	0.44	0.03	4.89	<1.0	<2.08	<0.4	<2.0
18	29/30.05.2015	90	56	9.2	27.5	15.5	34.5	0.25	0.04	9.69	3.6	3.56	2.55	<2.0
19	31.05/01.06.2015	65	31	5.6	20.2	16.6	26.6	0.29	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
20	02/03.06.2015	95	55	8.5	32.2	21.2	32.20	0.33	0.04	6.28	<1.0	<2.08	<0.4	<2.0
21	04/05.06.2015	75	40	7.5	28.5	20.2	26.2	0.18	0.02	6.12	2.65	4.55	2.62	<2.0
22	08/09.06.2015	88	46	6.2	26.6	18.5	<19.62	0.45	0.03	4.59	5.6	<2.08	<0.4	<2.0
23	10/11.06.2015	64	31	8.5	32.2	16.6	<19.62	0.31	0.03	<4.0	<1.0	3.26	1.88	<2.0
24	12/13.06.2015	80	42	8.1	26.6	20.2	51.2	0.26	0.03	<4.0	<1.0	<2.08	<0.4	<2.0

Location : Bariyahi Village (AAQ-9)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_2 (µg/m³)	NH_3 (µg/m³)	O_3 (µg/m³)	CO (mg/m³)	Pb (µg/m³)	Ni (ng/m³)	As (ng/m³)	Benzene (µg/m³)	Benzo(a) pyrene (ng/m³)	Hg (ng/m³)
1	11/12.04.2015	80	39	5.6	22.2	16.6	38.6	0.33	0.03	<4.0	<1.0	<2.08	<0.4	<2.0
2	14/15.04.2015	75	37	8.2	28.3	14.5	42.2	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
3	20/21.04.2015	60	26	7.4	30.5	25.5	37.5	0.25	0.03	5.66	<1.0	<2.08	<0.4	<2.0
4	23/24.04.2015	56	33	6.6	27.5	20.2	40.5	0.54	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
5	27/28.04.2015	68	30	4.8	26.1	19.6	37.8	0.44	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
6	30.04/01.05.2015	76	37	5.0	24.4	21.2	25.5	0.29	<0.02	7.85	<1.0	<2.08	<0.4	<2.0
7	03/04.05.2015	66	38	6.3	20.2	16.6	33.7	0.33	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
8	05/06.05.2015	58	31	5.7	26.6	18.5	45.5	0.25	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
9	07/08.05.2015	72	40	7.5	30.2	17.5	45.8	0.26	<0.02	6.66	<1.0	3.22	2.56	<2.0
10	11/12.05.2015	85	48	6.0	28.5	20.2	32.2	0.20	<0.02	<4.0	< 1.0	<2.08	<0.4	<2.0
11	13/14.05.2015	72	42	9.5	27.5	22.7	39.6	0.15	<0.02	8.55	3.66	3.66	1.62	<2.0
12	15/16.05.2015	58	30	7.2	30.2	19.8	30.2	0.26	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
13	18/19.05.2015	48	26	4.5	26.2	21.2	26.6	0.18	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
14	20/21.05.2015	67	31	6.2	20.2	16.6	31.2	0.26	0.02	4.59	<1.0	<2.08	<0.4	<2.0
15	23/24.05.2015	78	41	8.5	28.5	20.2	25.5	0.32	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
16	25/26.05.2015	75	33	6.2	32.2	24.2	30.2	0.62	0.04	4.50	4.55	2.33	1.25	<2.0
17	27/28.05.2015	87	42	7.5	21.2	20.2	45.5	0.25	0.03	4.53	<1.0	<2.08	<0.4	<2.0
18	29/30.05.2015	80	42	8.6	31.2	25.2	44.2	0.32	0.03	4.96	2.25	3.26	<0.4	<2.0
19	31.05/01.06.2015	72	37	4.2	16.6	12.2	23.3	0.45	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	02/03.06.2015	69	32	5.2	32.2	26.3	31.2	0.55	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	04/05.06.2015	45	28	6.2	25.2	18.5	<19.62	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
22	08/09.06.2015	62	30	4.5	28.5	21.2	20	0.32	<0.02	<4.0	< 1.0	<2.08	<0.4	<2.0
23	10/11.06.2015	82	48	8.5	26.6	29.6	45.5	0.25	<0.02	7.09	3.66	2.27	1.62	<2.0
24	12/13.06.2015	75	40	7.5	19.6	15.5	26.6	0.65	<0.02	8.66	<1.0	<2.08	<0.4	<2.0

Location : Akashpur (AAQ-10)														
SL.No.	Date of Monitoring	Concentration of Pollutants												
		PM$_{10}$ (µg/m^3)	PM$_{2.5}$ (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	NH_3 (µg/m^3)	O_3 (µg/m^3)	CO (mg/m^3)	Pb (µg/m^3)	Ni (ng/m^3)	As (ng/m^3)	Benzene (µg/m^3)	Benzo(a) pyrene (ng/m^3)	Hg (ng/m^3)
1	13/14.04.2015	62	30	5.5	26.2	20.2	25.2	0.22	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
2	17/18.04.2015	75	34	6.6	31.2	26.3	32.2	0.15	<0.02	4.22	<1.0	2.66	<0.4	<2.0
3	19/20.04.2015	48	22	7.5	15.2	20.2	26.3	0.62	<0.02	<4.0	<1.0	<2.08	2.52	<2.0
4	22/23.04.2015	90	52	8.2	35.5	21.2	48.3	0.51	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
5	28/29.04.2015	66	38	7.5	27.5	18.6	32.5	0.32	<0.02	<4.0	<1.0	<2.08	<.0.4	<2.0
6	01/02.05.2015	78	41	6.0	33.2	15.3	30.5	0.38	0.02	5.36	<1.0	2.33	<0.4	<2.0
7	04/05.05.2015	66	35	5.5	27.6	13.2	28.7	0.32	<0.02	4.78	<1.0	<2.08	<0.4	<2.0
8	06/07.05.2015	84	43	6.8	38.5	18.8	39.6	0.45	0.04	7.36	<1.0	3.28	1.24	<2.0
9	08/09.05.2015	56	30	4.7	29.3	24.2	31.2	0.22	<0.02	4.10	<1.0	3.02	1.96	<2.0
10	10/11.05.2015	68	37	5.8	30.2	20.4	26.3	0.24	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
11	12/13.05.2015	81	42	6.5	36.2	14.7	42.3	0.37	0.03	6.98	<1.0	3.69	<0.4	<2.0
12	14/15.05.2015	75	42	7.1	25.6	12.8	35.5	0.33	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
13	17/18.05.2015	54	26	5.2	18.5	16.6	26.3	0.22	<0.02	7.58	<1.0	<2.08	<0.4	<2.0
14	19/20.05.2015	62	30	4.6	24.2	17.5	32.2	0.18	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
15	21/22.05.2015	43	28	6.2	20.2	14.5	34.5	0.32	<0.02	<4.0	5.0	<2.08	<0.4	<2.0
16	24/25.05.2015	58	29	5.5	26.2	20.2	25.2	0.2	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
17	26/27.05.2015	78	35	4.8	31.2	21.2	23.2	0.45	0.02	5.12	5.6	4.2	1.24	<2.0
18	28/29.05.2015	68	34	5.6	20.2	16.5	23.2	0.26	0.02	4.53	<1.0	<2.08	<0.4	<2.0
19	01/02.06.2015	65	32	6.6	20.2	15.5	23.2	0.18	0.02	<4.0	<1.0	<2.08	<0.4	<2.0
20	03/04.06.2015	78	38	4.5	28.5	16.6	25.2	0.22	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
21	05/06.06.2015	48	26	4.5	16.6	<10.0	21.2	0.42	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
22	07/08.06.2015	65	30	7.2	32.2	24.2	45.5	0.36	<0.02	<4.0	<1.0	<2.08	<0.4	<2.0
23	09/10.06.2015	51	26	5.5	22.2	18.5	32.2	0.51	0.02	5.67	5.2	3.2	2.2	<2.0
24	11/12.06.2015	69	32	6.6	20.1	19.6	29.6	0.43	0.02	5.56	<1.0	<2.08	<0.4	<2.0

Annex 4.3

Hourly Noise Monitoring Data

Location	Purba Kasaha Diara	Janjira Dumra	BTPS Colony	Bariyahi Village	Simariya Ghat	Near Raichiahi - ChawkTo wards Akashpur	Railway Crossing towards Bariyahi Village	Near Chakiya Thermal Bus Stand	Malipur Bintola	Simariya Village near proposed Water Intake Point	Entry Point of New Plant	Kiul Village
Station Code	NQ-1	NQ-2	NQ-3	NQ-4	NQ-5	NQ-6	NQ-7	NQ-8	NQ-9	NQ-10	NQ-11	NQ-12
Time (In Hrs.)	**Hourly Leq dB(A)**											
06.00-07.00	47.6	52.2	45.5	45.5	54.7	58.1	45.8	51.2	55.7	45.6	68.5	49.0
07.00-08.00	50.9	62.2	54.5	52.2	57.8	54.2	54.5	46.5	55.8	50.9	71.2	47.6
08.00-09.00	60.3	54.5	51.2	62.2	57.8	51.2	62.2	58..6	49.6	49.5	65.5	51.4
09.00-10.00	60.5	51.2	56.6	54.5	64.6	56.6	55.8	65.5	62.6	45.5	68.5	61.1
10.00-11.00	55.5	74.2	62.2	48.5	58.9	54.5	74.2	68.5	59.5	50.2	64.5	58.4
11.00-12.00	54.6	62.5	54.5	58.5	77.8	65.3	68.4	67.5	60.0	46.6	59.5	58.7
12.00-13.00	54.3	50.2	65.4	50.2	72.2	63.2	71.6	54.5	54.9	50.2	62.2	59.0
13.00-14.00	56.7	56.5	58.4	58.5	58.3	63.5	63.5	66.0	56.0	48.5	54.5	58.2
14.00-15.00	63.6	62.2	57.5	42.2	68.5	63.6	56.8	66.6	48.5	58.6	51.2	63.6
15.00-16.00	62.3	54.5	57.0	65.5	70.2	56.6	59.9	61.2	51.2	57.9	50.2	66.2
16.00-17.00	59.4	51.2	58.4	62.2	65.5	64.3	59.2	64.0	50.3	55.8	74.2	54.2
17.00-18.00	61.7	54.5	54. 5	58.5	62.2	68.8	55.5	57.1	49.5	51.2	70.2	50.2
18.00-19.00	50.8	52.2	52.2	59	62.2	45.5	55.0	57.4	48.5	48.5	68.5	50.2
19.00-20.00	48.8	51.2	45.5	59.7	58.5	48.5	59.7	56.3	59.5	63.8	56.6	45.2
20.00-21.00	49.5	48.5	50.2	54.5	60.2	58.5	55.7	45.5	46.6	57.6	52.5	41.2
21.00-22.00	42.2	50.2	42.2	45.5	51.2	54.5	49.6	46.6	41.2	41.2	54.5	41.2
22.00-23.00	41.2	45.5	41.2	43.2	45.5	50.2	47.6	48.5	40.2	40.2	50.2	43.2
23.00-00.00	43.2	42.2	45.5	38.6	42.2	45.0	46.4	48.7	43.2	36.6	48.5	40.2
00.00-01.00	45.5	38.5	50.2	39.3	45.5	48.0	51.3	48.0	45.5	38.5	42.5	46.6
01.00-02.00	46.6	45.5	40.2	45.5	42.2	48.5	49.7	51.9	38.5	38.8	43.2	48.5
02.00-03.00	45.2	50.2	42.2	42.2	36.6	46.5	48.1	42.4	39.5	39.2	40.2	49.5
03.00-04.00	44.6	42.2	41.2	51.2	41.2	50.0	46.7	46.3	41.2	41.2	36.6	46.2
04.00-05.00	44.3	41.2	43.2	45.5	51.2	45.0	45.3	45.5	45.5	41.9	51.2	41.0
05.00-06.00	47.5	45.0	45.5	51.2	54.2	46.2	45.3	52.7	42.2	46.7	51.0	40.2

Annex 4.4

Hourly Traffic Monitoring Data

LOCATION : NH-31, Zero Mile to Bagusarai (UP) (TS-1)						**Date of Monitoring** : 28.05.2015	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus, Dumper, Tanker,Trailer)	(Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	78	62	30	30	**200**
2	10.00-11.00	85	67	80	22	**254**
3	11.00-12.00	65	99	138	15	**317**
4	12.00-13.00	81	55	72	13	**221**
5	13.00-14.00	62	42	68	17	**189**
6	14.00-15.00	49	58	70	32	**209**
7	15.00-16.00	71	67	68	15	**221**
8	16.00-17.00	50	63	32	17	**162**
9	17.00-18.00	43	67	41	21	**172**
10	18.00-19.00	52	63	75	5	**195**
11	19.00-20.00	67	41	32	4	**144**
12	20.00-21.00	68	21	8	0	**97**
13	21.00-22.00	60	15	4	0	**79**
14	22.00-23.00	42	16	0	0	**58**
15	23.00-00.00	32	10	0	0	**42**
16	00.00-01.00	26	10	0	0	**36**
17	01.00-02.00	26	8	0	0	**34**
18	02.00-03.00	41	9	0	0	**50**
19	03.00-04.00	16	5	0	0	**21**
20	04.00-05.00	18	17	0	0	**35**
21	05.00-06.00	27	16	6	5	**54**
22	06.00-07.00	20	24	12	6	**62**
23	07.00-08.00	30	56	24	17	**127**
24	08.00-09.00	42	45	35	20	**142**
Total Numbers		**1151**	**936**	**795**	**239**	**3121**

LOCATION : NH-31, Bagusarai to Zero Mile (DOWN) (TS-1)						Date of Monitoring : 28.05.2015	
S L. N O.	TIME (Hours)	MOTORIZED VEHICLES			NON-MOTORI ZED VEHICL ES	TOTA L
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers		
		(Truck,Bus, Dumper, Tanker,Trail er)	(Car,Jeep,Van, Metador, Tractor,Tempo, Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	82	83	95	21	**281**
2	10.00-11.00	57	82	102	22	**263**
3	11.00-12.00	56	78	102	17	**253**
4	12.00-13.00	62	72	99	18	**251**
5	13.00-14.00	61	69	111	20	**261**
6	14.00-15.00	51	67	88	22	**228**
7	15.00-16.00	49	79	72	21	**221**
8	16.00-17.00	47	96	73	29	**245**
9	17.00-18.00	48	87	79	13	**227**
10	18.00-19.00	49	82	80	8	**219**
11	19.00-20.00	50	50	41	3	**144**
12	20.00-21.00	62	42	22	0	**126**
13	21.00-22.00	61	22	15	0	**98**
14	22.00-23.00	42	15	4	0	**61**
15	23.00-00.00	50	14	6	0	**70**
16	00.00-01.00	48	12	0	0	**60**
17	01.00-02.00	42	0	0	0	**42**
18	02.00-03.00	32	0	5	0	**37**
19	03.00-04.00	20	0	0	0	**20**
20	04.00-05.00	15	0	0	0	**15**
21	05.00-06.00	26	0	8	0	**34**
22	06.00-07.00	47	12	10	21	**90**
23	07.00-08.00	41	8	15	12	**76**
24	08.00-09.00	49	15	18	17	**99**
Total Numbers		**1147**	**985**	**1045**	**244**	**3421**

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LOCATION : NH-31, Zero Mile to Bagusarai (UP) (TS-1)						**Date of Monitoring** : 30.05.2015
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus ,Dumper, Tanker,Trailer)	(Car,Jeep,Van, Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	52	72	35	11	**170**
2	10.00-11.00	62	68	90	32	**252**
3	11.00-12.00	102	107	140	25	**374**
4	12.00-13.00	88	80	72	14	**254**
5	13.00-14.00	81	55	69	20	**225**
6	14.00-15.00	70	60	72	11	**213**
7	15.00-16.00	43	67	102	21	**233**
8	16.00-17.00	52	63	107	13	**235**
9	17.00-18.00	43	67	109	14	**233**
10	18.00-19.00	67	50	41	16	**174**
11	19.00-20.00	68	62	22	19	**171**
12	20.00-21.00	102	45	15	5	**167**
13	21.00-22.00	85	32	10	0	**127**
14	22.00-23.00	67	15	0	0	**82**
15	23.00-00.00	70	10	0	0	**80**
16	00.00-01.00	21	12	0	0	**33**
17	01.00-02.00	26	21	0	0	**47**
18	02.00-03.00	40	25	5	0	**70**
19	03.00-04.00	30	5	6	0	**41**
20	04.00-05.00	10	6	6	0	**22**
21	05.00-06.00	49	21	12	11	**93**
22	06.00-07.00	29	15	12	21	**77**
23	07.00-08.00	30	41	39	15	**125**
24	08.00-09.00	40	32	50	20	**142**
Total Numbers		**1327**	**1031**	**1014**	**268**	**3640**

LOCATION : NH-31, Bagusarai to Zero Mile (DOWN) (TS-1)					**Date of Monitoring** : 30.05.2015	
S L. N O.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles (Truck,Bus,Dumper, Tanker,Trailer)	**Light Motor Vehicles** (Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	**Two/Three Wheelers** (Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	72	83	102	22	**279**
2	10.00-11.00	82	102	101	19	**304**
3	11.00-12.00	56	78	110	17	**261**
4	12.00-13.00	61	72	100	18	**251**
5	13.00-14.00	62	70	119	20	**271**
6	14.00-15.00	49	89	83	21	**242**
7	15.00-16.00	50	49	59	19	**177**
8	16.00-17.00	48	87	72	22	**229**
9	17.00-18.00	50	55	55	12	**172**
10	18.00-19.00	51	54	42	4	**151**
11	19.00-20.00	59	60	21	3	**143**
12	20.00-21.00	49	72	13	0	**134**
13	21.00-22.00	40	82	10	0	**132**
14	22.00-23.00	38	29	5	0	**72**
15	23.00-00.00	50	5	6	0	**61**
16	00.00-01.00	61	20	0	0	**81**
17	01.00-02.00	38	15	0	0	**53**
18	02.00-03.00	54	10	0	0	**64**
19	03.00-04.00	40	8	0	0	**48**
20	04.00-05.00	45	21	0	5	**71**
21	05.00-06.00	40	12	5	10	**67**
22	06.00-07.00	47	23	12	12	**94**
23	07.00-08.00	41	21	27	10	**99**
24	08.00-09.00	49	30	40	52	**171**
Total Numbers		**1232**	**1147**	**982**	**266**	**3627**

LOCATION : NH-31, Chakia Thermal Power Bus Stop to Zer Mile (UP) (TS-2)					**Date of Monitoring :** 24.05.2016	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus,Dumper, Tanker,Trailer)	(Car,Jeep, Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	42	30	32	18	**122**
2	10.00-11.00	53	29	30	13	**125**
3	11.00-12.00	58	23	27	14	**122**
4	12.00-13.00	60	21	26	12	**119**
5	13.00-14.00	53	14	36	17	**120**
6	14.00-15.00	52	18	32	11	**113**
7	15.00-16.00	57	32	27	12	**128**
8	16.00-17.00	59	29	25	9	**122**
9	17.00-18.00	62	31	34	12	**139**
10	18.00-19.00	61	27	37	12	**137**
11	19.00-20.00	50	22	12	2	**86**
12	20.00-21.00	48	23	8	0	**79**
13	21.00-22.00	42	12	8	0	**62**
14	22.00-23.00	47	11	6	0	**64**
15	23.00-00.00	40	8	5	0	**53**
16	00.00-01.00	39	8	2	0	**49**
17	01.00-02.00	37	15	0	0	**52**
18	02.00-03.00	38	0	5	0	**43**
19	03.00-04.00	40	0	0	0	**40**
20	04.00-05.00	43	0	2	7	**52**
21	05.00-06.00	49	5	6	18	**78**
22	06.00-07.00	51	6	14	12	**83**
23	07.00-08.00	60	19	17	14	**110**
24	08.00-09.00	46	22	20	17	**105**
Total Numbers		**1187**	**405**	**411**	**200**	**2203**

LOCATION : NH-31, Zero Mile to Chakia Thermal Power Bus Stop (DOWN) (TS-2)					**Date of Monitoring :** 24.05.2016	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus, Dumper, Tanker,Trailer)	(Car,Jeep, Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	21	63	69	12	**165**
2	10.00-11.00	27	70	73	11	**181**
3	11.00-12.00	32	71	69	10	**182**
4	12.00-13.00	31	69	72	9	**181**
5	13.00-14.00	29	68	80	27	**204**
6	14.00-15.00	37	57	82	21	**197**
7	15.00-16.00	41	62	87	20	**210**
8	16.00-17.00	32	80	86	17	**215**
9	17.00-18.00	37	67	79	19	**202**
10	18.00-19.00	31	61	77	12	**181**
11	19.00-20.00	32	59	80	12	**183**
12	20.00-21.00	42	52	72	5	**171**
13	21.00-22.00	45	49	71	3	**168**
14	22.00-23.00	43	35	21	0	**99**
15	23.00-00.00	21	37	5	0	**63**
16	00.00-01.00	15	24	5	0	**44**
17	01.00-02.00	6	27	6	0	**39**
18	02.00-03.00	12	17	4	0	**33**
19	03.00-04.00	6	19	0	0	**25**
20	04.00-05.00	27	23	5	0	**55**
21	05.00-06.00	20	32	2	15	**69**
22	06.00-07.00	19	31	12	21	**83**
23	07.00-08.00	28	42	35	17	**122**
24	08.00-09.00	29	49	42	19	**139**
Total Numbers		**663**	**1164**	**1134**	**250**	**3211**

LOCATION : NH-31, Chakia Thermal Power Bus Stop to Zer Mile (UP) (TS-2)					**Date of Monitoring :** 26.05.2016	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles (Truck,Bus,Dumper, Tanker, Trailer)	**Light Motor Vehicles** (Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	**Two/Three Wheelers** (Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	50	30	32	21	**133**
2	10.00-11.00	53	30	36	13	**132**
3	11.00-12.00	58	24	29	14	**125**
4	12.00-13.00	61	22	26	10	**119**
5	13.00-14.00	55	40	20	18	**133**
6	14.00-15.00	54	20	40	11	**125**
7	15.00-16.00	56	32	26	10	**124**
8	16.00-17.00	57	30	25	11	**123**
9	17.00-18.00	60	31	36	13	**140**
10	18.00-19.00	72	22	37	10	**141**
11	19.00-20.00	50	24	36	11	**121**
12	20.00-21.00	49	23	12	5	**89**
13	21.00-22.00	42	30	15	0	**87**
14	22.00-23.00	46	50	5	0	**101**
15	23.00-00.00	40	20	6	0	**66**
16	00.00-01.00	41	13	0	0	**54**
17	01.00-02.00	39	20	0	0	**59**
18	02.00-03.00	40	14	0	0	**54**
19	03.00-04.00	51	19	5	0	**75**
20	04.00-05.00	40	11	2	0	**53**
21	05.00-06.00	43	13	4	15	**75**
22	06.00-07.00	54	14	19	10	**97**
23	07.00-08.00	62	23	27	14	**126**
24	08.00-09.00	49	28	37	13	**127**
Total Numbers		**1222**	**583**	**475**	**199**	**2479**

LOCATION : NH-31, Zero Mile to Chakia Thermal Power Bus Stop (DOWN) (TS-2)					**Date of Monitoring :** 26.05.2016	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles (Truck,Bus,Dumper, Tanker,Trailer)	**Light Motor Vehicles** (Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	**Two/Three Wheelers** (Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	30	70	65	14	**179**
2	10.00-11.00	40	80	89	13	**222**
3	11.00-12.00	35	72	60	19	**186**
4	12.00-13.00	36	75	82	9	**202**
5	13.00-14.00	32	61	92	8	**193**
6	14.00-15.00	40	63	95	20	**218**
7	15.00-16.00	45	60	102	19	**226**
8	16.00-17.00	30	85	100	21	**236**
9	17.00-18.00	36	64	70	18	**188**
10	18.00-19.00	32	63	109	11	**215**
11	19.00-20.00	40	60	42	5	**147**
12	20.00-21.00	12	65	32	0	**109**
13	21.00-22.00	10	60	25	0	**95**
14	22.00-23.00	50	30	20	0	**100**
15	23.00-00.00	22	30	20	0	**72**
16	00.00-01.00	31	22	5	0	**58**
17	01.00-02.00	45	27	8	0	**80**
18	02.00-03.00	15	20	6	0	**41**
19	03.00-04.00	12	20	6	0	**38**
20	04.00-05.00	40	22	25	8	**95**
21	05.00-06.00	22	32	27	12	**93**
22	06.00-07.00	30	32	31	15	**108**
23	07.00-08.00	28	19	29	21	**97**
24	08.00-09.00	26	36	22	20	**104**
Total Numbers		**739**	**1168**	**1162**	**233**	**3302**

LOCATION : Bandh Road to BTPS Colony (UP) (TS-3)					**Date of Monitoring :** 27.05.2015	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus ,Dumper, Tanker,Trailer)	(Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	9	35	37	3	**84**
2	10.00-11.00	10	37	32	9	**88**
3	11.00-12.00	7	38	33	10	**88**
4	12.00-13.00	6	40	31	13	**90**
5	13.00-14.00	3	42	40	20	**105**
6	14.00-15.00	9	47	47	22	**125**
7	15.00-16.00	10	31	50	19	**110**
8	16.00-17.00	11	30	52	27	**120**
9	17.00-18.00	2	28	48	20	**98**
10	18.00-19.00	7	37	20	11	**75**
11	19.00-20.00	8	43	12	0	**63**
12	20.00-21.00	0	40	12	0	**52**
13	21.00-22.00	0	38	8	0	**46**
14	22.00-23.00	0	28	6	0	**34**
15	23.00-00.00	0	21	6	0	**27**
16	00.00-01.00	1	12	12	0	**25**
17	01.00-02.00	2	0	0	0	**2**
18	02.00-03.00	0	0	0	0	**0**
19	03.00-04.00	3	0	0	0	**3**
20	04.00-05.00	1	15	0	6	**22**
21	05.00-06.00	0	7	0	12	**19**
22	06.00-07.00	0	3	10	14	**27**
23	07.00-08.00	3	11	12	15	**41**
24	08.00-09.00	1	17	18	7	**43**
Total Numbers		**93**	**600**	**486**	**208**	**1387**

LOCATION : BTPS Colony to Bandh Road (DOWN) (TS-3)					Date of Monitoring : 27.05.2015	
SL. NO.	TIME (Hours)	MOTORIZED VEHICLES			NON-MOTORIZED VEHICLES	TOTAL
		Heavy Motor Vehicles	Light Motor Vehicles	Two/Three Wheelers		
		(Truck,Bus,Dumper, Tanker,Trailer)	(Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	17	30	50	12	**109**
2	10.00-11.00	12	35	47	10	**104**
3	11.00-12.00	9	40	43	13	**105**
4	12.00-13.00	8	32	42	15	**97**
5	13.00-14.00	12	31	39	16	**98**
6	14.00-15.00	7	42	34	7	**90**
7	15.00-16.00	2	47	37	9	**95**
8	16.00-17.00	1	49	41	17	**108**
9	17.00-18.00	10	50	32	10	**102**
10	18.00-19.00	7	43	31	9	**90**
11	19.00-20.00	8	42	27	12	**89**
12	20.00-21.00	0	48	29	5	**82**
13	21.00-22.00	1	49	12	0	**62**
14	22.00-23.00	2	52	8	0	**62**
15	23.00-00.00	0	32	6	0	**38**
16	00.00-01.00	0	12	2	0	**14**
17	01.00-02.00	0	11	6	0	**17**
18	02.00-03.00	0	0	0	0	**0**
19	03.00-04.00	0	0	0	0	**0**
20	04.00-05.00	2	15	0	0	**17**
21	05.00-06.00	0	8	2	12	**22**
22	06.00-07.00	7	7	1	14	**29**
23	07.00-08.00	6	10	10	20	**46**
24	08.00-09.00	8	12	12	18	**50**
Total Numbers		**119**	**697**	**511**	**199**	**1526**

LOCATION : Bandh Road to BTPS Colony (UP) (TS-3)						**Date of Monitoring :** 30.05.2015	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck, Bus,Dumper, Tanker ,Trailer)	(Car,Jeep,Van ,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	11	40	30	9	**90**
2	10.00-11.00	10	36	31	8	**85**
3	11.00-12.00	6	40	30	10	**86**
4	12.00-13.00	9	32	30	13	**84**
5	13.00-14.00	7	42	50	14	**113**
6	14.00-15.00	10	40	41	19	**110**
7	15.00-16.00	11	36	51	21	**119**
8	16.00-17.00	10	30	60	20	**120**
9	17.00-18.00	11	41	38	19	**109**
10	18.00-19.00	9	36	45	17	**107**
11	19.00-20.00	10	40	42	14	**106**
12	20.00-21.00	9	32	28	9	**78**
13	21.00-22.00	6	36	29	13	**84**
14	22.00-23.00	2	26	30	14	**72**
15	23.00-00.00	1	20	23	12	**56**
16	00.00-01.00	3	22	27	7	**59**
17	01.00-02.00	4	11	18	9	**42**
18	02.00-03.00	0	9	10	1	**20**
19	03.00-04.00	1	2	19	8	**30**
20	04.00-05.00	2	3	11	2	**18**
21	05.00-06.00	4	13	10	3	**30**
22	06.00-07.00	2	10	13	4	**29**
23	07.00-08.00	1	14	13	9	**37**
24	08.00-09.00	3	19	10	11	**43**
Total Numbers		**142**	**630**	**689**	**266**	**1727**

LOCATION : BTPS Colony to Bandh Road (DOWN) (TS-3)					**Date of Monitoring :** 30.05.2015	
SL. NO.	**TIME (Hours)**	**MOTORIZED VEHICLES**			**NON-MOTORIZED VEHICLES**	**TOTAL**
		Heavy Motor Vehicles	**Light Motor Vehicles**	**Two/Three Wheelers**		
		(Truck,Bus,Dumper, Tanker,Trailer)	(Car,Jeep,Van,Metador, Tractor,Tempo,Mini Bus)	(Scooter, Motor Cycle, Auto, Moped)	(Bicycle, Tricycle)	
1	9.00-10.00	5	23	25	9	**62**
2	10.00-11.00	12	41	23	8	**84**
3	11.00-12.00	6	22	30	10	**68**
4	12.00-13.00	7	30	24	13	**74**
5	13.00-14.00	5	18	29	14	**66**
6	14.00-15.00	8	55	40	19	**122**
7	15.00-16.00	9	42	32	21	**104**
8	16.00-17.00	5	24	55	20	**104**
9	17.00-18.00	3	31	42	19	**95**
10	18.00-19.00	15	35	21	17	**88**
11	19.00-20.00	24	10	15	5	**54**
12	20.00-21.00	15	5	8	6	**34**
13	21.00-22.00	6	6	6	0	**18**
14	22.00-23.00	15	15	2	0	**32**
15	23.00-00.00	1	13	3	0	**17**
16	00.00-01.00	15	0	0	0	**15**
17	01.00-02.00	16	0	5	0	**21**
18	02.00-03.00	2	0	3	0	**5**
19	03.00-04.00	1	1	4	0	**6**
20	04.00-05.00	0	3	2	5	**10**
21	05.00-06.00	0	11	12	12	**35**
22	06.00-07.00	6	8	16	14	**44**
23	07.00-08.00	2	6	20	15	**43**
24	08.00-09.00	3	16	16	11	**46**
Total Numbers		**181**	**415**	**433**	**218**	**1247**

Annex 4.5

Listing of Buffer Villages of the Study Area

Begusarai District

Name of the Villages	Rural/Urban	Number of Households	Total Population
Barauni Tehsil			
Ganga Prasad	Rural	848	4181
Chckbal Sirinath	Rural	0	0
Chak Risalatpur	Rural	46	217
Khem Karanpur	Rural	0	0
Narayanpur	Rural	156	864
Mahna	Rural	890	4303
Bhabhaur	Rural	195	1029
Rupaspur	Rural	222	1123
Sabaura	Rural	65	388
Bihat (Nagar Parishad)	Urban	12958	67952
Nurpur (CT)	Urban	1353	7202
Partappur	Rural	362	2514
Semaria	Rural	4762	25059
Chak Balli	Rural	922	4580
Bishunpur Chand	Rural	129	696
Amarpur	Rural	1668	8276
Sograha	Rural	0	0
Asurari	Rural	932	4988
Pipra Dewas	Rural	1786	9643
Rajaura Bhagwanpur	Rural	21	101
Malti	Rural	537	2885
Sograha Arazi	Rural	0	0
Hajipur	Rural	1178	6171
Mahammadpur Baro	Rural	0	0
Chak Kakim	Rural	68	331
Papraur	Rural	2016	11200
Hawaspur	Rural	472	2428
Pipraur	Rural	74	383
Singdaha	Rural	491	2685
Bathauli	Rural	1049	5664
Bakhatpur	Rural	283	1380
Sultanpur	Rural	118	552
Ninga	Rural	2205	11335
Ladaura	Rural	289	1626
Semrauna	Rural	56	279
Lagauli	Rural	622	3179
Telar	Rural	564	2748
Dholipur	Rural	58	247
Mosaedpur	Rural	504	2514
Dihpur	Rural	0	0
Khutaun	Rural	0	0
Fatehpur	Rural	174	798
Chak Aziz	Rural	0	0
Saidpur Hansa	Rural	70	342
Ckak Ahmad	Rural	106	550

Saidpur Hans	Rural	184	730
Bhaskara	Rural	86	465
Deonah	Rural	691	3687
Makhopur	Rural	89	520
Zamira	Rural	388	1608
Ibrahimpur	Rural	233	1456
Jamalpur	Rural	101	531
Milki Zamira	Rural	0	0
Gobindpur	Rural	704	3805
Daulatpur	Rural	130	619
Almo Chak	Rural	78	390
Kesabe	Rural	1151	6205
Siswa	Rural	198	1020
Makardahi	Rural	258	1311
Teghra Tehsil			
Chak Daud	Rural	0	0
Ehiyapur	Rural	0	0
Nipania	Rural	665	3045
Mirzapur Anman	Rural	0	0
Chak Surjai	Rural	0	0
Salempur Baro	Rural	0	0
Chak Abubakar	Rural	54	377
Kadir Chak	Rural	388	2188
Rajdevpur	Rural	52	248
Saistabad	Rural	0	0
Shasistabad	Rural	0	0
Tulsipur	Rural	270	1427
Barauni (Nagar Parishad)	Urban	12964	71660
Begusarai Tehsil			
Sherpur	Rural	308	1570
Milki	Rural	136	714
Hamir Chak Milki	Rural	0	0
Chak Farid	Rural	0	0
Hari Chak Milki	Rural	0	0
Mahadpur	Rural	479	2083
Amraur Kiratpur	Rural	1195	5741
Raichiahi Akaspur	Rural	384	2130
Raichiahi	Rural	0	0
Matihani Tehsil			
Mahazi Bhawanandpur	Rural	0	0
Ramdiri	Rural	4440	21323

Patna District

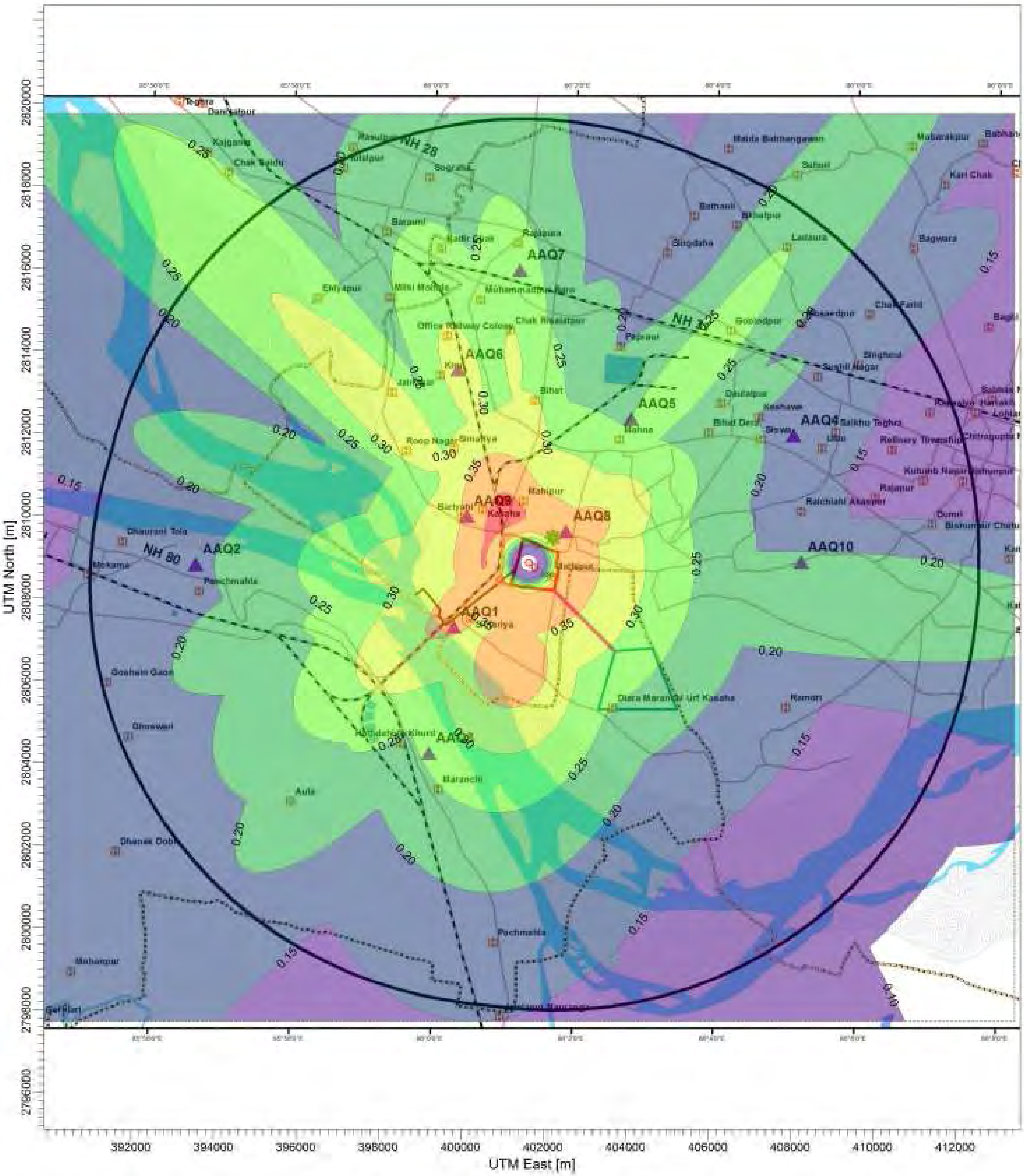
Name of the Villages	Rural/Urban	Number of Households	Total Population
Mokameh Tehsil			
Hathdeh	Rural	0	0
Aunta	Rural	0	0
Diara Maranchi Urf Kasaha	Rural	672	3636
Maranchi	Rural	2824	17227
Hathidah Buzurg	Rural	1637	9687
Hathdahidh Khurd	Rural	0	0
Jazira Mokama	Rural	142	681
Jazira Dumra	Rural	240	1329
Rampur Dumra	Rural	871	5339
Jalalpur Nauranga	Rural	757	4461
Pachmahla	Rural	522	2933
Badpur	Rural	273	1860
Murarpur	Rural	910	5268
Auta	Rural	1862	10880
Ghoswari Tehsil			
Goshain Gaon	Rural	1330	8627
Ghoswari	Rural	748	5133

Annex 5.1

Isopleths of Ground Level Concentrations for Different Air Quality Dispersion Modelling Scenarios

KEPCO - Barauni ESIA Study

24 Hourly Maximum PM Concentration Isopleths
Operation of Unit # 10 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: SRCGP1 ug/m^3

Max: 0.41 [ug/m^3] at (401135.22, 2810126.18)

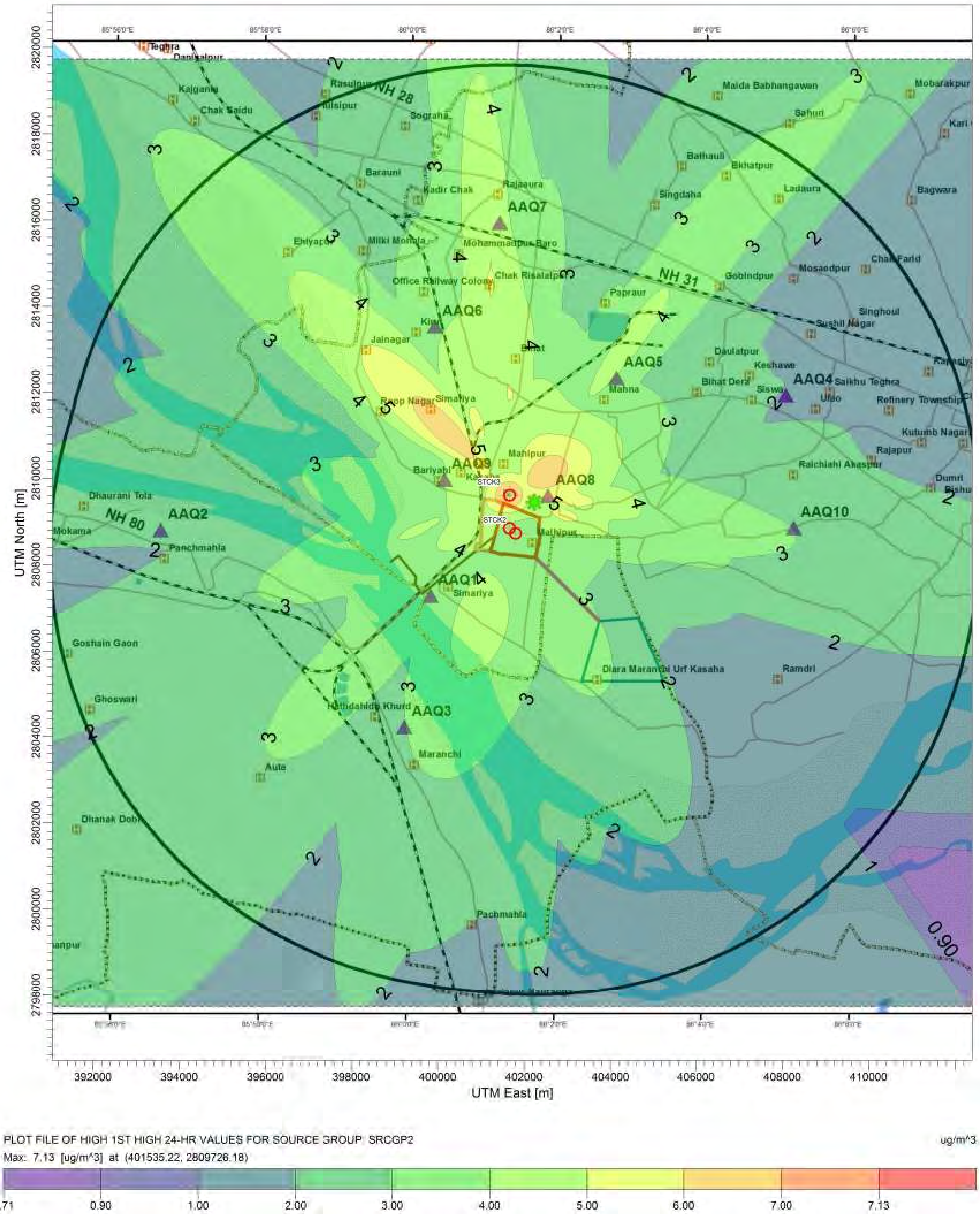
0.10 0.15 0.20 0.25 0.30 0.35 0.40

Sources: **2**		
Receptors: **53271**	Modeler: **NC**	ERM
Output Type: **Concentration**	SCALE: 1:100,000 (0 – 3 km)	
Max Concentration: **0.41 ug/m^3**	Date: **1/25/2016**	Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum PM Concentration Isopleths
Operation of Unit # 6, 7, 8, & 9 (Barauni TPS)



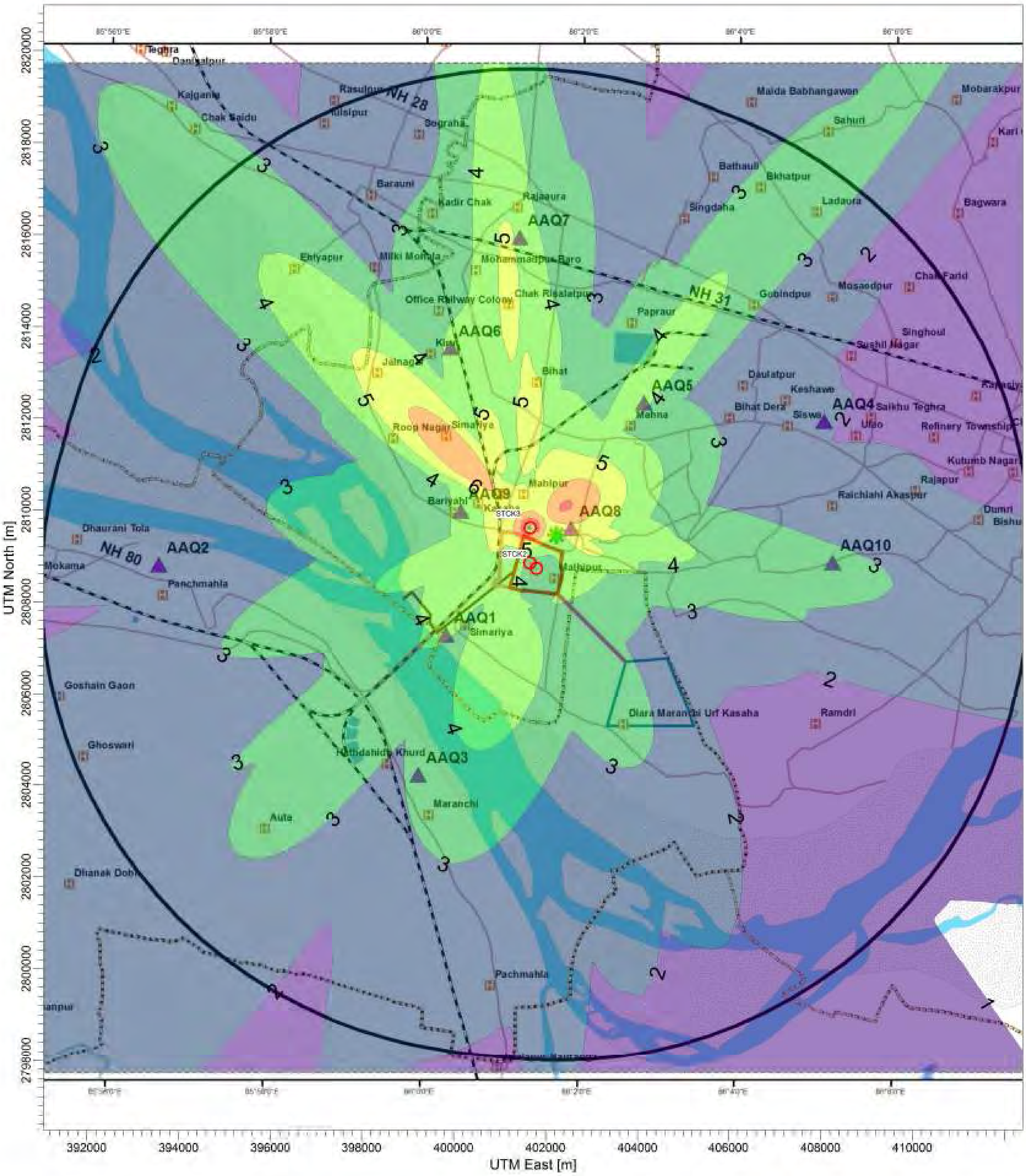
Sources:	
3	

Receptors:	Modeler:	
53271	NC	
Output Type: Concentration	SCALE: 1:90,000 (0 – 3 km)	ERM
Max Concentration: 7.13 ug/m^3	Date: 2/6/2016	Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum PM Concentration Isopleths
Operation of Unit # 6, 7, 8, 9 & 10 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ug/m^3

Max: 7 [ug/m^3] at (401535.22, 2809726.18)

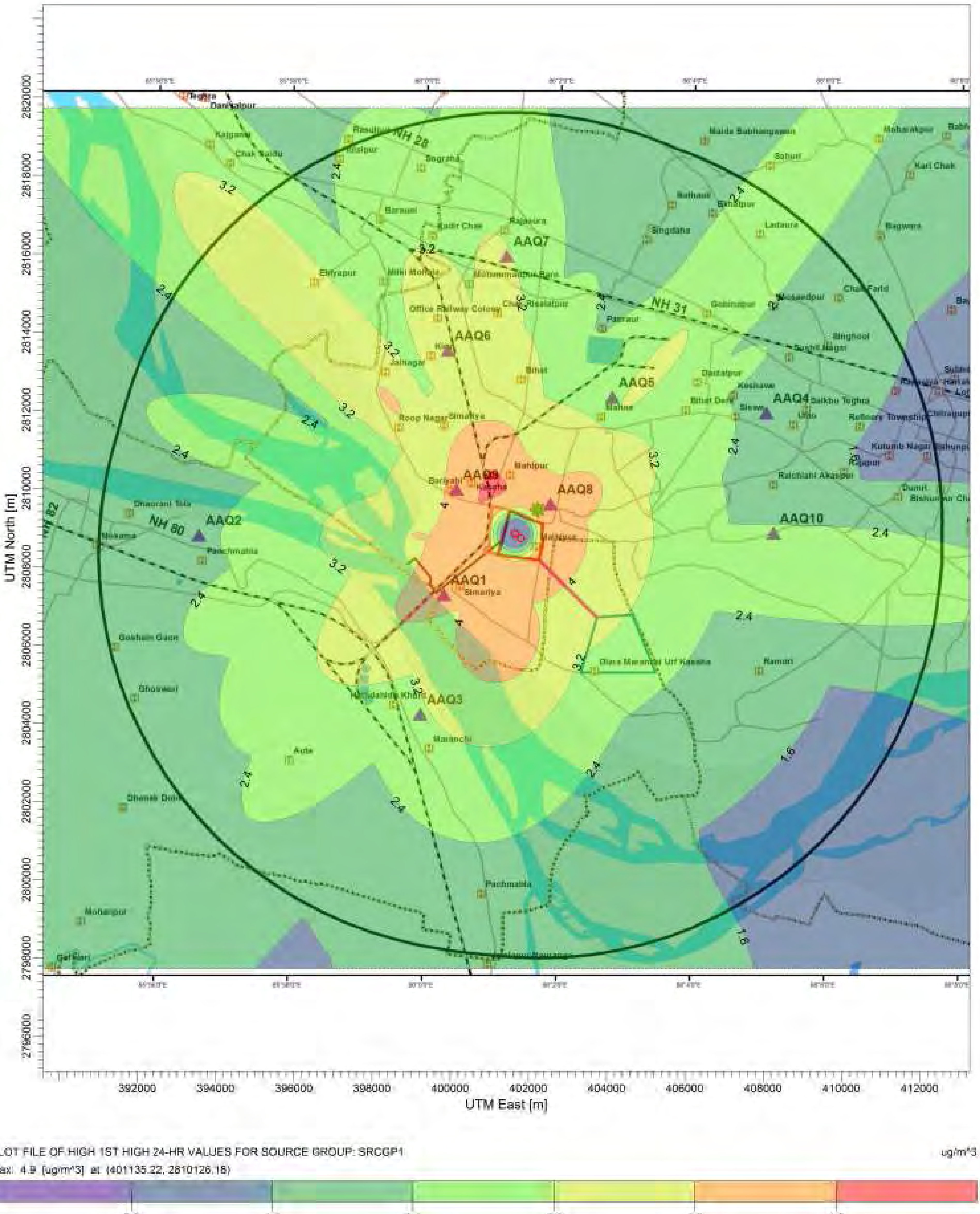
1 2 3 4 5 6 7

Sources:	
3	

Receptors:	Modeler:	
53271	NC	ERM
Output Type: Concentration	SCALE: 1:90,000 0 — 3 km	
Max Concentration: 7 ug/m^3	Date: 2/6/2016	Project No.: 0293599

KEPCO - Barauni ESIA Study

24 Hourly Maximum SO2 Concentration Isopleths
Operation of Unit # 10 (Barauni TPS)



Sources:	
2	
Receptors: 53271	Modeler: NC
Output Type: Concentration	SCALE: 1:100,000 (0 — 3 km)
Max Concentration: 4.9 ug/m^3	Date: 1/25/2016

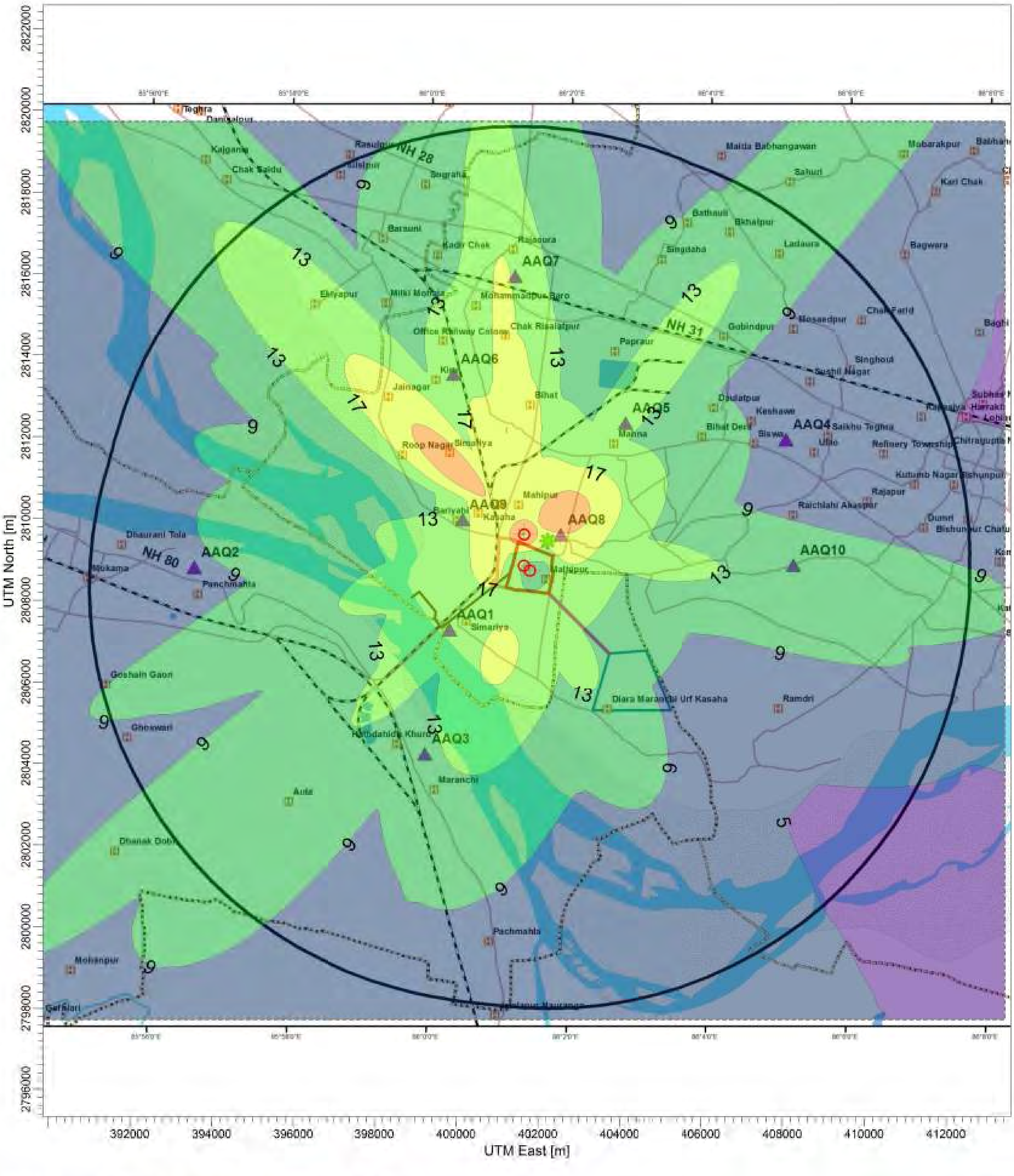
ERM

Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum SO2 Concentration Isopleths
Operation of Unit # 6, 7, 8 & 9 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: SRCGP2

Max: 25 [ug/m^3] at (401535.22, 2809726.18)

ug/m^3

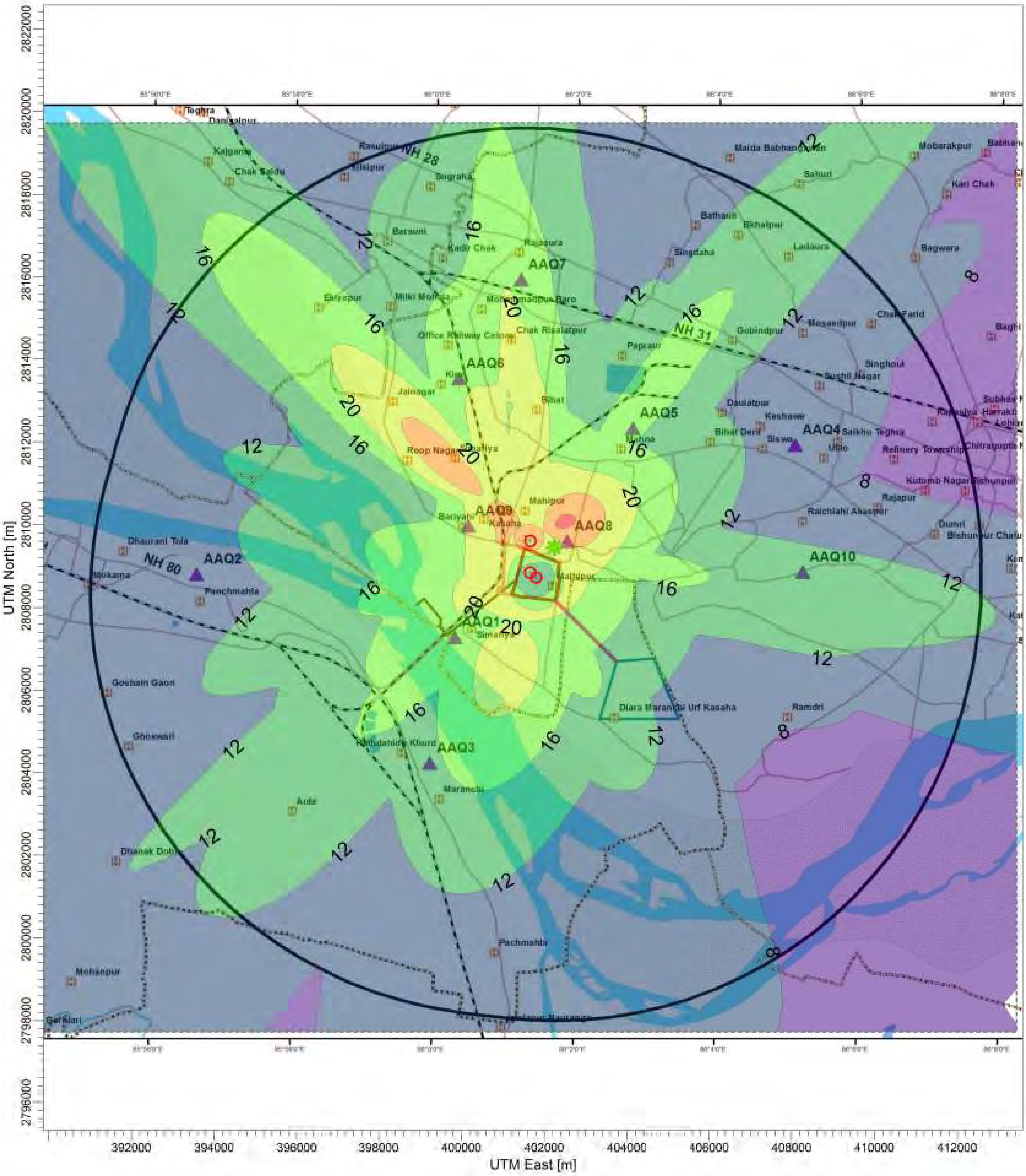
3 5 9 13 17 21 25

Sources: 3		
Receptors: 53271	Modeler: NC	ERM
Output Type: Concentration	SCALE: 1:100,000 0 — 3 km	
Max Concentration: 25 ug/m^3	Date: 2/6/2016	Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum SO2 Concentration Isopleths
Operation of Unit # 6, 7, 8, 9 & 10 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ug/m^3

Max: 29 [ug/m^3] at (402435.22, 2810026.18)

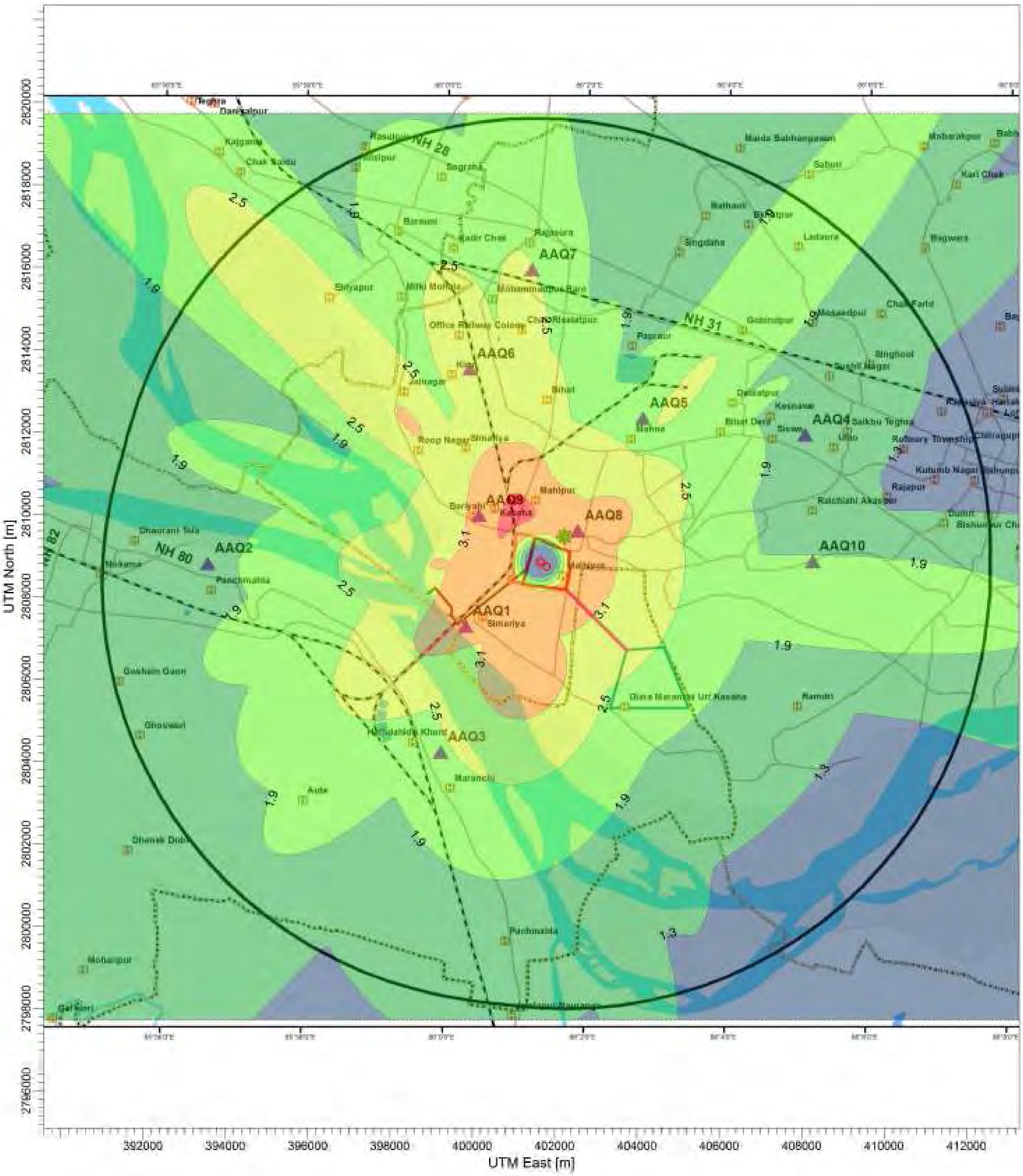
4 8 12 16 20 24 28

Sources: 3		
Receptors: 53271	Modeler: NC	ERM
Output Type: Concentration	SCALE: 1:100,000 (0 – 3 km)	
Max Concentration: 29 ug/m^3	Date: 2/6/2016	Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum NOx Concentration Isopleths
Operation of Unit # 10 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: SRCGP1

ug/m^3

Max: 3.8 [ug/m^3] at (401135.22, 2810126.18)

0.1 0.7 1.3 1.9 2.5 3.1 3.7

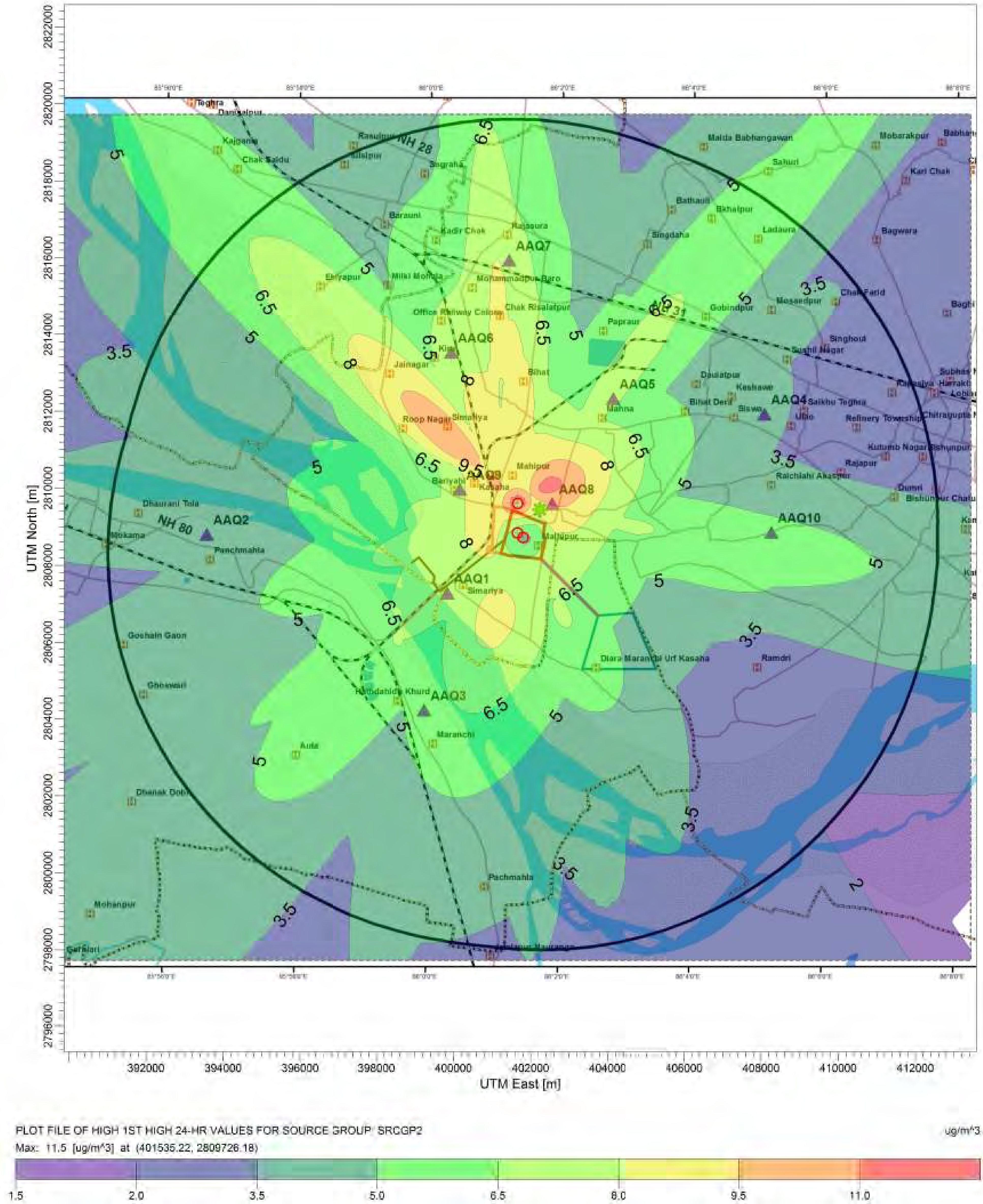
Sources: 2	
Receptors: 53271	Modeler: NC
Output Type: Concentration	SCALE: 1:100,000 (0 — 3 km)
Max Concentration: 3.8 ug/m^3	Date: 1/25/2016

ERM

Project No.: 0293599

KEPCO - Barauni ESIA Study

24 Hourly Maximum NOx Concentration Isopleths
Operation of Unit # 6, 7, 8 and 9 (Barauni TPS)



Sources:	
3	
Receptors: 53271	Modeler: NC
Output Type: Concentration	SCALE: 1:100,000 (0 — 3 km)
Max Concentration: 11.5 ug/m^3	Date: 2/6/2016

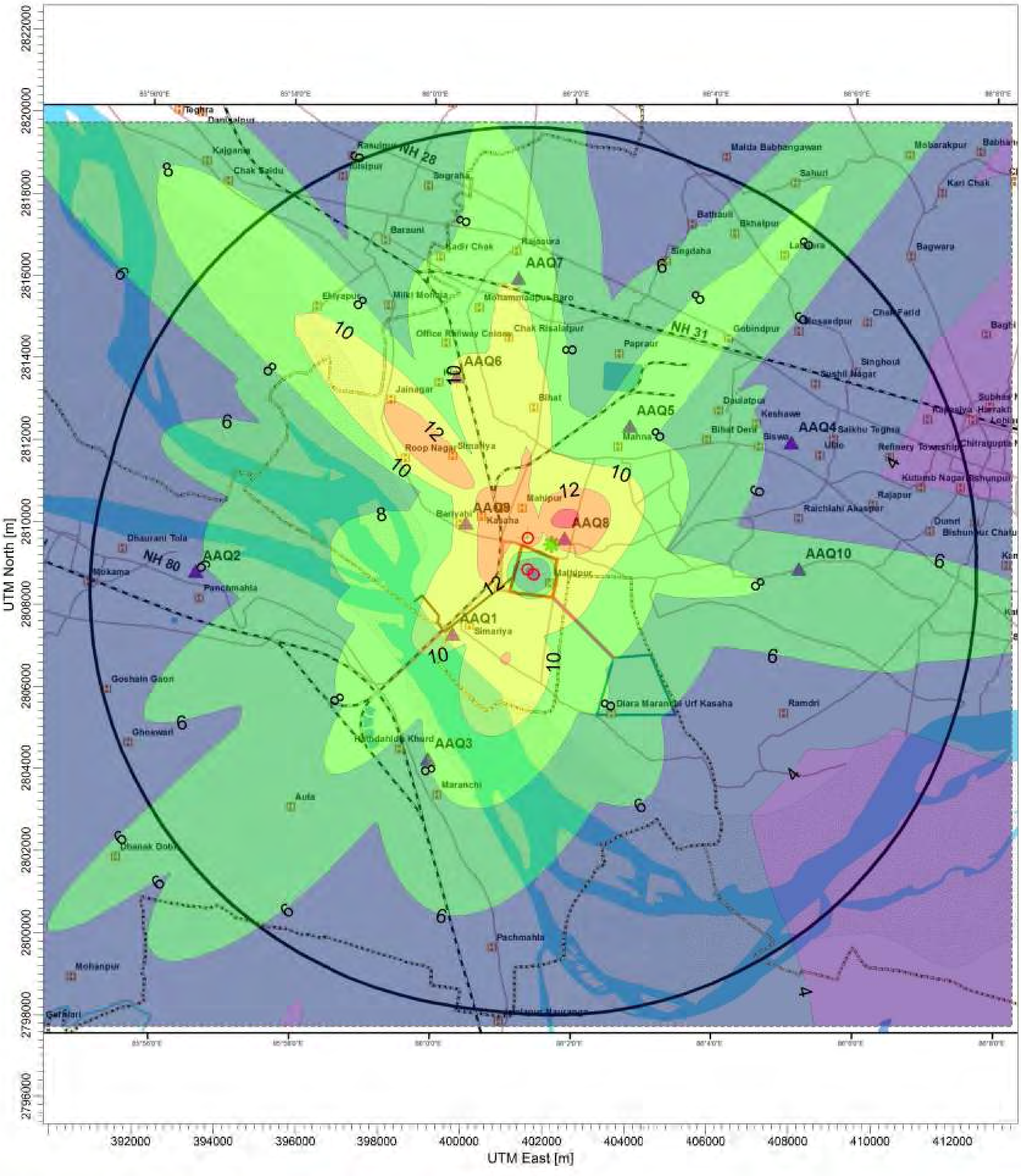
ERM

Project No.: 0293599

AERMOD View - Lakes Environmental Software

KEPCO - Barauni ESIA Study

24 Hourly Maximum NOx Concentration Isopleths
Operation of Unit # 6, 7, 8, 9 and 10 (Barauni TPS)



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

Max: 14 [ug/m^3] at (402435.22, 2810026.18)

ug/m^3

2 4 6 8 10 12 14

Sources: 3			
Receptors: 53271	Modeler: NC		
Output Type: Concentration	SCALE: 1:100,000 (0 — 3 km)		ERM
Max Concentration: 14 ug/m^3	Date: 2/6/2016	Project No.: 0293599	

AERMOD View - Lakes Environmental Software