Bangladesh – India Friendship Power Company (Pvt.) Limited
(A joint Venture of NTPC Ltd and BPDB)





Monitoring of environment parameters and implementation of Environmental Management Plan during pre-construction and construction period along with Engineering Activities for site development of Khulna 1320 MW Coal based Thermal Power Plant

Annual Monitoring Report of Second Year

Monitoring Period: November 2015 – January 2016

Combined Monitoring Report of Eight Quarters

February 2016

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Abbreviations and Acronyms

AECL	Adroit Environment Consultants Ltd
AAS	Atomic Absorption Spectrophotometer
BIFPCL	Bangladesh-India Friendship Power Company (Pvt.) Limited
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BCSIR	Bangladesh Council of Scientific and Industrial Research
BUET-BRTC	Bangladesh University of Engineering and Technology- Bureau of Research, Testing and Consultation
CEGIS	Center for Environmental and Geographic Information Services
COD	Chemical Oxygen Demand
CPUE	Catch per Unit Effort
DO	Dissolved Oxygen
DoE	Department of Environment
DPHE	Department of Public Health Engineering
dBH	Diameter at Breast Height
EC	Electrical Conductivity
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering Procurement Construction
FGD	Focus Group Discussion
FGD	Flue Gas Desulfurization
FSR	Fisheries Species Richness
GoB	Government of Bangladesh
GIS	Geographic Information System
GPS	Global Positioning System
HS	Household Survey
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
IFC	International Finance Corporation
Kg	Kilogram
KII	Key Informants Interview
MoPEMR	Ministry of Power, Energy and Mineral Resources

MW	Mega Watt
NTPC	National Thermal Power Corporation
OHSAS	Occupational Health and Safety Management Systems
PCU	Passenger Car Unit
PGCB	Power Grid Company of Bangladesh Ltd
PMU	Project Management Unit
PRA	Participatory Rural Appraisal
PWD	Public Works Datum
QMR	Quarterly Monitoring Report
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SRDI	Soil Resources Development Institute
SRF	Sundarbans Reserve Forest
TDS	Total Dissolved Solid
TH	Total Hardness
ToR	Terms of References
TSS	Total Suspended Solid
U.S.EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds

Unit

dB	Decible
ppm	parts per million
ppt	parts per thousand
hr	Hour
Kg	Kilogram
Km	Kilometer
KW	Killo Watt
m	Meter
mg	Milligram
ton/year	Ton Per Year
MW	Mega Watt
Nm	Normal Meter
s	Seconds
KV	Kilo Volt

Unit Conversion Table

General Units

1 meter = 3.2808 feet
1 kilometer = 0.621371192 mile
1 kilogram = 2.20 pound
1 metric ton = 1000 kg
1 square mile = 640 acres = 2.590 km^2
1 hectare = 10^{-2} km^2 = 2.471 acres
1 pascal = 1 N/m^2= 0.01 millibar
1 liter = 0.001 cubic meter
1°C = 274.15K=33.8°F
1 mg/m^3 = 1 µg /L
1 mg/L ≈1 g/m^3≈1 ppm (w/w)

Energy Unit

1 KWh = 3412 Btu
1MW=1000KW=10^6 W
1 KWh = 3.6 x 10^{6} J
1 kWh = 859.85 kcal
1 horsepower = 746 W
1 GWyr = 8.76 x 10^9 kWh

Glossary

Aman:	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus:	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
B:	When preceding a crop means broadcast (B. Aus)
Bazar:	Market
Beel:	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Boro:	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Haat:	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Gear/Jaal:	Different types of fishing net to catch fish from the water bodies.
Kutcha:	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal:	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
Kharif:	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Perennial Khal:	Water available in the khal all the year round.
Pacca:	Well constructedbuilding using modern masonry materials.
Rabi:	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
Seasonal Khal:	Water not available in the khal all the year round.
T. *Aman*:	When preceding a crop means transplanted (T. Aman).
Upazila:	Upazila is an administrative subdivision of a District.

Executive Summary

The study covers quarterly monitoring of different environmental and social parameters and environmental compliance monitoring of pre-construction activities. CEGIS has carried out the **4th**quarter of the **2nd** year monitoring activities in January, 2016 comprising of the monitoring of implementation of Environmental Management Plan (EMP) and Environmental Compliance, ambient air quality, noise level, water quality and hydro-morphological condition, fisheries resources covering fish habitats, migration and production, ecosystem and biodiversity and Sundarbans forest health.

EMP Monitoring during pre-construction activities deduced that the land development for the BIFPCL's site (Block A) has been completed. Construction of the embankments and slope protection work are about to complete. Site office construction has been continued. At present, the construction of main access road from Babur Bari to the Plant site is in progress and near to completion. In general, in this quarter, the environmental due diligence covered the Environmental Management System and Action Plan, Occupational Health and safety, workers' well being, Biodiversity and Sustainable Management of Natural Resources. The monitoring study found that BIFPCL has been complying with the EMP as suggested in the EIA report, which are stipulated in the pre-construction (Land development) stage, and has taken the preparation to meet the compliance requirements to the next stages. However, as per the EMP approved by DoE and being the Environmental Monitoring Consultant of the Project, CEGIS makes a few Site Specific Measure(s) that should be complied for ensuring environmental and social safeguarding of the Project, such as, demarcation of traffic way and taking precautionary measures like using proper road signs; temporary drainage for rain fall runoff should be constructed and sediment fences/traps need to be maintained to prevent sediment wash load to Maidara river; stockpile of construction materials should be placed at a safe distance from river bank; sufficient waste disposal bins need to be placed at the labor shed, and working area; the HR policies which are under preparation should include: Working Conditions and Management of Worker Relationship, Child labor policy, Occupational Health and Safety Policies, and worker's well beings following OHSAS 18001, ISO 14001; the grievance redress mechanism should be established; proper documentation of any accident or any health hazard risk needs to be maintained; preventive measures for near miss accidental events and any unforeseeable injury, illness, or damage should be adopted; an officer responsible for enforcing and monitoring safety procedure should be assigned; site specific ESMP should be prepared by the EPC contractors; safety training program for the Project personnel and labor force should be arranged.

Air quality monitoring inferred that the wind headed from North-West to the South-East. The weather condition is found mostly sunny and sometimes foggy. This time all the monitoring parameters (SO_2, NO_2, $PM_{2.5}$, PM_{10}, SPM, CO and O_3) of the ambient air are found within the standard limit. But, as this is a very dry season, there is an indication of increasing SPM and this will likely be a trend until the monsoon begins. Newly developed land for industrial activities along the Passur River, loading-unloading activities and cement industries are the known sources of SPM in this area. Other pollutants are generated from the commonly known sources like the rural vehicles (human hauler/ Nosimon) while working beside the roads; whereas in case of the monitoring spot in or around the waterways, the sources are engines of trawler, barges, ship etc.

Noise level has been found comparatively higher around the Project site, at township area due to the accelerated construction work, and at Gaurambha, because of the overcrowded bazar. Noise data at all points (Harbaria, and Akram Point) inside the Sundarbans are either below or equal to the threshold for a silent class (45dB) ranging from ~43dB to as high as

~45dB. Wind action on trees, splashing waves, bird's chirping, ship and fishing boats etc. are the sources of noise observed in Sundarbans.

Water quality monitoring mainly covers the Passur-Sibsa River system. The obtained results have been compared with the national and international standards and are found to be moderate for the aquatic ecosystem of Sundarbans and for domestic and industrial uses. In addition, Spatial and seasonal variations have also been examined and no significant variation has been found among the monitored values.

Land Resources monitoring inferred that EC and pH control most of the changes of elements in this region. Being a coastal zone of Bangladesh, the southern region receives large amount of sediments every year. Besides, the sampling zone is inherently sulphur rich. Overall sulphur content is above the average level of sulphur in soil but it does not exceed the maximum permissible limit, favourably most of it being flushed out in wet season with rain water. Organic matter content is also increasing due to practice of one cropping pattern and new sediment deposition every year. Macro nutrients also show the similar pattern. The presence of heavy metal (Pb and Cd) has been found in the sampling area. Pb content is higher than the average level in soil but within the maximum permissible limit, whereas Cd is found to be higher than the maximum permissible limit. So, there is a possibility of bioaccumulation in plant and successive biomagnification may lead to carcinogenic effect. Noteworthy, in most of the cases, both Pb and Cd are washed out in wet season with rain water.

Fisheries resources have been monitored and the findings show that yearly changes in habitat uses (when compared between 2014-2015 and 2015-2016) are mainly due to having tidal effect, seasonal variability and fisheries resource management. Moreover, through analyzing the type of habitat usage by different ages of various fish species (based on the length-based community structure model) two types of habitats have been found: i) Nursery and Feeding ground and ii) Feeding and Growing ground. Shannon-Weiner index has also been observed to vary between 4th quarter of 2014 and that of 2015. The highest index has been found at Chalna Point (0.81). On the contrary, the lowest evenness has been found at Mongla Point (0.41). Maximum FSR is recorded at Sheola Khal at Chandpai (n=7), while very low FSR at Akram Point, Haldikhali, Mongla Point and Maidara sampling sites (n=2). Furthermore, a management initiative of banning the fishing activities especially in the downstream of the Passur River (inside the Sundarbans) is expected to be a major cause of the spatial and annual variation for both the evenness and richness of fish species. Juveniles for fin fish are more widely distributed among the middle and lower stretches of the Passur River. Among these Bagda, Bele, Goda Chingri and Horina Chingri fishes are widely distributed among the sampling sites. Moreover, fry fish of Amadi Chela (Mongla Point), Bagda (Maidara and Mongla Point), Bele (Chalna Point and Maidara), Chali Chingri (Chalna Point and Maidara), Daitna (Maidara), Goda Chingri (Maidara), Golda Chingri (Maidara), Khorsula (Mongla Point), Poma (Mongla Point) and Tit Punti (Chalna Point) have been found. Fish species like Paissa attains the maximum abundance among the migratory fish species. Three species, Bagda, Poma and Bele show long range of distribution. The highest productivity has been found in Passur River at Akram Point and the lowest in the Maidara-Passur River confluence, because of the abundance of fries which are not considered as the production. Moreover, higher productivity is observed in this 4th quarter of 2015 as compared to the 4thquarter monitoring of the year 2014. The most frequently used gears are Behundi Jal and Net Jal in upper reach and Charpata Jal in lower reach of the Passur River. Furthermore, the total catch is higher in this monitoring year than that found in the first monitoring year. The fish production has been found only in the Gher of Rajnagar. In other

two farms, no fish production has been found during this quarter as is found in the 4thquarter of 1st year monitoring phase.

Ecosystem and Biodiversity study has depicted that Canopy status of studied homestead vegetation has been estimated more or less the same than the last monitoring session conducted in October, 2015, but slightly changed compared to the same season of the last year. Two main causes for this improvement are improved health of marginal mangrove vegetation (*Excoecaria agallocha)* at the monitoring homestead of Rajnagar, and increased foliage growth of planted saplings at the monitoring homestead of Borni. Coverage of living lichen on tree barks have been observed lower than previous monitoring in October, 2015 due to the lack of sufficient moisture on tree barks that hinders propagation of lichen. Occurrence of migratory birds has been observed in two major wetlands (Boro Charargher and Choto Charargher). In addition, local waterfowls are sighted at five wetlands out of eight monitoring sites. Population of migratory birds of these wetlands are reducing day by day for illegal hunting, re-starting shrimp culture within short intervals from shrimp harvesting in past year and indiscriminate use of pesticides in agriculture field and shrimp ghers. Occurrence of butterfly is not observed significant in this monitoring tier. Only four species of butterfly have been recorded from the two studied sites. A total of eight individuals of Ganges River dolphin have been sighted during transect survey at the three confluence points of Passur-Mongla, Passur-Maidara and Maidara-Ichamoti River. Beside, Ganges River dolphin is also found at Passur River near Karamjal and Harbaria.

Sundarbans Forest Health Monitoring observed five indicators (seedling density, Pneumatophore density, crab hole density, canopy cover and net canopy photosynthesis) in this quarter and compared with previous findings. After comparing two years of monitoring results, it can be predicted that the changing trend for almost majority of the indicators of forest health in SRF is related to seasonal variation. For example, seedlings density, Pneumatophore and canopy cover are found the highest and the lowest after and before monsoon period, respectively. The indicators even show variation among the monitoring sites (PSPs) that could be due to different physical environment for respective locations. However, with a view to establish a baseline on Sundarbans forest health monitoring attributes, this survey should be continued.

1 Introduction

1.1 Background

1. This study report intends to accomplish the monitoring of the recommended different environmental and social parameters, and environmental compliance monitoring of pre-construction activities for this quarter (**4th quarter of 2nd year)** for the proposed 1320 MW Coal based Thermal Power Plant being constructed at Rampal, Bagerhat.

2. The proposed Plant is a joint venture project of Bangladesh Power Development Board (BPDB) and National Thermal Power Corporation (NTPC) Ltd., India as per the contract signed in January, 2012 and run by Bangladesh-India Friendship Power Company Ltd. (BIFPCL).

3. The proposed coal based thermal power Plant falls under the Red category project as per ECA, 1995 and the followed up rules ECR, 1997, and needs Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from Department of Environment (DoE). As such, for obtaining these aforementioned clearance certificates from DoE, BPDB engaged Center for Environmental and Geographic Information Services (CEGIS) with the responsibility of conducting Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) studies under a Contract signed on 13th July, 2010 between BPDB and CEGIS.

4. Accordingly, CEGIS has conducted detailed EIA study in mid 2013 considering the study area which is also ecologically very important due to the world famous Sundarbans Mangrove Forest. As per the scope of EIA study, a detail Environmental Management Plan (EMP) has been developed suggesting mitigation, enhancement, contingency, and compensation measures that shall be duly implemented in project preconstruction, during construction and operation phase in order to minimize the negative impacts.

5. Successful implementation of the EMP depends on regular monitoring of the selective indicators at specified locations. Therefore, an independent environmental monitoring team has been proposed under the Department of environmental health and safety. Moreover, compliance monitoring has been suggested mandatory for this Project due to the presence of Sundarbans. The environmental monitoring officer/agency should monitor the EMP implementation and submit a quarterly report to the concerned department.

6. Subsequently, BIFPCL has initiated a study on monitoring environmental and social parameters and implementation of EMP during pre-construction and construction phases of the proposed Plant to safeguard the environment of the Sundarbans Mangrove Forest and the surrounding communities. CEGIS has been engaged for carrying out the study since early 2014 and will continue till early 2017, a span of three (3) years.

7. The location of the proposed project to be constructed that covers Sapmari Katakhali and Kaigar Daskati Mauza of Rajnagar Union under Rampal Upazila in the district of Bagerhat (Map 1.1). The Power Plant is located in between latitude 22^{0}37'0''N to 22^{0}34'30''N and longitude 89^{0}32'0''E to 89^{0}34'5''E, about 23km south from the Khulna City and 14 km north-westward from the Sundarbans. Location of the study area and their relative distance from various heritage sites is presented in Map1.1. The study area includes: i) area covering 10 km radius from the Plant location, ii) 10km strip from the both bank of Passur and Sibsa rivers starting from Plant site to Hiron point (Map 1.2).

8. The results of all the monitoring are reported quarterly to BIFPCL through monitoring report. Eventually, BIFPCL submits these reports to DoE and Forest Department. Accordingly, CEGIS has so far submitted seven (7) monitoring reports on quarterly basis. The current document constitutes **8th monitoring** report (i.e. monitoring activities of the **4thquarter of 2nd year**); the field study has been carried out in January 2016 covering Project monitoring locations and updates environmental monitoring database to January 2016.

1.2 Objectives

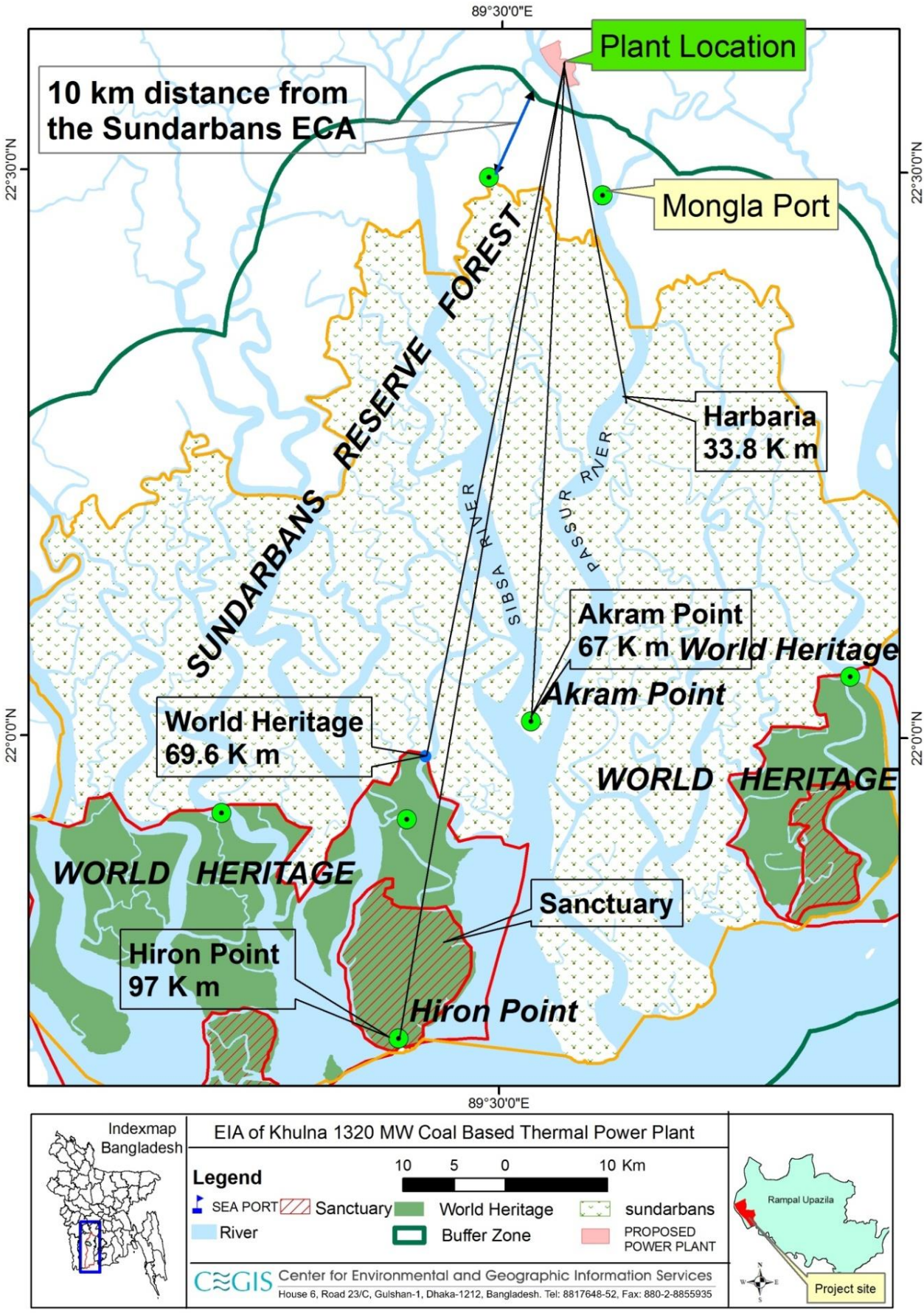
9. The overall objective is to monitor the environmental parameters and implementation of Environmental Management Plan (EMP) during pre-construction and construction phases of the installation of the Power Plant.

10. The aim of the quarter monitoring is to monitor the ambient state of environment that will be considered as the baseline and these will be compared with the environmental condition in future when the Power Plant will be in operation phase. The monitoring activities also include monitoring of environmental compliance of power plant pre-construction activities.

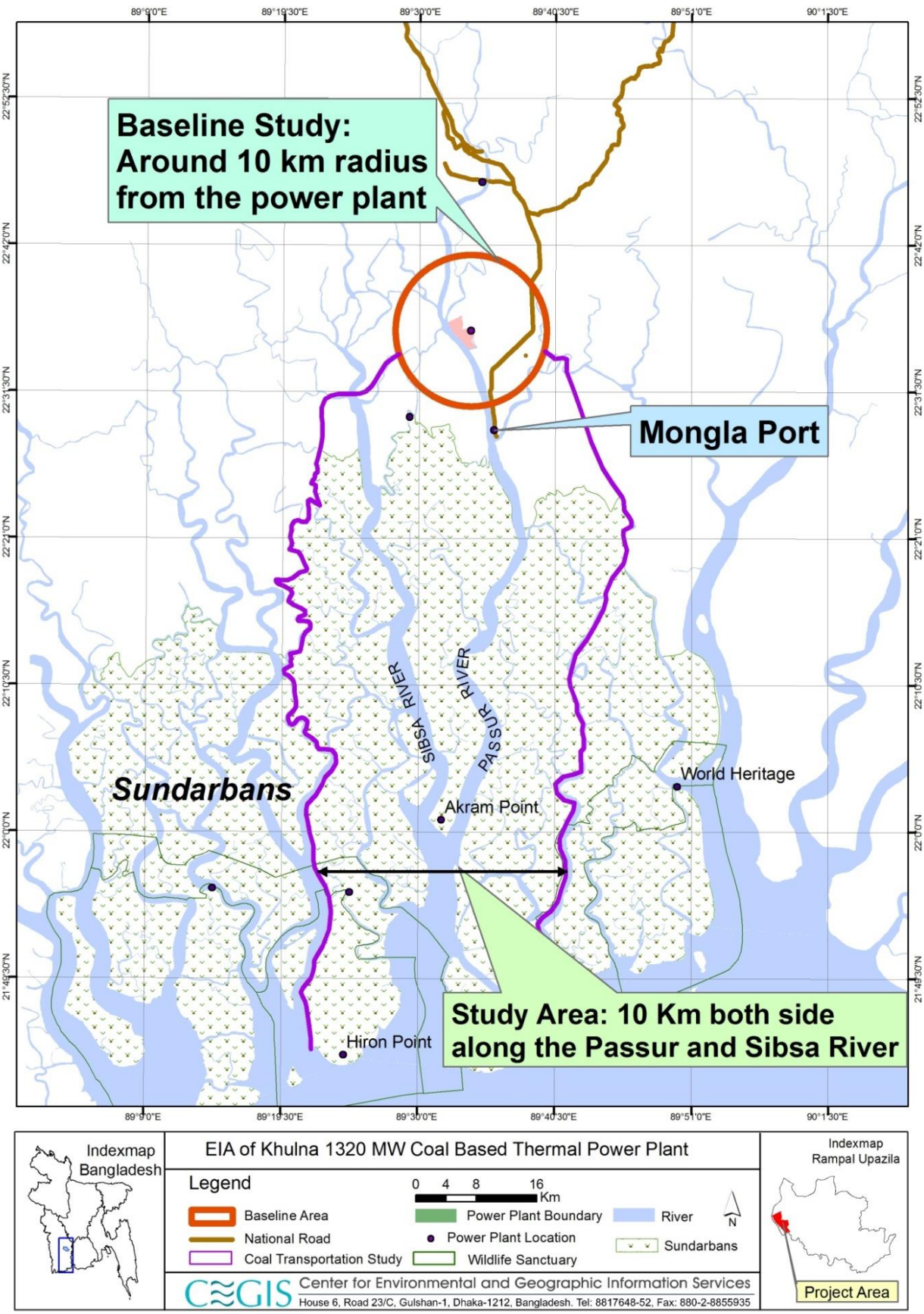
1.3 Criteria for Selection of Monitoring sites/locations

The monitoring sites have been selected taking into consideration the sensitive receptors, the ambience likely to be induced by the impact generated by the environmental parameters etc.

- Monitoring locations for ambient air quality are selected considering the wind direction, sensitive receptors in the vicinity of the Project etc. Site selection for monitoring of ambient noise condition also considers the same as Air quality.
- Sites for ambient water quality are selected taking into consideration the water sources likely to be impacted/polluted by the project activity.
- Monitoring sites of fisheries resources covers the fish habitats, biodiversity, migration and production zones likely to be impacted.
- Monitoring locations of ecosystem and biodiversity have been selected considering the induced impact likely to be happened by the Project.
- Sundarbans forest health Monitoring locations (PSPs) have been selected taking into consideration the potential access routes for Power Plant which may have impacts on Sundarbans Reserve Forest (SRF).



Map 1.1: Location Map of the Coal Based Thermal Power Plant



Map 1.2: Area under the Interest of Environmental and Socio-economic Monitoring

1.4 Main stakeholders

Forest Department

11. The monitoring of the study area includes some locations in Sundarbans that needs to comply to the conditions set out by the DoE in the approval of EIA report. Hence, permission from the Forest Department is necessary to carry out monitoring activities in the Sundarbans.

12. The Forest Department has issued the permission of carrying out monitoring activities in the Sundarbans under certain conditions that include keeping close communication with Forest Department, submitting the monitoring report to Forest Department and including the following activities in the monitoring study:

- Inclusion of soil scientist and a botanist in the monitoring team,
- Monitoring of regeneration, ingrowths (seedlings), diseases and pests (if necessary carry out laboratory analysis),
- Monitoring of soil nutrients (macro, micro) and heavy metals,
- Monitoring of floral diversity, species richness and dominancy,
- Measurement of carbon at above and below ground level,
- Assessment of impact on canopy cover, leaves phenology, flowers behaviour, pneumatophore condition.

13. The monitoring team has been formed as per the requirements of the Forest Department. BIFPCL also forwarded a copy of an earlier quarterly monitoring report to the Chief Conservator of Forest, Bangladesh Forest Department, Agargaon, Dhaka and Conservator of Forest, Khulna Circle, Boyra, Khulna. Similarly, this monitoring report will also be forwarded to the Forest Department.

Department of Environment (DoE)

14. The monitoring plan, including indicators, location and schedule, has been prepared incorporating the suggestion(s) of the Department of Environment. Before initiating the monitoring study, a discussion meeting is held with experts of DoE to finalize the monitoring plan at CEGIS office.

15. The BIFPCL forwarded the monitoring reports and data to the DoE regularly. In addition, the BIFPCL officials along with the study team members of the monitoring study visited DoE office to inform them the progress of the study. The monitoring report will also be presented to the Environmental Clearance Committee of the DoE during the renewal of the EIA approval.

2 Physical Environment

A number of physical environmental parameters including air quality, noise level, water quality, land resources and hydro morphology are monitored quarterly as per the monitoring schedule to establish a baseline.

2.1 Air Quality

16. The ambient air quality has been monitored in this **4th Quarter** of the **2nd year** at 10 (ten) specific locations.

2.1.1 Methodology

17. Five (5) major air quality criteria pollutants i.e., Particulate Matter ($PM_{2.5}$, PM_{10}, SPM), SO_X, NO_X, CO and O_3 in the ambient air based on the expected pollutants from the proposed Power Plant has been considered for monitoring in this study. The location for monitoring have been selected in the EIA study. In this context, eleven (11) sites have been seleted resting on a number of criteria e.g., the sensitivity of the receptors, project activities like coal-carrying vessel movement, transhipment point etc., wind direction and atmospheric stability class. Moreover, the potential location of air pollution has been projected on the basis of model generated pollutant dispersion scenario. U.S. EPA approved regulatory air quality software SCREEN 3.0. is used to select the location of potential pollutants dispersed from the Power Plant.

Photo 2.1.1: CEGIS professional checking Air Quality instruments in the Project Township area

Photo 2.1.2: Site attendants keeping records of Air Quality sampling in the Sundarbans

Method of Sampling and Laboratory Testing

18. Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550) have been used to collect the air sample. The $PM_{2.5}$, PM_{10}, and SPM have been tested by gravimetric method. The concentration of SO_2 has been tested by West-Gaeke method. Likewise the NO_2 has been tested by Jacob and Hochheiser method.

Monitoring locations

19. Ambient air quality has been monitored in the same locations as monitored in the earlier quarters except Hiron Point. Due to unavoidable circumstances, data from Hiron point

could not be collected during this quarter monitoring. The monitoring data of Hiron Point will be collected in the next monitoring field visit.The locations of the air quality monitoring points have been shown in **Map 2.1.1**. The details of the monitoring plan have been provided in the **Table 2.1.1**.

Pollution Sources

Pollution sources at Project area

20. The major pollution sources currently contributing to the ambient air pollution along the Passur River in between the Project site and Mongla Port are the existing infrastructures (i.e., cement and petroleum industries) and other pollution sources (i.e., marine vessels and residential sources) as listed in **Table A.2** of **Appendix IV**.

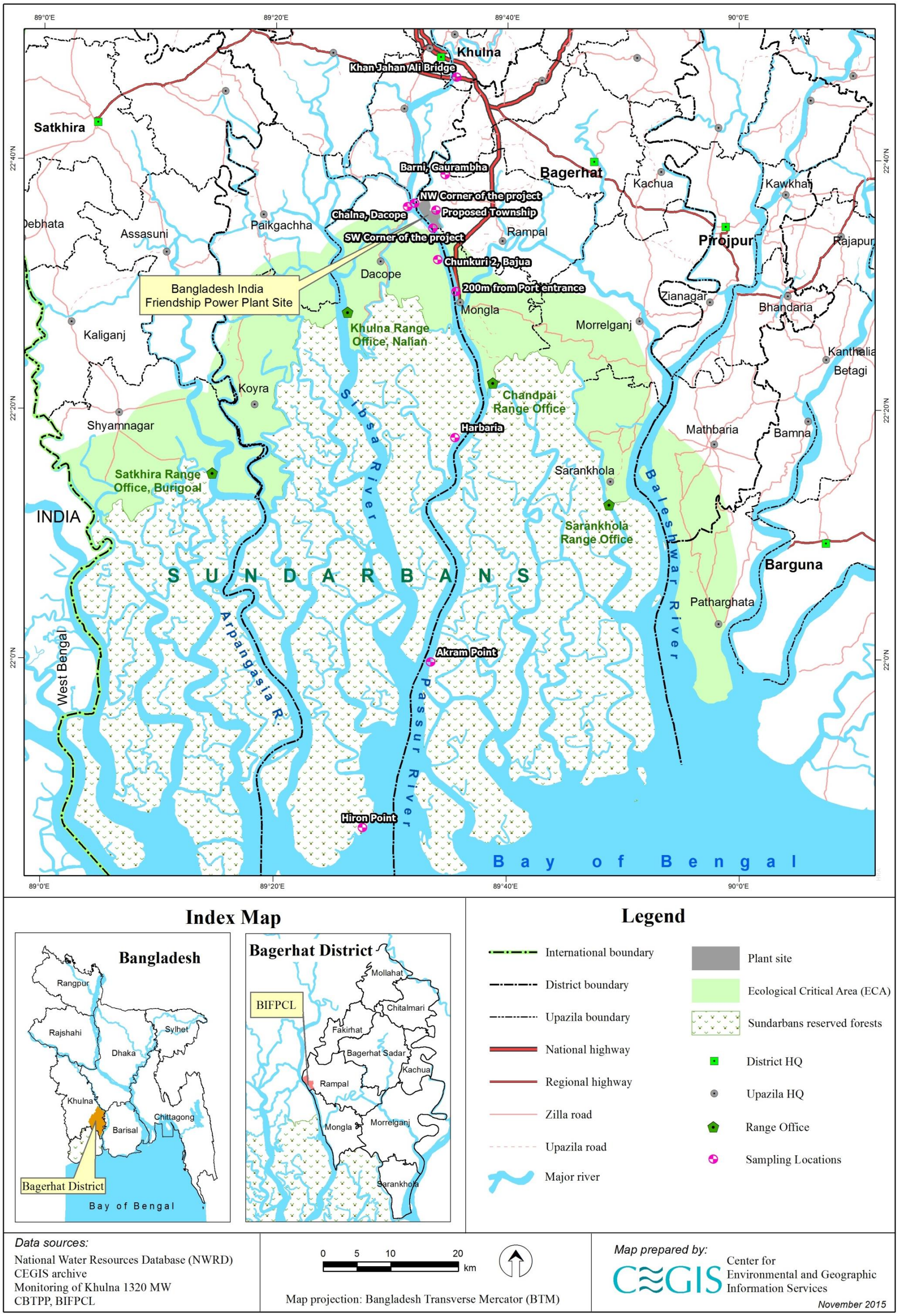
Pollution sources in the Sundarbans

21. Mostly river traffic of Mongla Port travelling across the Sundarbans are the sources of Suspended Particulate Matter (SPM), Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx) and Green House Gas (GHG).

22. An inventory of the existing emission types and sources in the study area have been provided in **Table A.2** of **Appendix IV**.

Table 2.1.1: Air Quality Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS Points	Frequency	Methods/Tools/Techniques
1	Particulate Matter ($PM_{2.5}$, PM_{10}, SPM) SO_X, NO_X, CO and O_3	South West corner of the Project boundary	89°33'34.5"E 22°34'33.8"N	Quarterly	In situ field measurement provided with the facilities of outsourced laboratory. Method of testing $PM_{2.5}$: Gravimetric Method of testing PM_{10}: USEPA (1997) Method 201 or 201A (as appropriate) Method of testing SO_X: USEPA (2000) Method 6 or 6A or 6B or ISO (1998) Method 11632 (as appropriate) Method of testing NO_X: USEPA (2000) Method 7 or 7A or 7B or 7C or 7D or ISO (1993) Method 10396 (as appropriate).
2		Proposed township area near Chimney location, Mauza: Sapmari Katakhali	89°32'3.8"E 22°36'32.5"N		
3		North West corner of the Project boundary (Kaigar Daskati)	89°33'51.8"E 22°36'1.06"N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89°34'37.7"E 22°38'51.8"N		
5		Chunkuri-2, Bajua Union (4km South West from the chimney location)	89°34'01.1"E 22°32'3.3"N		
6		Pankhali, Dacope, (4km North West from the Chimney location)	89°31'24.2"E 22°36'6.7"N		
7		Mongla Port Area	89°35'50.4"E 22°28'24.8"N		
8		Harbaria, Sundarbans	89°35'34.2"E 22°17'43.1"N		
9		Akram point, Sundarbans	89°30'54.1"E 22° '23.50"N		
10		Hiron Point, Sundarbans	89°27'53.2"E 21°46'27.60"N		
11		Khulna city near Khan Jahan Ali Bridge	89°35'35.5"E 22°46'36.8"N		



Map 2.1.1: Air Quality Monitoring Locations

2.1.2 Status of air quality

23. Air quality is expressed in terms of standards set forth for public health and welfare protection (against decreased visibility and damage to animals, crops, vegetation etc.). The current standards are listed below. Units of measurement for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (µg/m^3).

Pollutant		Averaging Time	National Ambient Air Quality Standards (NAAQS)	IFC/WB Standard	Bangladesh (DoE) Standard for ambient Air (ECR 2005)
Carbon Monoxide (CO)		1 hour	35 ppm	-	-
		8 hours	9 ppm	10 mg/m^3	10000
Nitrogen Dioxide (NO_2)		1 hour	100 ppb	200 µg/m^3	
		Annual		40 µg/m^3	100 µg/m^3
Ozone (O_3)		8 hours	0.070 ppm	100 µg/m^3	120 µg/m^3
Particle Pollution (PM)	$PM_{2.5}$	24 hours	35 µg/m^3	25 µg/m^3	65 µg/m^3
		Annual	15.0 µg/m^3		
	PM_{10}	24 hours	150 µg/m^3	50 µg/m^3	150 µg/m^3
	SPM	8 hours	-	-	200 µg/m^3
Sulphur Dioxide (SO_2)		1 hour	75 ppb	*350* µg/m^3	
		3 hours	0.5 ppm		
		24 hours		125 µg/m^3	365 µg/m^3

Particulate Matter ($PM_{2.5}$, PM_{10} and SPM)

24. The values of $PM_{2.5}$ and PM_{10} have been found within the standard limit at each location. Among those locations, the maximum concentration of $PM_{2.5}$ (47 µg/m^3) is found in Pankhali, Dacope and that of PM_{10} (135 µg/m^3) is near the SW corner of the Project area, the SPM is also noted the highest (182 µg/m^3) at Pankhali, Dacope. Large number of two-stroke human hauler, small engine boats and the anthropogenic activities are the possible sources of SPM. Cement industries, road traffic and ongoing dredging operation of Mongla Port Authority in Passur River might be the sources of SPM. All the monitoring data are given in **Table A.1** in **Appendix IV.**

Sulphur Dioxide (SO_2)

25. Concentration of Sulphur dioxide in the ambient air is found within the Bangladesh standard limit of *455 µg/m^3 for 8 hours (calculated)*. The SO_2 values in and around the Project ranged 13 - 21 µg/m^3. SO_2 concentration is measured in the Sundarbans reserve forest; the result indicates a moderate condition ranging 14-15 µg/m^3.

Nitrogen Dioxide (NO_2)

26. NO_2 concentration in the ambient air of Sundarbans ranged 13 - 18 µg/m^3. In Project site and its adjoining areas, the values are found higher but still within the Bangladesh standard limit of *405 µg/m^3 for 8 hours(calculated)*. The monitoring results are shown in **Table A.1** in **Appendix IV**.

Carbon Monoxide (CO)

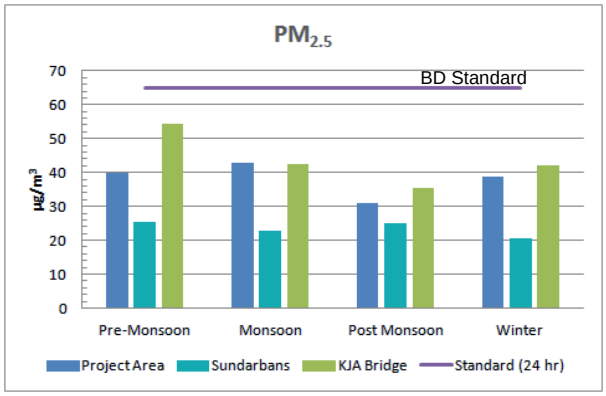
27. CO concentration is 62 - 101 µg/m^3 in and around Project area. The possible causes for the CO concentration are such activities—the big ship's anchorage beside the sampling point and for the loading-unloading activity; whereas in the Sundarbans, the concentration ranges 62 - 64 µg/m^3. The values are found very insignificant in the context of national standard (*10,000 µg/m^3 for 8 hours*).

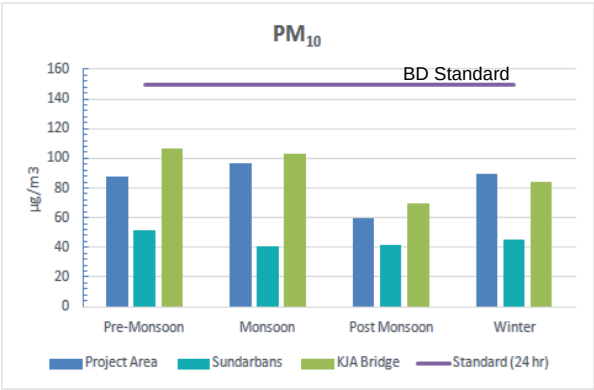
Ozone (O_3)

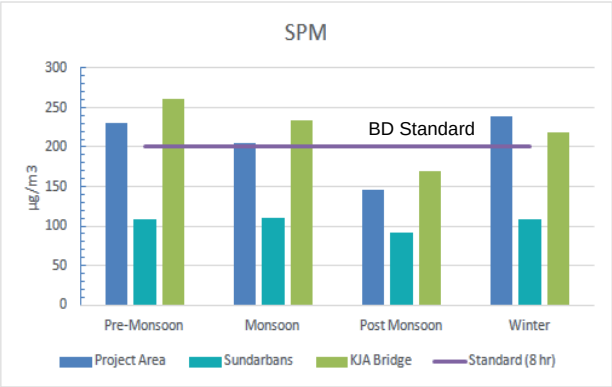
28. Similarly, results of O_3 both in the Sundarbans and Project area are lower (1 - 4 µg/m^3) than the Bangladesh standards of *157 µg/m^3 for 8 hours (calculated)*. Ground-level or "bad" ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight.

2.1.3 Findings

29. All the air pollutant data satisfactorily comply with the national standard except the values of SPM especially for dry season (i.e. winter and pre-monsoon) (Figure 2.1.1). This issue, however, is not a major concern for the ecosystem of Sundarbans.







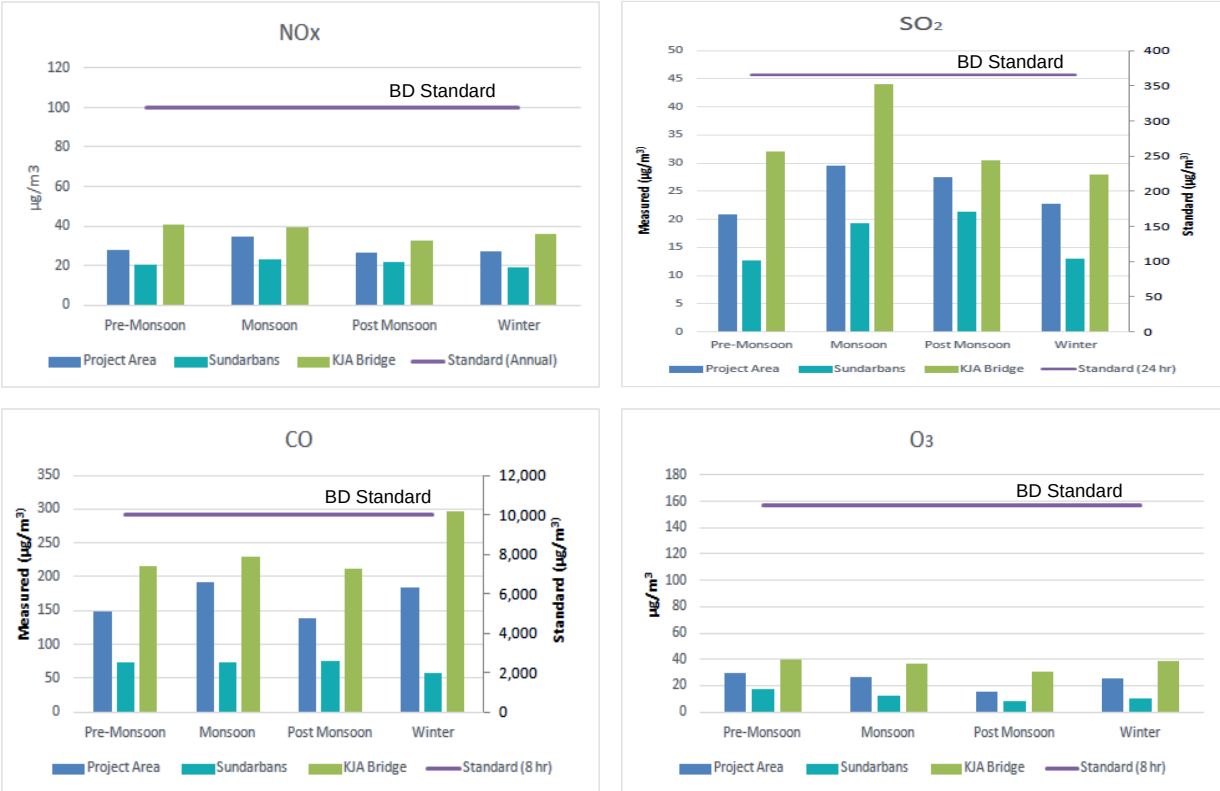


Figure 2.1.1: Seasonal variation of the Air Quality Parameters

2.2 Noise

30. Ambient noise levels are monitored as quarterly at ten (10) locations during this session. Noise levels have been monitored during 2014 (March, July, October) , 2015 (January, April, August, October) and 2016 (January). The monitoring plan is described in **Table 2.2.1**.

31. In this **4th Quarter** monitoring of the **2nd year**, the noise level is recorded in dry (winter) period.

32. The noise is generated from the common sources i.e., the rural vehicles (human hauler/ Nosimon, auto-rickshaw); whereas in case of the monitoring spot in or around the waterways, the sources are trawler, ship, sometimes waves breaking against the shore, etc. Barges, trawlers and ships are found plying over the waterway during this season.

2.2.1 Methodology

33. Noise levels has been measured thrice in a day (morning, afternoon and evening) at ten (10) locations. Each time noise level is recorded for a five minutes time span with a 30 second interval using portable noise level meter. Depending on the site condition and acoustic environment, the noise meter is set up and calibrated each time following the manual.

Photo 2.2.1: Specialists calibrating and setting up noise meter at site before use

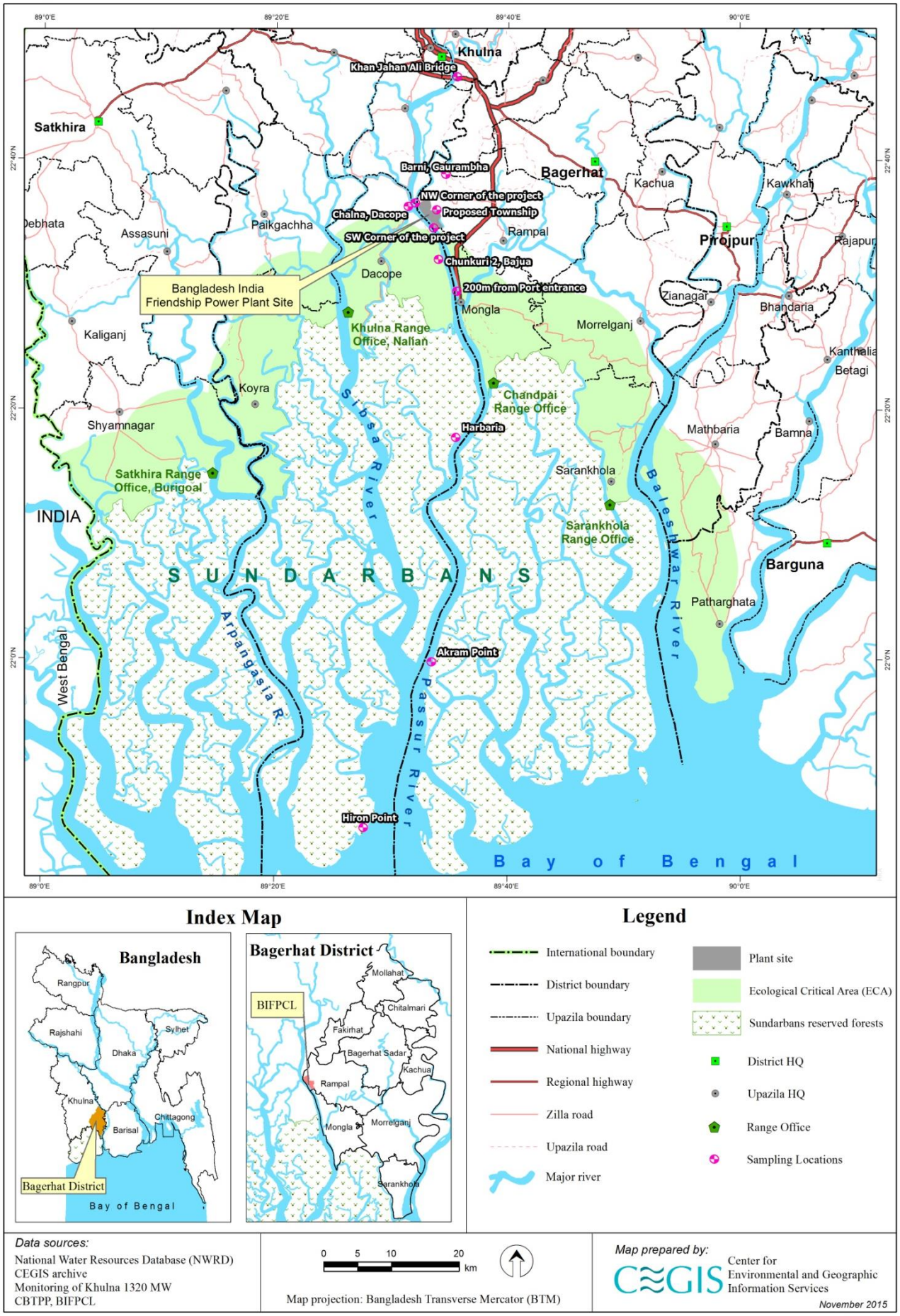
Photo 2.2.2: Professional conducting an ambient noise acquisition survey

Locations of Noise level Monitoring

34. There are eleven (11) locations for the noise level monitoring. Two locations are inside the Sundarbans, six locations are in and around the Project site, one is at Khan Jahan Ali Bridge on Rupsha River and one is at Mongla Port (**Map 2.2.1**). Due to unavoidable circumstances, data couldn't be acquired from Hiron point.

Table 2.2.1: Noise Level Monitoring Plan

Sl no	Monitoring Indicators	Locations	GPS Points (Decimal Degree)	Frequency	Methods/Tools/Techniques
1	Ambient Sound Pressure Level	South West corner of the Project boundary	89.5601°E, 22.5761°N	Quarterly	In situ field measurement by CEGIS Team using portable Noise Level (Sound Pressure Level) Meter
2		Proposed township area	89.5644°E, 22.6005°N		
3		North West corner of the Project boundary (Kaigar Daskati)	89.5334°E, 22.6093°N		
4		Barni, Gaurambha union (4km North East from the chimney location)	89.5772°E, 22.6477°N		
5		Chunkuri-2, Bajua Union (4km South West from the chimney location)	89.5669°E, 22.5342°N		
6		Pankhali, Dacope (4km North West from the Chimney location)	89.5234°E, 22.6046°N		
7		Mongla Port Area	89.5936°E, 22.4916°N		
8		Harbaria, Sundarbans	89.5926°E, 22.2968°N		
9		Akram point, Sundarbans	89.5152°E, 22.0219°N		
10		Hiron Point, Sundarbans	89.4614°E, 21.7755°N		
11		Khulna city near Khan Jahan Ali Bridge	89.5935°E, 22.7779°N		



Map 2.2.1: Noise Level Monitoring Locations

2.2.2 Status of Noise

35. Ambient noise data have been recorded at the following places:

Dacope Upazila Parishad

36. The monitoring location is at Chalna Bazar which is a commercial area. According to the Environmental Conservation Rules (ECR) 1997, noise level standard for commercial area at day time is 70dB (A). The noise level has been recorded as 66.07 dB which is below the Bangladesh standard (**Table 2.2.3**).

37. The significant noise sources at this place are road traffic and crowd. The road traffics are mostly from locally made engine van (locally called Nosimon), motor bike, easy bike (battery operated tri-cycle), etc.

North West Corner of the Project Area

38. The North West (NW) corner of the Project area is under Kaigar Daskati mauza of Gaurambha union. The monitoring location is nearby Gucchha gram (a cluster village built by the Government for the landless and homeless people). This area is residential and the standard is 50dB (A) at day time (ECR, 1997). This time the average day time noise level has been recorded as 50.96 dB, which is fairly similar to the day time standard value.

Chunkuri-2, Bajua

39. This area is residential and the standard is 50dB (A) at day time (ECR, 1997). Noise levels during the first, second and third quarter monitoring of 1st year are found higher than the day time standard (**Table 2.2.3**). During this time, it is found to be 53.62 dB which is above the standard. The noise sources are rural road traffic and crowd. The road traffics are mostly locally made engine van (called as Nosimon), motorcycle, bicycle, van, etc.

South West corner of the Project area

40. The South West corner of the Project area is in Sapmari, Katakhali mauza of Rajnagar union. This area is residential and the standard is 50dB (A) at day time (ECR, 1997). The noise level is found higher (60.44 dB) than the standard. (**Table 2.2.3**). Frequent water vessels' movement is the main reason for the exceedance of the standard.

Proposed township area of the Project

41. The proposed township area of the Power Plant is located at the middle of the eastern portion of the Project area. This area is residential and the standard is 50dB (A) at day time (ECR, 1997). Compared to the previous quarterly monitoring data, the noise level of this period are slightly higher (53.77 dB) than the day time standard (**Table 2.2.3**). due to accelerated construction works in the area.

Barni, Gaurambha

42. This area is also residential and the standard is 50dB (A) at day time (ECR, 1997). The noise levels are found higher (59.16 dB) than the standard limit. , it is a residential area, however there are lot of commercial activities increasing continuously, the ambience is becoming noisier due to these commercial activities (bazaar, local traffic, crowd etc.). The traffic load is higher than most of the past which has also accelerated the increase of the noise level.

Khan Jahan Ali Bridge, Khulna

43. The monitoring location is close to the toll booth of Khan Jahan Ali Bridge, Khulna. This area is considered as commercial due to activities around the bridge side and the

standard for the commercial area is 70dB (A) at day time (ECR, 1997).the average noise level are found 68.45 dB which is below the standard of day time. The highway traffic is the main source of noise. and the highest noise level has is recorded in the evening due to higher traffic load.

Mongla Port area

44. The monitoring location is at Khulna-Mongla highway, 200m northward from the main entrance of the Mongla Port area. The area is industrial and the standard for the industrial area is 75dB (A) at day time (ECR, 1997). The average day time noise level is found lower (52.70 dB).

45. The sources of noise are mostly road traffic (heavy vehicles, light vehicles, Nosimon, etc) and noise from Mongla Port activities (crane, ships, etc).

Harbaria, Sundarbans

46. Harbaria area of the Sundarbans is very critical considering the richness of biodiversity. The area is important navigation route for Mongla Port Area. Most of the sea going vessels are used to anchor at this site for lighterage operation. The area is under silent class of noise standard and standard of ambient at day time is 45dB (A) (ECR, 1997). the noise level is 45.20 dB measured at 100m inside the forest on the right bank of the Passur River to avoid the disturbance of noise from wave breaking against the shore and is found to be almost equal to the day time standard value.

47. Distant ship movement, running engines of anchored ships, wind, birds, wave and wind action on tree leaves are the main sources of noise.

Akram point, Sundarbans

48. Akram Point of the Sundarbans is another biodiversity hot spot in the Sundarbans. This area has been selected for anchorage point of coal carrying mother vessel for the Power Plant. This area is also under the silent class where the ambient day time noise standard is 45dB (A). The monitoring location is at the left bank of the Sibsa River. Noise is recorded at about 100m inside the forest from the river bank to avoid noise from wave breaking. The average day time ambient noise level during this monitoring period is found to be 42.95 dB which is within the standard . Birds' chirping, stormy wind, wave and tree leaves are the main sources of noise here.

Table 2.2.2: Summary of the ambient noise monitoring in First Year (2014-15)

Sl No	Location	QM1 (Noise Level in dB (A)) Mar-14				QM2 (Noise Level in dB (A)) Jul-14				QM3 (Noise Level in dB (A)) Oct-14				QM4 (Noise Level in dB (A)) Jan-15				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	80.32	60.86	63.22	68.13	52.71	55.62	50.27	52.87	53.37	53.52	57	54.63	51.92	53.7	54.21	53.28	70
2	NW Corner of the Project area	55.23	53	47.43	51.89	NM	NM	NM	NM	42.67	41.73	41.37	41.92	33.87	36.42	35.46	35.25	50
3	Chunkuri-2, Bajua	62.69	57.19	53.39	57.76	54.61	51.14	51.9	52.55	52.26	51.14	50.76	51.39	55.08	46.29	46.49	49.29	50
4	SW corner of the Project area	49.2	NM	NM	49.2	44.55	48.94	49.33	47.6	45.56	45.1	47.18	45.95	36.57	34.24	37.27	36.03	50
5	Proposed Township area, Project site	47.8	49.7	NM	48.75	46.15	47.21	NM	46.68	42.67	41.73	41.37	41.92	41.49	39.55	43.37	41.47	50
6	Barni, Gaurambha	64.95	50.93	60.65	58.84	48.73	50.37	50.75	49.95	50.18	50.89	48.27	49.78	43.36	38.56	48.86	43.6	50
7	Khan Jahan Ali Bridge, Khulna	76.12	66.72	72.25	71.7	55.97	64.68	61.75	60.8	72.24	58.3	68.3	66.28	61.34	63.4	60.41	61.72	70
8	Mongla Port area	69.38	54.55	59.79	61.24	54.75	54.2	52.58	53.84	66.8	55.2	59.5	60.5	40.26	35.04	40.76	38.69	75
9	Harbaria, Sundarbans	39.24	NM	42.51	40.88	59.25	60.52	48.62	56.13	54.08	56.51	NM	55.3	36.36	32.4	NM	34.38	45
10	Akram Point, Sundarbans	40.95	41.98	39.9	40.94	48.95	46.86	NM	47.9	45.27	42.69	NM	43.98	37.9	30.75	NM	34.32	45
11	Hiron Point, Sundarbans	35.99	40.75	39.16	38.63	51.29	NM	NM	51.29	47.98	39.42	NM	47.98	42.82	31.93	NM	37.37	45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

Table 2.2.3: Summary of the ambient noise monitoring in Second Year (2015-16)

Sl No	Location	QM1 (Noise Level in dB (A)) Apr-15				QM2 (Noise Level in dB (A)) Jul-15				QM3 (Noise Level in dB (A)) Oct-15				QM4 (Noise Level in dB (A)) Jan-16				Std*
		Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Morning (9:00)	A.noon (13:00)	Evening (18:00)	Day time AVG	Day time AVG
1	Chalna, Dacope	57.27	54.31	59.65	57.08	43.52	54.23	51.56	49.77	68.32	66.09	60.96	65.12	67.84	61.25	66.31	66.07	70
2	NW Corner of the Project area	45.05	42.15	46.8	44.67	37.58	40.91	46.18	41.56	41.51	39.58	44.74	41.94	53.91	49.02	49.95	50.96	50
3	Chunkuri-2, Bajua	45.9	48.19	NM	47.05	40.57	42.23	39.17	40.66	47.53	45.48	49.28	47.43	56.84	48.12	55.90	53.62	50
4	SW corner of the Project area	40.6	43.25	46.89	43.58	44.57	44.30	42.36	43.75	36.15	48.26	43.68	42.70	60.32	55.30	63.70	60.44	50
5	Proposed Township area, Project site	41.49	39.55	43.37	41.47	43.41	50.86	45.99	46.75	46.89	49.47	55.20	50.52	54.79	52.22	54.29	53.77	50
6	Barni, Gaurambha	58.23	50.11	NM	54.17	46.76	44.83	46.95	46.18	56.40	54.19	54.88	55.16	60.62	60.00	56.86	59.16	50
7	Khan Jahan Ali Bridge, Khulna	75.2	72.75	72.42	73.45	52.95	52.18	53.34	52.82	64.43	61.65	66.65	64.25	69.96	64.81	70.56	68.45	70
8	Mongla Port area	46.02	49.29	49.15	48.15	36.72	38.56	43.54	39.61	45.39	NM	48.63	47.01	54.15	51.82	52.14	52.70	75
9	Harbaria, Sundarbans	67.06	64.05	64.99	65.37	39.33	30.74	NM	35.03	54.97	46.54	NM	50.75	45.72	44.69		45.20	45
10	Akram Point, Sundarbans	53.35	56.37	NM	54.86	NM	NM	NM	-	45.28	53.92	NM	49.60	45.60	40.29		42.95	45
11	Hiron Point, Sundarbans	47.48	48.2	NM	47.84	NM	NM	NM	-	54.44	37.69	NM	46.06	-	-	-		45

*Note(s): NM – Not Monitored, *Std- Standard as defined in National Noise Control Rules 2006*

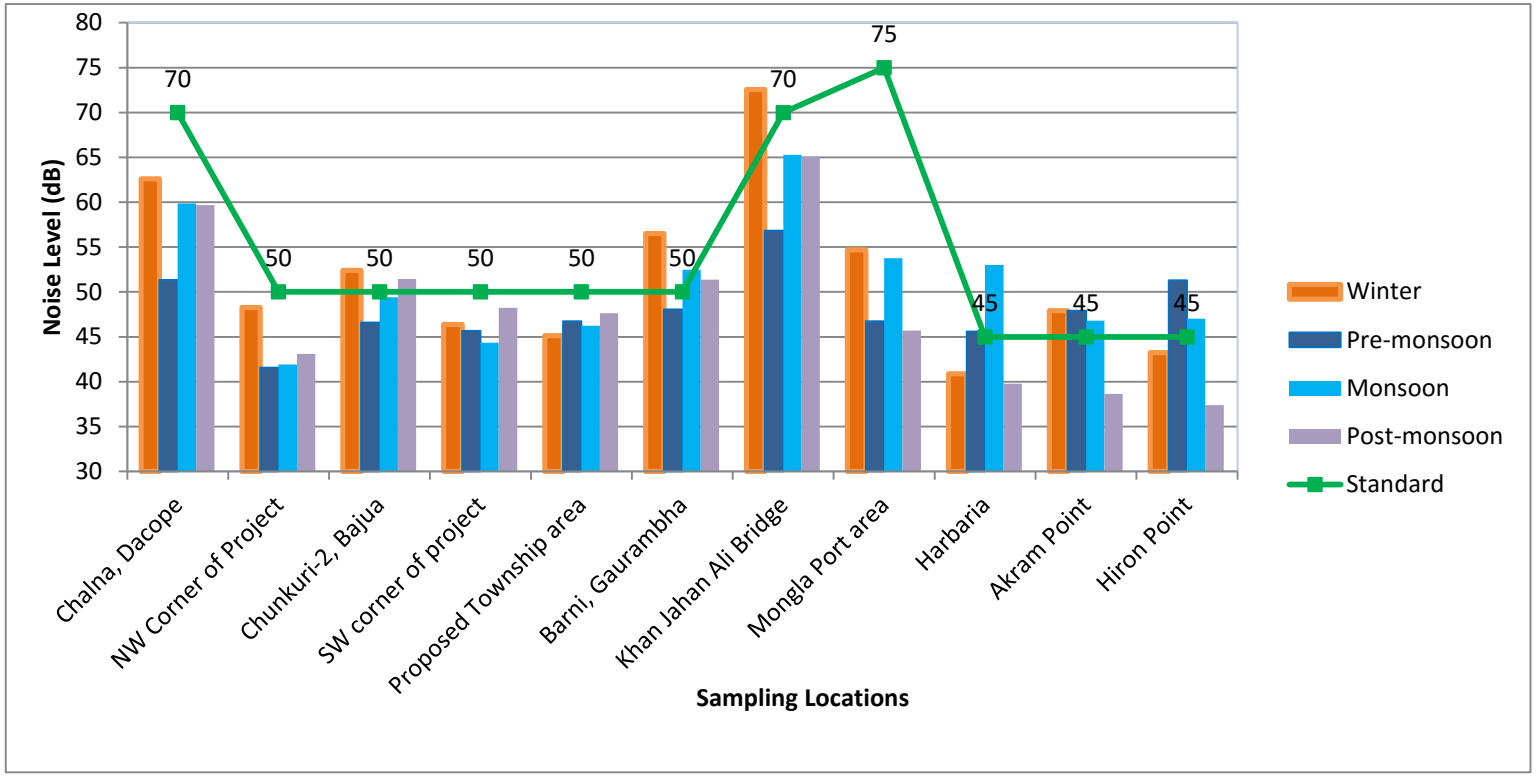


Figure 2.2.1: Seasonal variation of Noise level at different locations

2.2.3 Findings

All the average day time noise level data are relatively near or within the standard limits. Bajua and Barni are market places and noise level is recorded higher than the standard (Figure 2.2.1). In the Sundarbans, noise level is exceeding the threshold at all points, especially in the monsoon which could be due to interference of the splashing sound of water dropping on the leaves, frequent sound of thunder and waves breaking against the shoreline. The overall observation is that all the noise generation sources are mostly natural.

2.3 Water Quality

49. The current water quality status of Passur-Sibsa river system has been described in this section. A systematic sampling design has been adopted which emphasizes the multiple lines of evidence of the water quality. the water quality data collected under the 4th Quarter of 2nd year will update the available data up to November 2015.

50. The water quality monitoring activities include surface water and ground water at the respective locations. A number of identical parameters are chosen to understand the quality of the water, community use, aquatic life, and the Sundarbans forest ecosystem.

51. The samples collected for the 7th monitoring program (in October, 2015) have been analyzed for the specific parameters which is included in this report. However, the data collected under this moniring will be reflected in the next 9th Monitoring report due to timing of laboratory analysis.

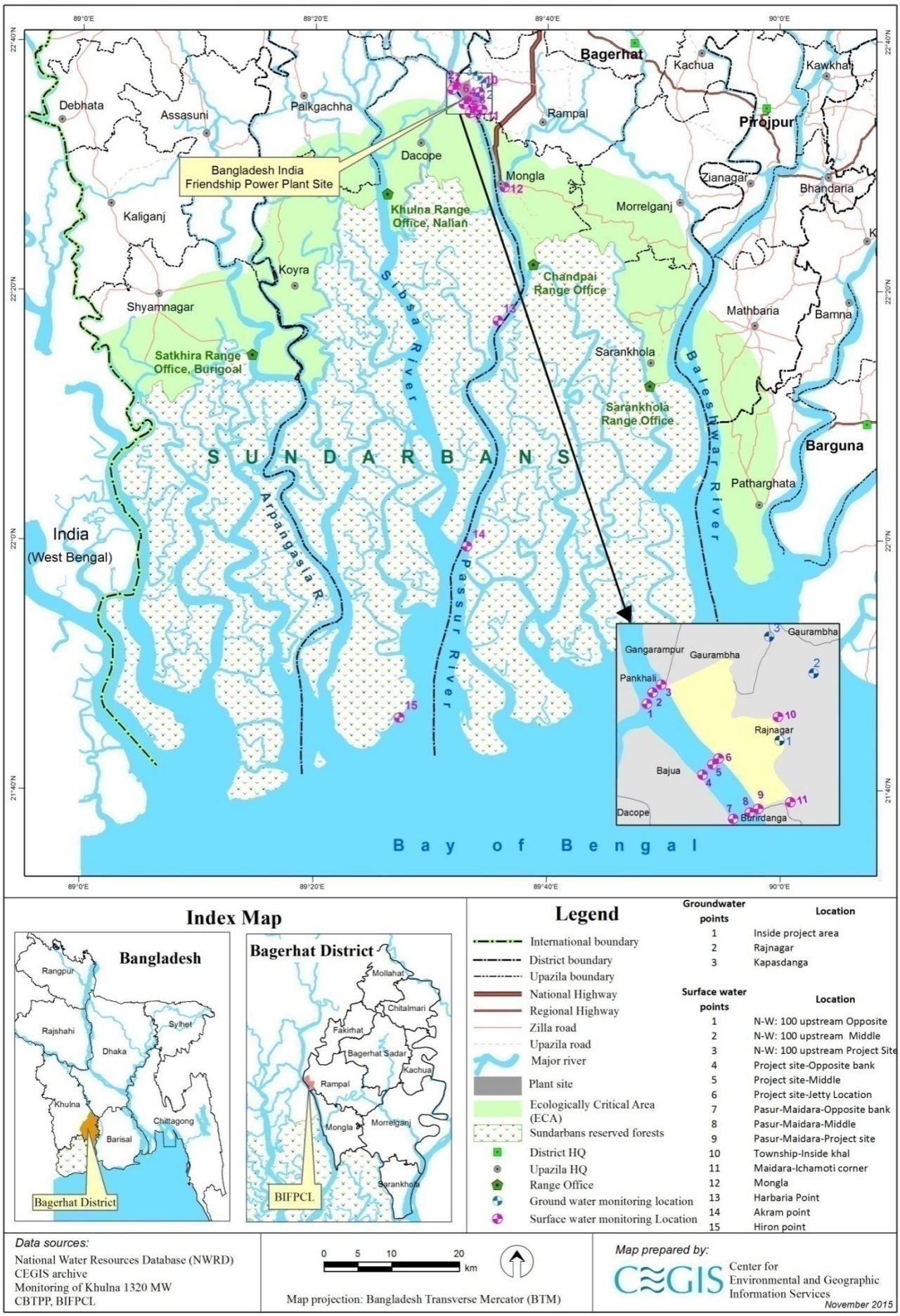
2.3.1 Methodology

52. Monitoring of water quality directly depends on selection of water quality parameters, sampling locations, sampling frequency, evaluation criteria etc. Standard practices have been followed for monitoring of water quality. Both the surface and ground water quality parameters have been assessed to examine the water quality status in the surroundings of Power Plant and the Sundarbans. The monitoring results have not only been presented but also been compared with the national standards (ECR, 1997 and all amendments).

53. The samples have been collected from the preselected sites (15 locations for surface water along Passur River, Sibsa River, Maidara River, near the plant site, and three locations for groundwater around the study area) for 8th monitoring program as shown in the **Map 2.3.1**. One tube well, once used for collecting groundwater sample, has been found damaged near Kalekarber from the 3rd monitoring program; hence the site has not been monitored since then. These sampling locations are preliminarily selected at inception stage and finalized during the 1st monitoring study. The details of the monitoring plan (selected water quality parameters, sampling locations, and frequency of sampling at each location) for surface water is shown in **Table 2.3.1** and for groundwater in **Table 2.3.2**.

Table 2.3.1: Surface Water Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, BOD_5, TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.604167°N	89.527222°E	Quarterly	In-situ measurement (pH, Temperature, Salinity, DO and BOD_5) and Laboratory analysis (TDS, TH, TSS, COD, Nitrate, Sulphate, Phosphate, Arsenic, Lead, Mercury, Oil & Grease)
2		Middle of Passur River at 100m u/s of North West corner from the Project boundary	22.607222°N	89.528889°E		
3		Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	22.609361°N	89.531417°E		
4		Left Bank of Passur River at Project site-Jetty	22.584833°N	89.543583°E		
5		Middle of Passur River at Project site-Jetty	22.587667°N	89.546472°E		
6		Right Bank of Passur River at Project site-Jetty	22.589333°N	89.548222°E		
7		Left Bank of Passur River at South West corner from the Project boundary	22.572889°N	89.552583°E		
8		Middle of Passur River at South West corner from the Project boundary	22.574611°N	89.557500°E		
9		Right Bank of Passur River at South West corner from the Project boundary	22.575667°N	89.559861°E		
10		Maidara river at the South East corner of the project at Ichamoti-Maidara confluence	22.600639°N	89.565611°E		
11		Maidara river near proposed Township area	22.577472°N	89.569250°E		
12		Passur river at Passur – Ghasiakhali confluence	22.473861°N	89.602361°E		
13		Passur river at Harbaria of Sundarbans	22.295250°N	89.593139°E		
14		Passur river at Akram Point of Sundarbans				
15		Passur river at Hiron point of Sundarbans				



Map 2.3.1: Surface water and Groundwater Quality Monitoring Locations

Table 2.3.2: Groundwater Quality Monitoring Parameters, Locations and Plan

Sl no	Monitoring Indicators	Locations	GPS (Decimal Degree)		Frequency	Methods/Tools/ Techniques
			Easting	Northing		
1	pH, Temperature, Salinity, DO, COD, As, Hg, Pb, TH, TDS, TSS, Nitrate, Sulphate, Phosphate	Near Proposed Township Area of the Project	22.594167°N	89.566139°E	Quarterly (April, July, October, January)	In-situ measurement and Laboratory analysis
2		Rajnagar	22.612528°N	89.576056°E		
3		Kalekarber	22.609306°N	89.596278°E		
4		Kapasdanga	22.622528°N	89.563000°E		

Sampling Procedure

54. The standard sampling procedure has been followed for both surface and groundwater to reduce the probability of error. Each sample is tagged at the time of sampling.

Photo 2.3.1: On-spot Water Quality parameters test at Power Plant site

Surface Water Sampling Procedure

55. The study area is highly influenced by tidal variation. Hence, temporal and spatial variations of tides have been considered significantly in sampling procedure. Surface water samples are collected during the low tides or relative slag period after the low tide. Samples are taken 50 m away from the riverbank and at a depth of 6 cm below the river surface, whereas for oil and grease, samples are collected from the river surface. The individual sampling bottle is rinsed with respective water samples before storing. Acidified sampling bottles are used for heavy metal (As, Pb, Hg) analysis and wrinkle bottles are used for BOD_5. All the samples are preserved as per standard practices.

Groundwater Sampling Procedure

56. Groundwater availability depends on the recharge factor of aquifer, seasonal variation in water table, excessive water extraction from nearby agricultural field. Groundwater samples are collected from hand operated tube wells after 5-7 minutes of water extraction. Each sampling bottle is rinsed with respective water samples before storing. Acidified sampling bottles are used for heavy metal (As, Pb, Hg) analysis and are preserved following standard practices.

Photo 2.3.2: Assessing salinity at Maidara River sampling Site

Parameters tested for water quality

57. Water quality parameters have been selected on the basis of tentative potential impacts generated during pre-construction, construction and operation phases of the Power Plant Project. Only five parameters namely pH, temperature, salinity, DO and BOD_5 have been tested while conducting the monitoring study and the rest of the preselected parameters are analyzed in the laboratories.

Surface Water Quality Parameters

58. The selected parameters for surface water quality includes Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Suspended Solids (TSS), Total Hardness (TH), Turbidity, Temperature and Oil and Grease. The main parameters are grouped into following four categories:

- Physical and aggregate properties i.e. pH, Temperature, Salinity, Hardness, TDS, TS, Turbidity, Oil & Grease
- Inorganic non-metallic constituents i.e., DO, NO^{3-}, PO_4^{3-} and SO_4^{2-}
- Aggregate organic constituents i.e. BOD, COD
- Heavy metals i.e. As, Pb and Hg

Groundwater Quality Parameters

59. The parameters for ground water quality includes Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Heavy Metals (As, Pb, Hg), pH, Salinity, Hardness, Nitrate (NO_3), Total Dissolve Solids (TDS), Total Hardness (TH) and Temperature.

Water quality analysis procedure

60. The collected samples of selected water quality parameters are analyzed as per the procedure of American Public Health Association (APHA) standard**.** All the analysis procedures along with the standards have been appended in **Table 2.3.3.**

Table 2.3.3: Testing Methodology of Water Quality Parameter

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Temperature	Thermometer	$^{\circ}C$	20 - 30
pH	Microprocessor pH meter		6.5-8.5
TDS	TDS meter (Multimeter)	ppm	1000
TSS	Drying and Filtration	ppm	10
Salinity	Salinity Refractometer (Master-S/MillM Cal. No. 2493, ATAGO)	ppt	
DO	Dissolved Oxygen meter DO-5509	ppm or mg/l	6
BOD_5	5-Day BOD Test at 20^0C	ppm or mg/l	50 (SW)
COD	Closed Reflux Method	ppm or mg/l	200 (SW), 4.0 (GW)
Total Hardness (as $CaCO_3$)	Titrimetric	ppm or mg/l	200-500
Ortho-Phosphate (PO_4^{3-})	UV-VIS Spectrophotometers	ppm	6
Nitrate (NO_3^-)	UV-VIS Spectrophotometers	ppm or mg/l	10
SO_4^{2-}	UV-VIS Spectrophotometers	ppm or mg/l	400
Oil and Grease	Liquid-liquid extraction with hexane, treatment with silica gel and gravimetric determination	ppm or mg/l	10 (SW)
Arsenic (As)	Atomic Absorption Spectrophotometers–Hydride Vapor Generating (AAS-HVG)	ppm or mg/l	0.05

Parameters	Methods/Measuring Tools	Unit	BD Standard (ECR 1997)
Lead (Pb)	Atomic Absorption Spectrophotometers–Graphite Furnace (AAS-GF)	ppm or mg/l	0.05
Mercury (Hg)	Mercury Analyzer	ppm or mg/l	0.001

2.3.2 Comments on the surface water quality monitoring

In-situ tested parameters

(a) pH

61. During this period of monitoring pH values ranged 7.1 - 8.2. The highest value is found in Passur River at Harbaria of Sundarbans while the lowest value is observed in the Left Bank of Passur River at 100m u/s of North West corner from the Project boundary.

62. The results show conformity among the locations but are slightly lower compared to the monitoring results of the same period of previous year.

63. It is observed that there is seasonal variation in pH values of the Passur-Sibsa RS (River system). According to the seven consecutive quarterly monitoring results, pH values of pre-monsoon and monsoon seasons are found to be comparatively lower than post-monsoon and winter seasons. During post monsoon and winter seasons, river water level normally goes down because of less rainfall and less from u/s flow of Passur-Sibsa RS and as a result, pH values becomes higher than pre-monsoon and monsoon seasons as reported by others (Rahman et al., 2013). Fluctuations in pH values during different season of the year can be attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of waste with fresh water, reduction in salinity and temperature, and decomposition of organic matter (Rajasegar, 2003).

64. No significant seasonal pH differences are observed except spatial variation in the river water. Seasonal variations in pH among the selected monitoring locations during first and second year quarterly monitoring of Passur-Sibsa RS are presented in **Figure-2.3.1** and all the observed dataset are attached in **Table B.1** of **Appendix- IV.**

(b) Temperature

65. Recent monitoring results of temperature show close conformity with the previously monitored values in the same season of 1st year. The latest values vary from 21^0C to 23^0C among the monitored locations. During all the monitoring period maximum temperature is found in July 2014 which seemed to be slightly higher than the standard limit set by environmental conservation rules, 1997. But all other values are found to be within the BD standard (20^oC-30^oC).

66. The surface water temperature largely depends on daily weather condition (Bartram J et al., 1996). According to the seasonal weather pattern of Bangladesh the temperature drops to a minimum level during winter which is also applicable for the water temperature and thus it differs largely than the others season's data. However, the average temperature in all the other seasons is seen to be very similar with each other. No significant spatial variation had been observed during the monitoring periods. The measured temperature values of selected monitoring locations during quarterly monitoring of first and second year are presented in **Figure-2.3.2** and all the observed dataset are attached in **Table B.2** of **Appendix- IV**

(c) Salinity

67. Salinity level recorded during 8th monitoring period at all points is closely conformable to that of winter 2014 except Akram point (16 ppt). The observed values vary from 2.5 ppt to 11.3 ppt during this monitoring period and the maximum value is observed at Akram point while the minimum value has been recorded in Maidara River near proposed township area. Noteworthy that the salinity of Passur River at Akram point and Hiron point has always been found higher than the other locations in any season as these are nearer to the seal than the others.

68. No salinity is found in the Passur River up to Harbaria during post monsoon of 2014 and monsoon and post-monsoon of 2015. This might be due to excessive rainfall and fresh water flow from upstream. The highest average values are found in pre-monsoon season of the both years.

69. Water salinity data at the selected sampling stations of Passur-Sibsa RS of eight consecutive periods are presented in **Figure: 2.3.3** and all the observed dataset are attached in **Table B.3** of **Appendix- IV.**

(d) Dissolved Oxygen

70. Average DO values at all the monitoring stations are found to be lower than those of the previously recorded values during the same season, although the concentrations are higher than the lowest limit of BD standard (6.0 mg/L). The lowest DO has been found in Ichamoti-Maidara confluence (4.1 mg/L) of Maidara River. The highest amount (6.2 mg/L) is observed both at Right Bank of Passur River at 100m u/s of North West corner from the Project boundary and at Akram point of Sundarbans.

71. It may be mentioned that the Maximum concentrations are observed during monsoon and post monsoon than the other two seasons. These higher values of DO in the upstream stations could be due to DO enriched inland freshwater input through the river.

72. Seasonal variations of DO at the monitoring sites of Passur-Sibsa RS are shown in **Figure: 2.3.4;** all the observed dataset are attached in **Table B.4** of **Appendix- IV**.

(e) Biochemical Oxygen Demand (BOD_5)

73. The BOD_5 values ranged 1.1-2.7 mg/L. Maximum value of BOD_5 is found at the South East corner of the Project at Ichamoti-Maidara confluence which is similar to the winter season of 2014. The lowest (1.1 mg/L) value is observed at Left Bank of Passur River at Project site-Jetty.

74. When BOD_5 levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria (Sawyer et al., 2003) in the water. All the recorded values have showed this general trend and are found within BD standards (0.2 ppm) at all the stations except at Right Bank of Passur River at South West corner from the Project boundary which is observed to be 6.5 in first year during pre-monsoon season. It is also evident from the figure that the highest average value has been recorded in Passur-Mongla confluence during monsoon season because of the river receives huge amount of organic load and agricultural runoff from the adjacent areas.

75. Thus, BOD_5 has been found higher during summer season than monsoon and the least during winter. The water temperature normally goes down in winter season than those of pre-monsoon, monsoon and post monsoon seasons, which in turn decreases the bacterial and microbial activities and contributes a low level of BOD_5.

76. The measured BOD_5 values at different monitoring locations during first and second year monitoring of Passur-Sibsa RS are presented in **Figure: 2.3.5** and all the observed dataset are attached in **Table B.5** of **Appendix- IV.**

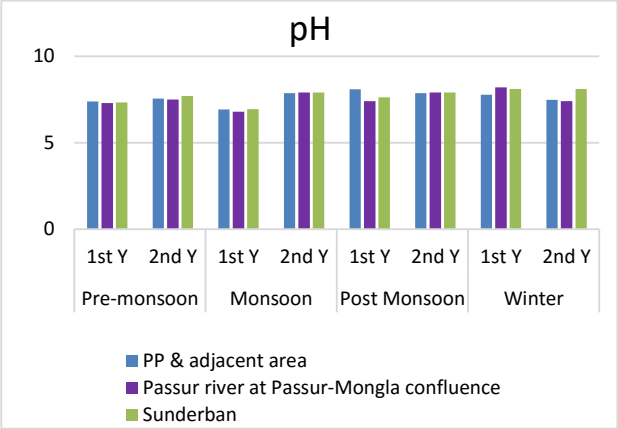


Figure: 2.3.1- Variations in average pH values in sampling spots for the consecutive seasons

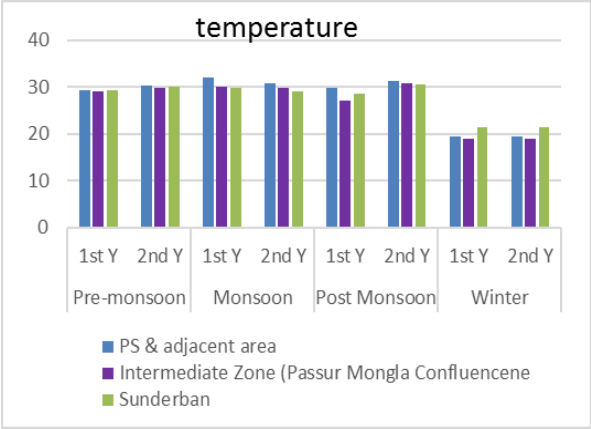


Figure: 2.3.2- Variations in average temperature values in sampling spots for the consecutive seasons

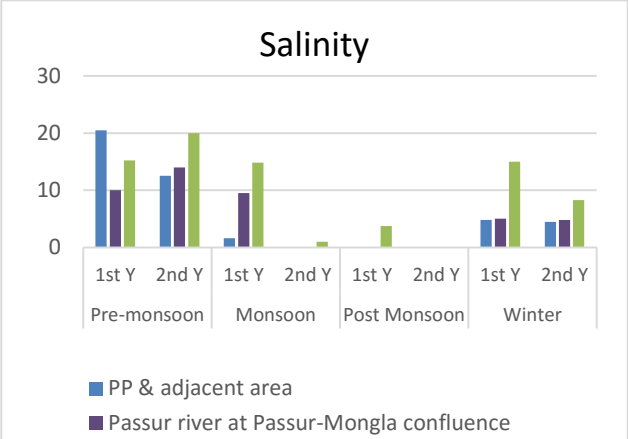


Figure: 2.3.3- Variations in average salinity values in sampling spots for the consecutive seasons

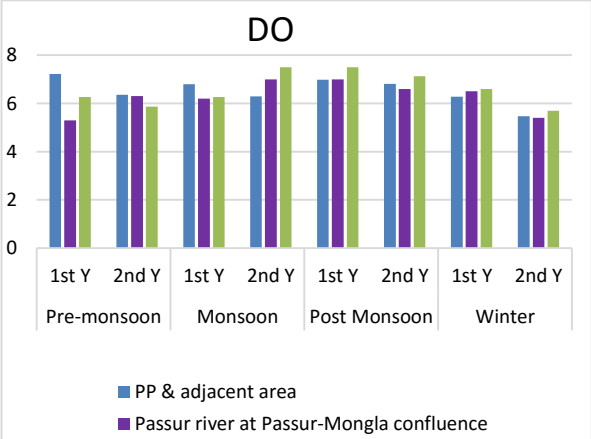


Figure: 2.3.4- Variations in average DO values in sampling spots for the consecutive seasons

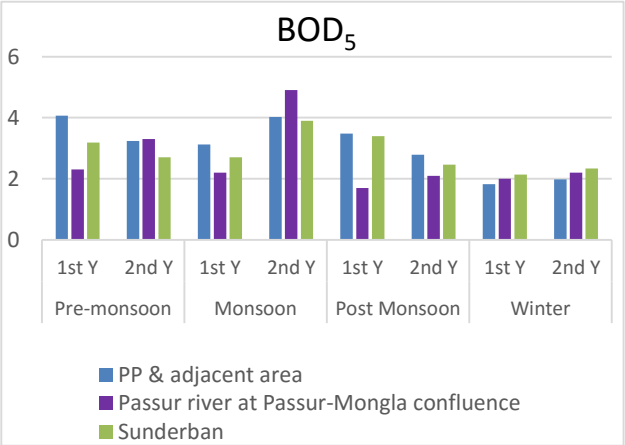


Figure: 2.3.5- Variations in average BOD_5 values in sampling spots for the consecutive seasons

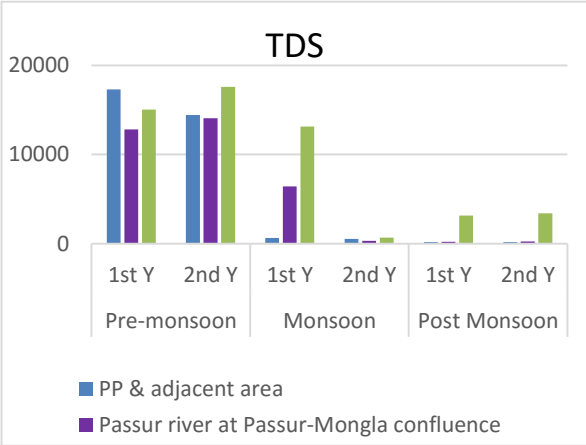


Figure: 2.3.6- Variations in average TDS values in sampling spots for the consecutive seasons

Laboratory tested parameters

(a) Total Dissolved Solids (TDS), Total Hardness (TH) and Total Suspended Solids (TSS)

77. The values of TDS vary from 1158 mg/L to 5830 mg/L. The observed results of this season are close to the value of the same season of the previous year. The highest value is observed at Hiron point. Before this monitoring period there has been heavy rainfall in the Sundarbans. Moreover, during monsoon period the river receives huge amount of water from the upstream and from inland sources which in turn increase the concentration of TDS.

78. The results revealed a moderate level of TDS concentration in the samples as per Bangladesh and WHO (1000 mg/L) standards (ECR, 1997 and WHO, 1993 and 2007). In most of the observed locations, the TDS concentrations seem to be lower in monsoon and post monsoon period and higher in pre-monsoon and winter season. A Significant spatial variation is found, which could be due to the sea water and the erosion-accretion process of the river. Sediment load in Passur River is relatively higher as it is located in the south western part of Bangladesh. TDS mainly indicates the presence of various kinds of minerals like ammonia, nitrite, nitrate, phosphate, alkalis, some acids, sulphates and metallic ions etc. which comprise both colloidal and dissolved solids in water (Tareq M S et al., 2013).

79. The values of TH are found similar to the previously obtained dataset of the same season. During the rainy season, the hardness in all monitoring stations in Passur River are found to be lower (183-3050 mg/L) whereas it is found remarkably higher (870-4850 mg/L) in pre-monsoon season. Though in general cases the hardness is found to be higher in monsoon season but in Passur River it is found higher in pre monsoon season due to the saline water intrusion to the upstream in this season (Rahman et al., 2013). The results have showed a close similarity to that of 2014 post-monsoon period. The fresh water sometimes lowers down the amount of hardness in post-monsoon and monsoon period. It is also observed that in Akram point and Hiron point of the Sundarbans the TH values always found higher than those of other monitored locations. This is because the locations are nearer to the Bay of Bengal than all the monitored sites.

80. TSS includes solid materials of organic and inorganic in origins which are suspended in water. In Passur and Sibsa Rivers system the suspended matters generally contain sand, clay, silt and loam. During the last monitoring period, the maximum TSS concentration (144 mg/L) is found in Hiron point of Sundarbans while the lowest amount is recorded as 60 mg/L at Passur-Mongla confluence. However, TSS values in every spots are found to be within the standard (150 mg/L) suggested for Bangladesh (ECR, 1997). The values are found to be relatively higher in pre-monsoon season than those of monsoon. During dry season (pre-monsoon and winter season) the TSS value increases, probably due to less freshwater flow, urban runoff, industrial wastes, bank erosion, bottom feeders (such as carp), algae growth or wastewater discharges. In Mongla-Passur confluence the concentration is very high which could be due to the heavy load of marine vehicles, and Mongla Port Authority's development work, and most importantly the domestic and industrial runoff from the adjacent areas.

81. The TDS, TH and TSS of Passur River in pre-monsoon, monsoon, post-monsoon and winter seasons at different monitoring locations are presented in **Figure: 2.3.6, 2.3.7** and **2.3.8** respectively and all the observed dataset are attached in **Table B.8** of **Appendix-IV**.

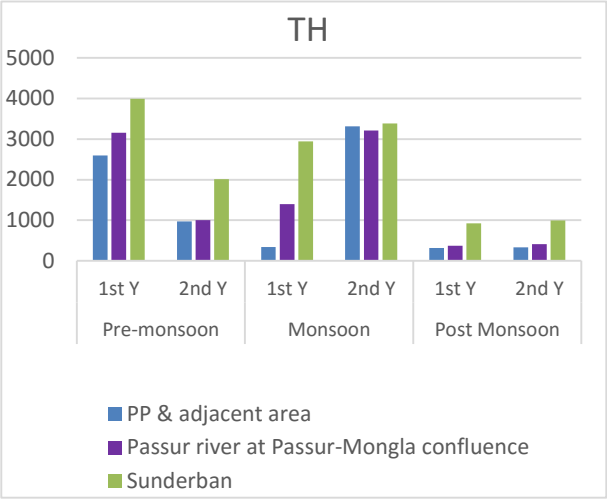


Figure: 2.3.7- Variations in average TH values in sampling spots for the consecutive seasons

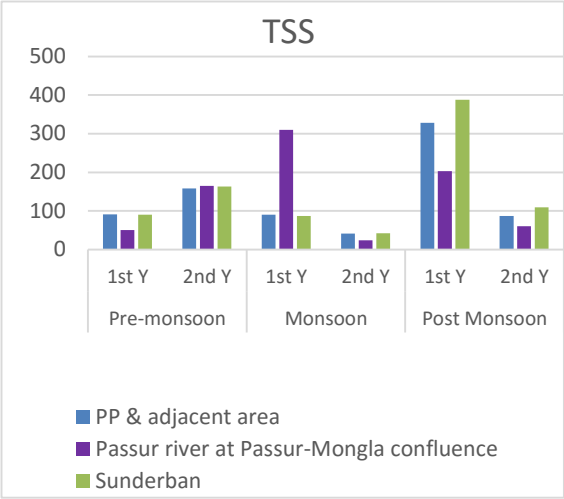


Figure: 2.3.8- Variations in average TSS values in sampling spots for the consecutive seasons

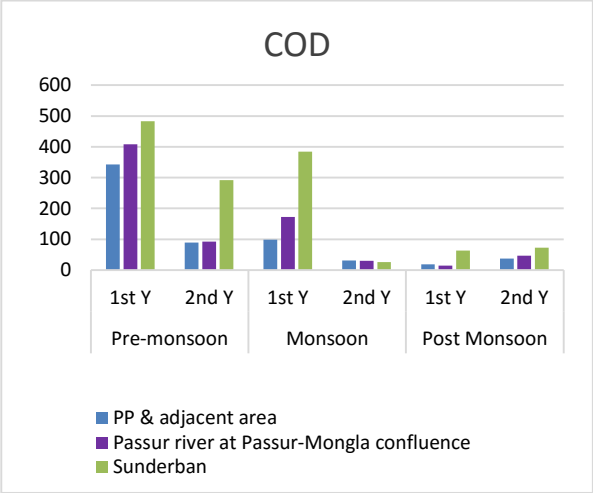


Figure: 2.3.9- Variations in average COD values in sampling spots for the consecutive seasons

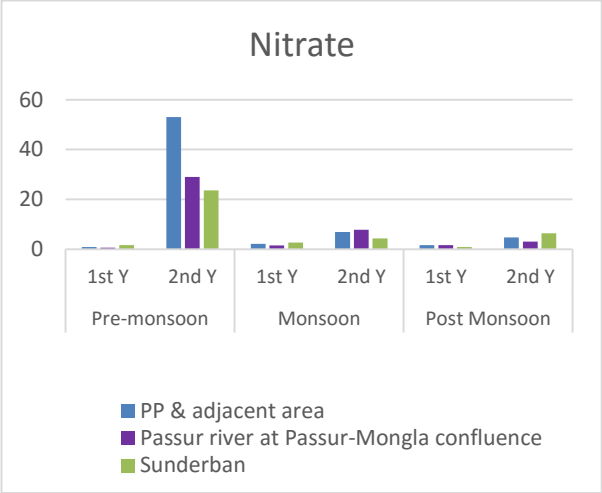
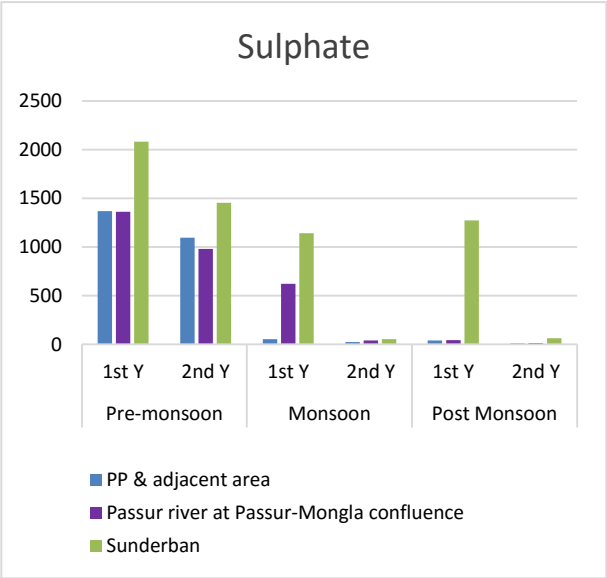


Figure: 2.3.10- Variations in average Nitrate values in sampling spots for the consecutive seasons



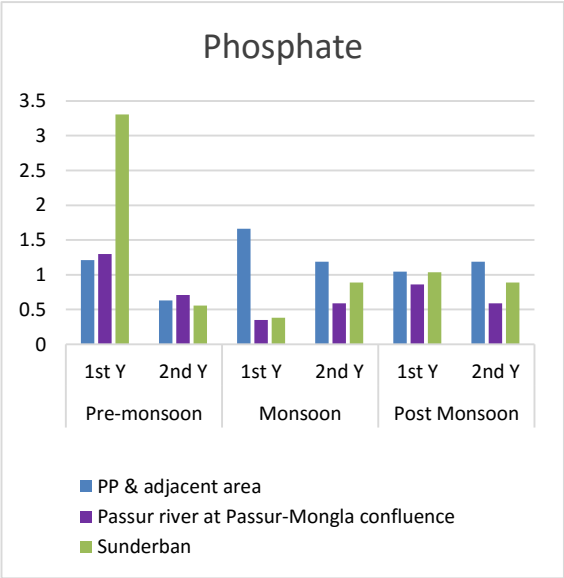


Figure: 2.3.11- Variations in average Sulphate values in sampling spots for the consecutive seasons

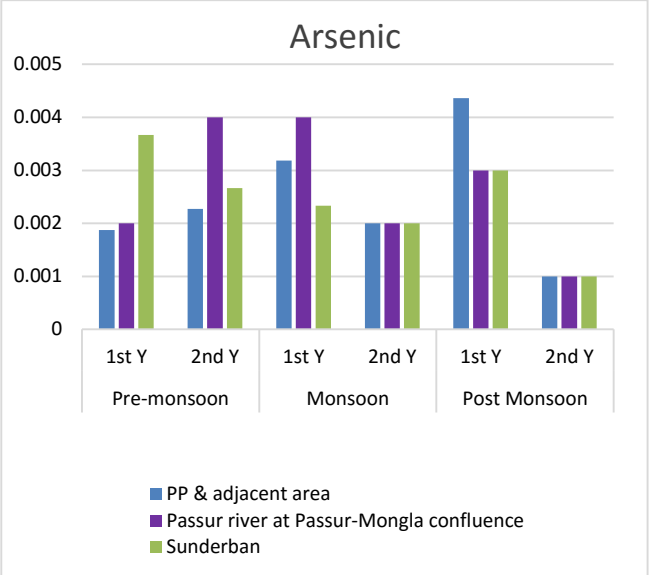


Figure: 2.3.12- Variations in average Phosphate values in sampling spots for the consecutive seasons

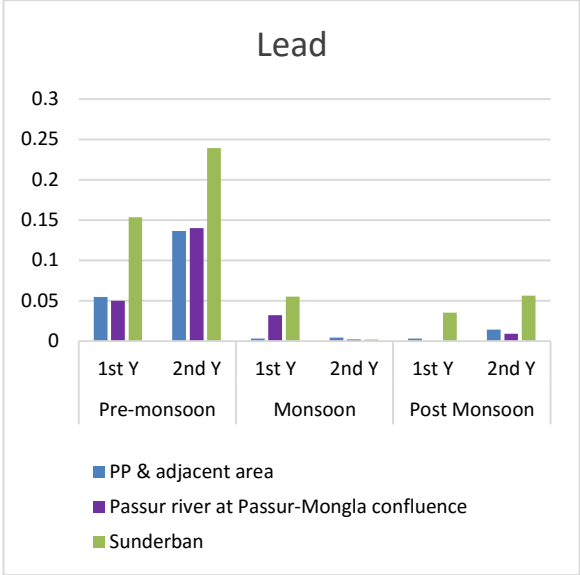
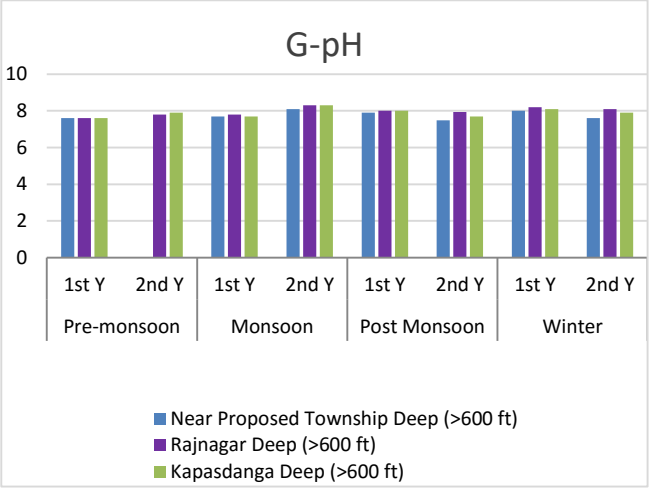


Figure: 2.3.13- Variations in average Arsenic values in sampling spots for the consecutive seasons

Figure: 2.3.14- Variations in average Pb values in sampling spots for the consecutive seasons



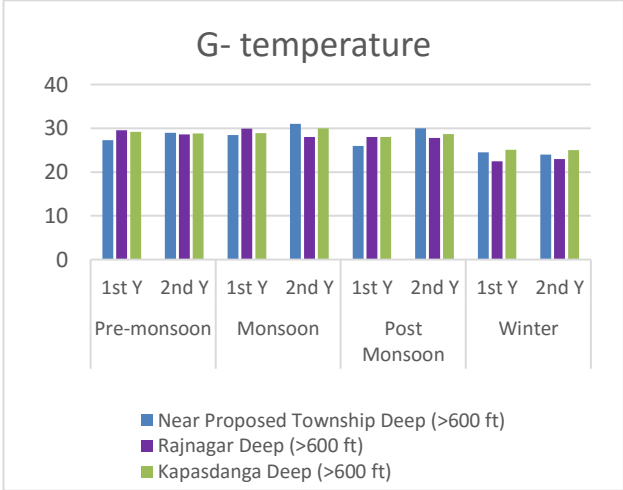


Figure: 2.3.15- Variations in average G-pH values in sampling spots for the consecutive seasons

Figure: 2.3.16- Variations in average G-Temperature values in sampling spots for the consecutive seasons

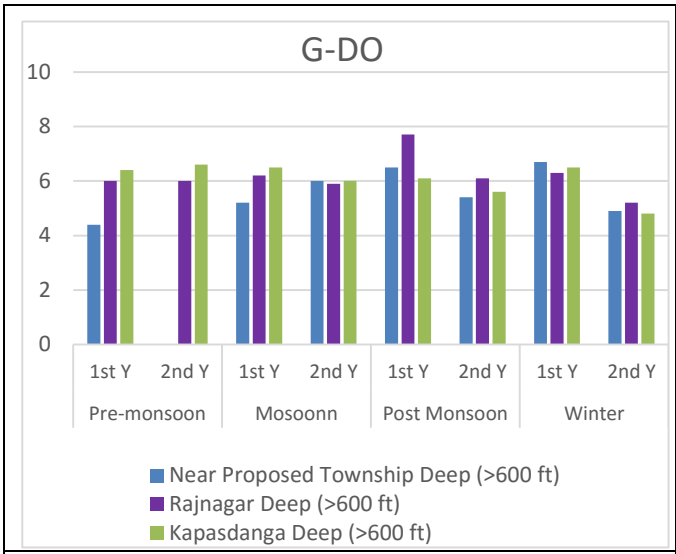


Figure: 2.3.17- Variations in average G-DO values in sampling spots for the consecutive seasons

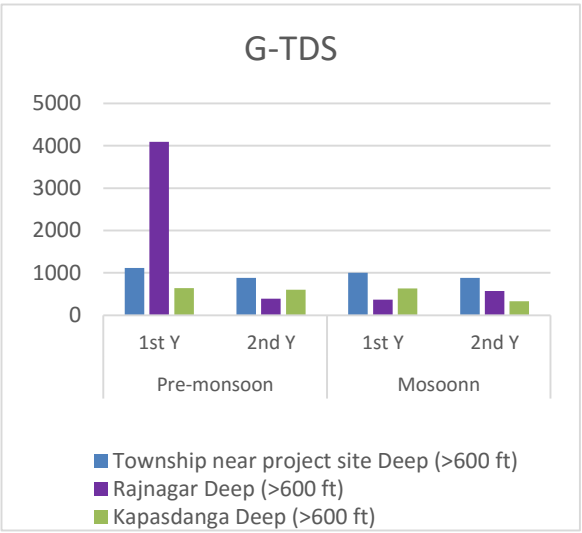


Figure: 2.3.18- Variations in average G-TDS values in sampling spots for the consecutive seasons

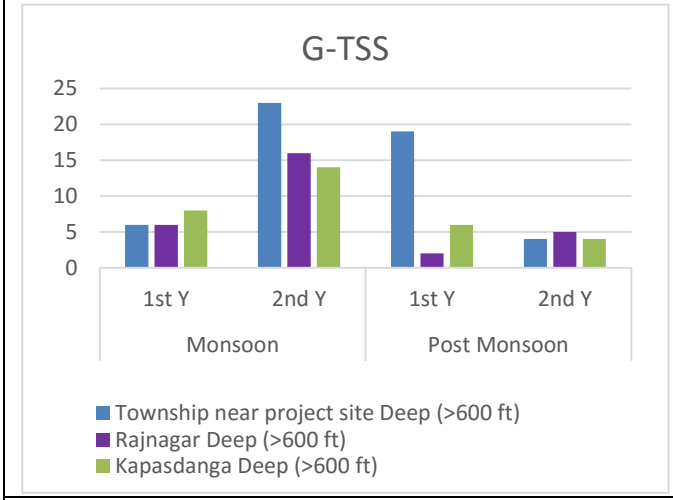


Figure: 2.3.19- Variations in average TSS values in sampling spots for the consecutive seasons

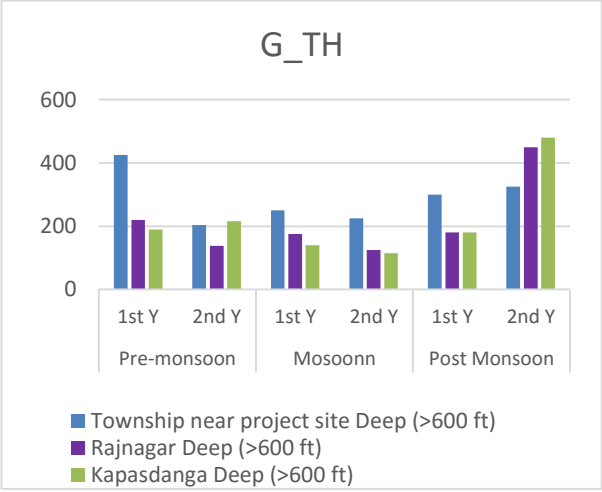


Figure: 2.3.20- Variations in average TH values in sampling spots for the consecutive seasons

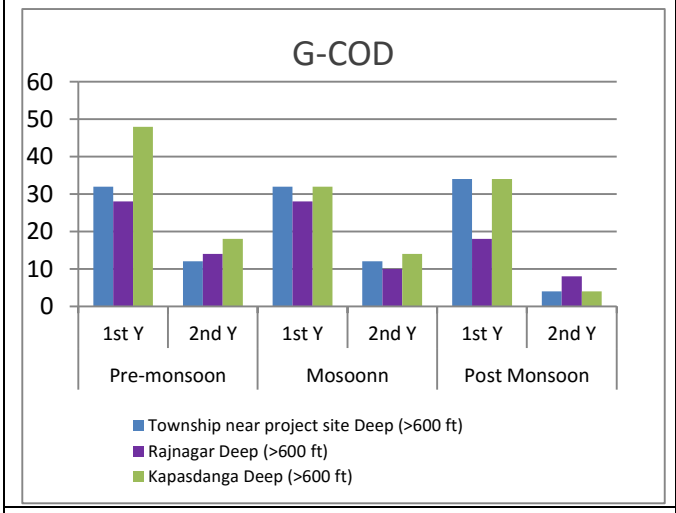


Figure: 2.3.21- Variations in average COD values in sampling spots for the consecutive

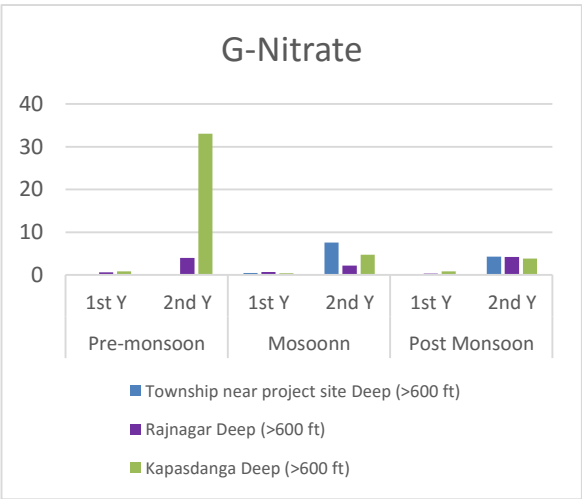


Figure: 2.3.22- Variations in average G-Nitrate values in sampling spots for the

seasons	consecutive seasons

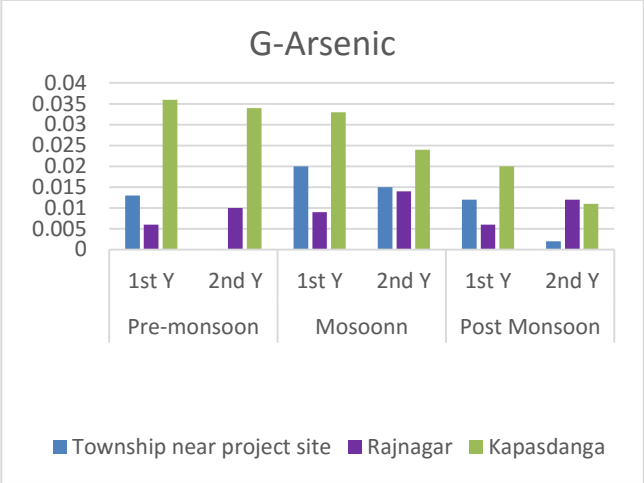
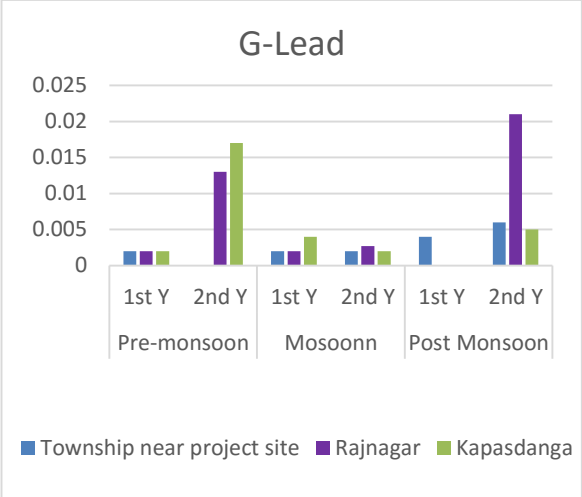

	

Figure: 2.3.23- Variations in average G-Nitrate values in sampling spots for the consecutive seasons	**Figure: 2.3.24- Variations in average G-Nitrate values in sampling spots for the consecutive seasons**

(b) Chemical Oxygen Demand

82. COD is an indicator of organic pollution, which is caused by the inflow of domestic, livestock and industrial waste that contains elevated levels of organic pollutants (Ayati, 2003).Generally, COD found to be higher in Passur-Sibsa RS as it receives high amount of organic matter from the Sundarbans forest. The values of Chemical Oxygen Demand vary from 28 mg/L to 96 mg/L in the last monitoring period. Maximum value is obtained from Passur River at Hiron point of Sundarbans. However, high values of COD indicate high levels of organic pollution in the river water (Sivasubramanium, 1999). Moreover, a large scale industrial activity is taking place along the left bank of Passur River from Chalna to Harbaria, which might also contribute to the high concentration of COD.

83. The COD concentrations of pre-monsoon and winter seasons (dry) are found to be higher than monsoon and post-monsoon seasons. In monsoon, higher discharge diluted the COD load in the river which in turn reduces COD concentration in post monsoon. The observed dataset are shown in **Figure: 2.3.9** and all the observed dataset are attached in **table B.6** of **Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

84. The maximum value of nitrate (11.5 mg/L) is recorded in Passur River at Hiron point while the lowest value (2.9 mg/L) is recorded at Maidara River near proposed township area. The results obtained from all the monitoring locations from 7th monitoring period are found within the standard limit set by the Environmental Conservation Rules 1997, Bangladesh but higher than the previously analyzed data of the same season. The highest values are found in pre-monsoon season of 2nd year, which may be due to the higher amount of surface and groundwater runoff, dissolution of nitrogen-rich geological deposits, and biological degradation of organic matter (Spencer, 1975; Kinne, 1984; Gleick, 1993; Wetzel, 2001; Rabalais, 2002).

85. Naturally, SO_4^{2-} concentration is higher in sea water as well as in river in coastal region. The SO_4^{2-} concentrations are found to be lower than the previously monitored data in the same season except in the Sundarbans region. The results found to be very high in pre-monsoon followed by the winter season. The values ranged in between 6 mg/L and 97 mg/L in Oct'15 visit (Post-monsoon)) which found to be within the standard limit (400 mg/L)

specified in ECR, 1997. Usually, SO_4^{2-} concentration of Passur-Sibsa RS increases in the direction of upstream to downstream. However, comparatively lower concentration of SO_4^{2-} in monsoon and post monsoon seasons could be due to the dilution effect of upstream fresh water.

86. In the 7th monitoring phase, the values of PO_4^{2-} (0.35-2.53 mg/L) are found to be similar to that of previous post-monsoon period (0.67-1.27 mg/L). The results also indicate similarity with the values of pre-monsoon period of 2015. The highest value observed in pre-monsoon period of 2014 could be due to the discharge of bilge water from numerous ships and fishing boats. The highest amount of phosphate is found at Left Bank of Passur River at Project site-Jetty while the lowest is recorded in Passur River at Harbaria of the Sundarbans. No significant variations are found at the observed locations in all three consecutive seasons of 2nd year. However, all the observed values are found to be within the standard limit (6 mg/L) specified for surface water. The recorded low phosphates value during dry seasons could be attributed to the limited flow of freshwater from upstream, high salinity and utilization of phosphate by phytoplankton (Senthilkumar et al., 2002; Rajasegar, 2003) but agricultural fields as fertilizers and alkyl phosphates used in households as detergents can be other sources of inorganic phosphates during the season (Tiwari and Nair, 1993).

87. The observed NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentrations at different monitoring locations of five consecutive monitoring periods are presented in **Figure: 2.3.10, 2.3.11** and in **2.3.12** and all the observed dataset are attached in **table B.9** of **Appendix- IV.**

(d) Heavy Metals

88. The observed dataset of Arsenic (As) concentrations demonstrated conformity among all the seasons in all the spots which vary from 0.001 mg/L to 0.0043 mg/L. The concentrations in 2014 are found to be higher in all the spots than that of 2015. In pre-monsoon season subsurface flow from groundwater to river might increase the concentration of As in the river water. In monsoon, lower concentration of As is recorded. It might be due the dilution effect in river water caused by surface runoff.

89. The average values of Pb are observed to be higher in pre-monsoon than in monsoon and post-monsoon in both the years. Huge amount of fresh water flow from upstream during monsoon results in lower concentration of Pb in the river water. On the other hand, the concentration is seen higher in the Sundarbans area. Heavy metal (Pb) dissolved in water is very harmful to aquatic organisms; due to bioaccumulation, it increases in body tissue of organisms (Rompas, 2010). It is also evident that organic fertilizer, which comes from lime and compost fertilizers, can contain heavy metal, e.g., NPK fertilizer (phosphate fertilizers containing Pyromorphite- $Pb_5(PO_4)_3(X)$) (Zhu et. al., 2004).

90. The values of Hg revealed a continuous consistency among all the spots in all the seasons. The values never exceeded 0.0020 mg/L. All observed data found to be within the Bangladesh standard limit set by the environmental Conservation rule, 1997, Bangladesh.

91. The observed As, Pb concentrations at different monitoring locations of five consecutive monitoring periods are presented in **Figure: 2.3.13** and in **2.3.14** and all the observed dataset are attached in **table B.10** and **B.11** of **Appendix- IV.**

(e) Oil and Grease

92. In order to measure the concentration of oil and grease in Passur River, samples have been taken from five locations during low tide from the surface layer. The analysis has been conducted through standard testing method of APHA. The concentration of oil and grease are presented in**Table-B.7** of **Appendix-IV**

93. During pre-monsoon, monsoon and post monsoon periods, the concentration of oil and grease has been found negligible and all of the monitoring results are fully in conformity

with the Standard of ECR 1997. Passur and Sibsa rivers have contained high concentration of oil and grease in winter period which may be due to accidental oil spill occurred on the 9th December, 2014. An amount of 350,000 liters (Philips, 2014) of furnace oil has been spilled in the river which spread over a 350 km^2 area (Welle, 2014).

94. During the 7th monitoring period, the concentrations of oil and grease are found within the standard for inland surface water, 10 mg/L (ECR, 1997) except in Passur River at Hiron point in Sundarbans. In this site, the concentration is found to be 10.8 mg/L. This higher concentration might be due to oil spill and discharge of other organic residues from mother vessels (as all the mother vessels are seen anchoring in Harbaria due to the lack of Navigability); oil discharge from the fishing boats and other anthropogenic activities might contribute to this higher amount of oil and grease concentration.

2.3.3 Comments on the Groundwater quality monitoring

In-situ tested parameters

a) pH and Temperature

95. The values of groundwater pH and temperature at observed locations are found fully complied with the drinking water quality standards as specified in ECR, 1997. The pH values of 8th monitoring program are found to be varied from 7.6 to 8.1 while temperature is found to be between 23.8°C and 25°C (Table 5.15). The recorded pH values are always found slightly alkaline in all the spots in all the season. No significant difference and negative health effect have been observed by the monitoring team. Similarly, no significant variation has been recorded in groundwater temperature over the monitoring period. In addition, larger seasonal variations, related to warming of or cooling at the surface are common, and ranges in the order of 5 to 10 degrees.

96. Both the results of pH and Temperature are found to be consistent with all the previously obtained data. It has already mentioned that ground water samples from Kalekarber have not been collected because the tube well was abandoned. The seven consecutive monitoring results of pH and temperatures of selected locations are presented in **Figure: 2.3.15** and **2.3.16** and all the observed dataset are attached in **Table B.12** of **Appendix- IV**

b) Salinity and Dissolved Oxygen

97. Salinity is a common parameter in order to determine the ground water quality for drinking and irrigation purpose. However, groundwater is found to have 0 ppt of salinity during the consecutive monitoring seasons.

98. The observed values of dissolved oxygen are ranged in between 4.8 mg/L and 5.2 mg/L which are within the BD standard (6.0 mg/L) set by ECR, 1997. In 8th monitoring period (winter season) the DO values are found to be lower than the previously monitored data in the same season.

99. Eight (8) consecutive monitoring results of salinity and DO of selected locations are presented in **Figure: 2.3.17** and all the observed dataset are attached in **Table B.13** of **Appendix- IV.**

Laboratory tested parameters

(a) TDS, TSS and TH

100. During the 7th monitoring period TDS values are found within the standard limit (1000 mg/L). Highest value (1007 mg/L) is recorded in Rajnagar area while the lowest value (377 mg/L) is recorded in Township area. The TDS concentration is found to be much higher than the BD standard (ECR, 1997) in pre-monsoon of the first quarterly monitoring period than those of other seasons.

101. Total Suspended Solids (TSS), also known as non-filterable residue, are those solids (minerals and organic material) that remain trapped on a 1.2µm filter (U.S.EPA, 1998). Among all the monitoring season the values are found to be much higher in monsoon season which could be due to the runoff from industrial, urban or agricultural areas. TSS values are measured in all the monitoring period except first quarterly monitoring. The TSS values of the last monitoring period have varied from 4 mg/L to 5 mg/L which presents an ideal condition and fully in conformity with the BD drinking water standards (ECR, 1997).

102. TH concentrations of the three monitored spots vary from 325 mg/l to 480 mg/l. The maximum value is found in Kapasdanga. The monitored values are found to be within the standard limit (200-500 mg/L) set by the ECR 1997. However, no incidents of weathering of Ca^{2+} bearing minerals or excessive application of lime is found during the monitoring period which could cause TH.

103. Groundwater TDS, TSS and TH value of seven (7) consecutive monitoring periods in all the monitoring period are presented in **Figure: 2.3.18, 2.3.19** and **2.3.20** and all the observed dataset are attached in **table B.14** and **B.15** of **Appendix- IV.**

(b) Chemical Oxygen Demand

104. The Bangladesh standard for COD in drinking water is 4.0 mg/L. However, all the monitored data from the tube wells show higher concentration than the standard limit except in the last monitoring period. COD concentrations are found in between 4 mg/L and 8 mg/L. in first year the values are higher than those of second year.

105. The analyzed results are found to be lower than those of the previously monitored results. The COD concentrations of all the monitoring locations are presented in **Figure: 2.3.21**.and all the observed dataset are attached in **Table B.16** of **Appendix- IV.**

(c) Nitrate, Sulphate and Phosphate

106. Nitrate values are found to be varied from 3.8 mg/L to 4.3 mg/L and remained within the standard limit (10mg/L) as specified in ECR, 1997. However, Maximum values are observed in winter season in 4th monitoring visit (i.e. 1st year 4th quarter). Again the value is found higher in pre-monsoon in Kapasdanga which might be due to the excessive fertilizer use in the nearby agricultural field.

107. SO_4^{2-} and PO_4^{2-} concentrations monitoring of Passur-Sibsa RS have been included in this study since 2nd monitoring report (i.e. 1st year 2nd quarter). Sulphate concentrations are found to be zero in all the points in every monitoring season except in monsoon of first year and winter of second year. During 7th monitoring the values have varied from 1 to 2 mg/L. On the other hand, the values of PO_4^{2-} are within the standard limit (6 mg/L) and ranged between 0.27 mg/L to 0.48 mg/L. Among all the monitoring period the recorded data are found maximum in the post-monsoon period. The values have never been higher than the Bangladesh drinking water quality standard. The observed ground water NO_3^-, SO_4^{2-} and

PO_4^{2-} concentrations are presented in **Figure 2.3.22** and all the observed dataset are attached in **Table B.17** of **Appendix- IV**.

(d) Arsenic (As), Lead (Pb) and Mercury (Hg)

108. As per Bangladesh Standard (ECR, 1997), the maximum acceptable concentration of Arsenic in groundwater is 0.05 mg/L. Among all the monitoring locations, the As concentration ranged between 0.002 and 0.012 mg/L which is completely within the BD permissible standard limit (ECR, 1997). The As values in Kapasdanga are found to have a decreasing trend in all the consecutive seasons.

109. The Pb and Hg concentrations are detected and the values remained much lower than the acceptable limit specified in ECR 1997. The concentration of Pb is found high in pre-monsoon and post-monsoon in Rajnagar and Kapasdanga respectively. In the 7th monitoring period the values of Pb concentration have ranged between 0.005 mg/L and 0.021 mg/L, while Hg concentration for that period is very much negligible (<0.00015 mg/L). Therefore, it reveals that the monitored tube well is found suitable for drinking purposes.

110. The observed values of As, Pb and Hg in all the monitored locations are presented in **Figure: 2.3.23** and **2.3.24** and all the observed dataset are attached in **Table B.18** of **Appendix- IV**

2.4 Land Resources

111. The soil samples have been collected from 3/10/15 to 5/10/15 for wet season of 2014-15 to determine the soil quality of the selected plots. Some basic indicators are selected to evaluate the base condition of adjacent area of Rampal power plant. Besides, continuous monitoring of that area gives an opportunity to observe the seasonal change of the indicators of that specific locality. The indicators are soil reaction(pH), salinity (EC), base cations-Ca, Mg, K and Na, Organic matter (OM), nutrient status (N, P, K and S), status of micro nutrients (B, Fe, Mn and Zn) and presence of heavy metals (Pb and Cd).

2.4.1 Methodology

Monitoring Indicators

112. Land use, soil fertility/nutrient status soil contamination with heavy metals and soil physical quality is the major monitoring indicators for land resources. During the operation phase of power plant, it is assumed that ash may be deposited on the surrounding agriculture land. Therefore, monitoring of the selected indicators is very crucial for land resources monitoring in the study area.

Sampling Frequency

113. Soil samples of wet season of have been collected in October, 2015. Next dry season soil samples will be collected in April 2016.

Location

114. Five mauzas within the 10 Km radius of the power plant have been selected for monitoring of land use, soil fertility/nutrient status of soil contamination with heavy metals. The selected mauzas are Baranpara (E-89°30′59.1″, N-22°37′57.0″) of Batiagahata Upazila, Chunkuri-2 (E-89°32′20.0″, N-22°34′51.0″) of Dacope Upazila, Kapalirmet (E-89°36′8.8″, N-22°32′18.9″) of Mongla Upazila, Chakgona (E-89°34′25.3″, N-22°34′18.3″) of Rampal Upazila and Basherhula (E-89°34′25.0″, N-22°36′14.0″) of Rampal Upazila under Khulna and Bagerhat district. Locations of the soil samples collection is presented in the **Table C.1** of **Appendix IV** and **Map 2.4.1.**

Process of soil samples collection

Land selection

115. Land has been selected before initiation of monitoring through group discussion, especially with the land owners and specific experts such as Upazila Agriculture Officer (Batiaghata, Dacope, Rampal and Mongla of Khulna and Bagerhat districts, Senior Scientific Officer of Soil Resource Development Institute, Khulna Office etc). All the selected areas are medium high (F_1) land, which is normally flooded to the depth of 30-90 cm continuously for more than two weeks to few months during the flood season. Main emphasis is given to potential locations of dry/wet deposition of ash, SOx and NOx to be emitted from the Plant**.**

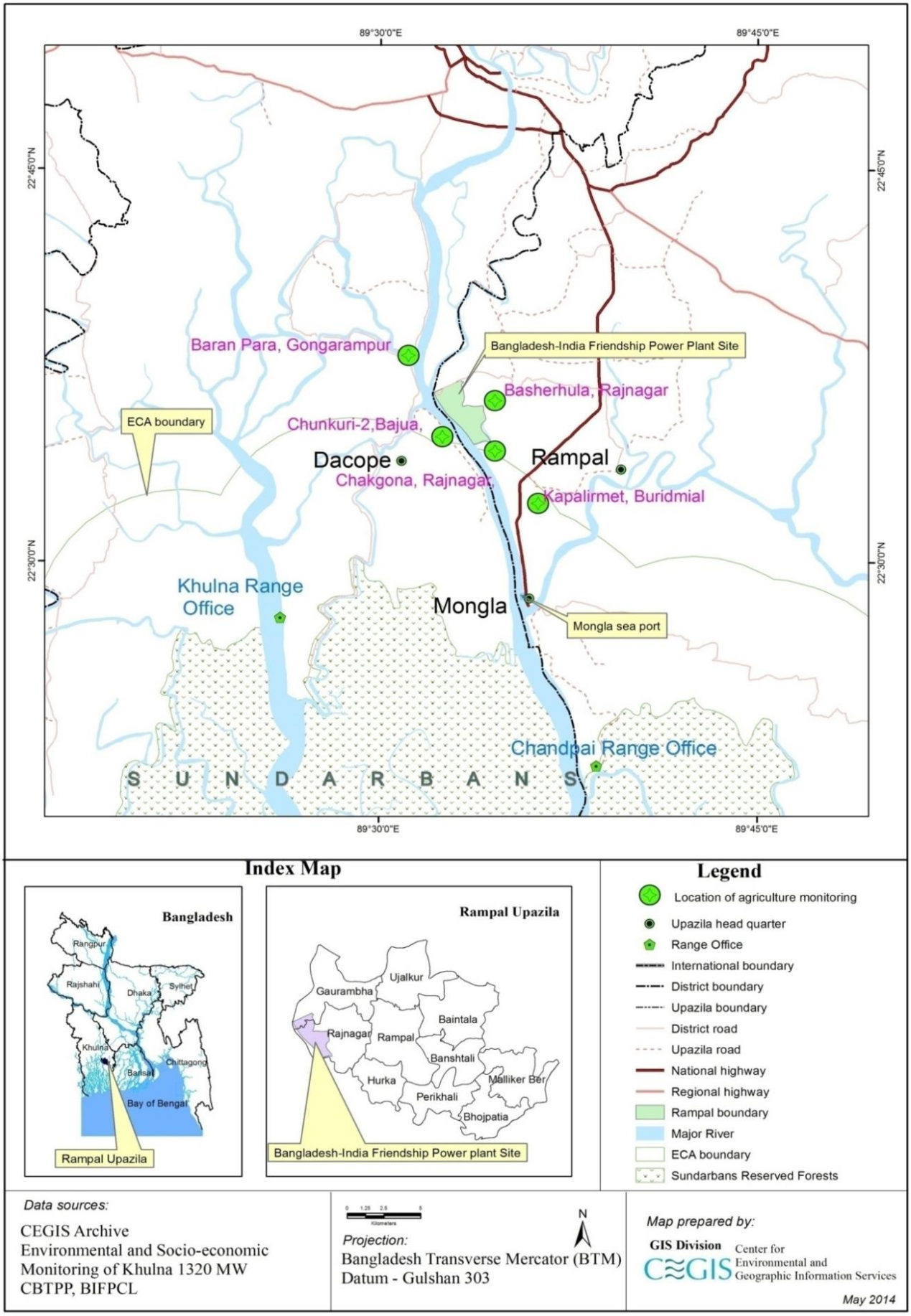
Soil samples collection

116. The wet season, soil samples are collected from, five locations in three different depths ((0-15 cm, 15-30 cm and 30-45 cm) in the monitoring area on October, 2015 of 2014-15.

117. Soil samples are collected following the standard practices of composite method. At each plot, soil samples are collected from three dug pit. From each pit, three soil samples are extracted from three different depths. Top soil from 0-15 cm depth, subsoil from 15-30 cm depth and sub stratum from 30-45 cm depth are collected using augur. The three top soil samples collected from three different pits are then mixed properly to make a composite sample and 500g of soil mass has been taken and stored in an air tight protective poly bag for laboratory analysis. Similar approach has been followed in collecting sub soil and sub stratum soil sample collection. To have more accurate results, it is ensured that the top, subsoil and substratum are taken from the same pit.

Laboratory analysis

118. The collected soil samples have been handed over to the Soil Resource Development Institute (SRDI), Dhaka for laboratory analysis. Results will be presented in the next monitoring report after obtaining the same from SRDI.



Map 2.4.1: Soil Quality Monitoring Locations

2.4.2 Status of Land Resources

119. The analyzed result of dry and wet season of the year 2013-14 and 2014-15 are compared in this 8th monitoring report. Seasonal variation of these indicators is described below according to their location. The parameter considered for earlier monitoring will be same in this quarter as well. The result of the dry and wet season of 2013-14 and 2014-15 year has been provided in the **Figure 2.4.1-2.4.16** and in **Table C.2** of **Appendix IV**.

120. In general monitoring study area comprises under the Agro-Ecological Zone, Ganges Tidal Flood Plain (AEZ13) (BARC, 2012). So, the analysis report of soils of monitoring land is compared to the physico-chemical properties of soils of AEZ 13 to understand the variation of the soil fertility status. Generally, organic matter content of the soil is low in the coastal regions of Bangladesh. Thus in addition to salinity, plant nutrients in soils affect plant growth. Some basic characteristics of AEZ 13 are PH: (4.5-8.4), OM(%): (1.0-3.4%), N(%): (0.091-0.18%), P: (<5.25-10.5) (µg/gm), K: (0.181-0.36 (meq/100g), S: (15.1-30.0) (µg/gm), Ca: (4.51-7.5) (meq/100g), Mg: (0.751-1.5) (meq/100g), Zn: (0.451-1.35) (µg/gm), B: (0.31-0.6) (µg/gm) , Mo: (0.226-0.30) (µg/gm).

121. Though the sampling area are medium high land, all are situated within a polder area. Another special characteristic of the area is frequent tidal waves, which makes some significant changes in pH and EC of the area.

Monitoring plot-1 (Baranpara)

122. It has been observed that salinity has increased in both seasons (wet and dry) of 2014-15 10.1 (ds/m)-dry and 5.56 (ds/m)-wet than that of 2013-14 9.6 (ds/m) -dry and wet 5.8 (ds/m)-wet among the three layers. This may be due to lack of water source connectivity of Baranpara. As a polder area, most of the openings of this locality are confined, so natural flow of water is disrupted. Natural precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity of a vast area. The present study also found the similar pattern. It is also noted that amount of base cations (except Mg) has increased Ca-31.50 (meq/100g)-dry and 14.75 (meq/100g)--wet, K-2.0 (meq/100g)--dry and.0.60 (meq/100g)-wet and S-354.40 (µg/gm)-dry and 262.0 (µg/gm)-wet) highest value among the three layers in 2014-15. Amount of Mg might be suppressed by Ca intrusion as both of them are divalent cations.

123. Due to top soil erosion, organic matter content drops in wet season (1.27%) than dry season (3.1%) of 2013-14. In 2014-15, owner of the land introduced fish and crab culture. To prepare the land for aquaculture he cut off the top soil, which drastically lowers the organic matter. After the wet season a portion of organic matter is replenished by sedimentation. Basic nutrients (N-0.06%, P-4.60 (meq/100g), K-0.57 (meq/100g) and S-210.0 (µg/gm) also follow the similar trend of organic matter in wet season of 2014-15 than wet season of 2013-14.

124. Micro nutrients (Fe, Mn, B, Na, Zn) in soil are also analyzed for baseline data. It has been noted that all these elements Fe-78.25 (µg/gm), Mn-6.89 (µg/gm), B-2.11 (µg/gm) and Na-6.83 (meq/100g) and Zn-3.19 (µg/gm) show an increasing pattern in wet season 2014-15 season. It might be due to increased salinity, which cannot be removed properly by rainwater. It has also been found that all the micronutrients decreased in wet season than that of dry season, which may be an after effect of leaching and percolation in wet season. Na has also decreased by this process.

125. There is a trace of heavy metal in dry season, where Pb is within the critical limit but Cd is not. But in wet season Cd has washed out by water, Pb concentration shows a decreasing trend.

Monitoring plot-2 (Chunkuri-2)

126. Salinity level has slightly increased 13.05 (ds/m)-dry and 8.20 (ds/m)-wet in both seasons of 2014-15 than 2013-14 {11.2 (ds/m)--dry and 5.6 (ds/m)—wet}. Polder areas are generally confined area with very limited water source connectivity. As a result natural flow of water is disrupted. Precipitation can dissolve a portion of salt particles, but this is not sufficient in terms of lowering the overall salinity. On the other hand, amount of base cations (except Mg) are also increases in similar pattern. Amount of Mg 6.34 (meq/100g)–dry and 3.13 (meq/100g)-wet might be suppressed by Ca intrusion as both of them are divalent cations.

127. Organic matter content has increased (1.75% -wet; 2014-15) than wet season of (1.4%:2013-14) in Chunkuri-2. Beyond Aman season, the sampling area is mostly used as a grazing land. Crop residue and animal wastes helped to improve the organic matter content in soil. New sedimentation also contributed in this process. Basic nutrients (N: 0.09%, P: 6.89 (µg/gm), K: 0.79 (meq/100g) and S: 500.0 (µg/gm)) also follow the similar trend of organic matter in wet season of 2014-15 over 2013-14.

128. Micro nutrients Fe: 91.20 (µg/gm), Mn: 8.29 (µg/gm), B: 1.52 (µg/gm), Na: 8.16 (meq/100g), Zn: 5.32 (µg/gm) show an increasing pattern in wet season of 2014-15 over wet season of 2013-14. It might be due to increasing salinity, which cannot be removed properly by rainwater. It has been found that all the micronutrients decreased in wet season than that of dry season, which could be an after-effect of leaching and percolation in wet season. Na^+ has also decreased this process.

129. There is a trace of heavy metal in dry season, where Pb has been within the critical limit but Cd is not. But in wet season Cd is totally washed out. On the other hand, amount of Pb decreases but it is not totally removed.

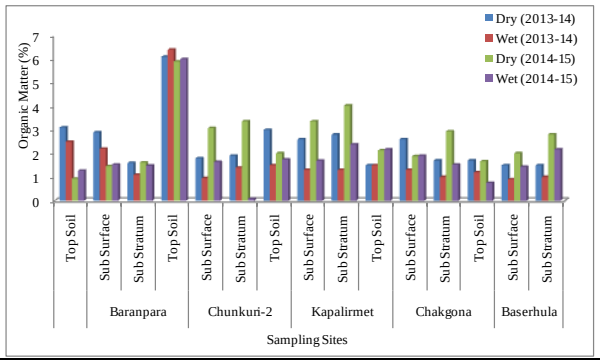


Figure 2.4.1: Organic matter concentration of the sampling sites around Project (cumulative year-2)

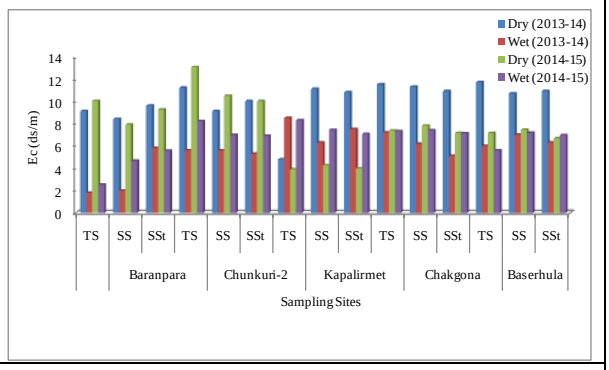


Figure 2.4.2: Ec concentration of the sampling sites around Project (cumulative year-2)

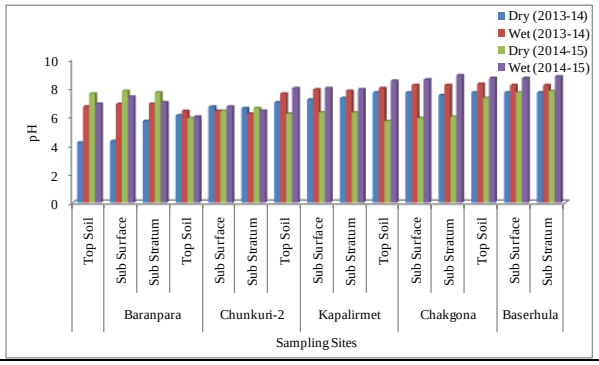


Figure 2.4.3: pH of the sampling sites around Project (cumulative year-2)

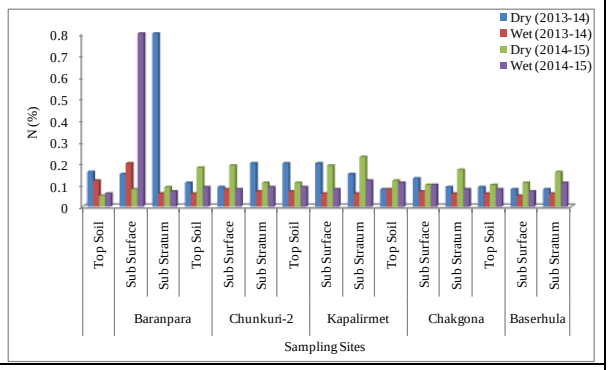


Figure 2.4.4: Nitrogen concentration of the sampling sites around Project (cumulative year-2)

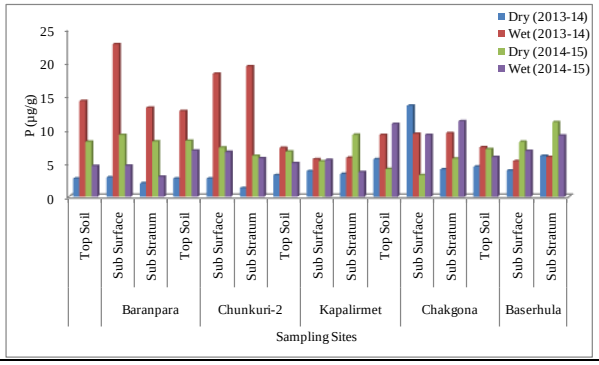


Figure 2.4.5: Phosphorus concentration of the sampling sites around Project (cumulative year-2)

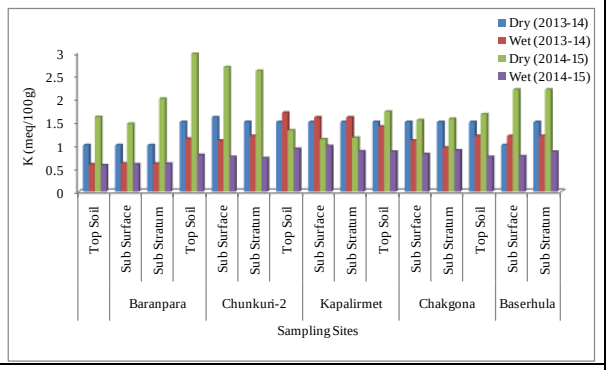


Figure 2.4.6: Potassium concentration of the sampling sites around Project (cumulative year-2)

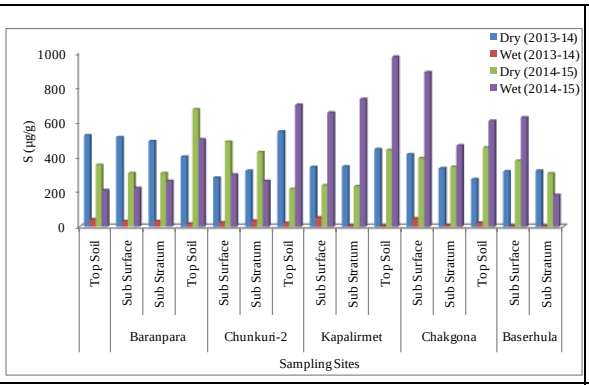


Figure 2.4.7: Sulphur concentration of the sampling sites around Project (cumulative year-2)

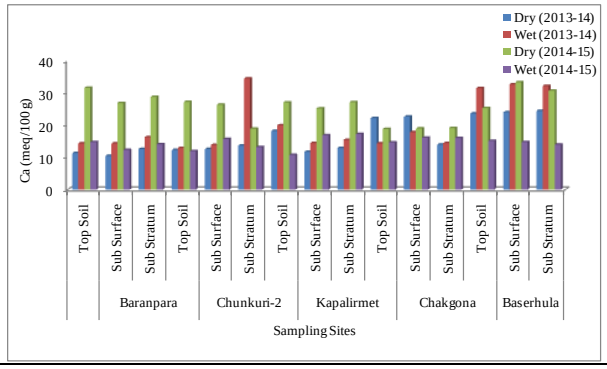


Figure 2.4.8: Calcium concentration of the sampling sites around Project (cumulative year-2)

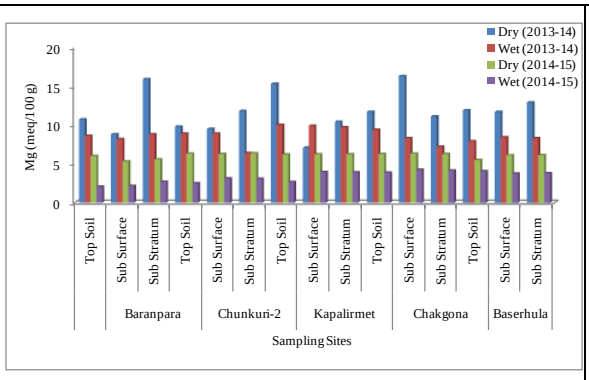


Figure 2.4.9: Magnesium concentration of the sampling sites around Project (cumulative year-2)

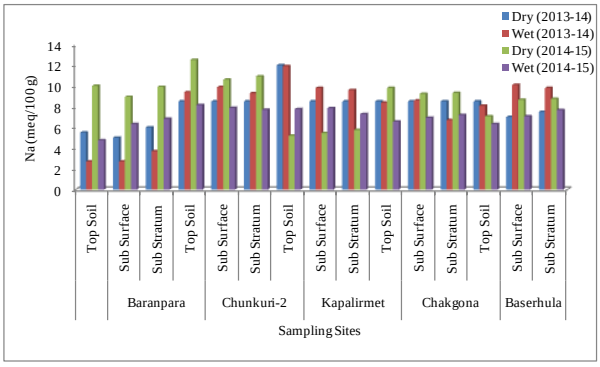


Figure 2.4.10: Sodium concentration of the sampling sites Project (cumulative year-2)

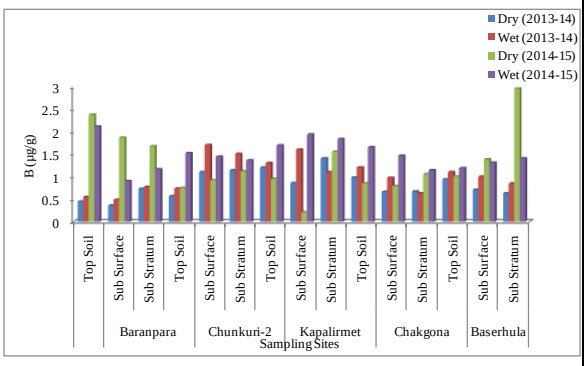


Figure 2.4.11: Boron concentration of the sampling sites around Project (cumulative year-2)

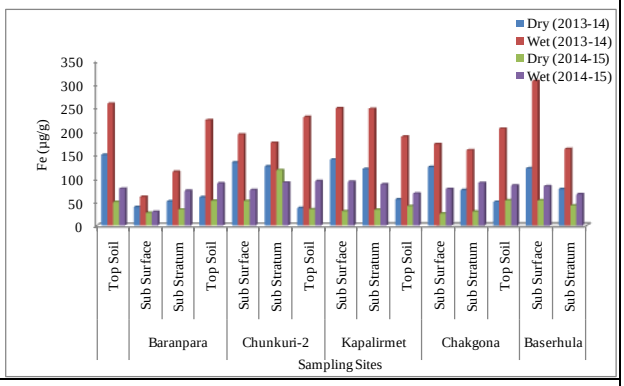


Figure 2.4.12: Iron concentration of the sampling sites around Project (cumulative year-2)

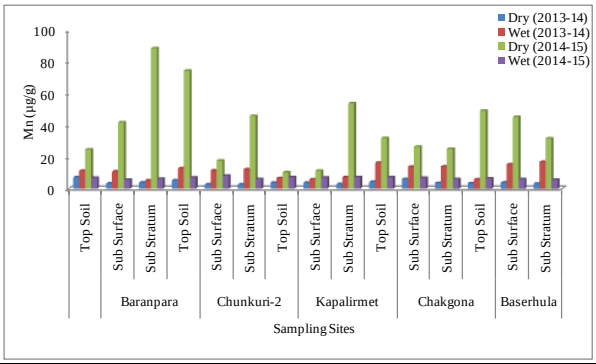


Figure 2.4.13: Manganese concentration of the sampling sites around Project (cumulative year-2)

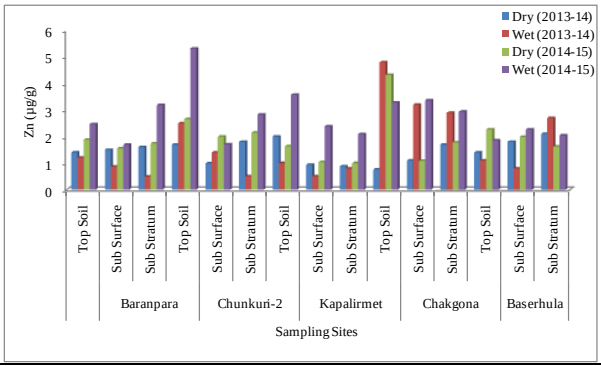


Figure 2.4.14: Zinc concentration of the sampling sites around Project (cumulative year-2)

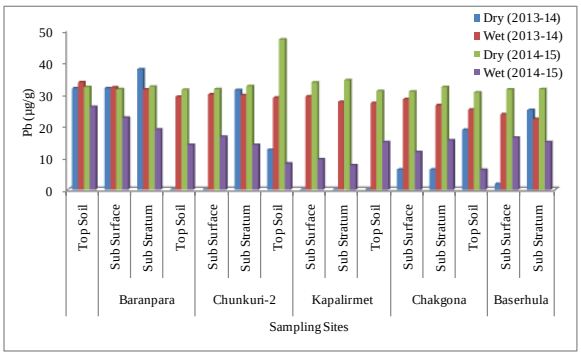


Figure 2.4.15: Lead concentration of the sampling sites around Project (cumulative year-2)

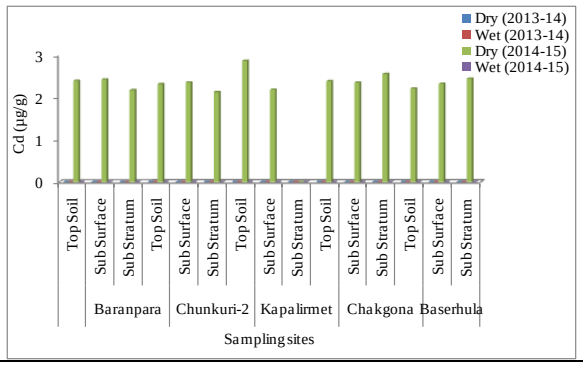


Figure 2.4.16: Cadmium concentration of the sampling sites around Project (cumulative year-2)

Monitoring plot-3 (Kapalirmet)

130. As regards, soil salinity in coastal belt, the general trend is that it increases in dry season. But in Kapalirmet this scenario is quite opposite. Soil salinity in wet season, 8.29 (ds/m), is almost double than that of dry season4.26 (ds/m) of 2014-15. Golbunia Khal and Gona River flooded the area including our sampling site. Besides, pH (8.0) is also found higher in wet season than those of dry season (7.3). It could be an impact of shrimp culture in this zone. Aman is the only crop of Kapalirmet but its practice is very limited. People used to store saline water for shrimp cultivation and as a consequence base cation presence did not change significantly. The Ca^{2+}, Mg^{2+} and K^{+} level are found almost similar in both seasons of first year (2013-2014) but in second year (2014-15) the concentrations decreases in wet season Ca:17.20 (meq/100g), Mg: 3.94 (meq/100), K: 0.98 (meq/100g) than that of dry season Ca:27.13 (meq/100g, Mg:6.25 (meq/100g), K:1.32 (meq/100g) in 2014-15. It has also been observed that concentration of S^{2+} has decreased in wet season of 2013-14, but has increased again in wet season of 2014-15. So, this might be due to replacement of base cations by S^{2+} at that time. Na is also decreased by this process.

131. Soil erosion is a common feature of coastal area. As a result, organic matter could also be eroded due to erosion. It has been observed that the overall organic matter content is increased (2.38%) in wet season 2014-15 than that of 2013-14(1.5%). Basic nutrients

(N:0.12%, P:5.01 (µg/gm) and K: 0.98 (meq/100g) also follow the similar trend of organic matter.

132. As regards micro nutrients, most of the elements show an increasing trend in wet season than those of dry seasons, which might be after effect of salinity. However, concentration of Pb did not show similar pattern in last two years. Its concentration in 2013-14 increases in wet season but it decreased to almost one-fourth in dry season of 2014-15. Cd could be totally washed-out by rain water in wet season. Pb is formed within the critical limit whereas Cd is not.

Monitoring plot-4 (Chakgona)

133. Salinity and pH play a vital role for the distribution of elements in Chakgona. In 2013-14, EC 7.38 (ds/m) dropped in wet season than dry season 7.81 (ds/m) but pH has been almost same. As a result, most of the cations show a decreasing trend in wet season. But EC content has been almost similar in both seasons of 2014-15 and pH (8.9) is found to be higher in wet season of 2014-15, which helped to move up the cation concentrations. Maidara River flooded the sampling area and as a result salinity has not changed that much in wet season. The most significant rise is found in case of sulphur 975 µg/gm, which is found 440 µg/gm in dry season. Other elements are found to be in a decreasing trend. This scenario indicates that sulphur replaced other cation from the exchange sites of clay.

134. Organic matter shows an increasing trend (2.17%) in wet season of 2014-15 at Chakgona over wet season (1.5%) of 2013-14., which might be due to stagnant water, limited crop production and grazing practice. Basic nutrients N:0.11%, P:11.26 (µg/gm)and K:0.89(meq/100g) also followed the similar trend of organic matter.

135. As organic matter and pH increases there is a possibility of formation of chelates. As a result, most of the micro nutrients show a decreasing pattern in second year.

136. In wet season of 2013-14, presence of Pb concentration is found in soil. Whereas in 2014-15, trace of Pb is found in both seasons. Moreover, as most of the Pb has possibly washed out in rainy season, concentration is found much lower in wet season than dry season. On the other hand, Cd might be completely washed out in wet season. Pb has been within the critical limit whereas Cd is not.

Monitoring plot-5 (Basherhula)

137. Level of EC dropped in dry season 6.3 (ds/m) from that of wet season 7.16 (ds/m) in 2014-15 over 2013-14. On the other hand, pH show the opposite trend. Although EC indicates that overall salinity is decreased in wet season but Na and Ca concentration increased at that time. But there is a possibility of increase in base cation due to high pH (8.3-8.7). But most of the elements show a decreasing trend at that time, except S and Fe. The overall situation indicates that there is a possibility of replacing other elements by S and Fe from exchange sites of clay. This area is flooded by Passur River and Basherhula Khal in rainy season.

138. Overall organic matter content (2.17%) increased in wet season of 2014-15 year than that of 2013-14. Every year's sedimentation could have contributed to this. But dry season content of organic matter is generally higher than wet season due to top soil erosion. Basic nutrients N: 0.11%, P: 9.12 (µg/gm) and K: 0.86 (meq/100g) also followed the similar trend of organic matter.

139. Micro nutrients Fe: 85.08 (µg/gm), Mn: 6.50 (µg/gm), B: 1.40 (µg/gm), Na: 7.68 (meq/100g, Zn: 2.27 (µg/gm) show an increasing pattern in 2014-15. It could be due to new

sedimentation, which is not removed properly by rainwater. It has also been found that all the micronutrients decreased in wet season than that of dry season, which could be an after effect of leaching and percolation in wet season.

140. Concentration of Pb did not show similar pattern in last two years. In 2014-15 its concentration increased in wet season but in 2014-15 it decreased to almost one-forth than that of dry season. Cd might be totally washed out by rain water in wet season. Pb is within the critical limit whereas Cd is not.

2.4.3 Expert Opinion (SRDI) on analysis result of monitoring plots

141. According to the expert of SRDI, Dhaka following factors might change the physico-chemical properties of soils of monitoring plot (especially sulphur content).

- The top soil may be in more dry condition.
- There may be the presence of acid sulphate content in soils.
- More use of Sulphate content fertilizers in dry condition.

2.5 Hydro-morphology

142. A comprehensive study has been conducted for morphological dynamics of river systems, drainage network and tidal properties of the study area. The monitoring information has been documented maintaining the temporal and spatial distribution. This study will articulate the result after a number of analyses and will be preserved for future comparisons.

2.5.1 Methodology

143. Four indicators namely tidal characteristics, drainage network, river bed sediment (quality and texture), and erosion-accretion process have been considered for monitoring hydro-morphological condition of the study area mainly Passur River .

Tidal behaviour

144. The Rampal Power Plant project is situated within the tidal river systems of South West hydrological region. Passur, Maidara, Ichamoti, Chunkuri rivers are highly influenced by tides. Two automated tide gauges of Mongla Port Authority (at Mongla port and Hiron point) have been selected to monitor the tidal characteristics of the Passur river.

145. The first monitoring is conducted during March, 2014. Tidal data has been collected from Mongla Port Authority (MPA) to produce the baseline condition. MPA will provide data of early 2016, by which the changes in tide level will be explained in the subsequent monitoring studies.

146. Tidal intrusion distance is also considered as a monitoring indicator for this monitoring study. Upstream pressure of fresh water heads protects intrusion of tide into the rivers and creeks. Tide also inundates the adjacent river flood plain. Tidal intrusion distance has been assessed mainly during field investigation in the study area. However, KII and PRA have also been used to assess the tidal behavior of the monitoring area.

Drainage network

147. Connectivity among the internal creeks, between the creeks and rivers in the study area has been verified.

148. The drainage network would be monitored by analyzing high resolution satellite image.

River bed sediment

(a) Particle size distribution

149. The particle size distribution of the river bed material reveals nature of sediment transportation as well as the nature of erosion and accretion of the river. Three (3) locations (Map 2.5.1) of the study area have been fixed for bed material monitoring. The selected locations are at Project jetty site, Harbaria and Akram point in the Passur River.

Photo 2.5.1: River bed sediment sampling by Grabber at Project Site

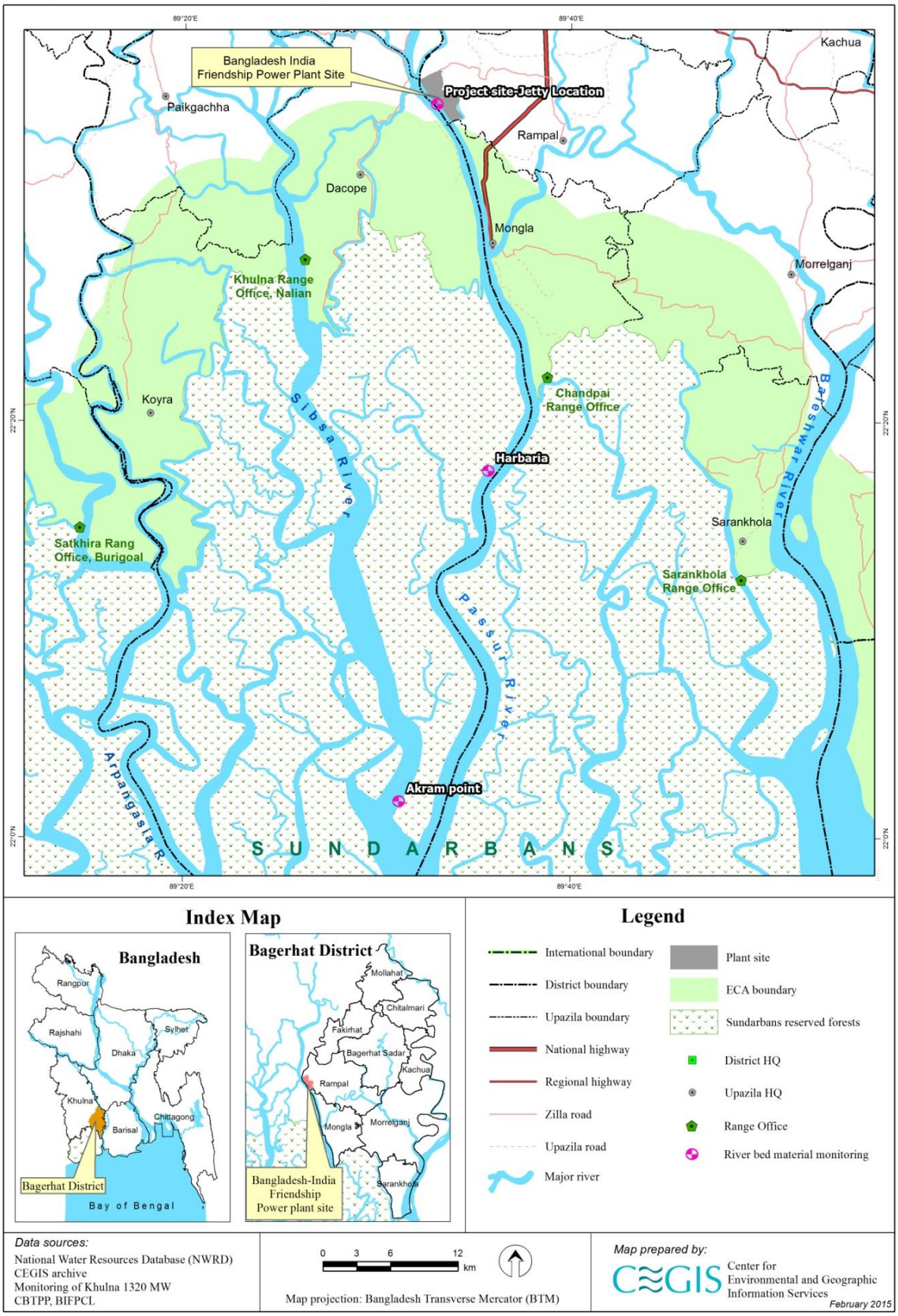
150. Collections of river bed sediment have been conducted by grab sampling procedure. River bed samples are collected at the time when the river current is relatively sluggish or calm; otherwise, the grab could not have performed well at the bottom of the river effectively. The samples are then preserved following the procedure of the Soil Resource Development Institution (SRDI) where the samples would be tested.

(b) River bed sediment quality

151. In addition to the particle size distribution, the sediment quality has also been considered for monitoring. The collected samples are submitted to SRDI laboratory for sediment quality analysis that would cover soil Organic Matter, Heavy Metals, pH, etc. The analysis reports will be provided in the next monitoring report.

Erosion and accretion

152. Initially erosion and accretion process of the study area have been planned to monitor through satellite image analysis and field observation. Erosion and accretion have been monitored at project site, Mongla port site and Akram point areas. Mostly, erosion of river bank, formation of new char or bank line shifting has been considered as the key indicators for this monitoring study. Eventually, the lower rate of erosion-accretion and continual tidal fluctuation made it difficult to use satellite image in this process. Therefore, field observation on the presumed location has been conducted. Moreover, KII and PRA tools have been used to finalize the potentially eroded and accreted zone of the study area.



Map 2.5.1: Location of River bed material monitoring

2.5.2 Status of monitoring

During this session of monitoring period, due to unprecedented reasons, data of tidal variation from MPA could not be acquired. Hence, data of the earlier records in the same context has been presented here. Nevertheless, updated data is in the process of acquisition from MPA and will be incorporated in the next monitoring report.

Tidal behaviour

153. Passur River receives semi diurnal tides from the Bay of Bengal. Therefore, two high tides e.g. flood tide and low tides e.g. ebb tides regularly take places in Passur river. Two tidal monitoring gauge stations e.g. Mongla Port Jetty station and Hiron Point Pilot station data have been collected for 24-hours in order to identify the tidal variation, lag period of the study area. Figure 2.5.1 shows a complete 24-hr tidal cycle of tide level on 30th March, 2014 for both stations.

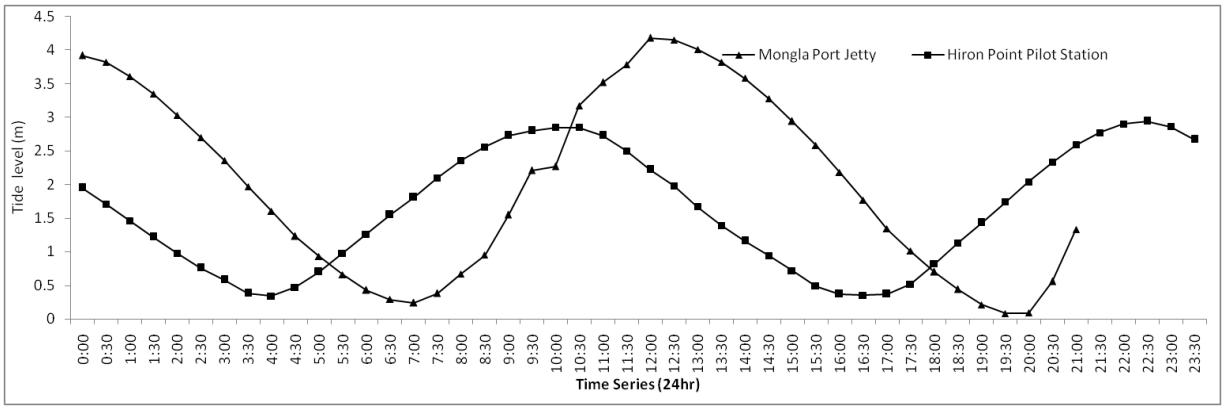


Figure 2.5.1 : Tidal variation at Mongla Port Jetty and Hiron Point

154. During the day of monitoring, at Hiron Point, the Highest High Water Table reached on 10.00hr with the tide of 2.85m. At Mongla Port Jetty the Highest High Water Table is found on 12.00 hr with the tide of 4.18m. Tide took 2hr to propagate from Hiron point to Mongla Port Jetty. Similarly the Lowest Low Water Table of the day is recorded on 4.00hr at Hiron point with tidal height of 0.34m and on 7.00hr at Mongla Port Jetty with tidal height of 0.24m. Tidal height is higher at Mongla Port due to squeezing effect.

155. There is also a daily variation in tidal height and timing. In the week (17 March to 23 March 2014) the Highest High Water Tide varied from 4.03m to 3.66m at Mongla Port Jetty and 2.62m to 2.85m at Hiron Point. Figure 2.5.2 and Figure 2.5.3 show the weekly variation of tides at Mongla Port Jetty station and Hiron Point Pilot station.

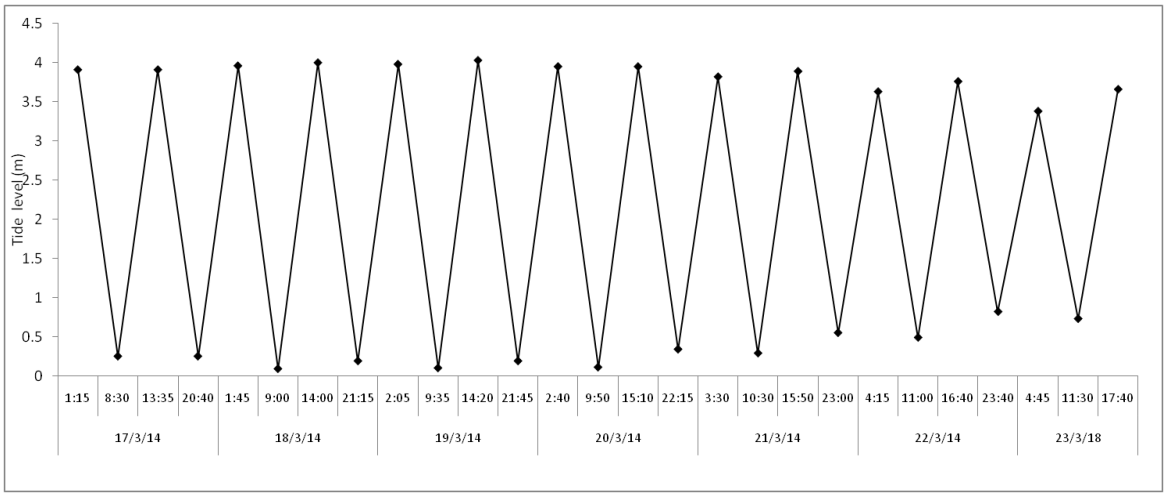


Figure 2.5.2 : Maximum and minimum tidal variation at Mongla Port Jetty (17-23), March, 2014

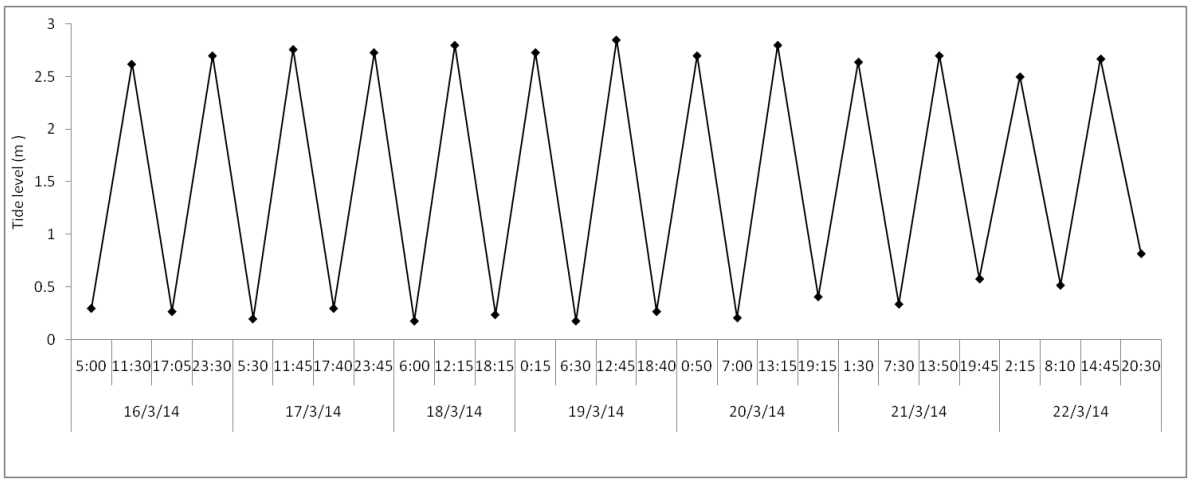


Figure 2.5.3 : Maximum and minimum tidal variation at Hiron point

156. The summary of the tidal characteristics of the Passur river is presented in table 2.5.1.

Table 2.5.1: Tidal range of Mongla and Hiron point stations

Tidal Characteristics	Hiron Point Pilot Station	Mongla Port Jetty
Highest High Water Tide	2.63m – 2.85m	3.66m-4.
Lowest Low Water Tide	0.18m-0.34m	0.09m-0.73
High Tide Lag time between Hiron Point and Mongla Point	2hr	
Low Tide Lag time between Hiron Point and Mongla Point	3hr	

Source: Data Collected from Mongla Port Authority for the period of 17 March to 30 March 2014

Drainage network

157. The RapidEye Satellite Image of 5 m resolution has been acquired from GEOPeakk Singapore. The satellite image is under process for further analysis to develop the existing drainage network of the monitoring area. The map of the drainage network would be the baseline map. The baseline drainage network map and the detail information will be provided into the next monitoring report.

River bed sediment

(a) Particle size distribution

158. The geometry and morphology of Passur river have direct consequence of the sediment transport process, discharge properties, catchment properties and tidal influences. Transported materials are used in eroding a riverbed (degradation) or deposited (aggradations) either temporarily or permanently along the course of a river. Throughout geological history, Passur river has altered its channels through erosion and deposition or human intervention.

159. The collected river bed samples are in SRDI laboratory for analysis. Once the results are available, it will be provided in the next monitoring report. However, **Table 2.5.2** shows the locations of the sample collection and the blank cells of the results.

Table 2.5.2: Particle size distribution (PSD) at three points in Passur River

Name of the Place	GPS Location	Sand (%)	Silt (%)	Clay (%)	Remark
Project site at Jetty location	N:22º35´21.6" E: 89º32´53.6"				
Harbaria point	N: 22º17´42.9" E: 89º35´35.3"				
Akram point	N: 22º35´35.3" E: 89º32´53.6"				

Note: All the information will be put in Ninth monitoring report after getting the test results of laboratory analysis.

(b) River bed sediment quality

160. Monitoring the quality of river bed sediment is important for future comparisons. Three (3) places have been selected to monitor the quality of river bed materials. After grab sampling, the river bed sediments have been collected. The samples are in process of analysis in the SRDI laboratory. **Table 2.5.3** shows the demo table to show how the data will be presented. The data will be provided in the next monitoring report.

Table 2.5.3: Quality of river bed sediments at three points in Passur River

Name of the Place	GPS Location	pH	As	Hg	Pb
Project site at Jetty location	N:22º35´21.6" E: 89º32´53.6"				
Harbaria point	N: 22º17´42.9" E: 89º35´35.3"				
Akram point	N: 22º35´35.3" E: 89º32´53.6"				

Note: All the information will be put in Ninth monitoring report after getting the test results of laboratory analysis.

Erosion and accretion

161. Passur River is prone to erosion and accretion as it shows the meandering nature. But the rate of erosion and accretion is slow (e.g. 5-7 meter in the present year) in the study area. Broadly three zones have been identified to give more attention about the erosion and accretion nature in Passur River. Most of the human settlement areas besides the Passur River are protected by embankments.

162. At present, the left bank of Passur River e.g. the bank of project site is eroding. Whereas the right bank e.g. the opposite site of the project is accreting. Most of cargos and vessels move through the left bank at the project site as this portion of the river is relatively deeper.

163. The Passur River at the north-western corner of the project in is relatively stable. However, the opposite side of that zone is showing eroding trend. East parts of Chalna bazaar is found in eroding situation... The opposite bank of Mongla e.g. Baniasanta Union is also susceptible to erosion. The primary and secondary tributaries of Passur River like Maidara, Ichamoti, Sholtekhali and Mongla are accreted highly for the last few years. High sedimentation makes those small rivers, creeks or khals near to dry during the lowest tide period. Their mouths are also shrinking where the boats cannot freely move during low tide in dry season.

164. The Sundarbans area besides Passur River is regularly flooded with tidal variation. The tide level decreases during dry seasons. In Akram point, moderate erosion has been found especially in the Sibsa part near to the confluence point. However, new extended land has been developed for couple of areas near the Akram point. Erosion and accretion prone reaches of the river system in study area have been presented below in **Table 2.5.4**.

Table 2.5.4: Selected reach of erosion and accretion

Erosion prone areas	Tentative coordinates	Accretion prone areas	Tentative coordinates
Chalna Bazar (along the Passur river)	N:22˚36´16.60" E: 89˚32´29.28"	Project N-W side (along Passur river)	N:22˚36´14.16" E: 89˚32´7.56"
Project site (along Passur river)	N:22˚35´9.12" E: 89˚33´5.01"	Bajua side (along the Passur river)	N:22˚34´36.65" E: 89˚32´57.81"
Priter baor (along the Passur river)	N:22˚32´27.0" E: 89˚34´43.1"	South east area of the project (along the Maidara river)	N:22˚34´40.22" E: 89˚34´11.52"
Baniasanta areas (along the Passur river)	N:22˚27´10.19" E: 89˚35´3.43"	Old Mongla port areas (Passur and Mongla river)	N:22˚28´3.68" E: 89˚35´40.72"
Akram point (along the Sibsa river)	N:22˚1´52.74" E: 89˚31´14.42"	East corner of the project (Maidara-Sholtekhali river system)	N:22˚36´1.76" E: 89˚33´55.48"

Source: Field Survey, 2014

3 Biological Environment

Biological resources include all living organism within an ecosystem which interact with one another as well as with the physical environment. Surrounding the project site, the biological agents are categorized into three major groups and monitored quarterly with the aim to baseline establishment for detecting probable impact of proposed project. These groups include fisheries resources, ecological resources and Sundarbans Reserve Forest (SRF) health conditions.

3.1 Fisheries Resources

165. Fisheries resources have been monitored quarterly in a year. Monitoring of all four quarters of 2014-15 and 1st, 2nd and 3rd monitoring of 2015-16 have been completed and reported earlier. This chapter contains the outcome of this 4th quarter monitoring of 2015-16 along with the comparisons with the earlier seven quarters.

Location of Monitoring Sites

166. The monitoring activities are being carried out at ten pre-selected locations of which seven (7) are capture fish habitat and three (3) are shrimp/fish farm. The capture sampling sites have been selected based on the fishing availability of upstream, middle stream and downstream of Passur River system. Shrimp/fish farms have been selected based on the direct impacted area of Plant site. The sampling sites are detailed in Table 3.1.1.

Table 3.1.1: The Sampling Locations for Fisheries Resources Monitoring

Site	Capture Habitat Location	Culture Habitat Location
A	Akram Point	Bhekatkhali Khal, Rajnagar
B	Haldikhali	Kapasdanga-Muralia
C	Harbaria	Chunkuri-2
D	Chandpai	
E	Mongla Port	
F	Maidara	
G	Chalna Point, Batiaghata	

Parameter Selection

167. In the fisheries monitoring, five major components had been selected according to TOR, such as, fish habitat status, fish migration, fish diversity, shrimp/fish farm practices and fish production. Fish habitat status has been monitored through investigating habitat suitability index in view of habitat classification based on length frequencies of different fish species and sensitivity of fish diversity and survival success of different life stages of fish to abiotic factors (water quality, bed material, hydrological condition, morphological aspects and biotic factors (food cover). Fish migration status has been monitored through assessing migratory fish species diversity, migration pattern, migration purpose, period and extent of migration etc. Species evenness, species richness and community structure have been investigated for monitoring fish diversity. Shrimp/fish farm practice has been monitored by viewing stocking pattern, growth rate and mortality rate. Fish production monitoring has been divided into capture and shrimp/fish farm production.

3.1.1 Methodology

Fish Habitat Status

168. Fish habitat status has been monitored through determination of Habitat Suitability Index (HSI) based on the habitat classification and sensitivity of fish diversity and survival success of different life stages of fish to abiotic and biotic factors. Fish habitat classification has been analyzed by calculating Ecludean Distance among sampling sties. Moreover, the similarities in species composition among the sites are analyzed using the Jaccard index (JI) for estimating the extent of similarity between pairs of data sets. Basic life requirements for fish community are given in D.1 of Appendix IV.

Fish Migration

169. Migratory species have been identified by analyzing the common species found in the catch assessment survey from the sampling sites based on IUCN list.

Fish Diversity

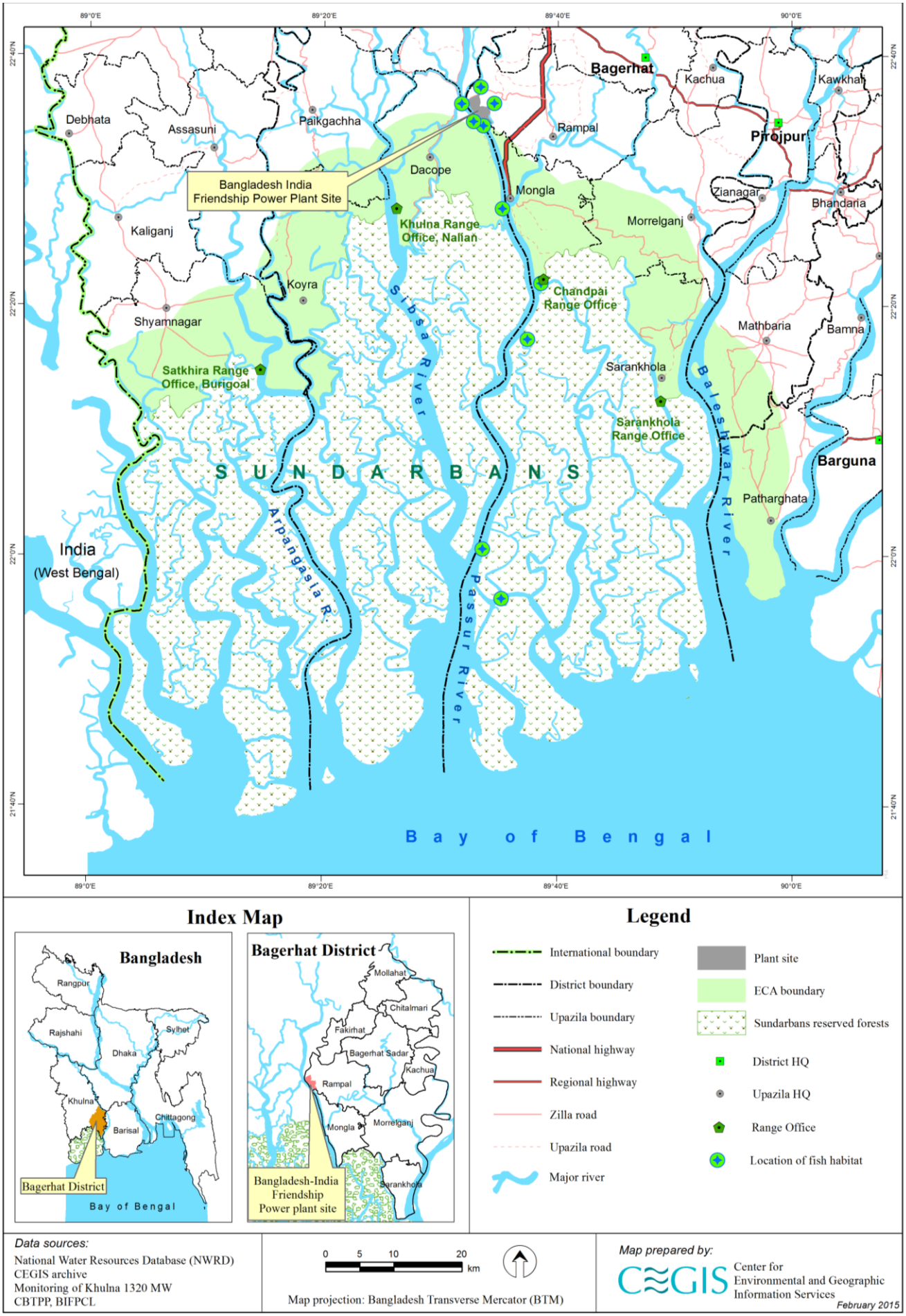
170. Fish diversity has been surveyed by Catch Per Unit Effort (CPUE) method. The fish individuals are counted according to the length of each species from the samples. Diversity has been estimated by analyzing Shannon-Weiner Index ranges from 0 to 1. Fish species richness (FSR) has been analyzed using the Sympson's Index that generates two types of values. The first one includes values from 0 to 1 expressing normalization scores for species richness status and the second one includes values from one (01) to values equal to the total number of species found in the sample which means that how many species are dominant in this fish community. Fish community structure has also been analyzed through counting the length-wise fish individuals.

Fish-Shrimp Culture Practice

171. For monitoring shrimp/fish farm, three farms within the direct impact zone of the proposed Power Plant have been surveyed. Stocking pattern of the shrimp/fish farm is the major issue for successful production, because of having natural genetic resources from the wild source of the Passur River System. Moreover, mortality rate should be minimized for getting more economical output from the farms. So, stocking pattern and mortality rate and its causes have been surveyed intensively.

Fish Production

172. Fish production for riverine fish has been surveyed through CPUE. The information on the species-wise production of shrimp/fish farm has been collected from the selected farms for the last catch.



Map 3.1.1: Fisheries Resources Monitoring Locations

3.1.2 Status of monitoring

173. Followed by the third quarter monitoring of the second year, fourth quarter monitoring has been conducted during the period of 19 to 25 January, 2016.

Fish Habitat Status

174. Fish habitat status has also varied in the view of habitat classification and habitat use pattern of different life stages of different fish species.

(a) Habitat Classification

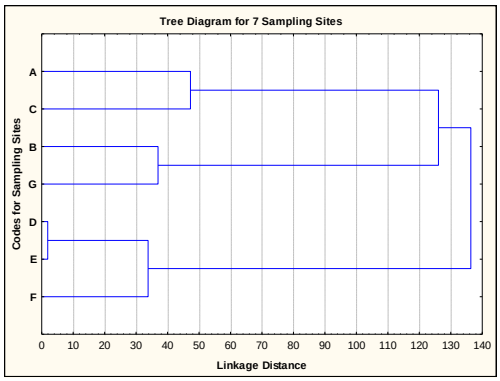
175. Habitat classification is analyzed by using the length-wise distribution of different fish species in the sampling sites. The length of different life stages of fish species are identified and collected from literature. Linkage distance is then calculated with the similarity in distribution. The entire stretch of the Passur River System consists of three major behavioural habitats. The sampling sites have been classified (shown in the **Figure 3.1.1**) on the basis of abundance of different life stages of fish species in those habitats.

176. During 1st monitoring (April, 2014) fish habitat had been classified as the grazing ground (Akram Point and Harbaria), grazing and breeding ground (Haldikhali and confluence of the Passur river at Chalna Point) as well as spawning and nursery ground (Sheola khal at Chandpai, Passur River at Mongla Point and Maidara River). In the second quarter monitoring (June – July 2014) two habitats – i) grazing ground, ii) spawning and nursery ground have been identified. However, during third quarter monitoring in the month of October 2014 the similarity of size group distribution of fish species among the habitats has been found to beshifted to some extent. In fourth monitoring phase in the month of January 2015 three habitats – i) grazing ground, ii) grazing and breeding ground; and iii) spawning, nursery and grazing ground have been identified. During the 1st quarter (April, 2015) of the second year three habitats – i) grazing ground, ii) nursery ground; and iii) spawning and nursery have been identified. During the 2nd quarter monitoring of 2nd year (October, 2015) two habitats have been identified as: i) grazing and breeding ground and ii) spawning and nursery ground. During the 3rd quarter monitoring of 2nd year (October, 2015) such three habitats as i) grazing ground, ii) nursery ground and iii) growing and feeding have been identified.

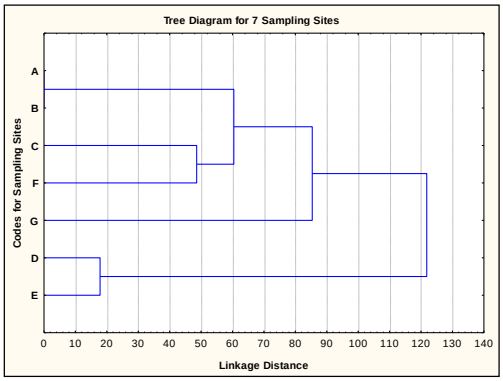
177. During the 4th quarter monitoring of 2nd year (January, 2015) two major habitats – i) nursery and feeding ground and ii) feeding and growing ground have been identified as shown in the **Figure-3.1.1**.

178. ***Nursery and Feeding Ground:*** Among the sampling sites, Akram Point (A), Mongla-Passur confluence (E) and Chalna Point of Passur River are identified as the nursery and feeding ground for abundance of fry to adult fishes.

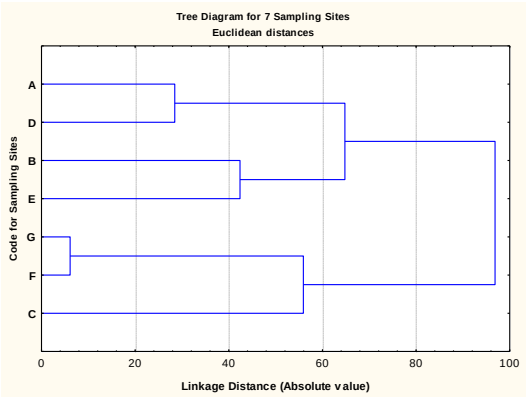
179. ***Growing and Feeding Ground:*** Among the sampling sites, the Haldikhali Khal at Haldikhali (B), Harbaria (C), the Sheola Khal at Chandpai (D) and Maidara-Passur confluence (F) are similar in the distribution of life stages from first aged juvenile to adult fish. These habitats are classified as the growing and feeding ground.



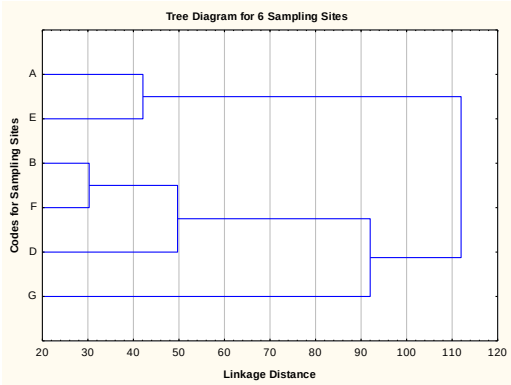
1st Monitoring, April, 2014



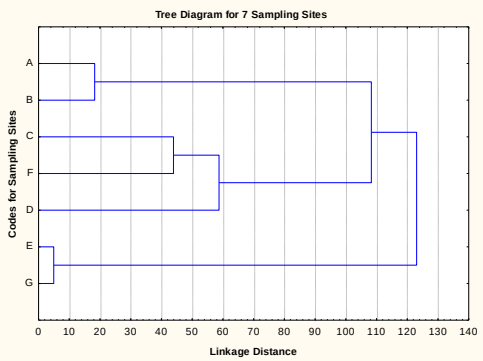
2nd Monitoring, July 2014



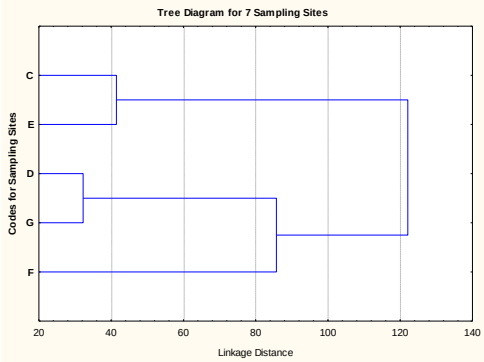
3rd Monitoring, October, 2014



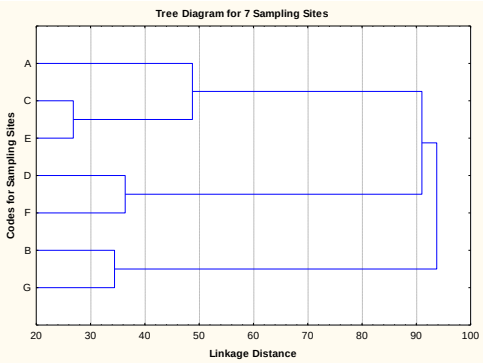
4th Monitoring, January 2015



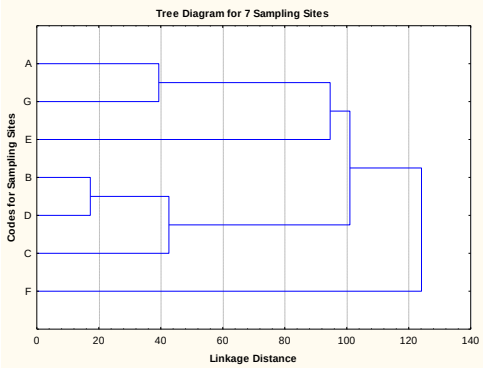
5th Monitoring, April, 2015



6th Monitoring, August, 2015



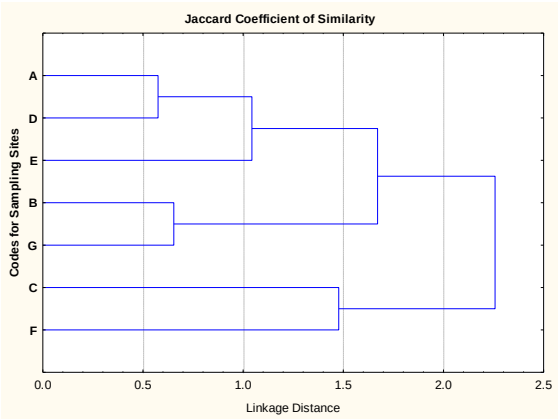
7th Monitoring, October, 2015



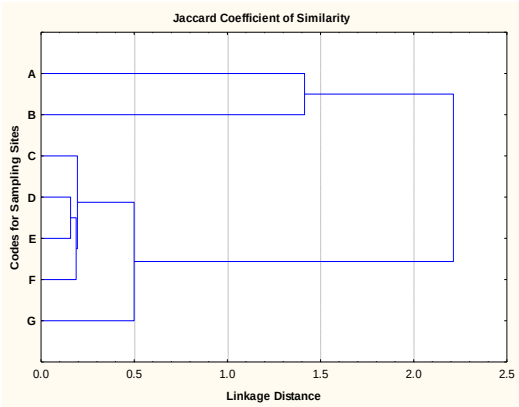
8th Monitoring, January, 2016

Figure 3.1.1: Habitat Classification on the basis of Different Life Stages of Fishes

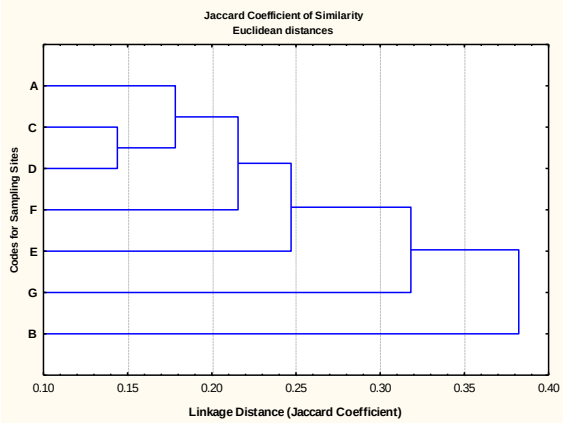
(Note: Life stage is identified through length measurement of the fish individuals)



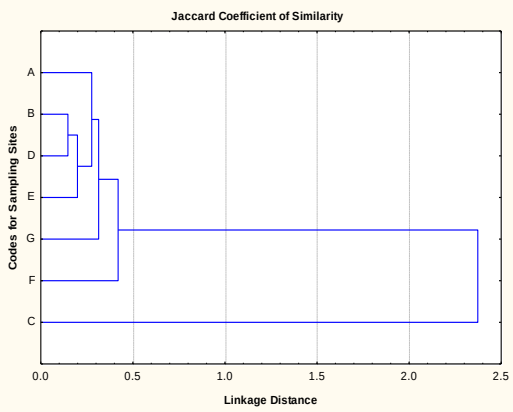
1st Monitoring, April, 2014



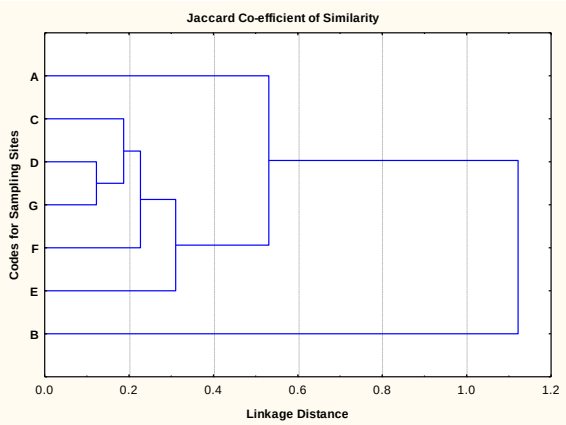
2nd Monitoring, July 2014



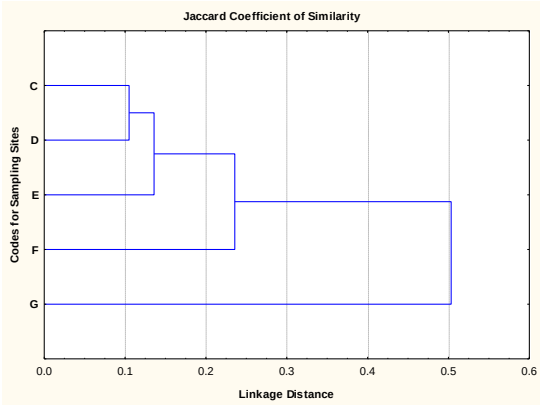
3rd Monitoring, October, 2014



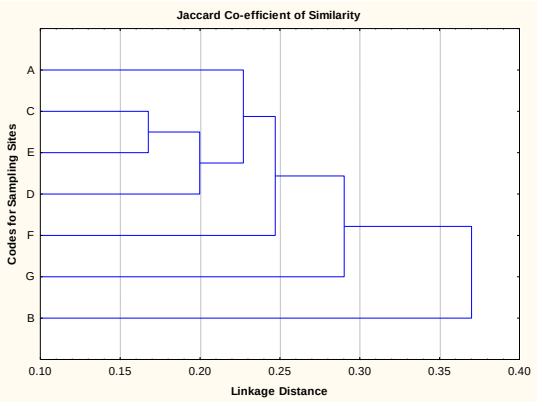
4th Monitoring, January 2015



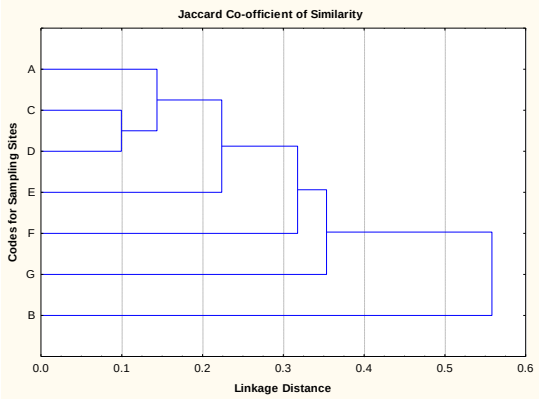
5th Monitoring, April, 2015



6th Monitoring, August, 2015



7th Monitoring, October, 2015



8th Monitoring, January, 2016

Figure 3.1.2: Dendogram Showing Similarity in Binary Species Composition in seven sampling sites

(b) Habitat Suitability Index (HSI)

180. Habitat Suitability Index (HSI) has been determined for the year of 2014 considering the exposure to water quality and the production performance of different fish species. Production performance has been measured through considering length-structured production assessment model (E. L. Cadima, 2003) Suitability analysis has been conducted by applying Iyengar and Sudarshan (1982) developed model. All data has been normalized through using UNDP developed normalization equation (UNDP, 2006).

181. Sheola khal at Chandpai has been found as the most suitable habitat for fish species among Passur River System which is followed by Haldikhali, Akram Point, Mongla Point, Harbaria, Maidara and Chalna Point (**Table 3.1.2**).

Table 3.1.2: Habitat Suitability Index (HSI) for selected spot in the study area

Sampling Sites	Location	HSI* (2014-2015)	HSI (2015-2016)	HSI (2016-2017)
A	Akram Point	0.334		
B	Haldikhali	0.408		
C	Harbaria	0.226		
D	Chandpai	0.520		
E	Mongla Port	0.321		
F	Maidara	0.224		
G	Batiaghata, Chalna Point	0.218		

**HSI value is calculated on the basis of life requirement and length-age structured population dynamics model*
Note: The HSI will be calculated on the basis of one year monitoring data

Fish Diversity

a) Shannon-Weiner Index

182. In the fourth quarter monitoring of second year (2015-16), highest Shannon-Weiner index has been found at Chalna Point (0.81) indicating most evenly distributed fish species. On the contrary, lowest evenness was found at Mongla Port (0.41) (shown in the **Table 3.1.3**).

Table 3.1.3: Site Wise Species Diversity using Shannon–Weiner Index

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct 2014)	4th QM(Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
A	33	0	13	7	3	-	10	15					0.49	0	0.73	0.57	0.96	-	0.55	0.44				
B	12	0	24	14	0	-	11	3					0.85	0	0.57	0.39	0.00	-	0.56	0.58				
C	2	12	9	0	11	26	18	24					0.29	0.77	0.40	0.00	0.78	0.59	0.54	0.67				
D	12	22	15	26	27	24	20	25					0.31	0.78	0.73	0.51	0.65	0.72	0.51	0.71				
E	7	13	10	11	6	16	9	9					0.38	0.6	0.76	0.77	0.15	0.73	0.85	0.41				

Site	Species No												Shannon-Weiner Index*											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct 2014)	4th QM(Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)	9th QM	10th QM	11th QM	12th QM	1st QM	2nd QM	3rd QM	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
														0										
F	3	13	6	4	10	8	14	6					0.82	0.77	0.54	0.60	0.67	0.39	0.77	0.65				
G	6	3	5	7	18	3	8	6					0.68	0.82	0.72	0.66	0.18	0.95	0.72	0.81				

*According to Shannon-Weiner Index, 0-0.30: Low diversity/equally distribution (VH); 0.31-0.50: Moderate Diversity (M); 0.51-0.80: High Diversity (HD) and 0.80-1.0: Very High Diversity (VHD)

b) Fish Species Richness (FSR)

183. Fish species richness has been identified through Simpson's Index[1]. Considerable difference is noticed in the fish species richness (FSR) in different habitat classes (**Table 3.1.4** and **Figure-3.1.3**).

184. In this monitoring phase, maximum FSR is obtained in Sheola Khal at Chandpai (n=7), while very low FSR is recorded at Akram Point, Haldikhali, Mongla Point and Maidara sampling sites (n=2). The richness in this quarter is more or less the same in both the monitoring years. Among habitats in upstream portions of the Passur River, Mongla Port has been home to a rich assemblage of Amadi Chela and Bagda; Maidara River at Boro Durgapur was of Bagda and Golda; and Chalna Point has been of Bele, Chali Chingri, Goda Chingri and Horina Chingri. Among the habitats in downstream portions, Chandpai has been rich in Paissa, Chela, Gulsha Tengra, Horina Chingri and Nona Bele; Harbaria has been in Baisakhi Chingri, Bele, Chami Chingri, Horina Chingri, Motka Chingri and Tou Paissa; Haldikhali Khal has been in Chaka and Chamu; and Akram Point has been in Chaka and Paissa.

Table 3.1.4: Site wise Rich Species Number

Site	Location	No. of Rich Species											
		2014-2015				2015-2016				2016-2017			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
A	Akram Point	4	0	4	3	3	-	3	2				
B	Haldikhali	7	0	4	2	0	-	3	2				
C	Harbaria	1	5	2	0	4	4	3	6				
D	Chandpai	2	2	5	4	5	8	3	7				
E	Mongla Point	1	10	4	5	3	6	4	2				
F	Maidara at Boro Durgapur	3	6	2	2	4	2	4	2				
G	Batiaghata, Chalna Point	3	3	2	3	1	3	3	4				

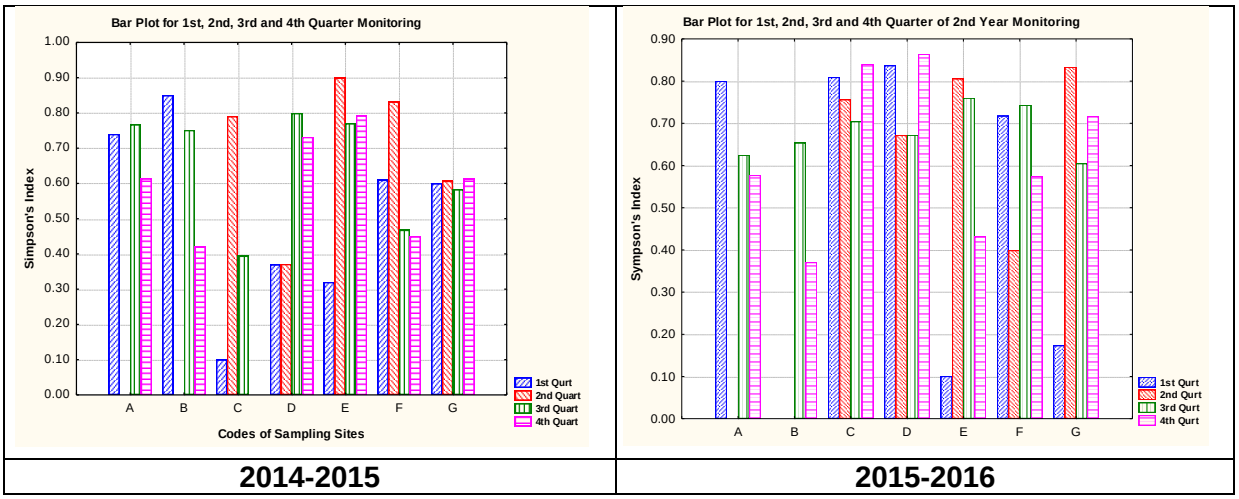
[1]Simpson's index is a method to calculate the community characteristics of fish in a particular habitat. It is mainly used to know about the species richness of a particular habitat to tell how many species are rich in their abundance. The value of this index ranges from 0 to 1. There is other kind of value which is described in the methodology section. The second value is mainly used tomeasure the species richness in the sampling sites.

	
Rupchanda in 1st Quarter of 1st Year	**Chela in 2nd Quarter of 1st Year**
	
Phessa, Chela, Hilsa, Gagla Tengra	Horina Chingri
Fish Species at 3rd Quarter Monitoring of 1st Year 2014-15	
	
Amadi Chela	Banspata
Fish Species in Upstream of Passur River at 4th Quarter Monitoring of 1st Year 2014-15	
	
Adult Poma in Chalna Point	Fry of Bagda at Chalna Point

	
Meth and Gagra Tengra	Gagra Tengra
Fish species found in 1st quarter of the second monitoring year (2015-16)	
	
Mutkuri and Paissa	**Khorsula**
	
Menu	**Vetki**
Fish species found in 2nd quarter of the second monitoring year (2015-16)	
	
Gulsha Tengra, Bele, Aswine Bele and Paissa	**Gangania**

	
Telcupa	**Golda**
	
Kain Magur	**A Mix of Culture and Capture Fishes**
Fish species found in 3rd quarter of the second monitoring year (2015-16)	
	
Tau Paissa	**Bele**
	
Horina Chingri	**Gulsha and Gagra Tengra**

	
Jaba	**Female Gulsha Tengra**
	
Fry Fishes	**Chata Bele**
Fish species found in 4th quarter of the second monitoring year (2015-16)	
Photo 3.1.1: Length-wise distribution of fish species	

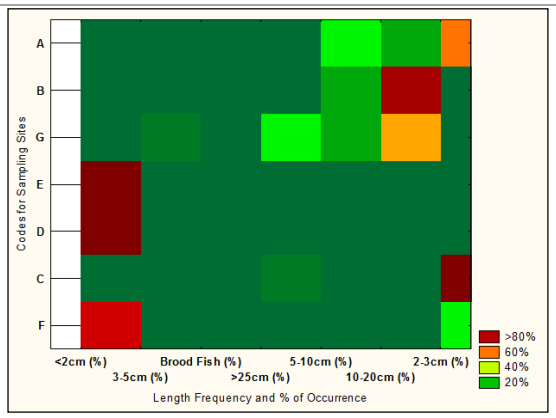


2014-2015	**2015-2016**

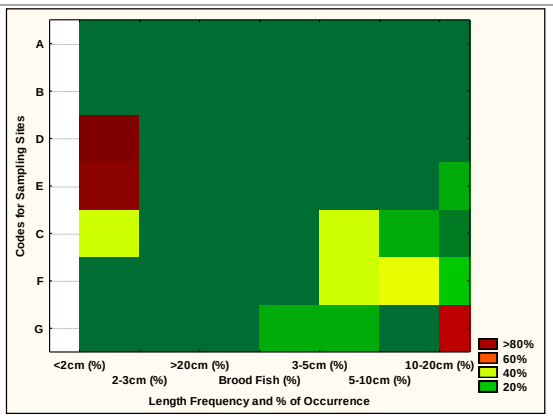
Figure 3.1.3: Site-wise fish species richness (FSR) in the Passur River System.
(FSR is identified though Simpson's Index)

c) Fish Community Structure

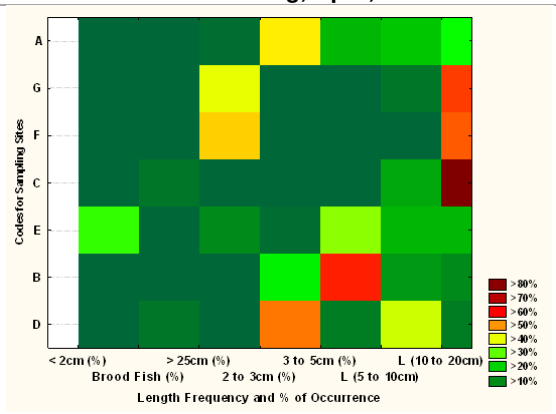
185. Fish community structure has been analyzed through counting the length-wise fish individuals (**Photo 3.1.1**). The following Table **D.2** and **D.3** of **Appendix IV** and **Figure 3.1.4** for fourth quarter of second monitoring year shows that juveniles for fin fish are more widely distributed among the middle and lower stretches of the Passur River. Among these Bagda, Bele, Goda Chingri and Horina Chingri fishes are widely distributed among the sampling sites. Moreover, fry fish of Poma, Khorsula and Amadi Chela are found at Mongla Port, Bagda at Maidara and Mongla Port), Bele and Chali Chingri at Chalna Point and Maidara, Daitna, Goda and Golda Chingri at Maidara and Tit Punti at Chalna Point. However, no brood female fish is observed in the sampling sites in this quarter.



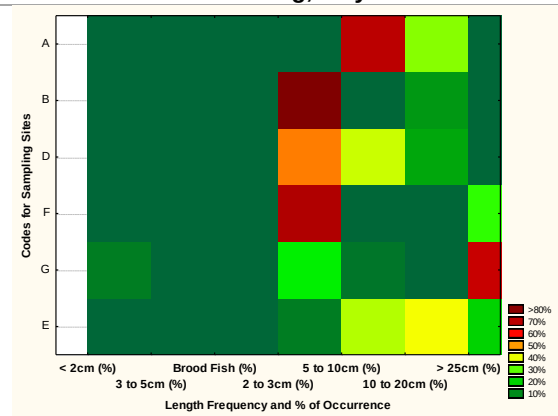
1st Monitoring, April, 2014



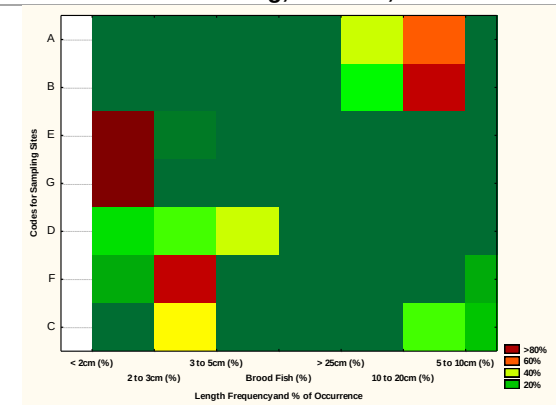
2nd Monitoring, July 2014



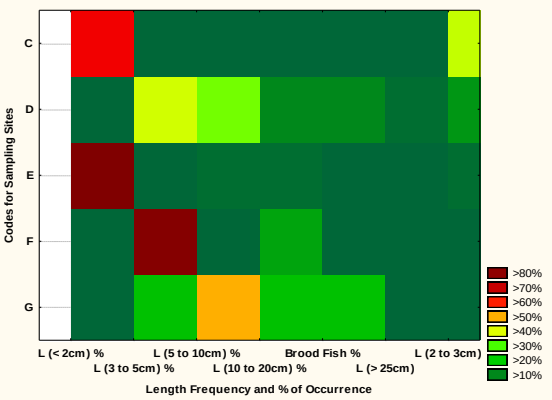
3rd Monitoring, October, 2014



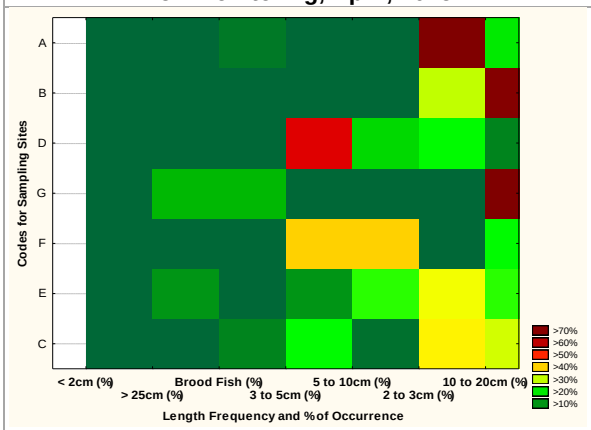
4th Monitoring, January 2015



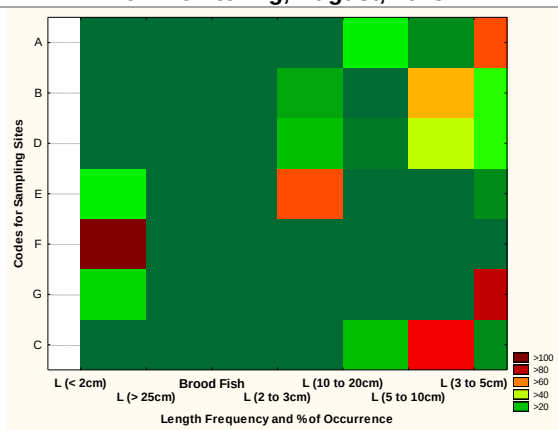
5th Monitoring, April, 2015



6th Monitoring, August, 2015



7th Monitoring, October, 2015



8th Monitoring, January, 2016

Figure 3.1.4: Habitat Distribution of Different Life Stages of Fish Species

Note: N.B.: Color ranges from deepest green to deepest red. 0-4.99% Occurrence signifies Deepest Green; 5-9.99%-Shaded Green; 11-14.99%-Normal Green; 15-19.99%-Light Green; 20-24.99%; 25-29.99%-Lightest Green; 30-34.99%; 35-39.99%; 40-44.99; 45-49.99; 50-54.99-Light Magenta; 55-59.99-Deep Magenta; 60-64.99%; 65-69.99%; 70-74.99%; 75-79.99%-Light Red; 80-84.99%-Deep Red; 85-89.99%; 90-94.99%; 95-100%-Deepest Red

Fish Migration

(a) Migratory Species Diversity

186. Migratory species have been identified by analyzing the common species available in the regular catch from the sampling sites. Fish species like Paissa attains the maximum abundance among the migratory fish species observed in fourth quarter of second monitoring year. The relative abundance of the migratory species is give below in the **Figure 3.1.5**.

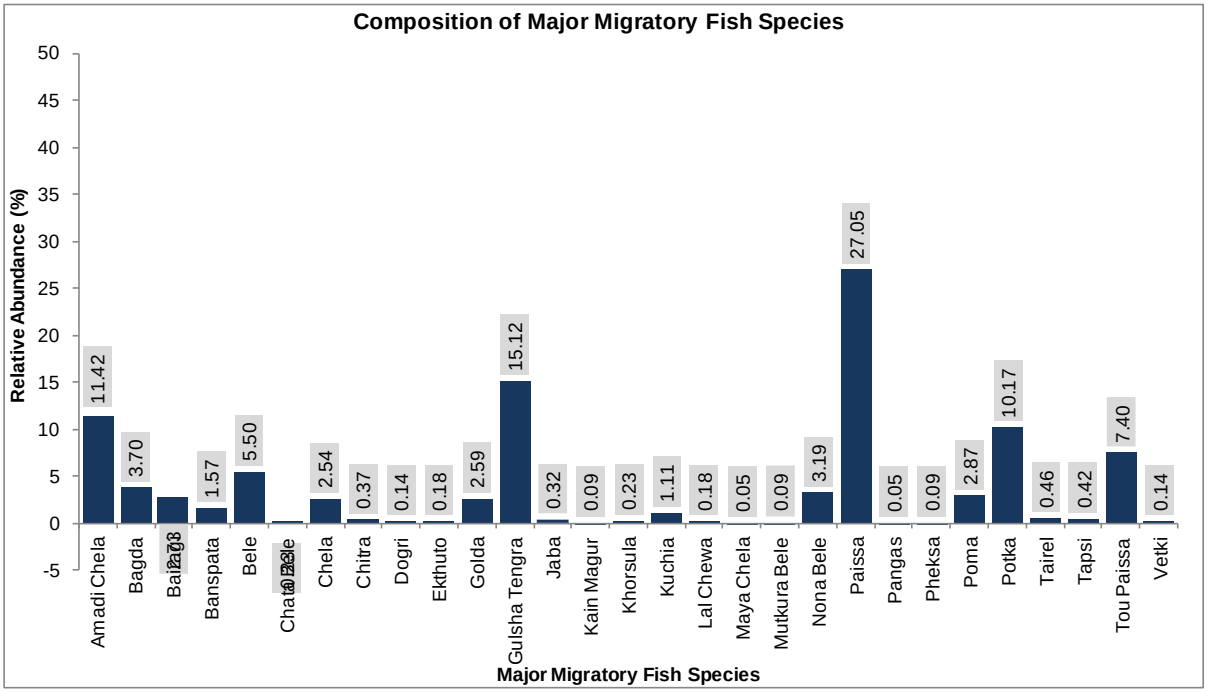


Figure 3.1.5: Relative abundance of major migratory fish species in sampling sites

(b) Migration Extent, Time and Purpose

187. Major fish species show interesting pattern in distribution for exploiting different purposes mentioned in the following table all along the sampling sites. Four (4) fish species are found common in most of the sites. Only three species, Bagda, Poma and Bele, have been observed indicating long range of distribution (**Table D.4 of Appendix IV**).

188. It is interpreted from the findings that in the month of January fish species migrate to the upper reaches of the Passur River mainly for feeding purpose and middle reaches for nursing.

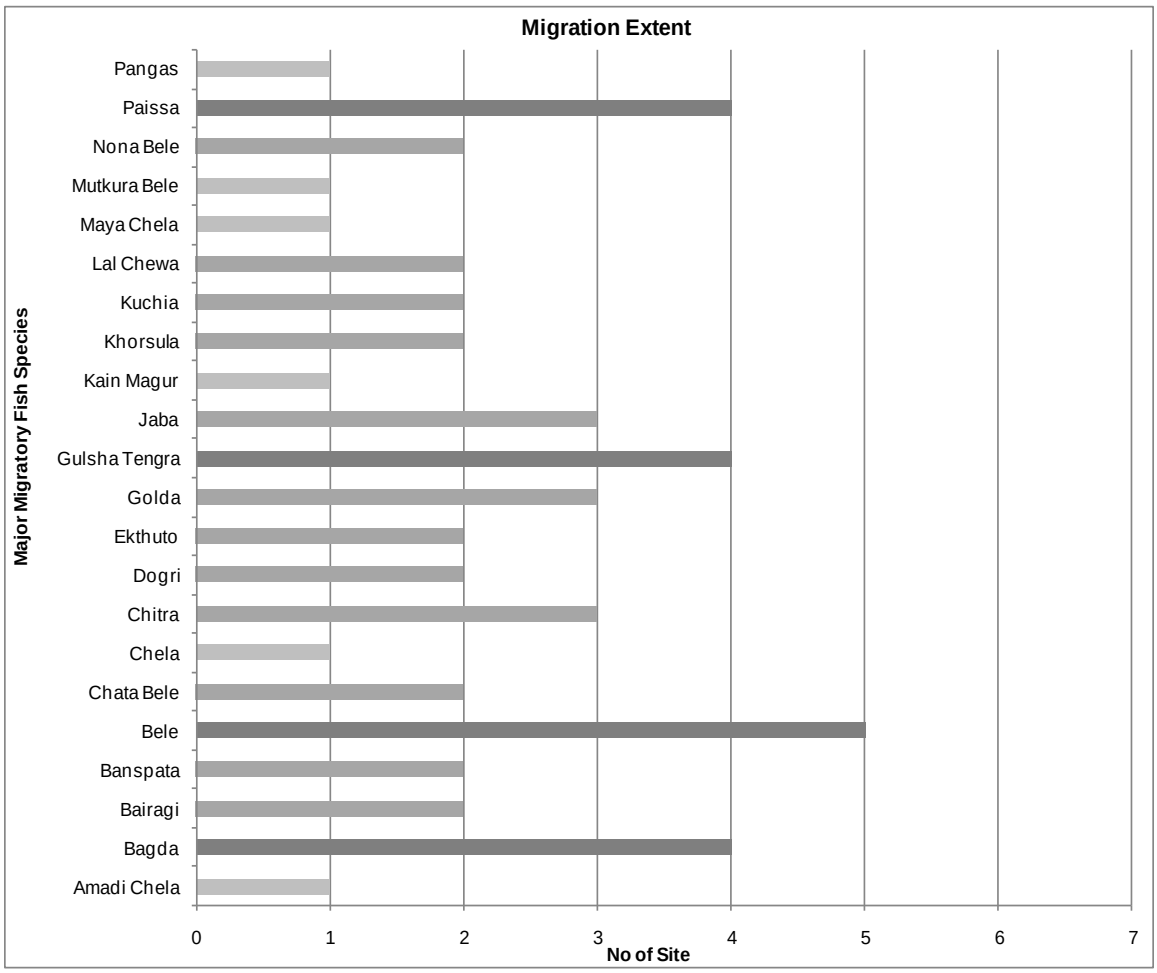


Figure 3.1.6: Migration extent of major migratory fish species in sampling sites

Shrimp/Fish Farm

189. Three farms situated in the direct impact zone of Power Plant have been surveyed for monitoring shrimp/fish farm. Stocking pattern of the shrimp/fish farm is one of the major issues for successful production because of having natural genetic resources from the wild source of the Passur River System. Moreover, maximization of growth rate and minimization of mortality rate should be ensured for getting more economical output from the farms. So, stocking pattern, growth rate and mortality rate and its causes have been surveyed intensively.

Stocking Pattern

190. It was reported by the farmers of the shrimp farms that availability of wild seed (PL) has been declining over the years. For this reason, most of the farmers are compelled to stock hatchery produced seeds along with some wild seeds in their farms. It is found during the present monitoring phase that Bagda stock has not been collected for the entire selected shrimp/fish farm. However, farms are being prepared for stocking from the next month (February-March).

Shrimp/Fish Growth Rate and Mortality

191. During the fourth quarter of second monitoring year, no growth rate and mortality rate has been calculated due to lack of farming practice within the period from third monitoring quarter to fourth quarter.

Table 3.1.5: Growth Rate and Mortality of Fish/Shrimp

Gher No.	1st QM (Apr 2014)		2nd QM (Jul 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug2015)		7th QM (Oct 2015)		8th QM (Jan 2016)		9th QM		10th QM		11th QM		12th QM	
	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)	Growth Rate (cm/day)	Mortality (%)
1	0.3	15-20	0.2	40	0.25	50	-	-	-	30	0.18	25	0.20	60	-	-								
2	0.3	30-35	0.3	94	0.25	10	-	-	-	-	0.14	20	0.15	100	-	-								
3	0.2	25-30	0.2	25	0.20	65	-	-	-	10	0.15	50	0.25	20	-	-								

Source: CEGIS Field Survey, 2014 & 2015

Fish Production

(a) Capture Fish Production

192. In fourth quarter monitoring of the second year, the highest productivity has been found in Passur River at Akram Point **(Table 3.1.6**). The lowest productivity has been found in the Maidara-Passur River Confluence, mainly because all the fry fishes (not considered as catch) have been found in this site which are considered as low level of productivity.

193. The present study observed that Charpata, Behundi and Net Jal are frequently used to catch fish. The highest catch susceptibility has been found in case of Charpata Jal (276.2 kg/haul) (**Table 3.1.6**). The following table also expresses that Behundi Jal and Net Jal are very commonly used in upper reach and Charpata Jal in lower reach of the Passur River. Moreover, the highest total catch is observed in Akram Point and lowest in the Maidara Point in this monitoring phase (**Table-3.1.7**).

Table 3.1.6: Total Catch in Different Gears in the Sampling Sites

Sl. No	Site	Habitat	Gear Name/Type	Haul Duration (hr)	No of Haul	Total Catch (kg)	kg/haul
A	Akram Point	Kukilmoni Khal	Charpata Jal	19	1	276.2	276.2
B	Haldikhali	Haldikhali Khal	Jhaki Jal	1	40	12.8	0.32
C	Harbaria	Harbaria Khal	Charpata Jal	11	1	173.6	173.6
D	Chandpai	Sheola Khal	Behundi Jal	6	4	113	0.00
			Charpata Jal	12.3	1	76	76.00
E	Mongla Point	Passur River	Behundi Jal	6	1	7.8	7.80
F	Maidara	Maidara River	Net Jal	1.3	1	0	0.00
G	Chalna Point	Passur River	Thela Jal	1	20	70	3.50

Source: Catch assessment survey, CEGIS (2015)

Table 3.1.7: Total Catch in the Sampling Sites

Sampling Site	Total Catch (kg)											
	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM(Oct 2014)	4th QM(Jan 2015)	5th QM(Apr 2015)	6th QM(Aug 2015)	7th QM(Oct 2015)	8th QM(Jan 2016)	9th QM	10th QM	11th QM	12th QM
A	28*	0	3	28.7	6	-	20	276.2				
B	65	0	1	3.3	0	-	10	12.8				
C	1,559	0.5	8	8.7	1.05	0.33	19.5	173.6				
D	**	12	3	30.0	10.5	5.08	10.75	189				
E	**	0.6	5	0	0.5	0.40	0.6	7.8				
F	**	1.2	13	3.7	1.5	0.70	0.8	0				
G	**	1.6	4	0.7	2.9	0.83	0.825	70				

*Average Weight 0.15kg/mud crab and average weight 0.6 kg/mud eel

** Weight of Fry is not considered for catch assessment

(b) Culture Fish Production

194. The present study on shrimp/fish farm in the fourth quarter monitoring of 2nd year phase show that the fish production has been found only in the Gher of Rajnagar. In other two farms, no fish production has been found during this quarter as found in the fourth quarter of 1st year monitoring phase **(Table D.5 in Appendix IV)**.

Photo 3.1.2: Fishing gears and crafts use in fishing at sampling sites

3.2 Ecosystem and Biodiversity

195. This section defines the prevailing ecological conditions in the surrounding monitoring sites of the Project study area and includes terrestrial and aquatic flora and fauna status in different habitats of the selected monitoring sites. The information obtained from this section will constitute part of the 8th monitoring (4th Quarter of 2nd year) report and would update environmental monitoring data up to February 2016.

3.2.1 Methodology

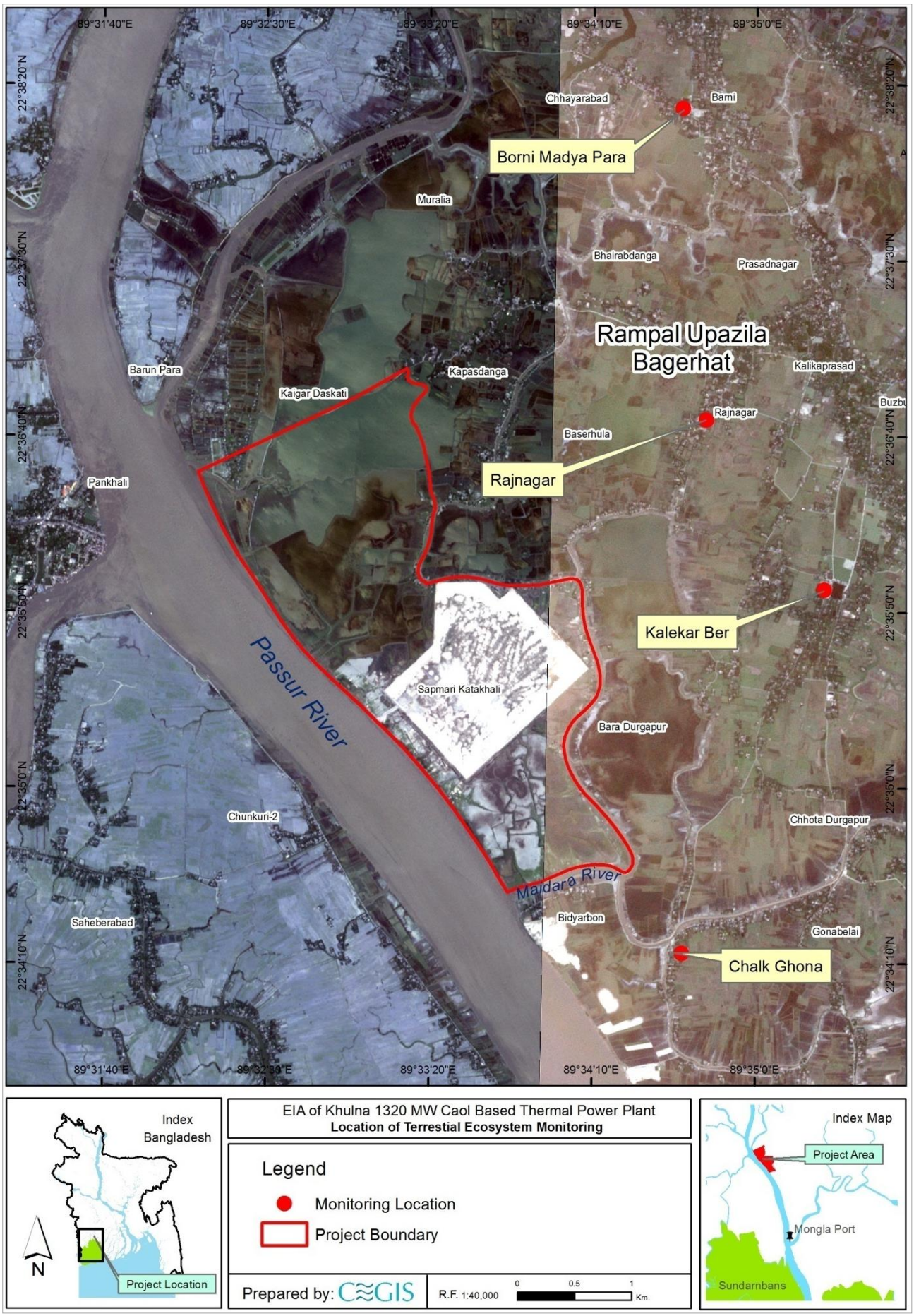
Indicators Selection

196. Indicators for terrestrial and aquatic ecosystems have been selected by prior anticipation of probable impacts on ecological resources in different phases of the proposed project. The overall indicators which are being monitored include the following:

- Plant composition and diversity along with the plant diseases and health condition;
- Canopy status of terrestrial vegetation;
- Lichens community;
- Suitability of habitat for local and migratory birds;
- Habitat suitability for insects (butterfly abundance);
- Dolphin occurrence for water quality assessment.

Rationales for selection of homesteads

197. Four (4) homesteads have been selected for monitoring terrestrial ecosystem's indicators of the study area. Locations of the homesteads have been selected considering wind direction and spatial distribution from the project boundary. The wind blows south to north direction at maximum time. Hence, all the selected locations for terrestrial ecosystem monitoring are at northern sites to observe anticipated impacts in this area. Besides, forest health monitoring indicators of SRF are being observed at south from the project. The monitoring locations are shown in **Map 3.2.1.**



Map 3.2.1: Ecosystem and Biodiversity Monitoring Locations

3.2.2 Status of Terrestrial Ecosystem

Terrestrial ecosystem supports most of the floral and faunal communities which are directly related to the environmental parameters like temperatures, air quality, sunlight, soil nutrients etc. In the study area, homesteads occupy maximum portions of terrestrial ecosystems. As such, observation of different indicators of selected homestead vegetation and dweller wildlife will be helpful to know the ecological impacts for the proposed project.

Description of the selected homestead

The homestead in Rajnagar is located at 2.5 km. east from upper North-east boundary of the project site. This is situated inside the damp area as numerous small swamps exist inside and surround the homesteads. Water retention capacity of surface soil of this homestead is very low and for this reason very little number of grasses and other herbs are present. Land elevation of selected homestead at Kalekarber village is comparatively flood free. This is located at about 1.8 km. east from Middle-east boundary of the project. Chakgona village is located at about 0.5 km south from south-east boundary of the project. The selected homestead of this village is close to Maidara River to its north side and saline water shrimp farms to its south periphery. Presence of shallow ditches and peripheral water bodies support to grow staple coverage of saline tolerant plant species. Borni village is located at about 3.0 km north from north-east boundary. Sampled homestead at Borni is situated at the middle part of the village. This homestead is also dominated by planted tree species and soil condition is similar to Rajnagar site. Vegetation of this homestead have been severely been damaged by past Cyclone Aila.

Species Composition of selected homestead vegetation

Homestead at Rajnagar

Among the trees, Gewa *(Excoecaria agallocha)* is dominating among all trees. Moist and saline soil favors luxurious succession of this mangrove plant in homestead vegetation. Besides, Safeda *(Manilkara zapota)* and Boroi *(Zizyphus sp)* are the two species of fruit yielding trees. Monocots including Narikel *(Cocos nucifera)* and Khejur *(Phoenix sylvestris)* occupied the top canopy of the vegetation. In addition three Bola *(Hibiscus tiliaceus)* and one Sundari (*Heritiera fomes)* also found to exist. The homestead has no grasses or undergrowth vegetation.

Homestead at Kalekarber dighi

Narikel (*Cocos nucifera*) and Khejur *(Phoenix sylvestris)* occupies the top canopy. Aam (*Mangifera indica*), Safeda (*Manilkara zapota*), Peyara (*Psidium guajava*) and Boroi (*Zizyphus sp*) are common trees having height of about 3-5 m. Rendi Koroi *(Albizia saman)* and Raj Koroi *(A. richardiana)* are timber trees. Beside this, Bakul (*Mimusops elengii*) and few number of Kola (*Musa* sp.) are found on these homestead platforms. Among the creepers and herbs, Swarnalata *(Cuscuta reflexa)* and Durba *(Cynodon* sp.*)* are found.

Homestead at Chakgona

Similar to the above homesteads, in the selected homestead at Chakgona, Narikel is the dominating tree species as well as occupying the top canopy. As the homestead is near the peripheries of river and shrimp gher, soil salinity supports luxurious growth of mangrove plant Gewa (*Excoecaria agallocha*). This homestead has two shallow ditches which contain brackish water throughout the year and 2 Golpata *(Nypa fruticans)* bushes exist there. Most of the medium size trees like Safeda *(Manilkara zapota),* Aam *(Mangifera indica),* Peyara *(Psidium guajava)*, Papay *(Carica papaya)* etc. are fruit bearing trees. Besides, some ornamental plants also exist. Detail plant species (trees and monocots only) are listed in **Table E.1** of **Appendix IV**.

Homestead at Barni

This homestead contains 21 tree species. Except Narikel (*Cocos nucifera*), Khejur (*Phoenix sylvestris*) and Taal (*Borassus flabellifer*), most of trees are young in age. The devastating cyclone Aila caused huge damage to the tree species. Then the house owner planted many timber and fruit yielding trees throughout the home yard. Detail plant species composition of this homestead has been mentioned in **Table E.1** of **Appendix IV**.

Species Diversity of homestead vegetation

198. A total number of 47 plant species belonging to 22 families have been enumerated from the 4 studied plots (except Homestead plot at Rajnagar). These species represent 8 monocots. Among the families, Palmae hold 7 species and *Cocos nucifera* having higher abundance. Species diversity of each studied homestead is described in following **Table 3.2.1**.

Table 3.2.1: Composition, Density and Abundance of top 5 species in studied homesteads

Location	Sl. No.	*Scientific Name*	Local Name	Family	Total Number of individuals	Density	Abundance
Chakgona	1	*Cocos nucifera*	Narikel	Palmae	39	7.8	975
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	36	7.2	720
	3	*Phoenix sylvestris*	Khejur	Palmae	24	4.8	600
	4	*Psidium guajava*	Peyara	Myrtaceae	17	3.4	567
	5	*Carica papaya*	Pepey	Caricaceae	5	1.0	500
Barni	1	*Swietenia mehagoni*	Mehogani	Meliaceae	11	2.2	550
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	8	1.6	400
	3	*Areca catechu*	Supari	Palmae	10	2	333
	4	*Musa sp*	Kola	Musaceae	6	1.2	300
	5	*Phoenix sylvestris*	Khejur	Palmae	12	2.4	240
Kalekarber Dighi	1	*Cocos nucifera*	Narikel	Palmae	56	11.2	1120
	2	*Excoecaria agallocha*	Gewa	Euphorbiaceae	6	1.2	600
	3	*Swietenia mehagoni*	Mehogani	Meliaceae	17	3.4	567
	4	*Areca catechu*	Supari	Palmae	18	3.6	450
	5	*Dyospyros blancoi*	Bilati Gab	Ebnaceae	12	2.4	300
Rajnagar	1	*Excoecaria agallocha*	Gewa	Euphorbiaceae	25	5	1250
	2	*Phoenix sylvestris*	Khejur	Palmae	25	5	500
	3	*Cocos nucifera*	Narikel	Palmae	17	3.4	340
	4	*Psidium guajava*	Peyara	Myrtaceae	2	0.4	200
	5	*Pongamia pinnata*	Koroj	Leguminosae	3	0.6	150

Source: CEGIS Field Monitoring, April 2014 and June 2014

Diversity Index of Sampling homesteads vegetation

199. The average Diversity Index of this area is 2.47. Chakgona possess top diversity rating with presence of 34 plant species. Following table provides the plant diversity index of different studied homesteads.

Table 3.2.2: Diversity Index of homestead plant species

Location	Total No. of Tree Species	Diversity Index (H)
Barni	20	2.75
Kalekarber Dighi	19	2.35
Chakgona	34	2.80
Rajnagar	15	1.99

Source: CEGIS Vegetation Survey, April 2014 and June 2014

Plant health

200. Plant health of this area is not satisfactory. Vegetation structure of this area is dominated by tree. Random saline water shrimp farming is a big threat to plant health of this area. Expansion of shrimp farming in this area triggered increasing of salinity of soils. For this reason, plant succession, growth and productivity have fallen down day by day.

Plant Diseases and symptoms in homestead vegetation

201. Plant diseases observation of an area is needed to evaluate plant health and productivity. During initial field survey, some tree species are selected for regular observation of plant disease. In this regards, a number of common tree species have been observed in each homesteads.

202. Leaf spot, leaf blast, nut fall, Mite damage on nut fruit are common diseases of the plants in the study area. A brief discussion has been held with home owners about diseases of selected economic plants which exist in their homesteads. Most symptoms for plant diseases are descriptive. Although, all plant diseases' symptoms are not visible in a same time of the year, but it has been tried to observe the existing disease symptoms. Leaf spot and mite damage on fruits is the common symptoms of *Cocos nucifera.* In addition, bud/trunk rot, lethal yellowing and diameter loss at top portion of this monocot is also common symptom of this plant in all location. Infection of fungal/bacterial is not remarkable all the homesteads. But Leaf Anthracnose on *Mangifera indica* and Bacteriosis on *Psidium guajava* is commonly found most of the trees. *Phoenix sylvestris* is also found unhealthy due to leaf yellowing from manganese deficiency.

Number of disease affected trees

203. Number of disease affected trees on was not monitored in this quarter. However, following table represent the proportion of healthy and unhealthy plants in studied homesteads till last monitoring period. However, comparing previous two monitoring results (Oct, 2014 and Oct, 2015); the overall status of plant health is found same except some variations. The date palm *(Phoenix sylvestris)* in Rajnagar village is found more affected with diseases in October 2015 compared to previous year. The cause could not be identified clearly, but this would happen for excessive saturation of soils in homestead margins and close contact with nearer saltwater shrimp farms.

Table 3.2.3: Proportion of healthy and unhealthy plants in studied homesteads

Location	Plant Name	Total No. of Plant	No. of Unhealthy Plant							
			1st QM (Apr 2014)	2nd QM (Jul 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan, 2016)
Rajnagar	*Cocos nucifera*	17	NS	10	5	5	15	4	5	NS
	Phoenix sylvestris	25	NS	15	4	4	22	9	13	NS
	Manilkara zapota	1	NS	0	0	0	0	0	0	NS
	Albizia saman	2	NS	0	0	0	0	0	0	NS
	Excoecaria agallocha	100	NS	0	1	1	0	0	0	NS
	Mangifera indica	3	NS	1	0	0	2	0	0	NS
	Psidium guajava	2	NS	2	0	0	2	0	0	NS
Borni	*Cocos nucifera*	10	7	3	0	0	3	1	2	NS
	Phoenix sylvestris	12	0	5	4	4	3	1	4	NS
	Borassus flabellifer	6	3	1	0	0	0	0	0	NS
	Mangifera indica	6	3	3	1	1	4	0	0	NS
	Excoecaria agallocha	18	0	0	0	0	0	0	0	NS
	Swietenia mehogani	11	0	0	0	0	1	0	0	NS
	Areca catechu	10	0	6	2	2	8	2	2	NS
	Manilkara zapota	1	0	0	0	0	0	0	0	NS
	Psidium guajava	2	2	1	0	0	0	0	0	NS
Kalekarber Dighi	*Cocos nucifera*	56	35	5	1	1	2	2	3	NS
	Phoenix sylvestris	10	0	3	0	0	1	0	1	NS
	Mangifera indica	5	1	1	0	0	0	0	0	NS
	Manilkara zapota	2	0	0	0	0	1	0	0	NS
	Borassus flabellifer	8	0	0	0	0	0	0	0	NS
	Zizyphus sp	1	0	0	0	0	0	0	0	NS
	Psidium guajava	8	0	0	0	0	0	0	0	NS
	Tamarindus indica	2	0	0	0	0	1	0	0	NS
Chalkghona	*Cocos nucifera*	39	25	19	5	5	34	20	0	NS
	Phoenix sylvestris	24	0	10	1	1	6	5	1	NS
	Albizia saman	3	0	0	0	0	1	0	0	NS
	Excoecaria agallocha	36	0	0	1	1	0	0	0	NS
	Manilkara zapota	1	0	0	0	0	0	0	0	NS
	Psidium guajava	17	1	7	0	0	0	0	0	NS
	Mangifera indica	7	2	1	0	0	0	0	0	NS
	Borassus flabellifer	2	0	0	0	0	0	0	0	NS

Note: NS = Not Surveyed

**=1 Cocos have been cut and 1 Excoecaria have been died*

Vegetation canopy

204. Canopy status of terrestrial vegetation indicates plant health and biomass properties of an area. Vegetation canopy structure may be changed for the change in plant growth rate due to soil properties change, plant physiological disorders due to change of climatic parameters or even for different human interventions. Canopy cover is monitored in different time intervals to observe the canopy status.

Species representation in different canopy layers of homestead vegetation

205. *Cocos nucifera* occupied top canopy of all the studied homestead vegetation. *Phoenix sylvestris* is prevalent as second top layer followed by *Excoecharia agallocha*. Most of the fruit yielding trees like *Manilkara zapota, Mangifera indica* possess upper bole of canopy layer. Lower bole are occupied by small fruit yielding trees like *Psidium guajava*, Musa sp. Very few grass species and undergrowth vegetation are followed at studied homesteads.

Estimated Canopy cover in homestead vegetation of sampling sites

206. Overall vegetation canopy status is followed similar or slightly decrease from the last monitoring period in all the monitoring locations. Kalekarber and Chakgona monitoring sites have showed little decrease due to seasonal effect on plant life cycle as well as slow foliage growth rate during winter. Comparing with same monitoring time in last (January, 2015) year, canopy coverage have been slightly deteriorated in Kalekarber and Chakgona sites

and improved in Rajnagar and Borni sites. There are two main causes for this improvement: a) Improve health of marginal mangrove vegetation (*Excoecaria agallocha)* at the monitoring homestead of Rajnagar and b) Increase foliage growth of planted saplings at the monitoring homestead of Borni. However this change is not significant. Canopy coverage of the studied homesteads has been represented in the following Table **3.2.4**:

Table 3.2.4: Vegetation Canopy Cover in different studied homesteads

Location	% of canopy Coverage							
	1st QM (Apr 2014)	2nd QM (Jul 2014)	3rd QM (Oct 2014)	4th QM (Jan 2015)	5th QM (Apr 2015)	6th QM (Aug 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)
Rajnagar	NS	19	19	17	20	20	20	20
Borni	NS	26	18	18	12	14	20	20
Kalekarber	NS	20	24	25	23	24	24	22
Chakgona	NS	13	24	22	17	21	21	20

Note: NS = Not Surveyed

Lichen cover

207. Alive lichen cover on tree barks have been observed lower than previous monitoring in Oct, 2015. This is happened due to lack of sufficient moisture on tree barks that hinder propagation of lichen. Like last monitoring, *Areca catechu*, and *Phoenix sylvestris* are mostly infected species with lichen all of the monitoring sites. Lichen coverage recorded highest in Borni site. **Table 3.2.5** refers average percentage of lichen coverage of the monitoring locations under this study.

Table 3.2.5: Lichen Coverage on different tree barks at studied homestead vegetation

Location	% of Lichen Coverage					
	1st QM (Apr 2014)	2nd QM (Jul 2014)	3rd QM (Oct 2014)	5th QM (Apr 2015)	7th QM (Oct 2015)	8th QM (Jan 2016)
Raj Nagar	NS	5.1	2.5	1.4	2.6	1.5
Borni	NS	7.8	3.1	2.4	4.8	3.1
Kalekarber	NS	4.3	3.2	1.0	2.1	1.6
Chakgona	NS	2.1	2.6	1.6	3.1	2.5

Note: NS = Not Surveyed

Photo 3.2.1: Alive lichen coverage on different tree barks

(From right 1. On *Areca catechu* at Borni, 2.On *Cocos nucifera* at Rajnagar and 3. On *Excoecaria agallocha* at Chakgona)

Bird Habitat

Local birds and their nesting behavior

208. The study area supports numerous local bird species. Most of which, dwell in homestead vegetation. Existence of vast shrimp farms as well as canals and rivers also favor good number of water dependent bird species in this area. Most of the birds are nesting on tall trees of homesteads. Coconut and Gewa followed top priority for nesting. Small bird like Tailor bird, prefer small bushy shrubs. Although, birds do not follow any local boundaries, a clear conception on available bird species have been gathered through discussions with studied homestead owners as well as physical observation.

Migratory birds and their habitats

209. Migratory and local migratory winter birds are followed at large shrimp gher along the study area. Common Coot, Common Snipe, Black Winged Stilt, Bar Headed Goose, Red Crested Pochard, Ruddy Shellduck, etc are common winter visitor of this area. In addition, local Ruddy Breasted Crake, Common Sandpper, Great Egret, Pond Heron, Little Cormorant are also found at most of the monitoring wetlands of the study area.

Photo 3.2.2: A colony of Great Egrate at Chotocharar Gher, Rajnagar

210. Out of eight locations/ wetlands, Boro Charar Gher and Choto Charar Gher are in top abundance of migratory birds which have been observed during recent field visit in January 2016. According to local knowledgeable persons, population of migratory birds are reducing day by day from these wetlands for illegal hunting, re-starting shrimp culture within short intervals from shrimp harvesting in past year and indiscriminate use of pesticides in agriculture field and shrimp ghers.

211. **Table 3.2.6** shows the presence of migratory birds at the important wetlands inside the study area.

Table 3.2.6: Presence of migratory birds at different wetland inside the study area

Wetland Name	Wetland type	Approximate distance from project Boundary (Km.)	Presence of Birds			
			4th QM (Jan 2015)		8th QM (Jan 2016)	
			LM	M	LM	M
Choto Charar gher	Saline Water Shrimp Farm	0.10	Y	N	Y	Y
Boro Charar gher	‘’	0.10	Y	Y	Y	Y
Putimari Gher	‘’	1.10	Y	N	N	N
Golbunia Gher	‘’	0.1	Y	Y	Y	N
Shukariar Gher	‘’	1.25	Y	N	N	N
Koigar Daskati Gher	‘’	0.25	N	N	Y	N
Badyamari Gher	‘’	1.00	N	N	Y	N
Chakgona Beel	‘’	1.50	Y	N	N	N

Note: ‘LM’=Local Migratory, ‘M’=Migratory, ‘Y’=Yes

Source: Field Monitoring, January 2015 and January 2016

Bird species and number of Bird nests in sampling sites

212. Observation of bird nest is not monitored in this monitoring period. However, it is observed from last monitoring result that local birds are not significantly tend to dwell in the settlement vegetation of this area. Over the last monitoring periods, a colony including 10 little egrets built their nest at Rajnagar sample homesteads during mid of the monsoon season. Except this, little cormorant, tailor bird and starlings are tended to nest at sample sites.

Table 3.2.7: Bird nest monitoring datasheet

Bird Name	No. of Bird Nest observed																															
	1st QM (Apr 2014)				2nd QM (Jul 2014)				3rd QM (Oct 2014)				4th QM (Jan 2015)				5th QM (Apr 2015)				6th QM (Aug 2015)				7th QM (Oct 2015)				8th QM (Jan 2016)			
	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C	R	B	K	C
Little Cormorant	NS	-	NS	-	12	-	-		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	NS	NS	NS	NS
Little Egret	NS	-	NS	1	4	-	-		-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	NS	NS	NS	NS

Asian Pied Starling	NS	1	NS	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS
Tailor Bird	NS	-	NS	1		-	-		-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	NS	NS	NS	NS
Spotted Dove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS

Note: R = Rajnagar, B = Barni, K = Kalekarber C= Chakgona, NS = Not Surveyed, '-' = Not Found

Butterfly occurrence

213. Population and abundance of butterfly is found poor in this monitoring period due to having cool and foggy weather. However 4 different species are observed at Kalekarber and Chakgona sites.

214. Altogether, 32 butterflies species have been recorded from studied sites during last different monitoring period of which Common crow, Common Emigrant, Common Rose, Grass yellow, Peacock Pansy are found in most of the homesteads. Abundance of butterfly fluctuated according to seasonal variations. However, butterflies are more abundant in the month of October last year:

Photo 3.2.3: Some of the observed butterflies at different locations of the study area

3.2.3 Status of Aquatic Ecosystem

215. Rivers, canals, ponds and saline water shrimp farms are main wetland forms in the study area, of which, river bear the flowing/lotic and ponds bear the stagnant/lentic water systems. Canals of this area have merged with shrimp farms. Shrimp farms extend a large proportion of total watershed of the study area which are intervened by human. Therefore, canals are not an actual flowing or stagnant water system.

216. Passur is the only external river beside the project area which maintains connectivity with all flowing water systems of the study area. On the other hand, Maidara River including two branches (Maidara Sholtekhali and Ichamoti) exists as internal river system. Hence, status of benthos, planktons and aquatic mammals (Dolphin) in different locations of the study area has been monitored. In case of stagnant (lentic) water system, indicator specimen has been collected from two big ponds inside the study area. Village pond is the only type of stagnant water body in the study area as maximum ditches, canals and beels have merged with saline water shrimp farms. All types of these wetlands are directly or indirectly connected with flowing river system.

Dolphin Occurrence

Dolphin migration route in study area

217. Two dolphin species (Ganges River Dolphin and Irrawaddy Dolphin) travel throughout the Passur river all along the year. The Ganges river dolphin migrates from estuary regions to upstream connected rivers like Rupsha and Madhumoti. Though Irrawarddy Dolphin is mostly habituated in estuary regions of Bangladesh, but this aquatic mammal was also sighted in Passur River. Ganges Dolphins also roam through Maidara River mainly during high tide. Siltation and narrowing of upstream branches is limiting the length of migration area of this river day by day.

Dolphin occurrence in Passur River

218. Occurrence of dolphin have been monitored by boat transect along about 20 km reach of Passur River surround the project area and up to Mongla river. A total of 6 Ganges River Dolphins are recorded at different locations of the surveyed transect. All of which are diving and occurrence concentrated at the confluence points of the river. Detail survey result is presented in following figure (Figure 3.2.1).

219. Another short survey has been conducted Karamjal, Harbaria and Akram Point while passing the river. Both at Karamjal and Harbaria, evidence of Ganges Dolphin was noticed. However, the survey result is included in Table: 3.2.8.

Dolphin occurrence in Maidara River

220. Occurrences of Dolphin have been observed inside Maidara and Ichamoti River in parallel survey with project site Passur River during flood and ebb tide. Two individual of Ganges dolphin are sighted inside the Maidara River and Maidara-Ichamoti confluence point.

Table 3.2.8: Dolphin observation Datasheet

Location of River systems	Occurrence Status															
	1st QM (Apr 2014)		2nd QM (Jul 2014)		3rd QM (Oct 2014)		4th QM (Jan 2015)		5th QM (Apr 2015)		6th QM (Aug 2015)		7th QM (Oct 2015)		8th QM (Jan 2016)	
	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T	F T	N T
Passur River Near Project Site	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	Y
Karamjal	NS	NS	NS	N	NS	Y	Y	Y	N	N	NS	Y	NS	Y	Y	N
Harbaria	NS	NS	NS	N	NS	Y	Y	N	N	N	N	N	Y	NS	Y	N
Akram Point	NS	NS	NS	N	NS	N	NS	Y	Y	Y	NS	NS	N	Y	Y	NS
Maidara River	Y	N	N	N	Y	Y	Y	N	Y	N	Y	N	NS	Y	N	Y

Note: FT=Flood Tide, NT=Neap Tide, NS=Not Surveyed,
Occurrence Status: Y = Occurred, N = Not occurred

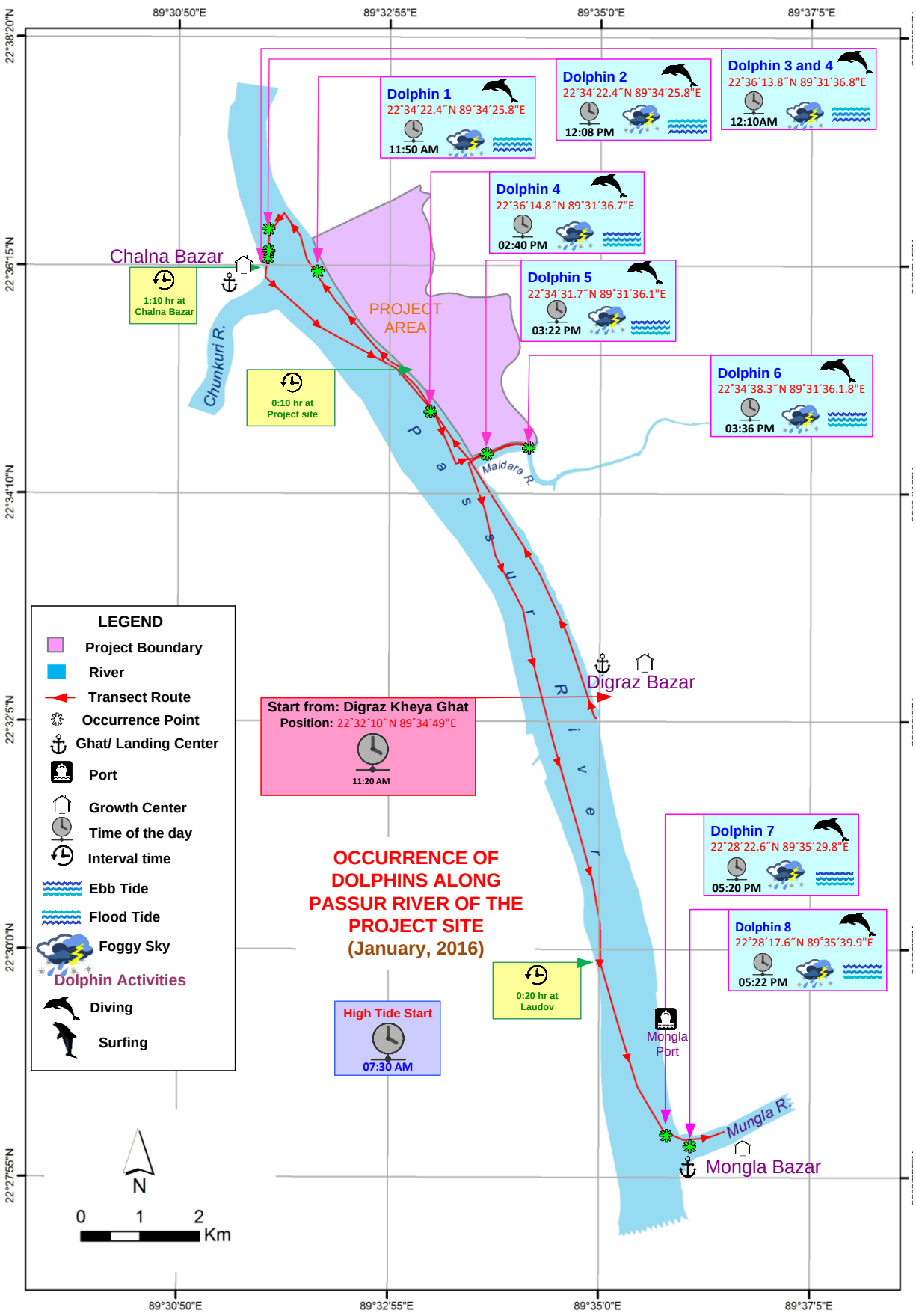


Figure 3.2.1: Occurrence of Dolphin at Passur and Maidara River along the Project site (January 2016)

CEGIS

Status of benthos and planktons in river systems

Benthos and plankton sample have been collected from 6 different locations of Passur and Sutarkhali rivers during different tidal conditions in January 2016. Detail current status of benthos and planktons will be incorporated with next monitoring report after getting the laboratory analysis report.

Species Composition of Benthos

From the last year monitoring during April 2014, altogether 46 species of benthos represented from 12 major groups are recorded in river water. The species are rich in Passur river system near Project Jetty site, where identified 31 benthic species. *Gammarus fasciatus, Palaemonetes paludosus, Ablabesmyia mallochi, Cryptochironomus fulvous, Epicordulia princeps* and *Limnodrilus hoffmeisteri* are the common benthos species observed from maximum monitoring locations.

In addition, a total of 32 benthic species from 11 major groups have observed in Kalekarber Dighi consists rich number of benthic community during April 2014. Detail benthos species association is presented in Table E.3 of Appendix IV.

Species Composition of Planktons

Phytoplankton: Passur and Maidara River support significant number of plankton species. Out of 82 Phytoplankton species, *Chaetoceros pendulus, Coscinodiscus granii, Coscinodiscus lineatus, Melosira granulate*and *Melosira moniliformis* show higher abundance in all locations. All of which are come from bacillarophyceae family.

Flowing water Phytoplankton species composition is varied from 1st Quarterly monitoring at April 2014 to 2nd Quarterly monitoring at July 2014. Minimize salinity as well as increase upstream flow of the Passur river during wet season contribute more than 15 new freshwater species like *Nostoc* spp., *Oocystis* spp., *Oscillatoria* spp., *Schizothrix* spp., *Ceratium* spp. than from dry season. But populations have dropped down for the saline tolerant species in wet season. The largest phytoplankton abundance followed at Akram Point containing 205 individuals/ liter from 27 classes. Species composition and abundance of Phytoplankton in different monitoring locations have been listed in the Table E.4 of Appendix IV.

Stagnant water body of sampling site have rich population diversity and abundance of planktonic organisms. A total of 56 phytoplankton species have been detected in Kalekarber Dighi. Of which, *Coscinodiscus* spp., *Closterium lagoense*, *Pediastrum simplex*, *Scenedesmus* spp., *Anabaena* spp., *Lyngbya* spp., *Oscillatoria* spp., are common phytoplankton species.

A total of 33 phytoplankton species have been identified during wet season monitoring in July 2014. Total number of species is followed lower than dry season. Population density/ abundance are also 3 to 10 times smaller in wet season. *Anabaena orientalis*, *Nostoc punctifome* are two species which possess highest abundance both in dry and wet season. Species composition and abundance of stagnant water body is included in Table E.4 of Appendix IV.

Zooplankton: A total number of 29 zooplanktons species from 4 major classes have been observed at different locations of river systems. In this case, Passur-Maidara confluence point shows higher population of zooplanktons. *Oithona rigida, Calanopia thompsoni, Corycaeus flaccus, Lucifer typus* etc. are the most common zooplanktons those come from Copepoda class.

Composition of zooplankton species is remaining same in two different monitoring seasons. But there is followed significant change of abundance for each species. Number of individuals has less in wet season compared to dry season monitoring. Species

compositions of plankton in different monitoring locations have been presented in **Table E.5** of **Appendix IV**.

In stagnant water body, among 4 major classes, 23 species of zooplankton have been found. *Alona costata, Cyclops nanus, Brachionus angularis* etc. are most common zooplanktons those present with high abundance in Kalekarber dighi. There is a difference of abundance between 1st Quarterly monitoring in April 2014 to 2nd Quarterly monitoring in July 2014. Detailed species composition and abundance of zooplanktons in stagnant water body have mentioned in **Table E.5** of **Appendix IV**.

3.3 Sundarbans Forest Health

221. CEGIS team is monitoring Sundarbans forest health periodically to oversee the probable impact of Rampal Thermal Coal Power Plant Project under implementation. This monitoring program will also support to determine the status, trend and changes in indicators of the forest condition. The Sundarbans forest health is being monitored quarterly as per monitoring schedule and so far eight (8) surveys has been conducted at five locations, namely Sutarkhali, Karamjal, Harbaria, Akram point and Hiron point. The overall monitoring indicators observed in eight monitoring schedule broadly includes plant growth, tree regeneration, tree crown condition, tree damage, lichen communities, plant diversity, soil chemistry, and plant physiology.

3.3.1 Methodology

Indicators Selected for Second Year Fourth Quarter

222. Monitoring frequency for different indicators has been determined considering efficiency in time, cost and applicability. In this quarter, the following indicators have been observed:

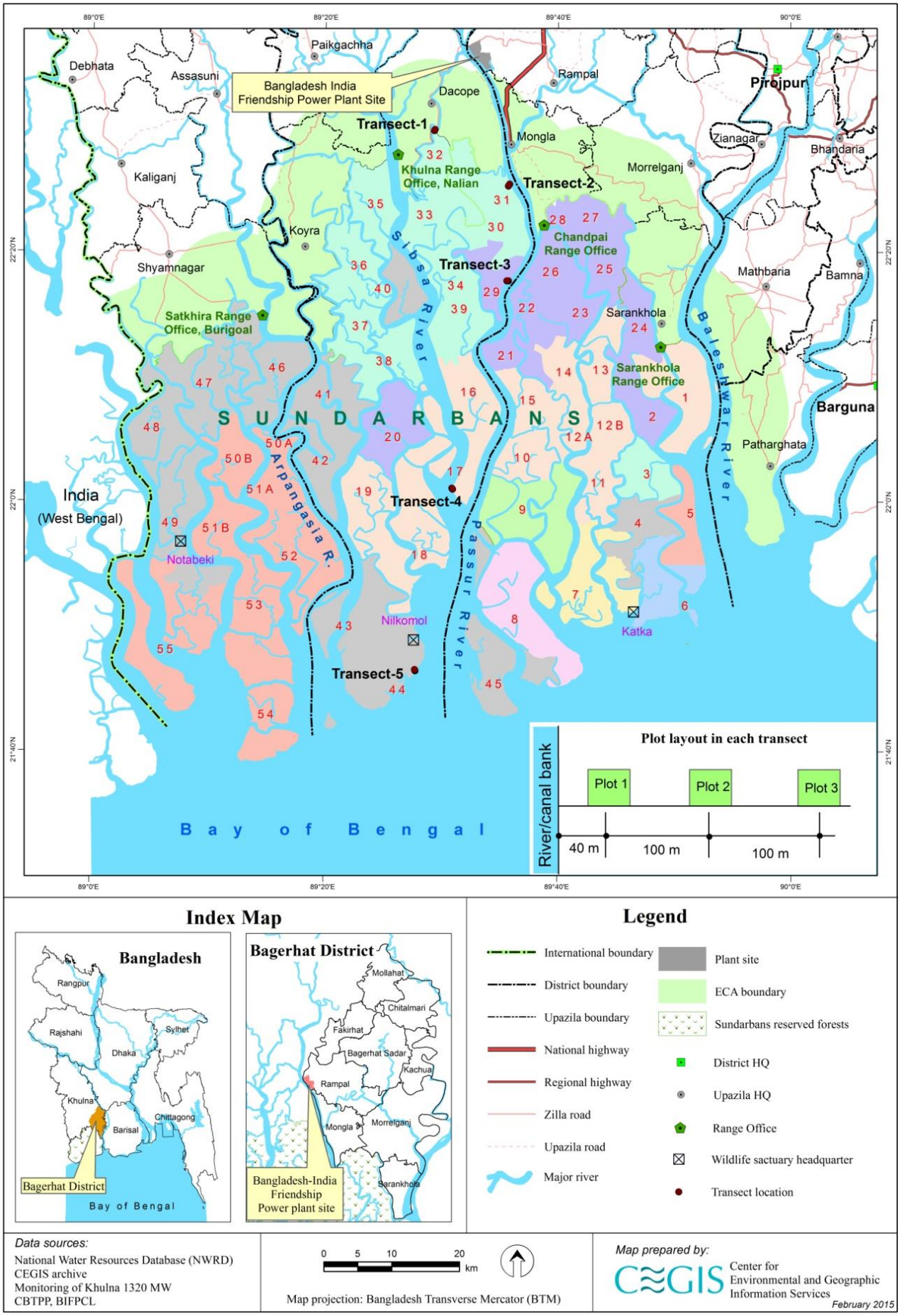
- Seedling Regeneration
- Pneumatophore
- Crab hole density
- Canopy cover
- Net canopy photosynthesis

Forest Health Monitoring Location

223. Five sites have been selected to set up permanent sample plot on the basis of the survey conducted from April 3 to 6, 2014 (**Map 3.1**). Among those, four sites are along the Passur River at Karamjal, Harbaria, Akram point and Hiron point and the fifth one is near Sutarkhali forest office. The sites have been selected considering distance from the proposed Project site, coal transportation route, protection of the permanent sample plots, and vegetation types.

Sampling Design of Permanent Sample Plots (PSPs)

224. In each site, a transect line has been laid out perpendicular to river or canal bank. Along, the transect line three circular nested subplots of 12.62 m radius has been laid out at 100 m intervals in order to capture maximum tree species (**Figure 3.3.1**). Because of the variation in species composition in SRF observation plots have been laid out from coast, river or canal side to landward zone (forest proper side). The location of the first subplot is 40 m away from ecotone (riverside) to inner ward of forest in order to save the subplot from river bank erosion. Each subplot are again subdivided into four quadrates for the ease of data detection and recording (**Figure 3.3.2**).



Map 3.3.1: Location Map of Sundarbans Forest Health Monitoring Plots (PSPs)

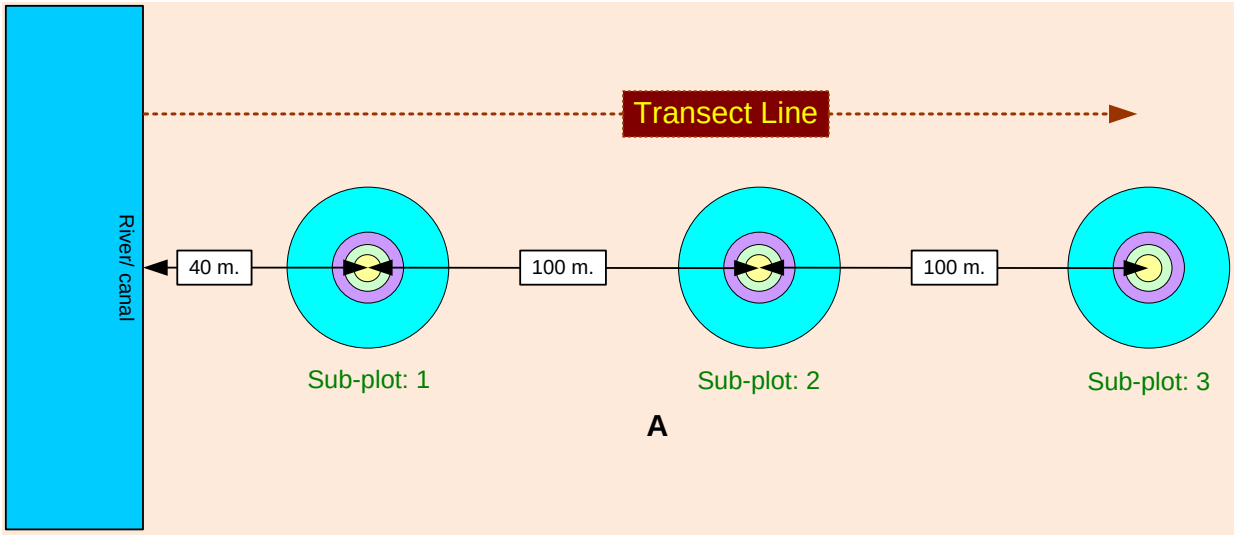


Figure 3.3.1: Layout of the subplots and transect line perpendicular from ecotone (river or canal bank)

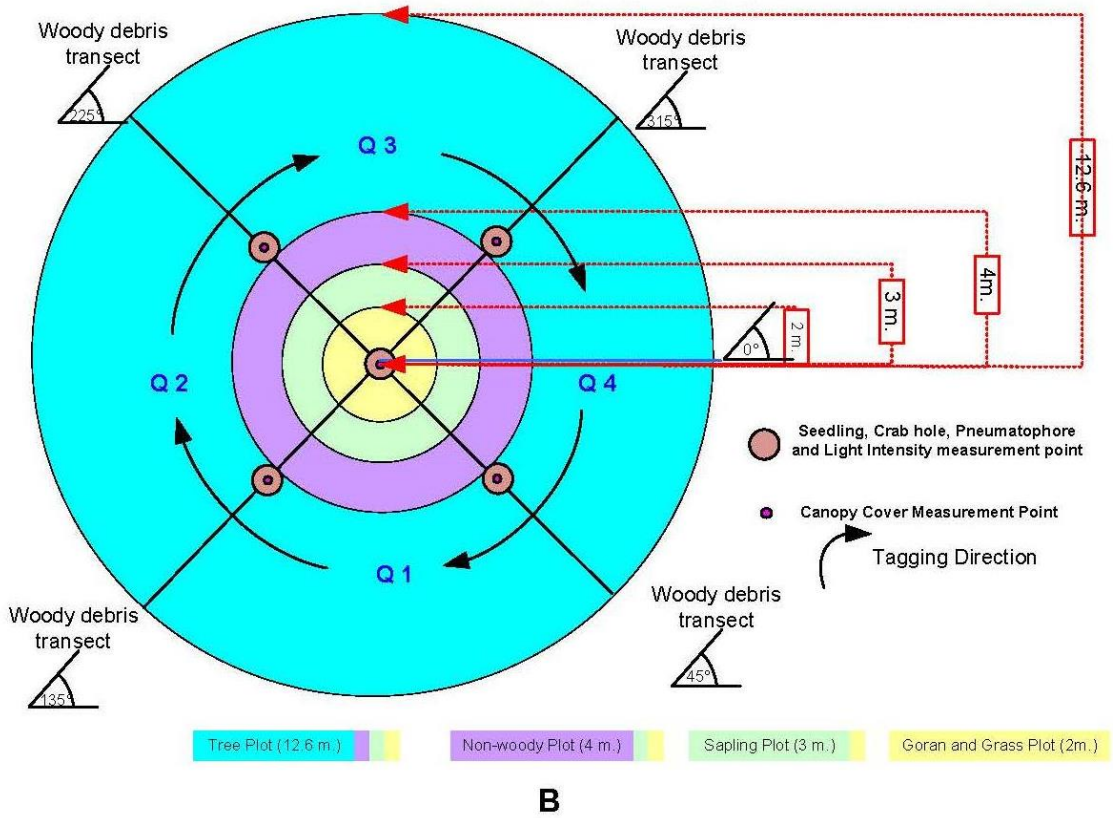


Figure 3.3.2: Layout of the survey activities in each subplot

Forest Health Survey

(a) Trees

225. The tag number of trees (DBH ≥ 5cm and lean angle greater than 450) is monitored and rewritten if any shade is found within 12.62 m radius circle of Permanent Sample Plot (PSP). In the same monitoring period a map showing the location of all trees (tag number) is developed for the ease of data collection next time (**Photo 3.3.1**).

(b) Sapling and seedling

226. Saplings (DBH < 5 cm and height 1.37 m) and seedlings (height < 1.37 m) have been assessed within 3m and 2m radius circle, respectively in each PSP. Seedlings have been counted species wise and there living status also recorded (**Photo 3.3.2**). For saplings species name and DBH have been recorded along with living status (**Photo 3.3.3**).

Photo 3.3.1: Team members checking tree tag number and painting marks on trees

Photo 3.3.2: Seedlings and saplings in the subplot

(c) Pneumatophore

227. The total number of pneumatophores with its living status has been recorded within a circular area of one meter radius around five points of each of the subplots. The first point has been laid out in the center of each subplot and other four have been in the midpoint of the four woody debris transects that are facing at 45°, 135°, 225° and 315° (**Photo 3.3.4**).

Photo 3.3.3: Team member measuring the DBH of trees in the subplot

Photo 3.3.4: Team members counting pneumatophore on forest floor

(d) Crab hole

Crab plays an important role in mangrove ecosystems such as decomposing litter fall thereby increasing fertility. In order to work out the crab density, usually crab hole abundance is monitored. For this purpose, the crab holes have been counted within an area of 1 m radius circle in each subplot's center and in the midpoint of four woody debris transects in this study (**Photo 3.3.5**).

(e) Canopy Cover

228. Percentage (%) of canopy cover has been estimated by a spherical densiometer which is a gridded convex mirror that provides a simple and inexpensive approach of measuring canopy cover. The densiometer has been held at a distance of 30–40 cm in front of the body and at an elbow height, so that head is not visible in the mirror (**Photo 3.3.6**). After levelling the instrument using the level bubble, the dots, which are not occupied by canopy, are systematically counted. In each subplot, the readings have been taken at five points facing at north, south, east, and west direction including subplot center point. First one has been taken standing at subplot center and the other four are taken at the middle point of the four transects between center and periphery. The canopy cover has been calculated by taking the average of these five readings.

Photo 3.3.5: Crab hole in the subplot

Photo 3.3.6: Team member taking canopy cover percentage

3.3.2 Status of monitoring of SRF Health

Seedling

229. The seedlings density (number of seedlings per ha) has been monitored in four PSPs excluding Hiron point in the second year final monitoring period. An increasing trend and good number of seedling survival have been observed in most of the sites, but in Akram point the seedlings status are comparatively lower. Seedlings usually die at the early stage in natural forest due to competition for nutrients as well as light intensity. Other than the silvicultural competition, the seedlings at Akram point and Hiron point also face natural stresses due to their location at very much close to the sea. It can be predicted from all monitoring results that the seedlings density shows an increasing trend in monsoon (July to October) but decreasing in dry season (January to April) almost in all sample plots (**Figure 3.3.3**). In the Sundarbans, most of the mangroves' seeds disperse in the rainy seasons and go up to forest floor. In this relation, seedlings are usually found more after the rainy season than that of other seasons.

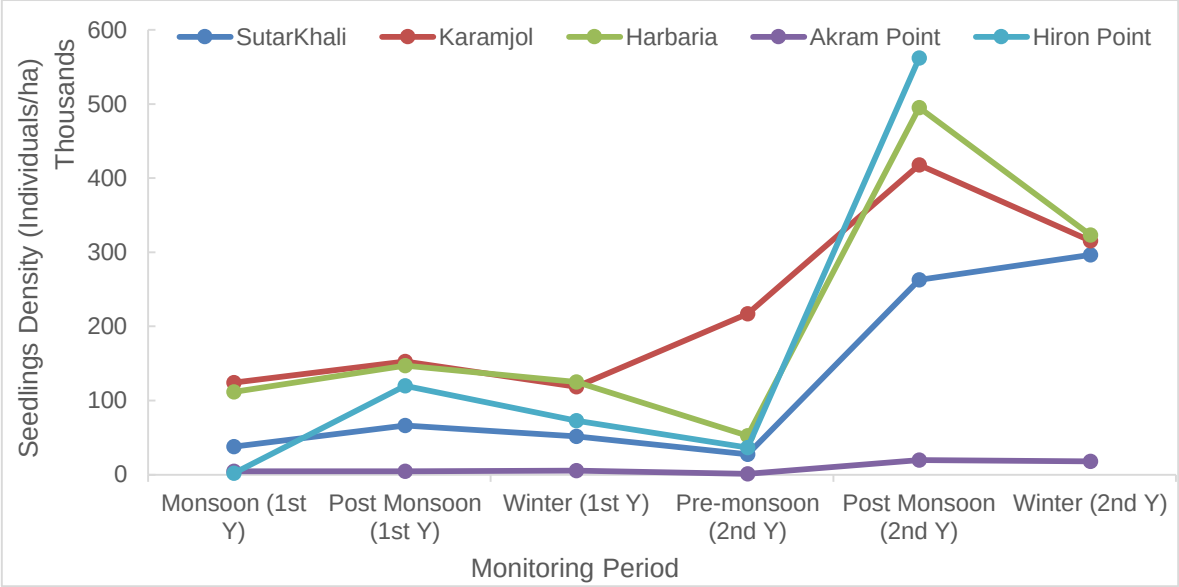


Figure 3.3.3: Mean (±95%CI) seedlings density among the quarterly surveys in five PSPs

Pneumatophore

230. Like seedlings, pneumatophore density also changes due to seasonal variability (**Figure 3.3.4**). Pneumatophores usually dry up and die during dry season. Hence, the number of pneumatophores per hectare is found comparatively higher in monsoon period. However, among five monitoring sites, the mean pneumatophores density is found lower in Akram point and Hiron point due to floristic composition. From the species composition inventory, it is found that these two monitoring sites are mainly dominated by Gewa (*Exoecaria agallocha*) species. On the contrary, Karamjal is mainly dominated by Baen (*Avicennia officinalis*) tree and it has numerous tender pneumatophores considering to others.

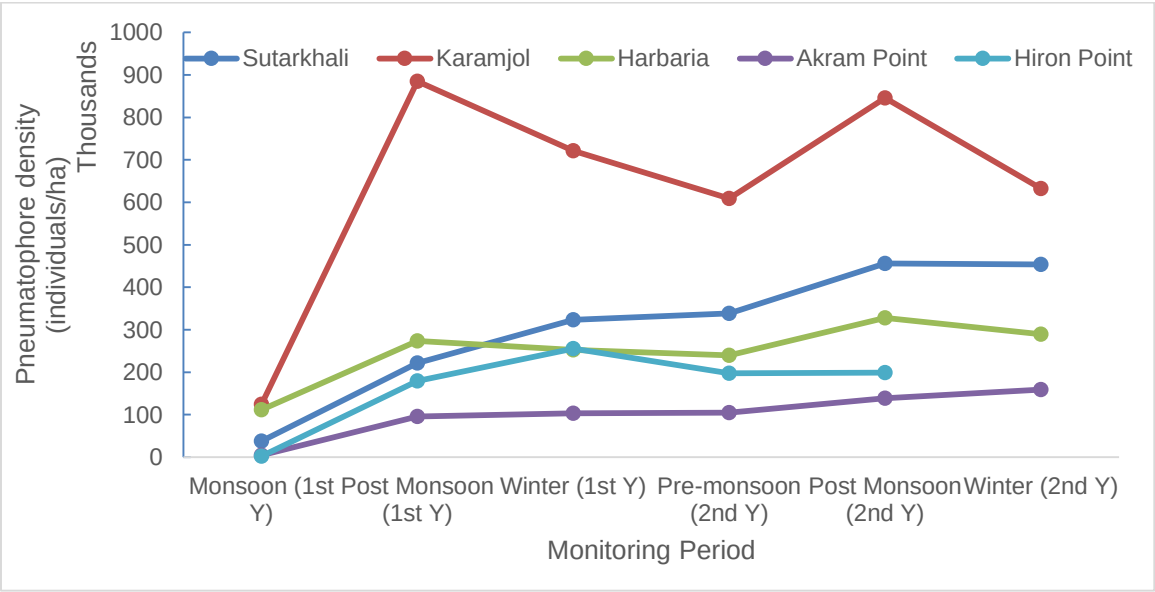


Figure 3.3.4: Mean (±95%CI) Pneumatophore Density among the quarterly surveys in five PSPs

Crab hole

231. The crab hole density, the indicator of availability of crab in a site, has been found highest at Akram point among the monitoring sites. However, it is difficult to predict whether

any relationship of changing crab hole density with seasonal variability from quarterly survey findings (**Figure 3.3.5**). But there may have a reverse relationship in between crab hole and other indicators (seedlings, pneumatophore density) as those indicators are found lowest in Akram point.

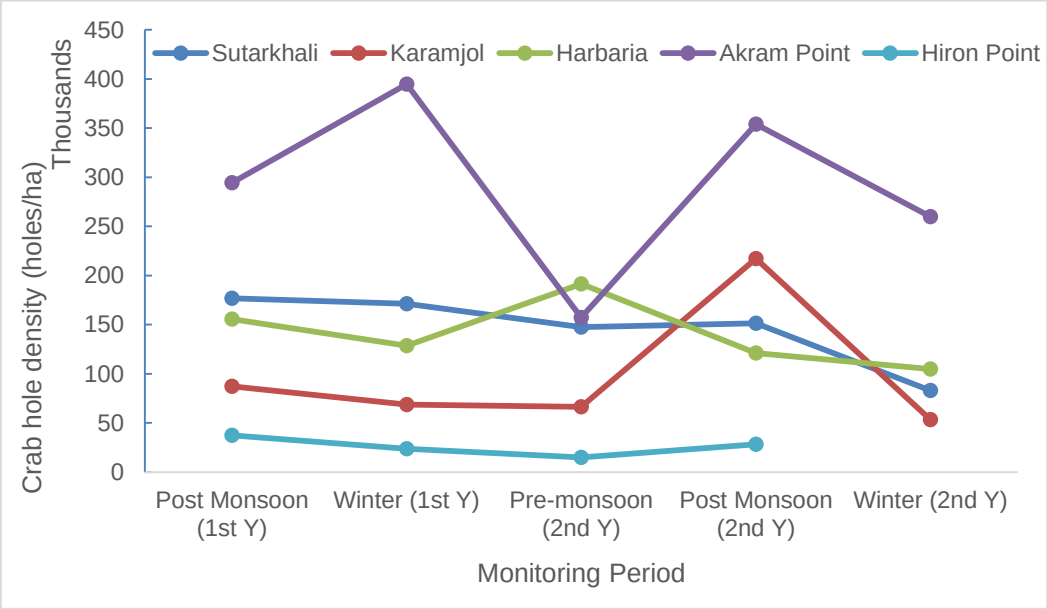


Figure 3.3.5: Mean crab hole density among the quarterly surveys in five PSPs

Canopy cover

232. In the monitoring plots, the canopy cover percentages have not varied significantly. It is found that the canopy cover percentages are similar among the monitoring sites (**Figure 3.3.6**). Since greater than 60% of canopy coverage in a site is treated as healthy, all the locations of the monitoring sites are in good shape. However, this attribute has also shown similar characteristics in terms of change i.e. highest canopy cover percentage are observed during monsoon to post monsoon which started decreasing at winter and found lowest at pre-monsoon period.

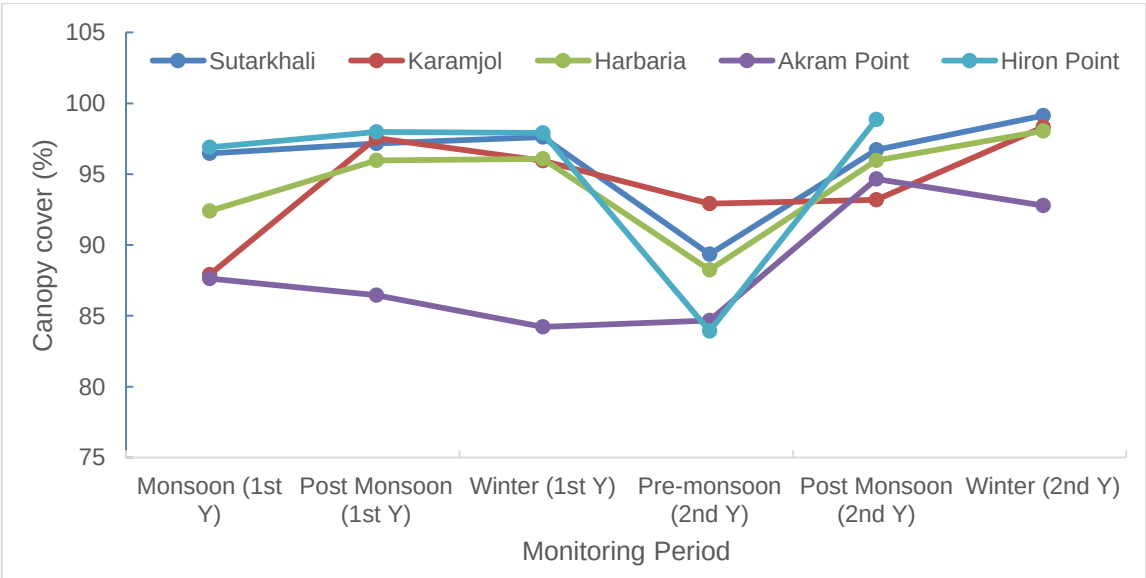


Figure 3.3.6: Mean canopy cover (%) among the quarterly surveys in five PSPs

Net canopy photosynthesis

233. Net photosynthesis of the four monitoring sites has been given in the **Table 3.3.1**. The net canopy photosynthesis of the monitoring sites is more or less similar; however Karamjal Site shows comparatively lower value. This is because Karamjal has lower leaf area index.

Table 3.3.1: Net canopy photosynthesis among the quarterly surveys in four PSPs

Monitoring Sites	Leaf area index	Net canopy Photosynthesis (g C $m^{-2}s^{-1}$)
Sutarkhali	4.04	2.62
Karamjal	3.61	2.34
Harbaria	5.12	3.32
Akram Point	3.87	2.51

3.3.3 Findings

After comparing two years monitoring results, it can be predicted that the changing trend for majority of the indicators of forest health in SRF is related to seasonal variation. For example, seedlings' density, pneumatophore, crab hole and canopy cover are found highest and lowest after and before monsoon period, respectively. Except crab hole density, all other indicators have been found lower at Akram point among five monitoring sites considering the indicators checked in fourth quarter of second year. It is strongly recommended that the monitoring should be continued to observe the seasonal variation of concerned indicators for sustenance of Sundarbans forest health.

4 Environmental Compliance

234. The Project is now at the site development stage and various development activities are in progress. The land development activities of the Project area for the first phase are nearly completed. The Project site for the first phase is encircled by boundary wall. Pre-fabricated office building, slope protection works, tree plantation activities etc. have been moving ahead. Construction and development of connecting (approach) road between the Project site and Khulna-Mongla road is progressing fast. However, there are some environmental compliance measures in environmental management plan that should be at place during this pre-construction stage.

235. The environmental compliance monitoring that includes monitoring of EMP implementation is based on physical observation and assessment. A comprehensive diligence checklist has been developed to monitor the environmental compliance to different components e.g., Environmental and Social Management System and Action Plan; Labor and Working Condition; Community Health, Safety and Security; Biodiversity and Sustainable Management of Living Natural Resources.

236. The aim of the checklists is to check the diligence of measures and effectiveness of the measures. The checklists are produced as Compliance Data Sheet that contains both quantitative and qualitative data. The details of the compliance checklist are attached in **Appendix I**. The **Table 4.1, 4.2, 4.3 and 4.4** present summary of the findings of the environmental compliance monitoring:

Table 4.1: Monitoring of Environmental and Social Management System Action Plan Implementation

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and also occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green plantation around the Project boundary • Switching off/ throttling down of machines/equipment/ generators which are not in use	• CEGIS is carrying out noise survey in ambient environment under environmental monitoring study. • BFD has initiated green plantation as a depository work of BIFPCL • Switching off/throttling down of machines/equipment/ generators which are passing idle period	• Create awareness among the labor for using noise muffler at construction site • Stop working of the heavy noise generating equipment operators (e.g. stone/brick crusher) during 6:00 pm-8:00 am	Being Complied
2	Dust Generation from land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly? • Construction of boundary wall	• CEGIS is quarterly monitoring the dust generated from land development activities and other construction works. • Construction of boundary wall for the main Plant is completed. • Sprinkling of water at some places • Preparing for construction of paved road	• Construct brick road within the Project site for traffic movement firstly(if possible) • Otherwise, demarcate traffic way and enforce that all the vehicles are using the demarcated way only. • Spray water along the road and road side to suppress dust generation	BIFPCL agrees to take such recommended measures
3	Water Quality	• Fencing the construction site • Arrangement of runoff drainage for reducing any water logging • Location of backfilling stockpile in safe area and protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and waste water to	• Construction of boundary wall for the main Plant • Rainfall runoff discharge to nearby river through unmanaged/unplanned drainage network at some places • Onsite sanitation facilities	• Temporary drainage for rain fall runoff should be constructed; • Stockpile of construction material should be placed at a safe distance from drainage network; • Sediment trapping pool	Being Complied

*Table 4.1: Monitoring of Environmental and Social Management System Action Plan Implementation **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		river or canal.	has been developed at the labor sheds as well as the working places	may be created before final discharge of the rainfall runoff from the Project site.	
4	Waste Management System	• Provision of onsite waste management system	• Conventional way of waste collection and disposal system at Plant office and kitchen	• Sufficient waste disposal bin/s with labelling should be installed at labor shed, and working area before the main construction works	Being Complied
5	Compensation and Resettlement	• Prepare Proper resettlement action plan and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • Cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for movable structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance • grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Human provide/ take extra care/caution for the disadvantaged/ vulnerable group/s (i.e. women, children, ethnic minorities,	• Compensation has been given to the rightful owners of the land as per the laws of Bangladesh e.g., Acquisition and Requisition of Immovable Property Ordinance, 1982 • Compensation made by local DC office • Local DC office facilitates unauthorized occupants of the acquired land to get home in the Government's shelter homes or cluster villages • BIFPCL gives priority to affected people in Project related employment • BPDB is communicating to the GoB for taking some further initiatives for resettlement of the people who do not own the land but have been dependent on it	• Initiatives should be taken for resettlement of the people who do not own the land but have been dependent on it for their livelihoods; • To meet the international standard and guideline of the funding agencies, necessary measures have to be undertaken. • The proponent should take initiatives to engage the PAPs during construction stages according to their skills and capabilities.	In the process of Compliance

*Table 4.1: Monitoring of Environmental and Social Management System Action Plan Implementation **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		indigenous people etc.) • Provision of monitoring the compensation and resettlement process	for their livelihoods		
6	Livelihood and living condition	• Does the Project pose any threat to the livelihood/living standards of the local people? If yes, are adequate steps taken to reduce the impacts? • Has the company developed any policy which prioritizes the local laborers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers? • If yes, are there any mitigative steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?	• Recruited a social officer responsible for maintaining social liaison; • Engagement of Human Resources consultant for preparing HR policies, Labor recruitment Policies, Manpower set up etc.; • Construction of toilets for labor near labor shed; • Provision of first aid; • Setting up medical unit capable of dealing emergency situation like injury, accident, etc.	• Monitoring the status regularly • Awareness program and grievance redress mechanism should be adopted in formal way • Accidental log sheet or injury log book should be put into display	Being Complied
7	Green House Gas Controlling Measures	• Use of efficient generator in the construction activities; • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications; • Use of approved pollution control devices fitted in the equipment and machineries; • Switching off and throttling down the machines/equipment/generators which are not in use.	• Informing the bidders for EPC of main Plants about measures to be followed; • Making IFC guidelines, EIA approval of DoE, and EMP of the EIA, etc. as a part of the bid document.	• Prepare checklist on equipment and their condition owned by the contractors; • GHG inventory checklist might be mandatory for the EPC contractors. • Use low GHG emission machineries and CDM during main Plant construction.	To be complied during construction and operation stage

Table 4.2: Monitoring of Labor and Working Condition

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers; • Defined Working condition and Terms of Employment for direct worker; • Sustainably equivalent terms and condition for migrant workers; • Compliance to national law of forming workers' organization; • No discrimination and equal opportunity for all; • Measures for diminishing past discrimination; • Grievance Redress Mechanism.	• Engaged HR consultant to prepare relevant policies; • Preparing to recruit Environment, Occupation and Health Safety Expert; • No discrimination has been recorded.	• The proposed EMP measures should be addressed in the HR policies; • Local unskilled workers would be given priority during recruitment for non-technical jobs. • Grievance Redress Mechanism should be established.	BIFPCL agrees to comply all the measures
2	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child health or physical, mental, spiritual, moral, or social development. • No Forced Labor	• Ensured no child labor employment • Ensured no forced labor • Using of appropriate PPE	• The HR policy should cover child labor policy and Labor Law 2006 and all other amendments; • Proper documentation of contract with the worker is required, which includes working hour, wage, and benefit.	Agrees to comply

*Table 4.2: Monitoring of Labor and Working Condition **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
3	Safety at site	• Installation/Construction of Safety Fence around the Project area; • Use of Personnel Protective Equipments (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.); • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.); • Practice of Tool box meeting, safety talks • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.); • Maintaining Material Safety Data Sheet (MSDS); • Provision of Health care facilities such as doctor, hospital etc available at/nearby the plant construction site; • Availability of First Aid at work place; • Preparation and Follow of Emergency Response Plan; • Adequate fire precautions in place (e. g., fire extinguishers, escape routes etc.); • Documentation and reporting of occupational accidents, diseases, and incidents; • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS.	• Construction of boundary wall; • Encouraged labor and Project personnel to use appropriate PPEs; • Safety Policy of DoE and IFC, Safety measures proposed in EIA report have been incorporated in the bid document of main Plant to aware the potential bidders; • Included the EHS plan in the tender documents for the EPC contractor.	• The EPC contractor should prepare Health and Safety Plan and safety procedure which covers all the measures of the EMP; • They should create suitable environment for the workers, safety equipments and facilities, develop an emergency response system; • Improve present situation of first aid medical facilities before commencing the main plant construction, as such many patients can be treated simultaneously	Being Complied

*Table 4.2: Monitoring of Labor and Working Condition **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual measures already Implemented	Recommended Action	Compliance Status
4	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/Organogram • Preparation of Safety Policy to be adopted during Plant operation	• Engagement of HR consultant to develop HR policy and Organogram; • Medical aid, fire extinguisher, PPE are provided; • Worker's shed and sanitation facilities have been developed at construction site; • Onsite medical facilities have been continuing.	• Develop a complete EHS division in the HR Management; • Regular training, awareness, motivational and mock drill should be arranged at this pre-construction phase; • The EPC contractor should prepare a safety policy for Plant operation; • OHS should also be followed by all workers including the labor from sub-contractors.	BIFPCL agrees to comply with all the measures. EHS & OHS policy in line with World Bank standard formulated and Health and Safety manual prepared.
5	Workers Well Being	• Provision of Welfare facilities for Worker/Labor such as, timely bonuses, salaries, sick leaves, vacations etc.; • Routine medical check-up and emergency medical care for the sick and injured; • Appointment of a leader amongst the labor group, who will look into workers' well being.	• Engagement of HR consultant to develop HR policy and Organogram; • Health care & information, canteen, restrooms, accommodation are facilitated by the proponents.	• The workers well being should be protected in the HR policy • Freedom of Association, Rights & scope of bargaining and Tripartite consultation should be open for the workers.	Being Complied

Table 4.3: Monitoring of Community Health, Safety and Security

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project area; • Installation of water spraying system to control dusts; • Conducting dust monitoring and visual inspection around the site boundary; • Adoption of Noise management plan.	• Construction of boundary wall around the Project area already completed; • Water spray for dust suppression being carried out around the Plant office.	• Water spray along the road way/walk way, major working area, labor sheds needs to be carried out.	BIFPCL agrees to take more such measures
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism; • Maintaining open communication channel with the local community.	• A Social officer has been recruited to maintain close relation with nearby community; • Regular monitoring has been conducted to identify the grievance of the nearby communities ; • National level stakeholder consultation has been conducted.	• Establish a Grievance Redress Mechanism; • Establish a system to receive the grievance, and to take appropriate measures to redress it; • Regular local level consultation is necessary in presence of the officers from BIFPCL.	BIFPCL agrees to establish a grievance redress mechanism
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area; • Practicing Risk Assessment and Evaluation Process; • Practicing safe management for hazardous materials which may pose threat to the community; • Availability and operation of Emergency Response Plan;	• Construction of boundary wall around the Project area; • Incorporating safety policies to be followed in the bid documents for the appointment of EPC contractors; • Preparing a safety checklist to be followed during	• Assign responsibility of enforcing and monitoring safety procedure to an officer • Aware labors and all employees about the safety procedure; • The EPC contractors should prepare site specific ESMPs;	BIFPCL agrees to comply all the measures during construction stage

*Table 4.3: Monitoring of Community Health, Safety and Security **(continued)***

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		• Maintaining open communication channel with the local community; • Training and instruction to the security personnel about their behavior and communication with the local people; • Aware the security personnel about the right of the community people.	selection of construction contractors; • Maintaining a good communication with local community; • Negotiation with local DC office and Bangladesh Ansar and VDP (who are responsible for security).	• Arrange a safety training program for Project personnel and labors; • Training and instruction to the security personnel about their behavior and communication with the local people; • Aware the security personnel about safeguarding environment and community.	
4	Community Health Risk	• Provision of providing health service facilities to community if the Project poses any health risk like sexually transmitted disease, contract disease, vector-borne diseases; • Implement all pollution mitigation measures to ensure safeguarding to community.	• Established a medical unit (consisting medical officer, medical assistant, office assistant) at Plant site; • Arranging weekly health service program (medical consultation and free medicine) for the local community; • Provided health services to around 1608 people during October, 2015 to December, 2015.	• The proponent should train the migrated labour regarding the local culture and customs • The proponent may arrange consultation meeting with the local communities	Being Complied
5	Youth Employment	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the	• Informal sitting with the community	• Initiate awareness program for the local youth to let them aware about the required qualification to get	Will be complied during construction stage

*Table 4.3: Monitoring of Community Health, Safety and Security **(continued)***

Sl no	Potential Impacts	Proposed EMP	Actual measures already Implemented	Recommended Action	Compliance Status
		Project related activities		involved in the Project related activities; • Appropriate hands on and hands-off training sessions, building them up for employment; • Assign job responsibilities based on skills and previous experience.	
6	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting; • Sharing of Project information with local people; • Organizing environmental and social awareness programs/meetings.	• Informal sitting with the community; • Display Project related information on a display board at Project site; • Recruitment of a Public Relation Officer at head office; • Preparing a video documentation on Project related information; • Publishing Project related discussion/article in different print media.	• Arrange dissemination workshop in Dhaka and Khulna to aware the community, civil society, environmentalists about the environmental safeguarding measures considered in basic design.	Being Complied

Table 4.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel would cause deterioration of aquatic ecosystem.	• Installation of proper runoff drains; • Use of sediment fences, traps and basins for trapping the sediment, if required.	• Temporary installation of runoff drains; • Construction of sediment traps is mentioned in the Bid documents to instruct the bidders; • Preparing to develop the drainage network inside the Project boundary.	• Sediment trap should be developed to prevent sediment wash load to Maidara and Passur river to minimize the impact on the aquatic ecosystem prevailing there; • The proponent has to ensure a good drainage system in before commencing the construction works by the EPC contractor.	Will be complied during the construction stage
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank; • Implementation of onsite waste and air quality management plan; • Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Safety fence around the construction site; • Limiting the use of night light; • Using shade (directed downwards) around the outdoor lights; • Provision of cut-off time to switch off unnecessary lights at night;	• No cutting/ felling of trees occurred along the river bank; • Limiting soil extraction activities within the defined area; • Limiting the vegetation clearance and base stripping process within the Project boundary; • Construction of Boundary wall; • Installation of few numbers of night light; • Provision of cut-off time to switch off unnecessary lights at night; • Selection of local plant species	• Using of light shade (directed downwards) around the outdoor lights; • Regular monitoring of the trees planted around the Project site.	Being Complied

*Table 4.4: Monitoring of Biodiversity and Sustainable Management of Living Natural Resources **(continued)***

Sl no	Potential Impacts	EMP measures as proposed in the EIA	Actual condition/ Measures already Implemented	Recommended Action	Compliance Status
		• Initiate Green plantation; • No plantation of non-native species; • Retaining top soil for future habitat restoration; • No degradation of critical habitat?	for green plantation; • No degradation of critical habitat.		
3	Disturbance to river, inter-tidal areas and wet lands	• No encroachment of inter-tidal flood plain area; • No disturbance to Dolphin community; • Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health; • If required, embankment should be constructed considering a setback distance from river/canal bank; • Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come, and; • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal dynamics	• Monitoring of forest health and ecosystem health in Sundarbans and around the Project site are being carried out by CEGIS; • Maintaining significant setback distance from Passur river to the Project site; • Completion of slope protection work; • Revising the drawing of embankment/slope protection works along the Maidara River keeping necessary setback distance from Maidara River. • The stream flow of Maidara River near access road has been blocked by a temporary cross dam of LGED and BWDB requested to keep it for the time being for widening and channel improvement of Maidara River.	• The proponent should develop sediment trap before final discharge of rainfall runoff into the Maidara river; • BIFPCL may take initiatives to excavate the silted reach of Maidara River near proposed township area to facilitate proper functioning of the River for maintaining tidal dynamics. • For removal of blockade, BIFPCL has taken up this matter with BWDB through LGED to keep the natural stream flow of Maidara River as it is and ensure the water connectivity like before.	Being Complied

4.2 Compliance to Conditions of DoE

Sl no	Condition of DoE	Compliance	Remarks
1	This EIA Report is approved only for 1320 MW Khulna Coal Based Power Plant. Any expansion or extension of this Power Plant will require obtaining further Environmental Clearance with additional EIA Study.	Not applicable now	***BPDB will comply with the condition prior to initiation of any extension/ expansion.***
2	The Coal Specification and Power Plant technology should be maintained as per EIA report. In case any change in design the proponent must obtain consent from DoE.	The Coal Specification and Power Plant technology will be maintained as per EIA report. In case of any change in Plant design and coal specification the proponent is to obtain consent from DoE.	***BIFPCL will comply with the condition***
3	Project Proponent may undertake activities for land development and infrastructural development of the Project.	BIFPCL has started land and infrastructure development activities- under pre-construction stage.	***Complied***
4	Project Proponent may open L/C (Letter of Credit) for importing machineries for the Project which shall also include machineries relating to waste treatment plant and other pollution control devices.	BIFPCL will open L/C after finalizing the EPC contractor.	***To be Complied***
5	The activity under Proposed Khulna 1320 MW Coal based Thermal Power Plant Construction and operation shall not release any pollutant that affect human health or will have damaging impact on the environment or natural resources.	At present the Plant is in preliminary stage. BIFPCL engaged CEGIS for monitoring pre-construction and construction activities for examining environmental impacts. No damaging impact on the environment or natural resources impact has been reported yet.	***Complied at present***
6	Proper and adequate mitigation measures shall be ensured throughout preparation, construction and operation period of the proposed Khulna 1320 MW Coal based Thermal Power Plant Project activities.	Mitigation measures appropriate at this stage (pre-construction) have been taken. BIFPCL is monitoring adoption of mitigation measures through CEGIS, as an environmental monitoring consultant.	***Complied at present***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
7	Any heritage sight, ecologically critical area, and other environmentally, religious and archaeologically sensitive places shall be kept protected during Project construction phase.	Sundarbans, 14 km away from the Project site is the only critical area of concern here. There is no religious, archaeological place in and around the site. The pre-construction activities has been carried out ensuring safeguarding to Sundarbans and ECA	***Complied at present***
8	Environment friendly construction and development practices shall be followed that minimize loss of habitats and fish breeding, feeding & nursery sites.	The pre-construction activity is being carried out keeping all the mitigation measures in order.	***Being Complied***
9	Construction works shall be restricted to daytime hours so as to avoid/mitigate the disturbance of local lives as well as implementation schedules of the works shall be notified in advance to nearby residents.	The local communities are notably far from the Project site and the present activities are limited to day time only. BIFPCL is keeping close communication with local people to receive the grievance.	***Being Complied***
10	Proper and adequate sanitation facilities shall be ensured in labor camps throughout the proposed Project period.	The Project is in preconstruction phase. Adequate and hygienic sanitation facilities are being ensured before starting of major construction works	***Being Complied***
11	In order to control noise pollution, vehicles & equipment shall undergo regular maintenance; working during sensitive hours and locating machinery close to sensitive receptor shall be avoided.	All vehicles & equipments used at site are under regular maintenance.	***Being Complied***
12	No solid waste can be burnt in the Project area. An environment friendly solid waste management should be in place during the whole period of the Project in the field.	At present (pre-construction phase), insignificant amount of solid waste (mostly papers, construction waste, kitchen waste etc) is generated at site. No waste is burnt at site. However, a proper system of waste collection and disposal system will be maintained at site when the major construction work will be started.	***Being Complied***
13	Proper and adequate on-site precautionary measures and safety measures shall be ensured so that no habitat of any flora and	Pre-construction activities are being taken up with adequate on-site precautionary measures and safety measures to safeguard flora and fauna.	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	fauna would be endangered or destructed.		
14	All the required mitigation measures suggested in the EIA report along with the emergency response plan are to be strictly implemented and kept operative / functioning on a continuous basis.	BIFPCL has appointed a doctor for regular health check up of the workers and villagers. Surrounding areas are also availing the health care facilities. Emergency response plan shall be strictly implemented and kept operative/ functioning on a continuous basis.	***Being Complied***
15	To control dust, spraying of water over the earthen materials should be carried out from time to time.	Water is sprayed in the area around the premises of site office to control dust. A boundary wall around the Plant has been constructed to control dust. However, the Project management has informed that measures are being taken to reduce the impact of dust generated in the Project area.	***Being Complied***
16	Storage area for soils and other construction materials shall be carefully selected to avoid disturbance of the natural drainage.	Construction materials have been stocked and piled in some selected storage areas to avoid disturbance of the natural drainage.	***Being Complied***
17	Adequate considerations should be given to facilitate drainage system for runoff water from rain/tidal surge.	The Project authority has undertaken necessary actions to repair the damaged portion of the boundary wall as well as restore proper drainage system to facilitate drainage of the runoff water as required at this stage. Adequate drainage shall be ensured during construction and operation phase of the Plant.	***Being Complied***
18	Adequate facilities should be ensured for silt trap to avoid clogging of drain/canal/water bodies	Run off/ storm water drainage system shall have silt trap. BIFPCL has taken action to address the issues.	***Being Complied***
19	The entire coal handling system should be designed as an enclosed (and not only covered) conveyor system. There should be integrated dust control system with dust extraction and bag filters at unloading areas and at each transfer points on the conveyor	Entire coal handling system are being designed as an enclosed conveyor system as per DoE requirement. Integrated dust control system with dust extraction system / bag filter and dust suppression system at crusher house, unloading points, transfer points has been specified in the technical	***Being Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	system.	specification of Main Plant EPC contract package.	
20	Coal Plant should have high-efficiency bag filter for arresting dust emissions.	All these stipulations have been included in the technical specification of EPC contract package and will be implemented accordingly.	***Will be Complied***
21	Coal should be stored in a covered storage yard.	same as above	***Will be Complied***
22	The entire coal stockyard should be covered with water sprinkler provided with automated moisture sensor to control self-combustion.	same as above	***Will be Complied***
23	100% utilization of fly ash and bottom ash should be planned and implemented throughout the operation of the Plant. There should only be a provision of small ash dyke that will not exceed 25 (twenty five) acres of land to store residual ash.	100% utilization of fly ash is being planned and shall be implemented throughout the operation of the plant.	***Will be Complied***
24	Integrated dry ash handling, loading, unloading and transportation system should be established.	Integrated dry ash handling, loading, unloading and transportation system will be established.	***Will be Complied***
25	There should be adequate and properly sized and designed dry ash silo with appropriate conveyor system.	Adequate and properly sized dry ash silo with appropriate conveying system have been specified in technical specification of EPC contract package.	***Will be Complied***
26	Bottom ash should be extracted, crashed and stored in silos for utilization with proper collection and conveyor system.	Bottom ash shall be extracted, crushed and stored in silos for utilization with proper collection and conveying system. The procedures have been included in the technical Specification of EPC contract package.	***Will be Complied***
27	Resettlement and rehabilitation of the displaced population (including those who do not own land) should be done properly.	Resettlement and rehabilitation action has been taken as per the law of GoB. BPDB has approached to GoB for suitable resettlement and rehabilitation as per requirements of the DoE.	***Being Complied***
28	Resettlement plan should be properly implemented and people should be adequately compensated.	Mentioned above	***Being Complied***

Compliance to Conditionsof DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
29	Construction material should be properly disposed off after construction work is over.	At present the Plant is in preliminary site preparation (pre-construction) phase. Construction wastes are being reused at this stage.	***Being Complied***
30	As described in the report environmental monitoring should be strictly followed and monitoring report should be shared with DoE to ensure the environmental management properly.	BIFPCL has engaged CEGIS for environmental monitoring in February 2014. From then on, each quarterly monitoring report have been submitted regularly, based on study conducted for that period, to be shared with DoE, which are available at BIFPCL web page.	***Being Complied***
31	All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP clearly listed in the EIA report.	BIFPCL has adopted all of the EMP applicable at this stage. CEGIS, as an environmental consultant of BIFPCL is monitoring implementation of EMP. BIFPCL is taking all possible actions based on EMP monitoring report.	***Being Complied***
32	A third party/independent monitoring bodies excluding JVC/BPDB should be engaged immediately for monitoring of all activities during pre-construction, construction and operation phases as per monitoring plan of EIA report and monitoring report must be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	CEGIS, as an independent monitoring body has been engaged by BIFPCL as environmental consultant since February 2014. From then on, CEGIS has been conducting the monitoring programs quarterly and producing monitoring reports on regular basis which are submitted to BIFPCL for onward submission to the relevant offices as directed by DoE.	***Being Complied***
33	Regular monitoring of the susceptible places of Sundarbans for protecting ecosystem, biodiversity and forest coverage should be made using latest high resolution image for keeping ambient environment.	The Monitoring activities of CEGIS included this part. The monitoring report contains analysis of biodiversity and forest coverage. However, in addition to this, Forest Department has also suggested some survey & analysis which have also been monitored and reported by CEGIS.	***Being Complied***
34	Air, water, soil, biological and social data should be monitored regularly with a network monitoring system with a view to assess the natural quality of the Sundarbans and other fragile	The network monitoring system will be installed when the Plant will be in operation.	***Will be Complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	ecosystem and report of monitoring results should be submitted to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.		
35	There should be regularly disclosure of the report through workshops and websites and responses should be taken care accordingly.	All the reports are available on website of BIFPCL (www.bifpcl.com). CEGIS is regularly carrying out public consultation. The progress of the monitoring is regularly discussed in monthly Project implementation monitoring meeting in presence of PGCB, LGED, Bangladesh Army, BPDB, CEGIS, etc. The same is being reviewed by the Project Steering Committee, Chaired by the Secretary, Power Division, MoPEMR, Government of Bangladesh.	***Being Complied***
36	Online air and water quality monitoring system should be made functional throughout the life of the Plant.	The online monitoring system will be installed when the Plant will be in operation phase and will continue throughout the life time of the Plant. All these stipulations have been included in the technical specification of Main Plant EPC contract package.	***Will be Complied***
37	Management Information System (MIS) are to be developed for this coal based Power Plant. The scope of MIS services will obviously include representing the real time monitored data especially environmental parameters displaying at Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment, BPDB and other concern agencies/Ministries. The MIS should be web based for accessing every individual to show the real time monitored records.	The MIS will be prepared before commissioning of the Plant. The consultant for developing MIS will be engaged at least one year earlier. Specification for elaborate MIS system is already included in EPC contract document.	***Will be Complied***
38	JVC should provide all sort of	BIFPCL is ready to provide all sort of	***Ready to***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	logistics support to DoE and other relevant agencies for monitoring environment related items/events.	logistic support as and when required by DoE and other relevant agencies for monitoring of environmental items/events.	***comply***
39	No ground water should be allowed to use for plant purposes.	No ground water has been used so far for Plant purposes. The Plant has been designed considering use of surface water only.	***Complied at this stage***
40	Conduct stakeholder meetings on regular basis for better performance of the Project as a whole.	At present the Plant is in pre-construction phase. BIFPCL has appointed a social worker who regularly visits nearby community to consult with the local people. Besides, CEGIS, appointed by the Project authority as environmental monitoring consultant, is carrying out consultation with local people.	***Being Complied***
41	Additional Environmental baseline data to be collected as suggested in the EIA report and conveyed to DoE and other concern authorities.	In February 2014, CEGIS has been engaged for preparing Detail Environmental Baseline. CEGIS has submitted annual monitoring report along with reports of quarterly monitoring containing latest baseline data.	***Being Complied***
42	The Environmental Management Plan under the EIA study shall strictly be implemented and kept functioning on a continuous basis.	BIFPCL has been implementing all the EMP measures phase by phase as suggested in EIA report and by DoE which is regularly monitored by CEGIS.	***Being Complied***
43	The Project authority shall submit a detail work plan with time schedule of development activities at least 7 (seven) days ahead of the work commences in the field to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment simultaneously.	BIFPCL shall submit detail work plan before the start of Main Plant Works.	***Agreed to Comply.***
44	Environmental Monitoring Reports according to specific format specified in the EIA Report shall be made available simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of	Environmental Monitoring Reports as per specific format provided in the EIA Report shall be made available by BIFPCL simultaneously to DoE Bagerhat District Office, Khulna Divisional Office and Headquarters on a monthly basis during the construction period of the Project.	***Agreed to Comply.***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	the Project.		
45	The following records must be kept in respect if any samples required to be collected for the purpose of environmental monitoring activities: (a) the date(s) on which the sample was taken; (b) the time(s) at which the sample was collected; (c) the point at which the sample was taken; and (d) the name of the person who collected the sample.	The Monitoring report of CEGIS keeps all the records as suggested.	***Being Complied***
46	The results of any monitoring required to be conducted under this EIA report must be recorded.	CEGIS is recording all the monitoring data and submitting to BIFPCL through proper documentation. The report is being shared with DoE on regular basis.	***Being Complied***
47	In case of any emergency, the following information shall be immediately be reported to Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) simultaneously a) Nature of incident (oil spill, fire, accident. Collision, land slide, etc.) b) Personnel affected (injured, missing, fatalities, etc.) c) Emergency support available and its location (standby transport, medical facilities, etc.) d) Weather conditions e) Current operations (abandoning the site, fire fighting, etc.)	So far no such emergency has occurred. BIFPCL would establish a proper mechanism for recording such incident as suggested.	***Will be complied as and when required***
48	The Project authority or its employees must notify the department of Environment of incidents causing or threatening	BIFPCL would establish a proper mechanism for recording such incident as suggested.	***Agreed to Comply***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	material harm to the environment as soon as practicable after the person becomes aware of the incident.		
49	All pollution incidents shall be reported immediately and simultaneously to the Bagerhat District Office, Khulna Divisional Office and Headquarters of the Department of Environment (DoE) in Dhaka.	So far no such incident has been happened. BIFPCL would establish a proper mechanism for recording such incident as suggested. CEGIS has been engaged to record such incident during pre-construction and construction period	***To be Complied***
50	Appropriate permission would require to be obtained from the Forest Department in favor of cutting/felling on any plant/tree/sapling forested by any individual or government before doing such type of activity.	There will be no need of cutting/felling down of any trees. However, in future, if any such case would arise, BIFPCL would seek for appropriate permission	***To be Complied***
51	Re-vegetation and re-plantation under green belt activities shall be undertaken in consultation with the Forest Department according to those mentioned in the EIA report.	An MoU signed with Forest Dept., Bangladesh on 24.02.2015 for implementation of Afforestation Programme. Initial target is planting of 2 lac saplings in 3 years. By this time they have already planted about 9000 nos. of saplings of different species.	***Being Complied***
52	Climate Change impacts and maximum storm surge height shall have to consider at the design and construction phase.	The level (elevation) of the land and earthen embankment has been fixed considering the climate change impact and maximum storm surge height.	***Being Complied***
53	A separate EIA/morphological study shall have to be conducted for coal transportation and river dredging to develop sound environmental management plan towards conservation of ecosystem and biodiversity.	Mongla Port Authority (MPA) is the Implementing Agency for dredging. Coal transportation will be done through the existing maritime route, which is Mongla port controlled waterways. M/s IWM has already completed the EIA study for the dredging activity and submitted the report to MPA. A separate EIA study for coal transportation is being conducted by M/s CEGIS as per approved ToR of DoE. Inception Report for the said study has been submitted to BIFPCL.	***Being Complied***
54	A full-fledged institutional setup for EHS and CSR must be put in place before operation of the	A full-fledged institutional setup for EHS activities shall be in place before operation of the Plant (Project).	***Being complied***

Compliance to Conditions of DoE ***(continued)***

Sl no	Condition of DoE	Compliance	Remarks
	Power Plant.	Meanwhile, a number of CSR activities are ongoing at Project site, like free medical facilities and medicines, free potable water supply to the local people. BIFPCL has appointed a social worker to collect relevant social data.	
55	The Project authority shall extend active cooperation to DoE officials to facilitate their visit to the site as and when necessary.	BIFPCL is extending its all cooperation to DoE	***Being Complied***
56	Violation of any of the above conditions shall render this approval void.	Noted by BIFPCL	-
57	Any injunction on this Project from the Honorable Supreme Court/High Court Division shall render this approval void.	Noted by BIFPCL	-
58	Without installation of 275 Meter Height Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Settling Pond, Desalinization Plant, API Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring system and other pollution control equipment and obtaining Environmental Clearance Certificate, the proponent shall not start operation of the Project.	At present the Plant is in pre-construction phase. The functional technical specification of the main Plant includes 275 Meter high Chimney, Effluent Treatment Plant (ETP), Waste Water Treatment Plant (WWTP), Setting Pond, Desalinization Plant, API, Oil Water Separator, High Efficiency Electro Static Precipitator (ESP), 'closed-loop' Flue Gas Desulfurization (FGD), Low NOx Burner, online air and water quality monitoring systematic for preventing pollution. All these stipulations have been included in the technical specification of Main Plant EPC contract package.	***To be Complied***
59	This EIA Approval has been issued with the approval of the appropriate authority.	BPDB and BIFPCL are thankful to DoE.	-

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Appendix I: Checklist of Monitoring Environmental Compliances

Table A: Checklist of Monitoring for ESMP Implementation (During Pre-Construction and Land Development)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Generation of Noise within the BIFPCL's Plant premises	• Conduct noise survey around and inside the site boundary • Reducing Noise and Vibrations to country's ambient standards, and occupational health and safety standards • Introducing vehicle speed limit and speed limit monitoring system • Green Plantation around the Project boundary • Switching off/ throttling down of machines/equipments/generators which are not in use			
2	Dust Generation from Land development activities and other construction works	• Conducting dust monitoring and visual inspection around the site boundary • No use of earthen and undeveloped roads by vehicles related to the Project use • Installation of water spraying system to control fugitive dusts • Introducing vehicle speed limit and speed limit monitoring system • If yes, do they monitor vehicle speed regularly?			
3	Water Quality	• Fencing the construction site by drum sheet or Tarjja of any other fencing • Arrangement of runoff drainage for reducing any water logging • Location of backfilling stockpile in safe area and			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		protected from wind and rain action • No storing of backfilling materials/spoil stored on river bank/slope • No disposal of waste and waste water to river or canal.			
4	Waste Management System	• Provision of onsite waste management system			
5	Compensation and Resettlement	• Prepare Proper resettlement action plant and compensation plan if the Project needs any land acquisition addressing compensation, restoration, livelihood, living standards etc. based on proper socio economic studies • Resettlement of the PAPs • cash for compensation of land (CCL) before resettlement • formal agreement with the affected people prior to migration/resettlement • Sufficient standing crop compensation • Compensation for shift able structures? • Retention of salvageable materials? • Compensation for loss of trading income? • one time moving assistance • grant to cover loss of regular wage income • Has a resettlement plan been developed which includes compensation, restoration, livelihood, living standards etc. based on proper socio economic studies? • Provide/take extra care/caution for the disadvantaged/vulnerable group(s) (i.e. women, children, ethnic minorities, indigenous people etc.)			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• Provision of monitoring the compensation and resettlement process			
6	Livelihood and living	• Does the Project pose any threat to the livelihood/living standards of the local people? • If yes, are adequate steps taken to reduce the impacts? • Has the company developed any policy which prioritizes the local laborers in employment opportunities? • Is there any possibility that large vehicle related to the Project will cause traffic induced disturbance/s to the local dwellers? • If yes, are there any mitigative steps taken to decrease the disturbance/s? • Has the road network been developed after the Project being proposed and during the construction phase? • Are there separate water and sanitation facilities for the construction workers in the Project area?			
7	Green House Gas Controlling Measures	• Use of efficient generator in the construction activities • Regular maintenance of vehicles, generator and machinery in accordance with manufacturer's specifications • Use of approved pollution control devices fitted in the equipments and machineries • Switching off and throttling down the machines/equipments/generators which are not in use			

Table B: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Labor and Working Condition)

Basic Data

Sl No	Description	Values
1	Direct Workers	
2	Contracted Workers	
3	Supply Chain Workers	
	Child labor	
	0 - 12	
	13 - 14	
	14 - 18	

Checklist for Labor and Working Condition

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Working Conditions and Management of Worker Relationship	• Preparation of Human Resources Policies and Procedures for Direct workers • Defined Working condition and Terms of Employment for direct worker • Sustainably equivalent terms and condition for migrant workers • Compliance to national law of forming workers' organization • No discrimination and equal opportunity for all • Measures for diminishing past discrimination • Grievance Mechanism			
	Protecting Workforce	• The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous or to interfere with the child education, or to be harmful to			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		the child's health or physical, mental, spiritual, moral, or social development. • No Force Labor			
	Safety at site	• Installation/Construction of Safety Fence around the Project area • Use of Personnel Protective Equipments (i.e. safety suit, safety goggles, ear plug, safety shoes, gloves, dust mask, etc.) • Safety trainings for workers (i.e. fire control, working at height, working in heat, first aid etc.) • Practice of Tool box meeting, safety talks, • Safe Storage of Hazardous Chemicals (e.g. fuel, flammable chemical, toxic chemicals, etc.) • Maintaining Material Safety Data Sheet (MSDS) • Provision of Health care facilities such as doctor, hospital etc available at/nearby the plant construction site • Availability of First Aid at work place • Preparation and Follow of Emergency Response Plan • Adequate fire precautions in place (for example, fire extinguishers, escape routes etc.) • Documentation and reporting of occupational accidents, diseases, and incidents • Policies and procedures for managing and monitoring the performance of third party employers in relation to OHS			

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
	Occupational Health and Safety Procedure	• Provision of complete EHS division in the Human Resources Planning/Organogram • Preparation of Safety Policy to be adopted during plant operation			
	Worker's Well Being	• Establishment Grievance Mechanisms • Ensuring fair treatment, non discrimination and equal opportunity • Compliance of Project's labor policy with the national labor law • No Child Labor • No incident of forced labor • Provision of Welfare facilities for Worker/Labor			

Table C: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Community Health, Safety and Security)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Disturbance to nearby community due to dust from newly developed land and Noise from construction activities	• Construction of boundary wall around the Project are • Installation of water spraying system to control dusts • Conducting dust monitoring and visual inspection around the site boundary • Adoption of Noise management plan			
2	Grievance of local people	• Availability and operation of Grievance Redress Mechanism • Maintaining open communication channel with the local community			
3	Risk of breaching Community Safety	• Construction of boundary wall/safety fence around the Project area • Practicing Risk Assessment and Evaluation Process • Practicing safe management for hazardous materials which may pose threat to the community • Availability and operation of Emergency Response Plan • Maintaining open communication channel with the local community • Training and instruction to the security personnel about their behaviour and			

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		communication with the local people • Aware the security personnel about the right of the community people			
	Community Health Risk	• Provision of providing health service facilities to community if the Project posses any health risk like sexually transmitted disease, communicable disease, vector-borne diseases • Implement all pollution mitigation measures to ensure safeguarding to community			
	Youth Employment	• Providing training/awareness program for the local youth to let them aware about the required qualification to get involved in the Project related activities			
	Public Communication, Consultation and Awareness	• Arranging public communication/consultation meeting • Sharing of Project information with local people • Organizing environmental and social awareness programs/meetings			

Table D: Checklist of Monitoring ESMP Implementation (During Pre-Construction and Land Development)

(Biodiversity and Sustainable Management of Living Natural Resources)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
1	Runoff (contain mostly sediment load) from newly developed land falls into nearby river and channel.	• Installation of proper run on/runoff drains • Use of sediment fences, traps and basins for trapping the sediment, if required			
2	Disturbance to nearby ecosystem due to different construction activities	• No cutting/ felling of trees along the river bank • Implementation of on-site waste and air quality management plan • Limiting soil extraction activities limited within the defined area • Limiting the vegetation clearance and base stripping process within the Project boundary • Safety fence around the construction site • Limiting the use of night light • Using shade (directed downwards) around the outdoor lights • Provision of cut-off time to switch off unnecessary lights at night • Initiate Green plantation • No plantation of non-native species • Retaining top soil for future habitat restoration • No degradation of critical habitat?			
3	Occupation of river, inter-tidal areas and wetlands	• No encroachment of inter-tidal flood plain area • No disturbance to Dolphin community			Complied

(continued)

Sl no	Potential Impacts	Proposed EMP	Actual Implementation	Recommended Action	Compliance Status
		• Monitoring of Ecosystem Health and Monitoring of Sundarbans Forest Health • If required, embankment should be constructed considering a setback distance from river/canal bank • Slope protection work along the Maidara River should be completed on an urgent basis before rainy season come and • BIFPCL may take initiatives of excavating of silted reach of Maidara river near proposed township area to facilitate proper functioning of River for maintaining tidal dynamics			

Appendix II: Photo Album

Environmental Monitoring of Rampal 1320 MW Power Plant for 4th Quarter of 2nd Year *(January 2016)*

The Monitoring Team

Estimating Light Intensity by Lux Meter at Karamjal

Recording forest data at Akram Point

(continued)

	
Laying out of Plot at Harbaria	Collecting SRF soil sample by Augering from Akram Point
	
Conducting Ecology & Biodiversity monitoring at Chakgona village	Observe Tree Canopy cover with Densiometer
	
Taking Tree DBH at Akram Point	Collecting Benthos at Harbaria

(continued)

	
Cross-checking of present data with previous	Counting woody debris at Akram Point
	
Acquiring noise data at Harbaria	Collecting river bed sediment sample from Akram Point
	
Temporary cross-dam over Maidara River restricting natural flow	Environmental Experts visiting the Plant site for EMP status monitoring

	
Workers recycling the scrap materials	Road construction for the Project in progress
	
Length frequency survey for Fish of Passur R.	Fish community structure evaluation at Harbaria
	
Choto Charer gher at Rajnagar	Capture fish habitat at Chalna point

	
Capture fish habitat at Akram Point	Capture fish habitat at Haldikhali
	
Capture fish habitat at Maidara River	Capture fish habitat at Harbaria

Appendix III: Terms of References (ToR)

As per ECA 1995 and ECR 1997, the proposed Project "1320MW coal based thermal Power Plant at Rampal, Khulna" falls under red category; needs proper monitoring and documenting of environmental and socio-economic parameters.

Accordingly, the EIA study of the proposed plant has already been conducted. The EIA of the proposed Power Plant briefly describes the monitoring plan. The ToR has been prepared for engaging Engineering, environmental and social Contractor for monitoring the environmental and socio-economic parameters during pre-construction and construction phases along with the engineering consideration of the site development and construction of the Project so that the monitoring plan suggested in the EIA is properly followed and satisfies the requirement of ECR 1997 and ECR 2005.

The monitoring works has been divided in to two major components:

Work A: Monitoring of Engineering activities of site development and others.

Work B: Monitoring of Social and Environmental parameters for updating the baseline and Implementation of the Project.

Work A: The main objective of this component is to monitoring the engineering activities of site development and others during pre-construction and construction phase for installation of the Power Plant.

The specific objectives of the monitoring program are:

- To establish baseline environmental conditions;
- To detect adverse environmental impacts for river dredging and land filling activities for site development;
- To demonstrate whether the environmental control measures are operating as per designed;
- To provide data for emission inventories;
- To provide data at regular intervals for dissemination to the stakeholders
- To provide data for improvement and updating of the monitoring program;
- To assist in investigating the event of a trigger level or emission limit value being crossed.

Landfill monitoring is an interactive process of incorporating the findings of the site investigation, the environmental impact assessment, environmental monitoring results, risk assessment and the conclusions reached in the investigations.

Work B: The main objective of this component is to monitor the environmental parameters and implementation of environmental management plan during pre-construction and construction phase for installation of the Power Plant. The specific objectives of the monitoring program are:

- Update baseline data as per monitoring schedule and location.
- Monitor and provide the environmental parameters during pre construction activities.
- Provide technical assistance to the client for implementation of the EMP at different sector of construction activities.
- Monitor the environmental aspects during construction of the Project.
- Review the EIA document to evaluate the EMP measures incorporated in the contract to mitigate different social and environmental hazards and risks during construction of the Project

- Submit progress reports to the client.
- Render any other related services as and when requested.

The scope of the services can be specified as bellows:

Monitoring Parameter	Indicators
Socio-economy	Livelihood and Occupation
	Income and expenditure
	Displacement and Migration
	Cultural and heritage
	Health and sanitation
	Risks and accidental assessment
	Transportation and communication
	Public and private Infrastructure development
Ecology and Biodiversity	Bio-indicator Assessment
	Movement of indigenous/ native species
	Envision of exotic species and regime dominance
	Species composition (Flora and Fauna)
	Assessment the services of dependent ecosystem
Agriculture	Land use and canopy coverage
	Soil quality (Salinity, pH, OM,)
	Cropping pattern and crop intensities
	Irrigation and crop production
	Farmers survey result
Fisheries	Fish diversity and specification
	Fish production and availability
	Fisher survey result
Noise level	Sound level at the sensitive zone
Water resources	DO, BOD, COD, Salinity , TDS, TS, pH, Hg, Pb
	Total Hardness, Hg, NO_3 and PO_4
	River Morphology,
	Tidal inundation
	Drainage Network
	Erosion and Accretion
	Ground water quality
Air quality	SOx
	NOx
	SPM (PM_{10} and $PM_{2.5}$)
	CO

Reporting Requirements

As it is proposed to carry out the monitoring program for three (3) years, the schedule of deliverables has to be re-scheduled. The proposed deliverables are scheduled below

- An Inception Report shall be submitted within 30 (thirty) days from the commencement of the assignment
- Submission of 1st quarterly monitoring report at the end of three (3) months from the date of signing contract;
- Submission of 2nd quarterly monitoring report at the end of six (6) months from the date of signing contract;
- Submission of 3rd quarterly monitoring report at the end of nine (9) months from the date of signing contract;
- Submission of Annual (1st) monitoring report at the end of one (1) year from the date of signing contract;
- Submission of 5th quarterly monitoring report at the end of fifteen (15) months from the date of signing contract;
- Submission of 6th quarterly monitoring report at the end of eighteen (18) months from the date of signing contract;
- Submission of 7th quarterly monitoring report at the end of twenty one (21) months from the date of signing contract;
- ***Submission of Annual (2nd) monitoring report at the end of twenty four (24) months from the date of signing contract;***
- Submission of 9th quarterly monitoring report at the end of twenty seven (27) months from the date of signing contract;
- Submission of 10th quarterly monitoring report at the end of thirty (30) months from the date of signing contract;
- Submission of 11th quarterly monitoring report at the end of thirty three (33) months from the date of signing contract;
- Submission of Annual (3rd) monitoring report at the end of thirty three months from the date of signing contract;
- All report shall be submitted to BIFPCL in (five) hard copies and soft copy on CD.

Appendix IV: Monitoring Data

(A) Air Quality Data

Table A.1: Ambient Air Quality Monitoring Results

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
Weather		Sunny	Rainy/ Cloudy	Sunny	Sunny	Sunny	Rainy/ Cloudy	Sunny to Rainy	Sunny						
Wind Direction		SE	SE	SE	NW	SE to NW	SW to NE	SW to NE	NW to SE						
		Concentrations are in µg/m^3													
SW Corner of the PP area	$PM_{2.5}$	33	37	25	33	47	25	22	34					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	78	77	53	79	83	35	52	135					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	207	239	190	200	177	42	91	175					*(200)*	*NF*
	SO_2	21	24	19	23	15	52	35	14					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	26	29	27	31	29	35	29	18					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	120	188	140	190	144	146	88	74					*(10000)*	*NF*
	O_3	27	26	19	22	26	12	5	4					*(157)*	*(100)*
Proposed Township area of the PP	$PM_{2.5}$	39	48	48	39	34	18	17	35					*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	89	90	74	102	97	31	48	116					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	217	263	217	274	266	47	79	192					*(200)*	*NF*
	SO_2	19	28	22	21	22	58	27	13					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	29	39	27	26	24	46	25	16					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	165	210	230	164	136	127	102	77					*(10000)*	*NF*
	O_3	33	26	26	23	21	16	1	1					*(157)*	*(100)*
NW Corner of the PP area	$PM_{2.5}$	37	44	19	42	59	28	19	24					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	67	78	56	98	91	96	29	125					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	234	217	157	310	244	321	66	187					*(200)*	*NF*
	SO_2	19	22	18	27	21	56	32	13					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	23	28	22	32	39	43	21	18					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	110	178	110	210	140	133	87	77					*(10000)*	*NF*
	O_3	25	19	17	36	44	11	8	2					*(157)*	*(100)*
Barni, Gaurambha	$PM_{2.5}$	39	47	57	39	41	34	11	29					*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	103	122	67	97	82	65	26	97					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	233	244	183	277	236	79	112	176					*(200)*	*NF*
	SO_2	21	23	17	22	25	41	31	16					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	25	28	22	26	27	44	32	21					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	175	210	190	150	196	96	96	81					*(10000)*	*NF*
	O_3	26	29	22	19	15	9	6	4					*(157)*	*(100)*
Chunkuri-2, Dacope	$PM_{2.5}$	35	39	46	37	33	35	28	31					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	77	86	69	68	61	109	49	98					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	117	113	162	183	188	175	94	167					*(200)*	*NF*
	SO_2	19	24	21	18	11	55	33	21					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	23	26	27	24	18	49	23	16					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	190	205	170	170	33	133	75	70					*(10000)*	*NF*
	O_3	27	24	18	22	41	21	2	1					*(157)*	*(100)*
Pankhali, Dacope	$PM_{2.5}$	47	49	57	41	39	-	25	47					*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	119	127	139	101	105	144	62	128					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	297	266	254	208	299	339	183	198					*(200)*	*NF*
	SO_2	28	31	31	24	30	58	36	18					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	41	39	36	26	27	47	23	15					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	230	217	250	188	177	125	105	101					*(10000)*	*NF*
	O_3	49	38	36	27	11	13	5	2					*(157)*	*(100)*
Mongla Port area	$PM_{2.5}$	47	55	39	41	26	33	19	34					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	139	174	77	82	35	52	33	132					*150^{24hr} (233)*	*50^{24hr} (78)*
	SPM	288	303	197	217	214	118	65	189					*(200)*	*NF*
	SO_2	27	28	26	24	14	45	36	16					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	44	39	33	27	17	40	20	13					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	230	320	220	211	24	110	84	71					*(10000)*	*NF*
	O_3	57	52	37	26	09	15	8	3					*(157)*	*(100)*
Harbaria, Sundarbans	$PM_{2.5}$	19	22	33	27	24	27	24	26					*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	41	39	59	56	49	42	50	82					*150^{24hr} (233)*	*50^{24hr}(78)*
	SPM	111	117	129	139	109	70	73	159					*(200)*	*NF*
	SO_2	9	10	14	12	16	51	34	15					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	19	22	27	18	22	34	22	14					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	65	58	70	64	56	112	81	62					*(10000)*	*NF*
	O_3	13	12	13	11	14	12	4	2					*(157)*	*(100)*
Akram Point, Sundarbans	$PM_{2.5}$	17	19	23	18	49	-	25	18					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	39	44	32	39	77	-	32	77					*150^{24hr} (233)*	*50^{24hr}(78)*
	SPM	114	133	97	88	102	-	51	128					*(200)*	*NF*
	SO_2	7	9	12	13	21	-	27	14					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	17	19	22	17	27	-	19	15					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	49	60	50	46	163	-	92	64					*(10000)*	*NF*
	O_3	11	14	9	10	27	-	8	1					*(157)*	*(100)*
Hiron Point,	$PM_{2.5}$	15	23	19	17	28	-	27	-					*65^{24hr} (100)*	*25^{24hr} (39)*

Locations of Monitoring	Pollutants	1st QM, Apr 2014	2nd QM, Jul 2014	3rdQM, Oct 2014	4th QM, Jan 2015	5th QM, Apr 2015	6th QM, Jul2015	7th QM, Oct 2015	8 QM, Jan 2016	9th QM, Apr 2016	10th QM, Jul 2016	11th QM, Oct 2016	12th QM, Jan 2017	Bangladesh (DoE) Standard (ECR 2005)	IFC/WB Standard
	PM_{10}	44	38	34	41	60	-	45	-					*150^{24hr} (233)*	*50^{24hr}(78)*
	SPM	101	119	107	97	110	-	88	-					*(200)*	*NF*
	SO_2	8	7	13	14	15	-	28	-					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	18	18	19	22	20	-	23	-					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	52	62	65	60	60	-	93	-					*(10000)*	*NF*
	O_3	14	13	11	9	23	-	2	-					*(157)*	*(100)*
Khulna City, near Khan Jahan Ali Bridge	$PM_{2.5}$	54	39	52	42	55	46	19	35					*65^{24hr} (100)*	*25^{24hr} (39)*
	PM_{10}	139	117	91	84	75	89	49	112					*150^{24hr} (233)*	*50^{24hr}(78)*
	SPM	301	287	239	219	222	181	101	181					*(200)*	*NF*
	SO_2	33	29	33	28	31	59	28	16					*365^{24hr} (455)*	*125^{24hr} (80)*
	NOx	49	41	39	36	33	38	26	16					*100^{Annual} (405)*	*200^{1hr} (162)*
	CO	330	370	330	296	101	89	94	98					*(10000)*	*NF*
	O_3	59	67	57	39	21	7	4	2					*(157)*	*(100)*

Note(s):

- *Concentrations are in µg/m³ ;*
- *DoE- Department of Environment, NF – Not found;*
- *Fine Particulate Matter ($PM_{2.5}$), Respirable Dust Content (PM_{10}), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_X). Sulfur dioxide (SO_2), Carbone Monoxide (CO) & Ozone (O_3);*
- *All Standards within parentheses "()" are calculated for 8hr or collected directly from standard guidelines for 8hr;*
- *Standards for 1hr, 24hr or Annual are indicated using superscript;*
- *This monitoring was carried out by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech India APM-550).*

Table A.2: Baseline conditions of emission of different infrastructures and sources

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
SW Corner of the PP area	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Proposed Township area of the PP	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
NW Corner of the PP area	PM	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Barni, Gaurambha	PM	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

Table A.2: Baseline conditions of emission of different infrastructures and sources ***(continued)***

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
	SOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Chunkuri-2, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Pankhali, Dacope	PM	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
Mongla Port area	PM	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	SOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓
	NOx	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
	GHGs	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓
Harbaria, Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

Table A.2: Baseline conditions of emission of different infrastructures and sources ***(continued)***

		Cement Industry	Condensate Fractionating Plant	LPG Bottling Plant	Brick Field	Road Traffic	Small vessels, engine boat	Inland Water Cargo vessel	Sea going Mother Vessel (MV)	Fly ash Carrier	Clinkers Carrier	Clinker, Fly Ash Handling	Coal Carrier (MV)	Coal Ash Carrier (MV)	Coal Carrier (Lighter Vessel)	Coal Ash Carrier (Lighter Vessel)	Coal Loading and Unloading	Coal Handling (Stock Yard, Conveyor belt, etc)	BIF Power Plant (PP)	Other Coal Based PP	Other Fuel Based PP	Dredging and Land Filling	Earth excavation	Other Construction Activities	Residential sources
	SOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Akram Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Hiron Point Sundarbans	PM	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	SOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	NOx	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	GHGs	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Khulna City, near Khan Jahan Ali Bridge	PM	✓	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓
	SOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	NOx	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	GHGs	✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓

Legend ✗ *Absence of source or no emission,* ✓ *Presence of source, emission of pollutant*

CEGIS

(B) Water Quality Data

➢ Surface Water Quality Monitoring Data

Table B.1: pH Values of Passur River Water

Sl	Sampling Locations	pH Values								
		1st year				2nd Year				BD Standard
		Apr	July	Oct	Jan	Apr	July	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.1	7.9	7.6	7.8	7.6	7.1	6.5 – 8.5
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	7.2	7.0	8.2	8.0	7.7	7.9	7.58	7.3	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	7.2	6.9	8.0	8.1	7.8	7.8	7.64	7.3	
4	Left Bank of Passur River at Project site-Jetty	7.9	7.1	8.1	7.9	7.5	7.9	7.6	7.1	
5	Middle Passur River at Project site-Jetty	7.1	6.9	8.1	7.9	7.6	8	7.58	7.5	
6	Right Bank of Passur River at Project site-Jetty	7.1	6.9	8.2	7.9	7.7	8	7.62	7.6	
7	Left Bank of Passur River at South West corner from the Project boundary	7.4	7.0	8.1	7.6	7.5	8.1	7.78	8.1	
8	Middle of Passur River at South West corner from the Project boundary	7.4	6.9	8.0	7.5	7.2	8	7.6	8	
9	Right Bank of Passur River at South West corner from the Project boundary	7.3	6.8	8.0	7.8	7.3	8.1	7.64	7.9	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	7.4	6.9	8.1	7.7	7.5	8.1	7.3	7.3	
11	Maidara river near proposed township area	7.4	6.8	8.1	7.3	7.6	6.9	7.56	7.1	
12	Passur river at Passur-Ghasiakhali confluence	7.3	6.8	7.4	8.2	7.5	7.9	7.1	7.4	
13	Passur river at Harbaria of Sundarbans	7.9	6.9	8.0	8.1	7.7	7.9	7.8	8.2	

Sl	Sampling Locations	pH Values								
		1st year				2nd Year				BD Standard
		Apr	July	Oct	Jan	Apr	July	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
14	Passur river at Akram point of Sundarbans	7.2	6.9	7.9	8.1	7.7	NS	7.63	8	
15	Passur river at Hiron po.000int of Sundarbans	7.2	7.0	7.0	8.1	7.7	NS	7.39	NS	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.2: Surface Water Temperature in Passur River

Sl	Sampling Locations	Temperature (°C)								
		1st Year				2nd Year				BD Standard
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	19	30	31.8	31.2	22.0	20°C – 30°C
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	31	33	31	20	30	30.5	31.8	21.0	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	31	33	30	20	30	30.5	30.9	21.0	
4	Left Bank of Passur River at Project site-Jetty	31	33	31	19	31	30.8	31.3	22.0	
5	Middle Passur River at Project site-Jetty	30	32	31	19	30	30.6	31.6	22.0	
6	Right Left Bank of Passur River at Project site-Jetty	30	32	31	19	30	30.4	31.1	21.0	
7	Left Bank of Passur River at South West corner from the Project boundary	31	32	30	20	31	30.5	30.3	23.0	
8	Middle of Passur River at South West corner from the Project boundary	31	31	29	19	30	30.8	30.5	22.0	
9	Right Bank of Passur River at South West corner from the	31	31	29	19	31	30.6	30.8	21.0	

	Project boundary									
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	30	31	28	19	30	30.8	31.8	22.0	
11	Maidara river near proposed township area	30	32	27	20	30	31.6	31.2	23.0	
12	Passur river at Passur-Ghasiakhali confluence	29	30	32	19	30	29.8	30.7	21	
13	Passur river at Harbaria of Sundarbans	30	30	27	22	30	29.0	30.8	22.0	
14	Passur river at Akram point of Sundarbans	29	29	30	21	30	NS	30.2	21.0	
15	Passur river at Hiron point of Sundarbans	29	30	29	21	30	NS	30.4	NS	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.3: Salinity (ppt) in Passur River

Sl	Sampling Locations	Salinity (ppt)							
		1st Year				2nd Year			
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan
		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	2.5	0.0	4.5	13	0	0	4.1
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.3	0.0	4.1	15	0	0	4.3
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	11.5	0.2	0.0	4.5	16	0	0	4.3
4	Left Bank of Passur River at Project site-Jetty	12.0	2.2	0.0	4.7	9	0	0	4.4
5	Middle of Passur River at Project site-Jetty	12.0	0.3	0.0	5.1	13	0	0	5.1
6	Right Bank of Passur River at Project site-Jetty	12.0	0.5	0.0	5.0	14	0	0	5
7	Left Bank of Passur River at South West corner from the Project boundary	9.5	4.0	0.0	5.2	14	0	0	5.2
8	Middle of Passur River at South West corner from the Project boundary	9.0	0.0	0.0	5.2	13	0	0	4.9
9	Right Bank of Passur River at South West corner from the Project boundary	10.0	2.5	0.0	5.1	12	0	0	5.5
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	10.0	0.5	0.0	5.2	10	0	0	3.8
11	Maidara river near proposed township area	9.0	4.5	0.0	4.5	9	0	0	2.5
12	Passur river at Passur-Ghasiakhali confluence	10.0	9.5	0.0	5.0	14	0	0	4.8
13	Passur river at Harbaria of Sundarbans	12.0	10.0	0.0	6.0	15	0	0	5.3
14	Passur river at Akram point of Sundarbans	19.0	15.0	1.0	16.0	20	NS	5	11.3
15	Passur river at Hiron point of Sundarbans	23.0	19.5	2.0	23.0	25	NS	6.2	NS

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.4: Dissolve Oxygen in Passur River

SL	Sampling Locations	Dissolve Oxygen (mg/L)								
		1st Year				2nd Year				BD Standard
		Apr	Jun	Oct	Jan	Apr	July	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.9	6.1	5.6	5.5	6.2	5.3	6.8	5.1	5 or more (standard for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	6.8	7.7	6.6	6.4	5	6.4	5.1	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	5.2	6.7	7.7	6.7	6.2	5	7.1	6.2	
4	Left Bank of Passur River at Project site-Jetty	5.7	6.8	7.6	5.8	6.2	6.7	6.8	5.9	
5	Middle of Passur River at Project site-Jetty	5.9	6.9	7.2	5.9	6.6	6.6	7.2	5.3	
6	Right Bank of Passur River at Project site-Jetty	5.8	6.6	8.0	6.8	6.4	6	7.6	5.4	
7	Left Bank of Passur River at South West corner from the Project boundary	6.6	7.3	5.6	6.1	6.3	7.5	6.4	6	
8	Middle of Passur River at South West corner from the Project boundary	6.5	7.1	5.6	6.9	6.5	7.4	6.1	6.1	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	7.2	5.8	6.6	6.4	7.3	6.3	5.8	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	6.0	6.5	8.0	6.0	6.2	6	7.1	4.1	
11	Maidara river near proposed township area	6.7	6.8	8.0	6.2	6.5	6.4	7.1	5.2	
12	Passur river at Passur-Ghasiakhali confluence	5.3	6.2	7.0	6.5	6.3	7	6.6	5.4	
13	Passur river at Harbaria of Sundarbans	5.4	5.9	7.0	6.6	5.8	7.5	7.1	5.2	
14	Passur river at Akram point of Sundarbans	7.9	6.4	7.7	6.7	6	NS	7.3	6.2	
15	Passur river at Hiron point of Sundarbans	7.5	6.5	7.8	6.5	5.8	NS	7	NS	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring (April, 2014), 2QM = Second Quarterly Monitoring (July, 2014), 3QM = Third Quarterly Monitoring (October, 2014), 4QM = Fourth Quarterly Monitoring (January 2015)

Table B.5: BOD_5 of Passur River Water

SL	Sampling Locations	Biochemical Oxygen Demand (mg/L)								BD Standard
		1st Year				2nd Year				
		Apr	Jul	Oct	Jan	Apr	July	Oct	Jan	
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	4QM	
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	3.4	2.2	1.9	1.6	3.1	3	2.1	2.1	6 or less (for sustaining fisheries)
2	Middle of Passur River at 100m u/s of North West corner from the Project boundary	4.9	3.3	4.1	2.3	3.2	2.4	1.9	2.2	
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	2.2	2.8	3.4	2.7	3.1	2.9	3.4	1.9	
4	Left Bank of Passur River at Project site-Jetty	3.2	3.1	4.0	0.8	3	4.4	3.2	1.1	
5	Middle Passur River at Project site-Jetty	3.0	2.5	3.5	1.4	3.5	4.3	3.7	2.4	
6	Right Left Bank of Passur River at Project site-Jetty	5.8	3.5	3.6	2.0	3.4	3.7	2.9	1.7	
7	Left Bank of Passur River at South West corner from the Project boundary	3.9	2.8	2.6	1.0	3.1	5.3	2.2	1.2	
8	Middle of Passur River at South West corner from the Project boundary	3.8	3.3	2.8	2.6	3.2	5.2	2.3	2.3	
9	Right Bank of Passur River at South West corner from the Project boundary	6.5	3.8	2.9	2.1	3.4	5	3.1	2.4	
10	Maidara river of the South East corner of the Project at Ichamoti-Maidara confluence	3.2	3.3	5.5	1.5	3.2	3.9	4.2	2.7	
11	Maidara river near proposed township area	4.1	3.7	4.0	2.0	3.4	4.2	1.6	1.8	
12	Passur river at Passur-Ghasiakhali confluence	2.3	2.2	1.7	2.0	3.3	4.9	2.1	2.2	
13	Passur river at Harbaria of Sundarbans	2.2	2.5	2.6	1.9	2.4	3.9	2.7	2.1	
14	Passur river at Akram point of Sundarbans	5.0	2.9	3.7	2.2	3	NS	2.2	2.4	
15	Passur river at Hiron point of Sundarbans	4.3	2.7	3.9	2.3	2.7	NS	2.5	NS	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring, NS – Not Surveyed

Table B.6: COD of Passur River System

Sl	Sampling Locations	COD (mg/L)						
		1st Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	July	Oct
		1QM	2QM	3QM	4QM	1 QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	288	24	6	128	87	42	32
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	284	20	30	68	58	43	36
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	328	56	14	92	132	18	28
4	Left Bank of Passur River at Project site-Jetty	376	28	18	84	102	26	36
5	Middle Passur River at Project site-Jetty	400	60	14	116	110	21	36
6	Right Bank of Passur River at Project site-Jetty	364	496	18	108	88	24	40
7	Left Bank of Passur River at South West corner from the Project boundary	364	108	10	104	96	32	42
8	Middle of Passur River at South West corner from the Project boundary	400	40	22	16	18	25	28
9	Right Bank of Passur River at South West corner from the Project boundary	408	120	10	100	106	25	48
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	276	32	10	116	88	51	40
11	Maidara river near proposed township area	284	96	26	84	94	36	42
12	Passur river at Passur - Ghasiakhali confluence	408	172	14	96	92	30	46
13	Passur river at Harbaria of Sundarbans	372	216	14	96	102	26	36
14	Passur river at Akram point of Sundarbans	536	520	54	316	302	NS	84
15	Passur river at Hiron point of Sundarbans	540	416	122	472	470	NS	96

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.7: Oil and grease concentration of Passur River System

Sl	Sampling Locations	Oil and Grease (mg/L)							ECR, 1997 (mg/L)*	IFC, 2007 (mg/L)
		1st Year				2nd year				
		Apr	Jul	Oct	Jan	Apr	Jul	Oct		
		1QM	2QM	3QM	4QM	1QM	2QM	3QM		
1	Left Bank of Passur River at South West corner from the Project boundary	<5	<5	<5	>15	16.9	9	<5	10	10
2	Passur-Ghasiakhali Confluence	<5	<5	<5	>15	13	7.63	9.87		
3	Passur river at Harbaria of Sundarbans	<5	6.3	<5	>20	39.1	10.1	<5		
4	Passur river at Hiron point of Sundarbans	<5	<5	<5	>20	<5	NS	10.8		
5	Akram Point of Sundarbans	<5	<5	<5	>20	<5	NS	9.73		

Table B.8: TDS, TH and TSS of Passur River System

SL	Sampling Locations	TDS (mg/L)							TH (mg/L)							TSS (mg/L)						
		1St Year				2nd year			1St Year				2nd year			1St Year				2nd year		
		Apr	Jul	Oct	Jan	April	July	Oct	April	Jul	Oct	Jan	April	July	Oct	Apr	Jul	Oct	Jan	April	July	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	**Left Bank of Passur River at 100m u/s of North West corner from the Project boundary**	13060	251	176	4360	14400	937	158	2900	250	216	930	3000	245	250	59	126	234	180	160	26	76
2	**Middle of Passur River at 100m u/s of North West corner from the Project boundary**	12630	246	162	3950	14700	941	169	2500	180	218	870	3050	110	330	45	92	193	210	167	25	80
3	**Right Bank of Passur River at 100m u/s of North West corner from the Project boundary**	12900	383	153	4330	14900	127	152	2650	170	335	870	3250	105	360	53	112	174	230	170	127	65
4	**Left Bank of Passur River at Project site-Jetty**	13190	445	169	4750	14600	175	172	2550	175	390	940	3450	118	365	54	99	227	450	160	30	92
5	**Middle Passur River at Project site-Jetty**	13330	353	156	4920	14500	132	162	2600	275	340	990	3250	103	355	60	100	232	250	165	27	85
6	**Right Bank of Passur River at Project site-Jetty**	13380	402	152	4870	14200	156	160	2625	350	355	970	3200	105	350	55	105	186	200	155	40	97
7	**Left Bank of Passur River at South West corner from the Project boundary**	13180	655	162	5040	14500	336	192	2550	325	330	1045	3600	153	345	24	116	185	300	150	32	104
8	**Middle of Passur River at South West corner from the Project boundary**	13390	587	153	5050	14600	158	164	2800	350	345	1125	3670	105	390	27	112	536	530	147	40	90

SL	Sampling Locations	TDS (mg/L)							TH (mg/L)							TSS (mg/L)						
		1St Year				2nd year			1St Year				2nd year			1St Year				2nd year		
		Apr	Jul	Oct	Jan	April	July	Oct	April	Jul	Oct	Jan	April	July	Oct	Apr	Jul	Oct	Jan	April	July	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
9	**Right Bank of Passur River at South West corner from the Project boundary**	13240	916	154	5130	14250	160	164	2500	475	325	975	3540	165	445	67	37	459	450	155	44	82
10	**Maidara river of the South East corner of the project at Ichamoti-Maidara confluence**	12400	455	214	5050	14000	2320	183	2500	450	350	980	3260	470	183	7	65	798	280	148	36	96
11	**Maidara river near proposed township area**	10970	2510	257	4390	13900	355	176	2400	725	330	970	3190	130	340	9	24	389	206	160	28	92
12	**Passur river at Passur - Ghasiakhali confluence**	12800	6410	209	5130	14050	298	227	3150	1400	377	1000	3210	135	410	50	310	203	280	165	24	60
13	**Passur river at Harbaria of Sundarbans**	12280	9360	285	4780	13900	683	205	2625	2150	345	970	3080	200	430	65	90	869	400	160	42	74
14	**Passur river at Akram point of Sundarbans**	21500	15960	3400	12350	13600	NS	4220	4500	3625	980	2380	3420	NS	1090	115	99	280	103	150	NS	110
15	**Passur river at Hiron point of Sundarbans**	21500	14050	5720	17900	25300	NS	5830	4850	3050	1440	2690	3640	NS	1460	91	72	267	200	180	NS	144

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.9: NO_3^{2-}, SO_4^{2-} and PO_4^{2-} concentration of Passur River System

SL	Sampling Locations	NO_3^{2-} (mg/L)							SO_4^{2-} (mg/L)							PO_4^{2-} (mg/L)						
		1St Year				2nd year			1St Year				2nd year			1St Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	**Left Bank of Passur River at 100m u/s of North West corner from the Project boundary**	0.90	2.89	0.32	3	-	9.1	4	1840	20	26	580	1360	67	7	0.52	2.23	0.67	0.32	0.86	.10	1.27
2	**Middle of Passur River at 100m u/s of North West corner from the Project boundary**	0.70	2.40	1.57	1.5	-	7.5	7.1	1320	23	28	450	1260	11	8	0.50	1.99	1.12	0.61	0.53	0.23	1.97
3	**Right Bank of Passur River at 100m u/s of North West corner from the Project boundary**	0.10	3.20	1.84	4.3	-	6.2	5	1280	36	34	480	1240	9	11	1.10	2.55	0.95	0.7	0.72	0.67	1.94
4	**Left Bank of Passur River at Project site-Jetty**	1.30	0.76	1.64	3.1	-	6.6	5.7	1360	45	33	550	1240	26	10	2.10	0.45	0.92	0.43	0.49	0.27	2.53
5	**Middle Passur River at Project site-Jetty**	1.40	2.69	1.42	2.2	-	6.1	3.3	1040	32	30	520	1120	6	8	2.20	2.13	1.11	0.41	0.68	0.59	1.3
6	**Right Bank of Passur River at Project site-Jetty**	1.10	2.98	1.33	8.5	-	6.6	4.7	1320	20	27	540	820	8	9	2.00	2.42	0.99	0.55	0.61	0.13	1.32
7	**Left Bank of Passur River at South West corner from the Project boundary**	0.75	2.13	1.85	2.7	-	14.9	4.4	1640	60	40	630	880	9	12	0.57	1.25	1.18	0.76	0.65	0.1	0.99
8	**Middle of Passur River at South West corner from the Project boundary**	1.10	2.43	2.09	1.8	-	4	6.2	1520	40	35	560	1180	19	8	1.20	1.51	1.25	0.85	0.53	0.18	1.02

SL	Sampling Locations	NO_3^{2-} (mg/L)							SO_4^{2-} (mg/L)							PO_4^{2-} (mg/L)						
		1St Year				2nd year			1St Year				2nd year			1St Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
9	**Right Bank of Passur River at South West corner from the Project boundary**	1.20	2.05	2.21	1.9	-	4.9	4.4	1280	80	64	620	900	12	6	1.50	1.10	1	0.53	0.6	0.1	1.39
10	**Maidara river of the South East corner of the project at Ichamoti-Maidara confluence**	0.3	2.18	2.26	6	-	7	4.9	1120	20	63	570	1220	72	11	0.55	2.1	1.27	0.59	0.7	0.5	1.27
11	**Maidara river near proposed township area**	0.5	0.88	1.98	4	-	3.1	2.9	1320	210	63	460	840	27	9	1.1	0.53	1.04	0.64	0.55	0.29	1.28
12	**Passur river at Passur - Ghasiakhali confluence**	0.6	1.52	1.64	4.5	-	7.8	3.1	1360	620	44	630	980	39	13	1.3	0.35	0.86	0.42	0.71	0.59	0.95
13	**Passur river at Harbaria of Sundarbans**	1.4	1.75	1.67	2.7	-	4.4	4.4	1560	860	69	590	900	51	7	1.1	0.56	1.22	0.61	0.59	0.89	0.35
14	**Passur river at Akram point of Sundarbans**	2.7	3.32	0.59	1.5	-	NS	3.2	2600	1400	1390	850	1540	NS	84	1.3	0.29	0.8	0.42	0.61	NS	0.43
15	**Passur river at Hiron point of Sundarbans**	0.8	2.84	0.4	2	-	NS	11.5	2080	1160	2360	1500	1920	NS	97	7.51	0.29	1.09	0.44	0.47	NS	0.45

Table B.10: As, Pb concentration of Passur River System

Sl	Sampling Locations	As (mg/L)							Pb (mg/L)						
		1st Year				2nd year			1st Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	July	Oct	Apr	Jul	Oct	Jan	Apr	July	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.053	0.004	0.002	0.104	0.098	0.0059	0.007
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	0.002	0.003	0.004	0.003	0.002	0.002	0.001	0.055	0.002	0.003	0.104	0.102	0.0038	0.006
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	0.001	0.003	0.004	0.003	0.003	0.002	0.001	0.055	0.005	0.002	0.111	0.138	0.0058	0.008
4	Left Bank of Passur River at Project site-Jetty	0.002	0.004	0.004	0.004	0.002	0.002	0.001	0.057	0.002	0.003	0.154	0.142	0.011	0.01
5	Middle Passur River at Project site-Jetty	0.002	0.004	0.004	0.003	0.002	0.001	0.001	0.060	0.002	0.002	0.139	0.135	0.002	0.009
6	Right Bank of Passur River at Project site-Jetty	0.002	0.003	0.003	0.003	0.002	0.002	0.001	0.058	0.002	0.002	0.138	0.156	0.0021	0.007
7	Left Bank of Passur River at South West corner from the Project boundary	<0.001	0.003	0.006	0.003	0.002	0.002	0.001	0.053	0.002	0.003	0.16	0.142	0.0076	0.01
8	Middle of Passur River at South West corner from the Project boundary	<0.002	0.004	0.004	0.003	0.002	0.002	0.001	0.054	0.003	0.004	0.153	0.148	0.002	0.011
9	Right Bank of Passur River at South West corner from the Project boundary	0.002	0.003	0.006	0.003	0.002	0.003	0.001	0.056	0.005	0.004	0.139	0.163	0.002	0.009
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.001	0.003	0.006	0.004	0.003	0.002	0.001	0.053	0.004	0.004	0.143	0.135	0.002	0.07
11	Maidara river near proposed township area	0.002	0.002	0.003	0.003	0.003	0.002	0.001	0.048	0.004	<0.002	0.133	0.14	0.002	0.008
12	Passur river at Passur - Ghasiakhali confluence	0.002	0.004	0.003	0.003	0.004	0.002	0.001	0.050	0.032	<0.002	0.141	0.14	0.002	0.009
13	Passur river at Harbaria of Sundarbans	0.004	0.003	0.004	0.004	0.004	0.002	0.001	0.043	0.044	0.004	0.137	0.13	0.002	0.012
14	Passur river at Akram point of Sundarbans	0.004	0.002	0.002	0.003	0.002	NS	0.001	0.194	0.071	0.032	0.309	0.297	NS	0.084
15	Passur river at Hiron point of Sundarbans	0.003	0.002	0.003	0.002	0.002	NS	0.001	0.224	0.050	0.07	0.309	0.291	NS	0.073

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS – Not Surveyed.

Table B.11: Hg concentration of Passur River System

SI	Sampling Locations	Hg (mg/L)						
		1st Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	July	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Left Bank of Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
2	Middle Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
3	Right Bank of Passur River at 100m u/s of North West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
4	Left Bank of Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
5	Middle Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
6	Right Bank of Passur River at Project site-Jetty	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
7	Left Bank of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
8	Middle of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
9	Right Bank of Passur River at South West corner from the Project boundary	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
10	Maidara river of the South East corner of the project at Ichamoti-Maidara confluence	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
11	Maidara river near proposed township area	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
12	Passur river at Passur - Ghasiakhali confluence	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
13	Passur river at Harbaria of Sundarbans	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	0.00015	0,00015
14	Passur river at Akram point of Sundarbans	0.0020	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015
15	Passur river at Hiron point of Sundarbans	0.0023	<0.00015	<0.00015	<0.00015	<0.00015	NS	0,00015

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed

➢ Parameters for ground water quality monitoring

Table B.12: pH and Temperature of Ground Water

Sl	Locations	Tube Well Type	pH value									Temperature (ºC)								
			1st Year				2nd Year				BD Standard*	1st year				2nd Year				BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	
1	Near Proposed Township	Deep (>600 ft)	7.6	7.7	7.9	8.0	TC	8.1	7.49	7.6	6.5 -8.5	27.3	28.5	26	24.5	TC	31	30	24	20 – 30 ºC
2	Rajnagar	Deep (>600 ft)	7.6	7.8	8.0	8.2	7.8	8.3	7.93	8.1		29.6	29.9	28	22.5	28.6	28	27.8	23	
3	Kalekarber	Shallow (<250 ft)	6.3	6.5	NF	NF	NF	NF	NF	NF		27.5	28.7	NF	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	7.6	7.7	8.0	8.1	7.9	8.3	7.7	7.9		29.2	28.9	28	25.1	28.8	30	28.7	25	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed: NF=Non functional

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.13: Salinity and DO in Groundwater

Sl	Locations	Tube Well Type	Salinity (ppt)									DO (mg/L)								
			1st Year				2nd Year				BD Standard*	1st Year				2nd Year				BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Jan	
			1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM		1st QM	2nd QM	3rd QM	4th QM	1st QM	2nd QM	3rd QM	4th QM	
1	Near Proposed Township	Deep (>600 ft)	0	0	0	1	TC	0	0	0	N/A	4.4	5.2	6.5	6.7	TC	6	5.4	4.9	6 mg/L
2	Rajnagar	Deep (>600 ft)	0	0	0	0	0	0	0	**0**		6.0	6.2	7.7	6.3	6.0	5.9	6.1	5.2	
3	Kalekarber	Shallow (<250 ft)	0	0	NF	NF	NF	NF	NF	NF		4.4	6.0	NF	NF	NF	NF	NF	NF**	
4	Kapasdanga	Deep (>600 ft)	0	0	0	0	0	0	0	**0**		6.4	6.5	6.1	6.5	6.6	6	5.6	4.8	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.14: TDS and TSS concentrations in Groundwater

Sl	Locations	Type of tube wells	TDS (mg/L)								TSS (mg/L)							
			1st Year				2nd year			BD Standard*	1st Year				2nd year			BD Standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct		Apr	Jul	Oct	Jan	Apr	Jul	Oct	
			1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM		1 QM	2 QM	3 QM	4 QM	1 QM	2 QM	3 QM	
1	Township near project site	Deep (>600 ft)	1113	999	-	1021	NF	881	377	1000 mg/L	-	6	19	40	NO	23	4	10 mg/L
2	Rajnagar	Deep (>600 ft)	4090	371	-	378	390	574	1007		-	6	2	28	4	16	5	
3	Kalekarber	Shallow (<250 ft)	1055	970	-	NF	NF	NF	NF		-	48	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	643	635	-	600	600	328	611		-	8	6	32	6	14	4	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.15: TH concentrations in Groundwater

Sl No	Locations	Type of tubewell	TH (mg/L)							
			1st Year				2nd year			BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Township near project site	Deep (>600 ft)	425	250	300	235	NO	225	325	200-500 mg/L
2	Rajnagar	Deep (>600 ft)	220	175	180	110	138	125	450	
3	Kalekarber	Shallow (<250 ft)	780	450	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	190	140	180	125	216	115	480	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.16: COD concentrations of monitored ground water locations

Sl	Locations	Tubewell Type	COD (mg/L)							
			1st Year				2nd year			BD standard*
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	
1	Township near project site	Deep (>600 ft)	32	32	34	20	NO	12	4	4.0 mg/L
2	Rajnagar	Deep (>600 ft)	28	28	18	16	14	10	8	
3	Kalekarber	Shallow (<250 ft)	32	36	NF	NF	NF	NF	NF	
4	Kapasdanga	Deep (>600 ft)	48	32	34	20	18	14	4	

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

*Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; *Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.17: NO_3, SO_4 and PO_4 Concentrations in Ground Water

Sl	Locations	Type of tube well	NO_3^{2-} (mg/L) *BD Standard (10 mg/L)							SO_4^{2-} (mg/L) *BD Standard (400 mg/L)							PO_4^{2-} (mg/L) *BD Standard (6.0 mg/L)						
			1st Year				2nd year			1st Year				2nd year			1st Year				2nd year		
			Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct
			1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	Deep (>600 ft)	0.20	0.48	<0.10	28	-	7.6	4.3	-	3	-	-	-	-	1	-	2.2	-	0.74	NO	1.4	0.31
2	Rajnagar	Deep (>600 ft)	0.60	0.68	0.31	26	-	2.2	4.2	-	2	-	-	-	-	2	-	2.5	-	0.44	1.98	1.6	0.27
3	Kalekarber	Shallow (<250 ft)	0.40	0.56	NF	NF	-		NF	-	3	NF	-	-	-	-	-	1.2	NF	NF	NF		NF
4	Kapasdanga	Deep (>600 ft)	0.80	0.40	0.80	13	-	4.7	3.8	-	10	-	-	-	-	2	-	6.2	-	0.48	4.54	4.1	0.48

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability;

**Drinking water quality standards, The Environment Conservation Rules, 1997*

Table B.18: As, Pb and Hg concentrations (mg/L) of monitored ground water locations

SI	Locations	As (mg/L) *BD Standard (0.05 mg/L)							Pb (mg/L) *BD Standard (0.05 mg/L)							Hg (mg/L) *BD Standard (0.001 mg/L)						
		1st Year				2nd year			1st Year				2nd year			1st Year				2nd year		
		Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	Apr	Jul	Oct	Apr	Jul	Oct	Jan	APR	Jul	Oct
		1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM	1QM	2QM	3QM	4QM	1QM	2QM	3QM
1	Township near project site	0.013	0.020	0.012	0.014	NO	0.015	0.002	0.002	<0.002	0.004	0.023	NO	0.002	0.006	<0.00015	<0.00015	<0.0005	<0.0005	NO	0.00015	<0.00015
2	Rajnagar	0.006	0.009	0.006	0.008	0.01	0.014	0.012	<0.002	<0.002	<0.002	0.016	0.013	0.0027	0.021	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015
3	Kalekarber	0.376	0.407	NF	NF	D	D		0.002	0.008	NF	NF	D	D	NF	<0.00015	<0.00015	NF	NF	NF	NF	NF
4	Kapasdanga	0.036	0.033	0.020	0.017	0.034	0.024	0.011	<0.002	0.004	<0.002	0.013	0.017	0.002	0.005	<0.00015	<0.00015	<0.0005	<0.0005	<0.00015	0.00015	<0.00015

Source: CEGIS Field Survey- April, July and October 2014 and January, April, July and October 2015

Note: 1QM= First Quarterly Monitoring, 2QM = Second Quarterly Monitoring, 3QM = Third Quarterly Monitoring, 4QM = Fourth Quarterly Monitoring: NS=Not Surveyed; NF=Non functional; N/A=Not Availability; TC=temporarily closed, D=Damaged

**Drinking water quality standards, The Environment Conservation Rules, 1997*

(C) Land resources monitoring data

Table C.1: Land Resources Monitoring Plan

Site No.	Monitoring indicators	Location	GPS(Decimal Degree)		Sampling Frequency	Methods/Tools/Techniques
			Easting	Northing		
1	Land use, Soil fertility and Nutrient, Chemical Properties of Soil (pH, Pb and Cd), Crop production, and damage	Mauza: Baranpara, Union: Gangarampur Upazila: Batiaghata, District: Khulna	E-89°30′59.1″	N-22°37′57.0″	Bi-yearly (April and October)	In situ field sampling and Laboratory Testing in SRDI
2		Mouza:Chunkuri-2,Union:Bajua Upazila: Dacope, District :Khulna	E-89°32′20.0″	N-22°34′51.0″		
3		Mauza: Kapalirmet/Buridmial Union: Burirdanga, Upazila: Mongla District: Bagerhat	E-89°36′8.8″	N-22°32′18.9″		
4		Mauza: Chakgona, Union: Rajnagar Upazila: Rampal, District: Bagerhat	E-89°34′25.3″	N-22°34′18.3″		
5		Mauza: Basherhula, Union: Rajnagar Upazila: Rampal, District: Bagerhat	E-89°34′25.0″	N-22°36′14.0″		

Table C.2: Chemical Properties of Soil on monitoring land

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
1.	Baran para	Top soil(0-15cm)												
		EC(ds/m)	9.1	Moderately saline	1.8	Non saline	10.01	Moderately saline	2.54	Very slightly saline				
		pH	4.2	Very strongly acidic	6.7	Neutral	7.6	Slightly alkaline	6.9	Neutral				
		OM (%)	3.1	Medium	2.5	Medium	0.93	Very low	1.27	Low				
		N (%)	0.16	Low	0.12	Low	0.05	Very low	0.06	Very low				
		K (meq/100g)	1.00	Very high	0.59	Very high	1.61	Very high	0.57	Very high				
		Ca (meq/100g)	11.3	Very high	14.3	Very high	31.50	Very high	14.75	Very high				
		Mg (meq/100g)	10.7	Very high	8.6	Very high	6.00	Very high	2.06	Very high				
		Na(meq/100g)	5.50	*	2.7	*	10.01	*	4.76	*				
		P(µg/gm)	2.7	Very low	14.3	Medium	8.19	Low	4.60	Very low				
		S(µg/gm)	523.2	Very high	41.4	Very high	354.40	Very high	210.0	Very high				
		B(µg/gm)	0.45	Medium	0.55	Very high	2.37	Very high	2.11	Very high				
		Fe(µg/gm)	150.3	Very high	258.6	Very high	49.72	Very high	78.25	Very high				
		Mn(µg/gm)	7.2	Very high	11.3	Very high	24.72	Very high	6.89	Very high				
		Zn(µg/gm)	1.4	Medium	1.2	Medium	1.88	High	2.47	Very high				
		Lead(Pb) (µg/gm)	31.8	*	33.7	*	32.21	*	25.95	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.39	*	00	*				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Chloride (Cl-) (µg/gm)	762.2	*	0	0	0	0	00					
		Subsurface soil(15-30cm)												
		EC(ds/m)	8.4	Moderately saline	2.0	Non saline	7.90	Slightly saline	4.65	Slightly saline				
		pH	4.3	Very strongly acidic	6.9	Neutral	7.8	Slightly alkaline	7.4	Slightly alkaline				
		OM (%)	2.9	Medium	2.2	Medium	1.46	Low	1.53	Low				
		N (%)	0.15	Low	0.2	Medium	0.08	Very low	0.08	Very low				
		K (meq/100g)	1.0	Very high	0.61	Very high	1.46	Very high	0.59	Very high				
		Ca(meq/100g)	10.48	Very high	14.3	Very high	26.84	Very high	12.31	Very high				
		Mg(meq/100g)	8.8	Very high	8.2	Very high	5.30	Very high	2.15	Very high				
		Na(meq/100g)	5.00	*	2.7	*	8.95	*	6.32	*				
		P(µg/gm)	2.9	Very low	22.8	High	9,23	Low	4.65	Very low				
		S(µg/gm)	513.7	Very high	31.4	High	307.65	Very high	221.0	Very high				
		B(µg/gm)	0.36	Medium	0.49	Optimum	1.86	Very high	0.90	Very high				
		Fe(µg/gm)	39.1	Very high	60.9	Very high	26.60	Very high	29.27	Very high				
		Mn(µg/gm)	3.3	High	10.9	Very high	41.87	Very high	5.75	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Zn(µg/gm)	1.5	Optimum	0.87	Low	1.56	Optimum	1.69	Optimum				
		Lead(Pb) (µg/gm)	31.8	*	32.1	*	31.54	*	22.56	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.42	*	00	*				
		Chloride (Cl-)(µg/gm)	398.4	*	0	0	0	0	0					
		Substratum(30-45cm)												
		EC(ds/m)	9.6	Moderately saline	5.8	Slightly saline	9.26	Moderately saline	5.56	Slightly saline				
		pH	5.7	Slightly acidic	6.9	Neutral	7.7	Slightly alkaline	7.0	Neutral				
		OM (%)	1.6	Low	1.1	Low	1.62	Low	1.48	Low				
		N (%)	0.08	Very low	0.06	Very low	0.09	Very low	0.07	Very low				
		K (meq/100g)	1.0	Very high	0.6	Very high	2.00	Very high	0.60	Very high				
		Ca(meq/100g)	12.6	Very high	16.3	Very high	28.69	Very high	14.06	Very high				
		Mg(meq/100g)	15.9	Very high	8.8	Very high	5.57	Very high	2.71	Very high				
		Na(meq/100g)	6.00	*	3.7	*	9.91	*	6.83	*				
		P(µg/gm)	2.00	Very low	13.3	Medium	8.24	Low	2.99	Very low				
		S(µg/gm)	490.9	Very high	31.9	High	307.29	Very high	262.0	Very high				
		B(µg/gm)	0.73	High	0.77	Very high	1.67	Very high	1.16	Very high				
		Fe(µg/gm)	51.3	Very high	113.9	Very high	33.91	Very high	73.87	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Mn(µg/gm)	3.9	Very high	5.2	Very high	88.75	Very high	6.21	Very high				
		Zn(µg/gm)	1.6	Optimum	0.49	Low	1.74	Optimum	3.19	Very high				
		Lead(Pb) (µg/gm)	37.8	*	31.5	*	32.29	*	18.89	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.17	*	00	*				
		Chloride (Cl-)(µg/gm)	692.9	*	0	0	0	0	0					
2.	Chunkuri-2	Top soil (0-15cm)												
		EC(ds/m)	11.2	Moderately saline	5.6	Slightly saline	13.05	Strongly saline	8.20	Moderately saline				
		pH	6.1	Slightly acidic	6.4	Slightly acidic	5.9	Slightly acidic	6.0	Slightly acid				
		OM (%)	2.1	Medium	1.2	Low	3.22	Medium	1.75	Low				
		N (%)	0.11	Low	0.06	Very low	0.18	Low	0.09	Very low				
		K (meq/100g)	1.5	Very high	1.14	Very high	2.97	Very high	0.79	Very high				
		Ca(meq/100g)	12.3	Very high	12.9	Very high	27.15	Very high	11.88	Very high				
		Mg(meq/100g)	9.8	Very high	8.9	Very high	6.33	Very high	2.50	Very high				
		Na(meq/100g)	8.5	*	9.4	*	12.51	*	8.16	*				
		P(µg/gm)	2.7	Very low	12.8	Medium	8.34	Low	6.89	Low				
		S(µg/gm)	401.9	Very high	16.9	Medium	673.58	Very high	500.0	Very high				
		B(µg/gm)	0.57	Optimum	0.74	High	0.75	High	1.52	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Fe(µg/gm)	60.2	Very high	223.6	Very high	52.46	Very high	89.23	Very high				
		Mn(µg/gm)	5.3	Very high	12.8	Very high	74.59	Very high	7.05	Very high				
		Zn(µg/gm)	1.7	Medium	2.5	Very high	2.66	Very high	5.32	Very high				
		Lead(Pb) (µg/gm)	0.00	*	29.2	*	31.34	*	14.09	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.31	*	00	*				
		Chloride (Cl-)(µg/gm)	1957.6	*	0	0	0	0	0					
		Subsurface soil(15-30cm)												
		EC(ds/m)	9.1	Moderately saline	5.6	Slightly saline	10.48	Moderately saline	6.97	Slightly saline				
		pH	6.7	Neutral	6.4	Slightly acidic	6.4	Slightly acidic	6.7	Neutral				
		OM (%)	1.8	Low	0.95	Very low	3.08	High	1.64	Low				
		N (%)	0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low				
		K (meq/100g)	1.6	Very high	1.1	Very high	2.68	Very high	0.75	Very high				
		Ca(meq/100g)	12.6	Very high	13.8	Very high	26.29	Very high	15.65	Very high				
		Mg(meq/100g)	9.5	Very high	8.9	Very high	6.29	Very high	3.13	Medium				
		Na(meq/100g)	8.5	*	9.9	Very high	10.61	*	7.89	*				
		P(µg/gm)	2.7	Very low	18.4	Optimum	7.32	Low	6.67	Low				
		S(µg/gm)	280.5	Very high	23.8	Optimum	487.29	Very high	298.0	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		B(µg/gm)	1.1	Very high	1.7	Very high	0.92	Very high	1.44	Very high				
		Fe(µg/gm)	133.9	Very high	193.3	Very high	52.20	Very high	75.51	Very high				
		Mn(µg/gm)	2.8	Optimum	11.6	Very high	17.75	Very high	8.29	Very high				
		Zn(µg/gm)	0.99	Medium	1.4	Optimum	2.00	High	1.71	Optimum				
		Lead(Pb) (µg/gm)	0.00	*	29.9	*	31.52	*	16.63	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.35	*	00	*				
		Chloride (Cl-)(µg/gm)	1,472.5	*	0	0	0	0	0					
		Substratum(30-45cm)												
		EC(ds/m)	10.1	Moderately saline	5.3	Slightly saline	10.00	Moderately saline	6.91	Slightly saline				
		pH	6.6	Neutral	6.2	Slightly acidic	6.6	Neutral	6.4	Slightly acid				
		OM (%)	1.9	Medium	1.4	Low	3.36	High	1.53	Low				
		N (%)	0.09	Low	0.08	Low	0.19	Medium	0.08	Low				
		K (meq/100g)	1.5	Very high	1.2	Very high	2.60	Very high	0.72	Very high				
		Ca(meq/100g)	13.7	Very high	34.4	Very high	18.87	Very high	13.16	Very high				
		Mg(meq/100g)	11.8	Very high	6.4	Very high	6.34	Very high	3.08	Very high				
		Na(meq/100g)	8.5	*	9.3	*	10.92	*	7.69	*				
		P(µg/gm)	1.3	Very low	19.5	Optimum	6.11	Low	5.71	Low				
		S(µg/gm)	320.4	Very high	32.8	High	428.10	Very high	262.0	Very high				
		B(µg/gm)	1.14	Very high	1.5	Very high	1.12	Very high	1.36	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Fe(µg/gm)	125.3	Very high	175.5	Very high	117.70	Very high	91.20	Very high				
		Mn(µg/gm)	2.7	Optimum	12.2	High	46.08	Very high	6.09	Very high				
		Zn(µg/gm)	1.8	Optimum	0.5	Low	2.15	High	2.83	Very high				
		Lead(Pb) (µg/gm)	31.3	*	29.7	*	32.46	*	14.10	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.12	*	00	*				
		Chloride (Cl-)(µg/gm)	1715.0	*	0	0	0	0	0					
3.	Kapalirmet	Top soil(0-15cm)												
		EC(ds/m)	4.8	Slightly saline	8.5	Moderately saline	3.89	Very slightly saline	8.29	Moderately saline				
		pH	7.0	Neutral	7.6	Slightly alkaline	6.2	Slightly acid	8.0	Slightly alkaline				
		OM (%)	3.0	Medium	1.5	Low	2.01	Medium	1.75	Low				
		N (%)	0.2	Low	0.07	Very low	0.11	Low	0.09	Very low				
		K (meq/100g)	1.5	Very high	1.7	Very high	1.32	Very high	0.92	Very high				
		Ca(meq/100g)	18.2	Very high	19.9	Very high	27.04	Very high	10.77	Very high				
		Mg(meq/100g)	15.3	Very high	10.0	Very high	6.21	Very high	2.67	Very high				
		Na(meq/100g)	12.0	*	11.9	*	5.22	*	7.77	*				
		P(µg/gm)	3.2	Very low	7.3	Low	6.76	Very high	5.01	Very low				
		S(µg/gm)	545.2	Very high	20.8	Medium	216.69	Very high	700.0	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		B(µg/gm)	1.2	Very high	1.3	Very high	0.95	Very high	1.69	Very high				
		Fe(µg/gm)	37.3	Very high	230.2	Very high	34.56	Very high	94.22	Very high				
		Mn(µg/gm)	3.8	Very high	6.6	Very high	10.26	Very high	7.28	Very high				
		Zn(µg/gm)	2.0	High	1.0	Low	1.64	Optimum	3.58	Very high				
		Lead(Pb) (µg/gm)	12.5	*	28.9	*	47.12	*	8.17	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.86	*	00	*				
		Chloride (Cl-)(µg/gm)	3741.9	*	0	0	0	0	0					
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.1	Moderately saline	6.3	Slightly saline	4.26	Slightly saline	7.43	Slightly saline				
		pH	7.2	Neutral	7.9	Slightly alkaline	6.3	Slightly acidic	8.0	Slightly alkaline				
		OM (%)	2.6	Medium	1.3	Low	3.36	High	1.69	Low				
		N (%)	0.2	Low	0.06	Very low	0.19	Medium	0.08	Very low				
		K (meq/100g)	1.5	Very high	1.6	Very high	1.13	Very high	0.98	Low				
		Ca(meq/100g)	11.7	Very high	14.4	Very high	25.16	Very high	16.89	Very high				
		Mg(meq/100g)	7.1	Very high	9.9	Very high	6.22	Very high	3.94	Very high				
		Na(meq/100g)	8.5	*	9.8	*	5.45	*	7.86	*				
		P(µg/gm)	3.8	Very low	5.6	Low	5.29	Low	5.52	Low				
		S(µg/gm)	341.4	Very high	52.1	Very high	236.58	Very high	655.0	Very high				
		B(µg/gm)	0.86	Very high	1.6	Very high	0.21	Low	1.93	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Fe(µg/gm)	140.2	Very high	249.0	Very high	30.03	Very high	93.15	Very high				
		Mn(µg/gm)	3.7	High	5.9	Very high	11.23	Very high	6.95	Very high				
		Zn(µg/gm)	0.94	Medium	0.5	Low	1.04	Medium	2.39	Very high				
		Lead(Pb) (µg/gm)	0.00	*	29.3	*	33.66	*	9.58	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.18	*	00	*				
		Chloride (Cl-) (µg/gm)	2217.4	*	0	0	0	0	0					
		Substratum(30-45cm)												
		EC(ds/m)	10.8	Moderately saline	7.5	Slightly saline	3.99	Very slightly saline	7.06	Slightly saline				
		pH	7.3	Neutral	7.8	Slightly alkaline	6.3	Slightly acidic	7.9	Slightly alkaline				
		OM (%)	2.8	Medium	1.3	Low	4.03	High	2.38	Medium				
		N (%)	0.15	Low	0.06	Very low	0.23	Medium	0.12	Low				
		K (meq/100g)	1.5	Very high	1.6	Very high	1.16	Very high	0.87	Very high				
		Ca(meq/100g)	12.9	Very high	15.4	Very high	27.13	Very high	17.20	Very high				
		Mg(meq/100g)	10.4	Very high	9.7	Very high	6.25	Very high	3.90	Very high				
		Na(meq/100g)	8.5	*	9.6	*	5.76	*	7.27	*				
		P(µg/gm)	3.4	Very low	5.8	Low	9.24	Optimum	3.65	Very low				
		S(µg/gm)	345.1	Very high	5.6	Very low	231.67	Very high	732.0	Very high				
		B(µg/gm)	1.4	Very high	1.1	Very high	1.55	Very high	1.83	Very high				
		Fe(µg/gm)	120.3	Very high	247.8	Very high	33.82	Very high	87.2	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
									6					
		Mn(µg/gm)	2.9	Optimum	7.2	Very high	53.90	Very high	7.31	Very high				
		Zn(µg/gm)	0.88	Low	0.79	Low	1.00	Medium	2.09	High				
		Lead(Pb) (µg/gm)	0.00	*	27.6	*	34.37	*	7.88	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.20	*	00	*				
		Chloride (Cl-) (µg/gm)	1801.6	*	0	0	0	0	0					
4	Chalkghona	Top soil(0-15cm)												
		EC(ds/m)	11.5	Moderately saline	7.2	Slightly saline	7.36	Slightly saline	7.31	Slightly saline				
		pH	7.7	Slightly alkaline	8.0	Slightly alkaline	5.7	Slightly acidic	8.5	Strongly alkaline				
		OM (%)	1.5	Low	1.5	Low	2.13	Medium	2.17	Medium				
		N (%)	0.08	Low	0.08	Low	0.12	Low	0.11	Low				
		K (meq/100g)	1.5	Very high	1.4	Very high	1.72	Very high	0.86	Very high				
		Ca(meq/100g)	22.2	Very high	14.3	Very high	18.79	Very high	14.58	Very high				
		Mg(meq/100g)	11.7	Very high	9.4	Very high	6.29	Very high	3.87	Very high				
		Na(meq/100g)	8.5	*	8.4	*	9.81	*	6.56	*				
		P(µg/gm)	5.6	Very low	9.2	Low	4.11	Very low	10.88	Medium				
		S(µg/gm)	444.2	Very high	4.1	Very low	440.19	Very high	975.0	Very high				
		B(µg/gm)	0.98	Very high	1.2	Very high	0.85	Very high	1.65	Very low				
		Fe(µg/gm)	55.3	Very high	189.0	Very high	41.14	Very high	68.05	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Mn(µg/gm)	4.3	High	16.4	Very high	32.04	Very high	7.23	Very high				
		Zn(µg/gm)	0.76	Low	4.8	Very high	4.33	Very high	3.28	Very high				
		Lead (Pb) (µg/gm)	0.00	*	27.2	*	30.99	*	14.94	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.38	*	00	*				
		Chloride (Cl-)(µg/gm)	1576.4	*	0	0	0	0	0					
		Subsurface soil(15-30cm)												
		EC(ds/m)	11.3	Moderately saline	6.2	Slightly saline	7.81	Slightly saline	7.38	Slightly saline				
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	5.9	Slightly acidic	8.6	Strongly alkaline				
		OM (%)	2.6	Medium	1.3	Low	1.88	Medium	1.90	Medium				
		N (%)	0.13	Low	0.07	Very low	0.10	Low	0.10	Low				
		K (meq/100g)	1.5	Very high	1.1	Very high	1.54	Very high	0.81	Very high				
		Ca(meq/100g)	22.6	Very high	17.8	Very high	18.96	Very high	16.05	Very high				
		Mg(meq/100g)	16.3	Very high	8.3	Very high	6.30	Very high	4.25	Very high				
		Na(meq/100g)	8.5	*	8.6	*	9.23	*	6.93	*				
		P(µg/gm)	13.6	Medium	9.4	Low	3.23	Very low	9.23	Low				
		S(µg/gm)	415.6	Very high	47.7	Very high	393.37	Very high	886.0	Very high				
		B(µg/gm)	0.66	High	0.97	Very high	0.79	Very high	1.46	Very high				
		Fe(µg/gm)	124.1	Very high	172.7	Very high	25.52	Very high	77.47	Very high				
		Mn(µg/gm)	6.1	Very high	13.8	Very high	26.59	Very high	6.78	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Zn(µg/gm)	1.1	Medium	3.2	Very high	1.09	Medium	3.37	Very high				
		Lead(Pb(µg/gm)	6.3	*	28.4	*	30.81	*	11.83	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.35	*	00	*				
		Chloride (Cl-)(µg/gm)	2113.5	*	0	0	0	0	0					
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline	5.1	Slightly saline	7.14	Slightly saline	7.12	Slightly saline				
		pH	7.5	Slightly alkaline	8.2	Slightly alkaline	6.0	Slightly acidic	8.9	Strongly alkaline				
		OM (%)	1.7	Low	1.0	Very low	2.94	Medium	1.53	Low				
		N (%)	0.09	Very low	0.06	Very low	0.17	Low	0.08	Very low				
		K (meq/100g)	1.5	Very high	0.95	Very high	1.57	Very high	0.89	Very high				
		Ca(meq/100g)	13.9	Very high	14.4	Very high	19.10	Very high	15.95	Very high				
		Mg(meq/100g)	11.1	Very high	7.2	Very high	6.26	Very high	4.15	Very high				
		Na(meq/100g)	8.5	*	6.7	*	9.33	*	7.20	Very high				
		P(µg/gm)	4.1	Very low	9.5	Low	5.67	Low	11.26	Medium				
		S(µg/gm)	334.6	Very high	8.3	Low	343.00	Very high	465.0	Very high				
		B(µg/gm)	0.67	High	0.63	High	1.05	Very high	1.14	Very high				
		Fe(µg/gm)	75.3	Very high	160.0	Very high	29.70	Very high	90.55	Very high				
		Mn(µg/gm)	3.6	Very high	14.1	Very high	25.22	Very high	6.03	Very high				
		Zn(µg/gm)	1.7	Optimum	2.9	Very high	1.78		2.94	Very high				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Lead(Pb) (µg/gm)	6.3	*	26.5	*	32.23	*	15.50	*				
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.55	*	00	*				
		Chloride (Cl-)(µg/gm)	1715.0	*	0	0	0	0						
5.	Basherhula	Top soil(0-15cm)												
		EC(ds/m)	11.7	Moderately saline	6.0	Slightly saline	7.14	Slightly saline	5.58	Slightly saline				
		pH	7.7	Slightly alkaline	8.3	Slightly alkaline	7.3	Neutral	8.7	Strongly alkaline				
		OM (%)	1.7	Low	1.2	Low	1.74	Low	1.59	Low				
		N (%)	0.09	Low	0.06	Very low	0.10	Low	0.08	Very low				
		K (meq/100g)	1.5	Very high	1.2	Very high	1.67	Very high	0.75	Very high				
		Ca(meq/100g)	23.6	Very high	31.4	Very high	25.26	Very high	15.11	Very high				
		Mg(meq/100g)	11.9	Very high	7.9	Very high	5.50	Very high	4.05	Very high				
		Na(meq/100g)	8.5	*	8.1	*	7.06	*	6.32	*				
		P(µg/gm)	4.5	Very low	7.4	Low	7.12	Low	5.92	Low				
		S(µg/gm)	272.3	Very high	21.8	Medium	454.19	Very high	607.0	Very high				
		B(µg/gm)	0.94	Very high	1.1	Very high	1.00	Very high	1.19	Very high				
		Fe(µg/gm)	50.3	Very high	205.6	Very high	53.37	Very high	85.08	Very high				
		Mn(µg/gm)	3.4	High	5.9	Very high	49.22	Very high	6.50	Very high				
		Zn(µg/gm)	1.4	Medium	1.1	Medium	2.27	Very high	1.86	High				
		Lead(Pb(µg/g	18.8	*	25.1	*	30.55	*	6.19	*				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		m)												
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.21	*	00	*				
		Chloride (Cl-)(µg/gm)	2442.6	*	0	0	0	0	0					
		Subsurface soil(15-30cm)												
		EC(ds/m)	10.7	Moderately saline	7.0	Slightly saline	7.44	Slightly saline	7.16	Slightly saline				
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.7	Slightly alkaline	8.7	Strongly alkaline				
		OM (%)	1.5	Low	0.9	Low	2.01	Medium	1.43	Low				
		N (%)	0.08	Very low	0.05	Very low	0.11	Low	0.07	Very low				
		K (meq/100g)	1.0	Very high	1.2	Very high	2.20	Very high	0.76	Very high				
		Ca(meq/100g)	24.0	Very high	32.6	Very high	33.28	Very high	14.75	Very high				
		Mg(meq/100g)	11.7	Very high	8.4	Very high	6.10	Very high	3.76	Very high				
		Na(meq/100g)	7.0	*	10.1	*	8.66	*	7.06	*				
		P(µg/gm)	3.9	Very low	5.3	Low	8.19	Low	6.82	Low				
		S(µg/gm)	317.2	Very high	2.8	Very low	379.38	Very high	627.0	Very high				
		B(µg/gm)	0.71	High	1.0	Very high	1.38	Very high	1.31	Very high				
		Fe(µg/gm)	121.4	Very high	307.0	Very high	53.18	Very high	83.13	Very high				
		Mn(µg/gm)	3.9	Very high	15.5	Very high	45.34	Very high	5.98	Very high				
		Zn(µg/gm)	1.8	Optimum	0.8	Low	1.99	High	2.27	Optimum				
		Lead(Pb) (µg/gm)	18.8	*	23.7	*	31.49	*	16.35	*				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		Cadmium (Cd)(µg/gm)	0	0	0	0	2.32	*	00	*				
		Chloride (Cl-) (µg/gm)	1611.1	*	0	0	0	0	0					
		Substratum(30-45cm)												
		EC(ds/m)	10.9	Moderately saline	6.3	Slightly saline	6.68	Slightly saline	6.96	Slightly saline				
		pH	7.7	Slightly alkaline	8.2	Slightly alkaline	7.8	Slightly alkaline	8.8	Strongly alkaline				
		OM (%)	1.5	Low	1.0	Low	2.81	Medium	2.17	Medium				
		N (%)	0.08	Very low	0.06	Very low	0.16	Low	0.11	Low				
		K (meq/100g)	1.5	Very high	1.2	Very high	2.20	Very high	0.86	Very high				
		Ca(meq/100g)	24.4	Very high	32.1	Very high	30.68	Very high	13.95	Very high				
		Mg(meq/100g)	12.9	Very high	8.3	Very high	6.11	Very high	3.80	Very high				
		Na(meq/100g)	7.5	*	9.8	*	8.76	*	7.68	*				
		P(µg/gm)	6.1	Low	5.9	Low	11.14	Medium	9.12	Low				
		S(µg/gm)	321.1	Very high	3.1	Very low	305.69	Very high	182.0	Very high				
		B(µg/gm)	0.63	High	0.85	Very high	2.95	Very high	1.40	Very high				
		Fe(µg/gm)	77.3	Very high	162.4	Very high	42.36	Very high	66.29	Very high				
		Mn(µg/gm)	3.2	High	16.9	Very high	31.74	Very high	5.69	Very high				
		Zn(µg/gm)	2.1	High	2.7	Very high	1.62	Optimum	2.04	High				
		Lead(Pb) (µg/gm)	25.00	*	22.2	*	31.54	*	14.96	*				
		Cadmium	0	0	0	0	2.44	*	00	*				

Sl No	Location	Parameter	2013-2014				2014-2015				2015-2016			
			Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (April)	Remarks	Wet season (October)	Remarks	Dry season (March)	Remarks	Wet season (October)	Remarks
		(Cd)(µg/gm)												
		Chloride (Cl-)(µg/gm)	1489.8	*	0	0	0	0	0					

*Source: SRDI Laboratory analysis, July; 2014; April and August; 2015, January; 2016 * Not specified*

(D) Fisheries resources monitoring data

Table D.1: Data for Basic life Requirements for a Good Fish Community

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
2014-2015									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
2015-2016									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
2016-2017									
Food (C_F)	V1	Phytoplankton (%)							
	V2	Zooplankton (%)							
Water Quality (C_{WQ})	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							
Reproduction (C_R)	V1	Phytoplankton (%)							

Life Requirements	Variable Sl.	Habitat Variables	A	B	C	D	E	F	G
	V2	Zooplankton (%)							
	V3	Turbidity							
	V4	TDS							
	V5	Surface water temperature							
	V6	Dissolved Oxygen (DO)							
	V7	pH							
	V8	Salinity							

Table D.2: Occurrence of Species

Local Name	Scientific Name	Local Status*	1st QM (April, 2014)	2nd QM (July, 2014)	3rd QM (Oct, 2014)	4th QM	5th QM	6th QM	7th QM	8th QM	9th QM	10th QM	11th QM	12th QM
			'-' = No; '+' = Occurrence											
Amadi Chela	*Chela sp.*	DD	-	-	+	+	+	-	+	+				
Hilsa	*Tenualosa ilisha*	NO	-	-	+	-	-	+	+	-				
Sagor Baim	*Anguilla bengalensis*		+	-	-	-	-	-	-	-				
Baim	*Pisodonophis cancrivorus*	NT	-	-	-	-	-	+	-	-				
Bacha	*Eutropiichthys vacha*	CR	+	-	-	-	-	-	-	-				
Bagda Chingri	*Penaeus monodon*	DD	+	+	+	+	+	+	+	+				
Banspata	*Brachypleura novae-zeelandiae*	NO	+	+	+	+	-	+	+	+				
Kukurjib	*Cynoglossus lingua*	NO	+	-	-	-	-	-	-	+				
Bele	*Glossogobius giuris*	NO	+	+	+	+	+	+	+	+				
Aswine Bele		NO	-	-	-	-	-	-	+	+				

Boiragi	*Coilia dussumieri*	NO	+	+	+	+	+	+	-	+				
Boishakhi Chingri		NO	-	+	-	-	+	+	+	+				
Chammu Chingri	*Metapenaeus brevicornis*	DD	+	+	+	-	+	+	+	+				
Chaka Chingri	*Penaeus indicus*	DD	+	+	-	+	+	+	+	+				
Ghora Chela	*Securicula gora*	-	+	-	-	-	-	-	-	-				
Chanda Chela			-	+	+	-	-	-	-	-				
Chitra			+	-	-	+	+	+	-	+				
Khayra Chela			-	+	-	-	-	-	+	-				
Sada Chewa	*Trepauchen vagina*	NO	+	-	+	-	-	+	-	-				
Lal Chewa	*Odontamblyopus rubicundus*	NO	+	+	+	+	+	+	+	+				
Chhuri	*Trichiurus muticus*	NO	+	-	+	-	-	-	-	-				
Sagor Chela	*Megalops cyprinoids*	NO	+	-	-	-	-	-	-	-				
Purabi Chela	*Thryssa purava*	NO	+	-	-	-	-	-	-	-				
Kabashi Tengra	*Mystus cavasius*	DD	+	-	-	-	-	-	-	-				
Gagra Tengra		DD	-	+	+	-	+	-	+	-				
Gulsha Tengra	*Mystus bleekery*	DD	+	+	-	+	-	+	+	+				
Harina Chingri	*Metapenaeus ensis*	DD	+	+	+	+	+	+	+	+				
Ekthuto	*Hyporhampus limbatus*	NO	+	-	+	+	-	-	-	+				
Kakila	*Xenentodon cancila*	NO	+	-	-	-	-	-	-	-				
Chapila	*Gudusia chapra*	NO	+	+	-	-	-	-	-	-				
Kuchia	*Monopterus cuchia*	DD	+	+	-	+	+	+	+	+				
Kain Magur		EN	-	+	+	+	+	+	+	+				
Loitta	*Harpodon nehereus*	NO	+	+	+	-	+	-	-	-				
Motka Chingri	*Macrobrachium villosimanusless*	DD	+	+	+	+	+	+	+	+				

Mud Crab	*Scylla serrata*	NO	+	-	+	+	+	+	+	+				
Tular Dandi	*Sillaginopsis panijus*	NO	+	-	+	-	+	-	+	-				
Paira Chanda	*Scatophagus argus*	DD	+	-	-	-	-	-	-	-				
Paissa	*Liza parsia*	NO	+	+	+	+	+	+	+	+				
Pangas	*Pangasius pangasius*	CR	+	-	+	-	-	-	-	+				
Tak Chanda	*Leiognathus equulus*	NO	+	-	-	-	-	-	+	-				
Phessa	*Setipinna phasa*	NO	+	+	+	+	+	+	+	+				
Teli Phessa	-	-	-	-	+	-	-	-	-	-				
Poma	*Poma poma*	NO	+	+	+	+	+	+	+	+				
Potka	*Chelonodon patoca*	NO	+	+	-	+	+	+	-	+				
Shilong	*Silonia silondia*	EN	+	-	+	-	-	-	-	-				
Tailla	*Eleutheronema tetradactylum*	-	+	-	-	-	-	-	-	-				
Tapse	*Polynemus paradiseus*	-	+	+	+	-	-	+	+	+				
Datina			-	-	-	+	-	-	-	+				
Jaba			-	-	-	+	-	-	+	+				
Shole	*Channa striatus*		-	-	-	+	-	-	-	+				
Magur	*Clarias batrachus*		-	-	-	+	-	-	-	+				
Koi	*Anabas testudineus*		-	-	-	+	-	-	-	+				
Vetki			-	-	-	+	+	+	+	+				
Gangania			-	-	-	+	+	-	+	-				

**Local Status Source: IUCN Red List*

Table D.3: Length-wise species distribution in sampling sites

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Amadi Chela	Mongla Point	9	81	9	2	0	0	0
Bagda	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
	Maidara	100	0	0	0	0	0	0
	Mongla Point	100	0	0	0	0	0	0
Bairagi	Akram Point	0	0	0	0	100	0	0
	Mongla Point	0	0	100	0	0	0	0
Baisakhi Chingri	Harbaria	0	0	0	0	100	0	0
Banspata	Akram Point	0	0	0	0	73	27	0
	Harbaria	0	0	0	0	83	17	0
Bele	Akram Point	0	0	91	9	0	0	0
	Chalna Point	100	0	0	0	0	0	0
	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	62	38	0	0
	Maidara	100	0	0	0	0	0	0
Chaka Chingri	Akram Point	0	0	100	0	0	0	0
	Haldikhali	0	0	93	7	0	0	0
	Harbaria	0	0	0	100	0	0	0
Chali Chingri	Chalna Point	0	0	100	0	0	0	0
	Maidara	100	0	0	0	0	0	0
Chami	Harbaria	0	0	0	100	0	0	0
	Haldikhali	0	19	10	69	0	2	0
Chata Bele	Akram Point	0	0	0	0	0	100	0
	Harbaria	0	0	0	50	50	0	0
Chela	Chandpai	0	0	100	0	0	0	0
Chitra	Chandpai	0	0	50	50	0	0	0
	Harbaria	0	0	0	100	0	0	0
Dairkana	Akram Point	0	0	0	100	0	0	0
Daitna	Maidara	100	0	0	0	0	0	0

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
Dogri	Chandpai	0	0	0	0	0	100	0
	Mongla Point	0	0	0	0	0	100	0
Ekthuto	Akram Point	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
Goda Chingri	Chalna Point	0	0	100	0	0	0	0
	Chandpai	0	100	0	0	0	0	0
	Maidara	100	0	0	0	0	0	0
Golda Chingri	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
	Maidara	100	0	0	0	0	0	0
Gulsha Tengra	Chandpai	0	0	1	99	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	0	0	100	0	0	0
Horina Chingri	Chalna Point	0	0	100	0	0	0	0
	Chandpai	0	0	100	0	0	0	0
	Harbaria	0	0	0	100	0	0	0
	Mongla Point	0	100	0	0	0	0	0
Jaba	Akram Point	0	0	0	0	100	0	0
	Chandpai	0	0	0	0	100	0	0
	Harbaria	0	0	0	0	100	0	0
Kain Magur	Chandpai	0	0	0	0	0	100	0
Khorsula	Harbaria	0	0	0	100	0	0	0
	Mongla Point	25	0	0	75	0	0	0
Koi	Chandpai	0	0	100	0	0	0	0
Kuchia	Chandpai	0	0	0	0	0	100	0
Lal Chewa	Chandpai	0	0	0	0	0	100	0
	Harbaria	0	0	0	0	100	0	0
Magur	Chandpai	0	0	0	0	100	0	0
Maya Chela	Mongla Point	0	0	0	100	0	0	0
Motka Chingri	Haldikhali	0	0	100	0	0	0	0

Fish Species	Site	L (< 2cm)	L (2 to 3cm)	L (3 to 5cm)	L (5 to 10cm)	L (10 to 20cm)	L (> 25cm)	Brood Fish
	Harbaria	0	0	100	0	0	0	0
Mud Crab	Chandpai	0	0	100	0	0	0	0
Mutkura Bele	Harbaria	0	0	0	100	0	0	0
Nairkhola	Chalna Point	100	0	0	0	0	0	0
Nona Bele	Chandpai	0	0	40	60	0	0	0
	Harbaria	0	0	0	5	84	11	0
Paissa	Akram Point	0	0	0	25	75	0	0
	Chandpai	0	0	100	67	33	0	0
	Harbaria	0	0	0	0	100	0	0
Pangas	Harbaria	0	0	0	0	100	0	0
Pheksa	Akram Point	0	0	0	0	0	100	0
Poma	Akram Point	0	0	0	22	67	11	0
	Chandpai	0	0	0	67	33	0	0
	Harbaria	0	0	0	0	0	100	0
	Mongla Point	67	0	28	6	0	0	0
Potka	Chandpai	0	100	0	0	0	0	0
	Harbaria	0	0	0	25	75	0	0
Sagar Bele	Harbaria	0	0	0	0	100	0	0
Shaplapata	Chandpai	0	0	0	0	0	100	0
Shole	Chandpai	0	0	0	0	40	60	0
Tairel	Akram Point	0	0	0	100	0	0	0
Tapsi	Akram Point	0	0	0	0	100	0	0
Tiger	Akram Point	0	0	100	0	0	0	0
Tit Punti	Chalna Point	100	0	0	0	0	0	0
Tou Paissa	Harbaria	0	0	0	98	2	0	0
Veda	Chandpai	0	0	0	100	0	0	0
Vetki	Akram Point	0	0	0	0	0	100	0

Source: CEGIS field survey, 2015

Table D.4: Purpose, timing and extent of migration for different year-class of migratory fish species

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
Tapsi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-		-				
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	-	-	Feeding	-				
		Adult	-	-	-	-	-	-	-	Feeding				
	Chalna Point	Age-1 adult and Brood fish	Feeding and Growing	Spawning	-	-	-	Feeding	Feeding and Spawning	-				
		Adult	-	-	Feeding and Growing	-	-	Feeding	Feeding	-				
	Harbaria	Juvenile and Age-1 adult	Feeding and Growing	Feeding and Growing		-	-	-	-	-				
		Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-				
	Chandpai	Juvenile	-	-	Feeding and Growing	-	-	-	Feeding	-				
	South-west of the Project	Age-1 adult	Feeding and Growing	Feeding and Growing	Feeding and Growing	-	-	Feeding	-	-				
		Brood Fish	-	-	-	-	-	Breeding and Spawning	-	-				
Bairagi	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-				
		Juvenile and Adult	-	-	-	-	-	-	-	Growing and Feeding				
	Chandpai	Fry	Breeding and Spawning	Breeding and Spawning	Feeding and Growing	Feeding	-	Feeding	-	-				
		Juvenile	-	-	-	-	-	-	-	-				
	Chalna Point	Juvenile and Age-1 adult	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-				
	Harbaria	Juvenile	Feeding and Growing	-	-	-	-	Feeding	-	-				
	Mongla Point	Fry	-	Nursing	-	Feeding	-	-	-	-				
		Juvenile	-	-	-	-	-	-	-	Feeding				
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-				
Chapila	Haldikhali	Juvenile	Feeding and Growing	-	-	-	-	-	-	-				
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	-				
	Mongla Point	Fry	-	Nursing	-	-	-	-	-	-				
	South-west of the Project	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-				
Loitta	Haldikhali	Juvenile and Age-1 adult	Feeding and Growing	-	Feeding and Growing	-	-	-	-	-				
	Akram Point	Juvenile	Feeding and Growing	-	-	-	Feeding and Growing	-	-	-				
	Akram Point	Age-1 adult	-	-	Feeding and Growing	-	Feeding and Growing	-	-	-				
	Chandpai	Juvenile	Feeding and Growing	-	-	-	-	-	-	-				
	Harbaria	Fry, Juvenile and Age-1 adult	-	Nursing, Feeding and Growing	-	-	-	-	-	-				
	Chalna Point	Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-				
Poma	Haldikhali	Juvenile	Feeding and Growing	-	-	Feeding	-	-	-					

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Juvenile	Feeding and Growing	-	-	-	-	-	-	Growing and Feeding				
		Age-1 adult	-	-	Feeding and Growing	-	-	-	Feeding	Feeding				
		Adult	-	-	-	-	-	-						
	Chandpai	Fry and Juvenile	Breeding and Spawning	Nursing	-	-	-	Feeding	-	-				
		Juvenile	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing					
		Adult	-	-	-	-	-	-	Feeding					
	Haldikhali	Fry and Juvenile	-	-	Nursing	-	-	-	-	-				
	Harbaria	Adult and Brood Fish	-	-	Breeding and Spawning	-	-	-	-	-				
		Adult	-	-	-	-	-	-	Feeding					
		Fry and Juvenile						Spawning and Nursery	-	-				
	Mongla Point	Fry, Juvenile and Age-1 adult	-	-	Spawning, Feeding and Growing	-	-	-	-	Nursing				
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
		Age-1 Adult	-	-	-	-	-	-	Feeding	Feeding				
		Adult	-	-		Feeding	-	Feeding	-	-				
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Feeding	-	-				
	Chalna Point	Juvenile, Adult and Brood Fish	Breeding and Spawning	-	-	-	-	-	-	-				
		Juvenile and Adult	-	-	Feeding and Growing	Feeding	Feeding and Growing	-	Feeding and Growing	-				
Chhuri	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-				
	Akram Point		Feeding	-	Feeding	-	-	-	-	-				
Chela	Haldikhali	Adult	Feeding	-	Feeding	-	-	-	-	-				
	Akram Point	Juvenile and Adult	Feeding and Growing	-	-	-	-	-	-	-				
	Harbaria	Juvenile	-	Feeding and Growing	-	-	-	Nursery	-	-				
	Chandpai		-	-	-	-	-	-	-	Growing and Feeding				
Gang Tengra	Haldikhali	Adult	Feeding	-	Feeding	Feeding	-	-	-	-				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Akram Point	Adult	Feeding and Breeding	-	-	Feeding	-	-	-	-				
	Harbaria	Adult	-	-	Feeding	-	-	-	-	-				
	Chandpai	Adult	-	-	Feeding	Feeding	-	-	-	-				
Gagra Tengra	Chandpai	Juvenile and Age-1 adult	-	Feeding and Growing	-	-	Feeding and Growing	-	-	-				
	Chalna Point	Age-1 adult	-	-	-	-	Feeding and Growing	-	-	-				
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	-	-	-	-	-				
	Akram Point	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-				
		Adult	-	-	-	-	-	-	Feeding	-				
	Haldikhali	Juvenile	-	-	-	-	-	-	Feeding and Growing	-				
	Harbaria	Adult	-	-	Feeding	-	Feeding and Growing	-	-	-				
Gulsha Tengra	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-				
	Akram Point	Adult	Feeding and Breeding	-	-	-	-	-	-	-				
	Chandpai	Age-1 adult	-	-	-	Feeding	-	Feeding	Feeding and Growing	-				
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Mongla Point	Age-1 adult	-	Feeding and Growing	-	Feeding	-	Feeding	Feeding	-				
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Maidara	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing	-				
Potka	Haldikhali	Adult	Feeding and Breeding	-	-	-	-	-	-	-				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
	Chandpai	Fry	Spawning	Spawning and Nursing	-	-	-	-	-	-				
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing				
		Adult	-	-	-	Feeding	-	-	-	-				
	Mongla Point	Fry	Spawning	-	-	-	-	-	-	-				
	Harbaria	Fry	-	-	-	-	-	Nursery	-	-				
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing				
Paira Chanda	Akram Point	Adult	Feeding	-	-	-	-	-	-	-				
	Chandpai	Fry	Breeding and Spawning	-	-	-	-	-	-	-				
Chewa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	-	-	-	-	-				
	Chandpai	Fry and Juvenile	Spawning	-	Feeding and Growing	-	Nursing and Grazing	Nursery	Feeding and Growing	-				
	Chandpai	Adult	-	-	-	Feeding	-	Feeding	-	Feeding				
	Haldikhali	Juvenile and Adult	-	-	Feeding and Growing	-	-	-	-	-				
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	-	Feeding and Nursery	-	Feeding				
	Mongla Point	Juvenile	-	Feeding and Growing	-	-	-	-	-	-				
	South-west of the Project	Juvenile	-	Feeding and Growing	-	-	-	-	-	-				
	Chalna Point	Adult	-	-	-	-	Feeding	-	-	-				
Bele	Akram Point	Adult	Feeding	-	Feeding	Feeding	-	-	-	-				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	-	-	-	-	-	Feeding and Growing				
	Haldikhali	Juvenile-1, Juvenile and Adult	-	-	Nursing and Growing	Feeding	-	-	-	-				
	Harbaria	Juvenile and Adult	-	-	Feeding and Growing	-	Feeding and Growing	Nursery and Feedliing	Feeding and Growing	-				
	Chandpai	Fry	Breeding and Spawning	Nursing	-	-	Nursing	Nursery	-	-				
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	Feeding	-	Feeding	-	Feeding				
	Harbaria	Juvenile and Age-1 Adult	-	-	-	-	-	-	Feeding and Growing					
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-				
	Mongla Point	Fry, Juvenile-1 and Juvenile			Nursing and Growing	-	-	-	-	-				
	Mongla Point	Juvenile and Adult	-	-	-	Feeding	Feeding and Growing	Feeding	Feeding and Growing	-				
	Chalna Point	Fry	Breeding and Spawning	Nursing	-	-	Nursing	-	-	Nursing				
	Chalna Point	Adult	-	-	-	Feeding	-	-	-	-				
	South-west of the Project	Juvenile and Age-1 adult	-	Feeding and Growing	Feeding and Growing	Feeding	Feeding and Growing	-	-	-				
		Fry	-	-	-	-	-	-	-	Nursing				
Tular Dandi (Nona bele)	Akram Point	Adult	Feeding	-	-	-	-	-	-	-				
	South-west of the Project	Adult	-	-	Feeding	-	-	-	-	-				
	Chalna Point	Adult	Feeding	-	Feeding	-	Feeding	-	Feeding	-				
Tairel	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding				
	Mongla Point	Juvenile	Feeding	-	-	-	-	-	-	-				
Phekssa	Akram Point	Adult	Feeding	-	-	-	-	-	-	Feeding				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	Feeding and Growing	-	-	-	-	-				
	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-				
	Haldikhali	Adult	-	-	-	Feeding	-	-	-	-				
	Chalna Point	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	Feeding and Growing	-				
	Chalna Point	Adult	-	-	Feeding	Feeding	Feeding	-	Feeding	-				
	Mongla Point	Adult	-	-	Feeding	Feeding	-	-	Feeding and Growing	-				
	Chandpai	Juvenile and Adult	Feeding	Feeding and Growing	-	-	Feeding and Growing	-	Feeding and Growing	-				
	South-west of the Project	Juvenile and Adult	Feeding	Feeding and Growing	-	-	-	-	-	-				
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-				
		Adult	-	-	Feeding	Feeding	-	Feeding	-	-				
Paissa	Akram Point	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	Feeding and Growing				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Juvenile	-	-	-	-	-	-	Feeding and Growing					
	Haldikhali	Juvenile and Adult	Feeding	-	Feeding and Growing	Feeding	-	-	-	-				
		Juvenile	-	-	-	-	-	-	Feeding and Growing	-				
	Harbaria	Juvenile-1 and Juvenile	-	-	Feeding	-	Feeding and Growing	-	Feeding and Growing	-				
		Adult	-	-	-	-	-	-	-	Feeding				
	Chandpai	Fry	Breeding and Spawning	-	-	-	Nursing	-	-	-				
	Chandpai	Juvenile and Adult	-	-	Feeding and Growing	-	-	Nursery and Feeding	-	-				
	Harbaria	Juvenile	-	-	-	-	-	-	Feeding and Growing	-				
	Mongla Point	Fry	Breeding and Spawning	-	-	-	-	Nursery	-	-				
		Age-1 Juvenile	-	-	-	-	-	-	-Nursing, Feeding and Growing	-				
		Age-1 Adult	-	-	-	-	Feeding and Growing	Feeding	-	-				
	South-west of the Project	Fry, Juvenile and Age-1 adult	Breeding and Spawning	Feeding and Growing	-	-	Feeding and Growing	-	-	-				
		Age-1 Juvenile, Juvenile and Age-1 Adult	-	-	-	-	-	-	Nursing, Feeding and Growing	-				
		Adult	-	-	-	-	-	Feeding	-	-				
Banshpata	Chandpai	Juvenile	Feeding	-	-	-	-	-	-	-				

Migratory Fish Species	Sampling Sites	Year Class*	Migration Purpose											
			1st Monitoring (April, 2014)	2nd Monitoring (July, 2014)	3rd Monitoring (Oct, 2014)	4th Monitoring (Dec, 2014)	5th Monitoring (April, 2015)	6th Monitoring (July, 2015)	7th Monitoring (Oct, 2015)	8th Monitoring (Dec, 2015)	9th Monitoring (April, 2016)	10th Monitoring (July, 2016)	11th Monitoring (Oct, 2016)	12th Monitoring (Dec, 2016)
		Adult	-	-	-	Feeding	-	Feeding	-	-				
	Akram Point	Juvenile	-	-	-	-	-	-	Feeding and Growing	-				
		Adult	-	-	-	-	-	-	-	Feeding				
	Haldikhali	Juvnile and adult	-	-	Feeding and Growing	Feeding	-	-	Feeding and Growing	-				
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding				
	Mongla Point	Fry and Adult	Feeding	Nursing	-	-	-	-	-	-				
	Mongla Point	Adult	-	-	-	Feeding	-	-	-	-				
	South-west of the Project	Adult	-	-	Feeding	Feeding	-	Breeding and Spawning	-	-				
	Chalna Point	Adult	-	-	Feeding	Feeding	-	-	-	-				
Hilsa	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-				
	Chandpai	-	-	-	-	-	-	-	Feeding and Breeding	-				
	Mongla Point	Adult	-	-	Feeding	-	-	-	-	-				
	Chalna Point	Brood fish	-	-	-	-	-	Breeding and Spawning	-	-				
Pangas	Haldikhali	Juvenile	-	-	Feeding and Growing	-	-	-	-	-				
	Harbaria	Adult	-	-	-	-	-	-	-	Feeding				
	Mongla Point	Juvenile and Adult	-	-	Feeding	-	-	-	-	-				

Source: Field findings at different times

**Only Age-1 to Brood fish has been allowed to interpret the migration purpose; F = Feeding; Sp = Spawning*

Table D.5: The Present Catch in Three Sampling Ghers

Sampling Site	Total Catch (kg)																							
	1st QM (Apr, 2014)		2nd QM (Jul, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton	Species	ton
1	Bagda	5	Bagda	6.42	Bagda	4.8	-	-	Bagda	-	Bagda	1.6	Bagda	2	Catla	2								
	Vetki	1.57	Bele	0	Gusha Chingri	-	-	-	Horina Chingri	1	Horina Chingri	1	Horina Chingri	3.2	Glass Carp	0.1								
	Bele	0.98	Cheng	0	Harina Chingri	-	-	-	Tengra	-	Chali Chingri	0.5	Gusha Chingri	0.8	Horina Chingri	0.8								
	Harina Chingri	0.78	Bhangan	0	Rui (kg)	-	-	-	Paissa	-	Paissa	0.25	Paissa	24	Minar Carp	0.1								
	Chali Chingri	0.11	Chali Chingri	0	Catla (kg)	-	-	-	Chela	-	Bele	0.25	Vetki	0.2	Nilotica	1.6								
	Chaka Chingri	0.08	-	-	-	-	-	-	Vetki	-	-	-	Kailla	0.4	Paissa	0.6								
	-	-	-	-	-	-	-	-	-	-	-	-	Bele	0	Rui	3								
	-	-	-	-	-	-	-	-	-	-	-	-	Tilapia	0	Vetki	0.8								
	-	-	-	-	-	-	-	-	-	-	-	-	Catla	0	-	0								
	-	-	-	-	-	-	-	-	-	-	-	-	Minar Carp	0	-	0								
	-	-	-	-	-	-	-	-	-	-	-	-	Glass Carp	0	-	0								
	-	-	-	-	-	-	-	-	-	-	-	-	Kakra	0.4	-	0								
Sub-total =		**8.52**		6.42		4.8	-	-		1		3.06	-	31	-	9								
2	Bagda	4	Bagda	1	Bagda	7	-	-	Bagda	-	Bagda	1.67	Bagda	0	-	0								

Sampling Site	Total Catch (kg)																							
	1st QM (Apr, 2014)		2nd QM (Jul, 2014)		3rd QM		4th QM		5th QM		6th QM		7th QM		8th QM		9th QM		10th QM		11th QM		12th QM	
	Harina Chingri	2	Harina Chingri	0.33	Vetki	1	-	-	-	-	Chali Chingri	0.30	Horina Chingri	0	-	0								
	Chali Chingri	0.18	Chali Chingri	0.08	Paissa	10	-	-	-	-	Horina Chingri	0.50	Chali Chingri	0	-	0								
	-	-	Golda Chingri	0.01	Phessa	2.4	-	-	-	-	Bele	0.30	Tilapia	0	-	0								
	-	-	Bele	0.08	Bhang an	1.7	-	-	-	-	Paissa	0.25	Vetki	0	-	0								
	-	-	Tengra& Paissa	0.04	Golda Chingri	0.9	-	-	-	-	-	-	Tengra	0	-	0								
	-	-	-		Gulsha Tengra	0.2	-	-	-	-	-	-	Paissa	0	-	0								
Sub-total =		**6.00**		2.00		23		-	-	-		3.02	-	0	-	0								
	Bagda	1.38	Bagda	2.4	Bagda	1.5	-	-	Bagda	-	Bagda	3.5	Bagda	0.4	-	0								
	Harina Chingri	0.34	Harina Chingri	0.34	Paissa	10	-	-	-	-	-	-	Paissa	3.2	-	0								
	Chali Chingri	0.17	Chali Chingri	0.17	Tengra	10	-	-	-	-	-	-	Vetki	0.4	-	0								
	-	-	-	-	Bele	20	-	-	-	-	-	-	Tilapia	0.06	-	0								
	-	-	-	-	Tilapia	22	-	-	-	-	-	-	Horina Chingri	0.35	-	0								
3	-	-	-	-	Rui	28	-	-	-	-	-	-	Chali Chingri	0.6	-	0								
	-	-	-	-	Vetki	-	-	-	-	-	-	-	Chaka Chingri	0.1	-	0								
	-	-	-	-	Harina Chingri	-	-	-	-	-	-	-	Tengra	0	-	**0**								
	-	-	-	-	Chami Chingri	-	-	-	-	-	-	-	Bele	0	-	0								
	-	-	-	-	Catla	56	-	-	-	-	-	-	Tairel	0.06	-	0								
	-	-	-	-	Mrigel	50	-	-	-	-	-	-	Bhanga n	0	-	0								
Sub-total =		1.89		2.91		197.5	-	-	-	-	-	-	-	5.17	-	0								
Grand-total =		17.00		11.33		226.5	-	-		1		3.5		36.17	-	0								

Source: CEGIS Field Survey, 2014 & 2015

(E) Ecosystem and Biodiversity monitoring data

Table E.1: Species Composition of studied homestead vegetation

Species Name	Local Name	Family	IUCN Global Conservation Significance	Location and No. of Plants			
				Borni	Kalekarber Dighi	Chalkghona	Rajnagar
Acacia moniliformes	Akashmoni	Leguminosae	NE	6	-	-	3
Aegle marmelos	Bel	Rutaceae	NE	-	-	2	-
Albizia richardiana	Chambol	Leguminosae	NE	2	8	3	-
Albizia saman	Sirish/Rendi Koroi	Leguminosae	NE	6	7	3	2
Anona squamosa	Ata	Anonaceae	NE	-	1	-	-
Areca catechu	Supari	Palmae	NE	10	18	-	-
Avecenia alba	Baen	Aviceniaceae	NE	-	-	2	-
Azadirachta indica	Neem	Meliaceae	NE	-	-	3	2
Borassus flabeliffer	Taal	Palmae	NE	6	8	2	-
Carica papaya	Pepey	Caricaceae	NE	-	-	5	-
Citrus medica	Kagoji Lebu	Rutaceae	NE	-	-	2	-
Cocos nucifera	Narikel	Palmae	NE	10	56	39	17
Cordia dichotoma	Bohal	Boraginaceae	NE	-	-	1	-
Diospyrus pregrina	Deshi Gab	Ebenaceae	NE	-	-	3	-
Dyospyros blancoi	Bilati Gab	Ebnaceae	NE	-	12	-	-
Excoecaria agallocha	Gewa	Euphorbiaceae	NE	8	6	36	100
Feronia lemonia	Kaotbel	Rutaceae	NE	1	-	1	1
Ficus religiosa	Aswath	Moraceae	NE	3	-	-	-
Ficus sp	Zeer Bat	Moraceae	NE	2	-	-	-

Species Name	Local Name	Family	IUCN Global Conservation Significance	Location and No. of Plants			
				Borni	Kalekarber Dighi	Chalkghona	Rajnagar
Gardenia augusta	Gondhoraj	Rubiaceae	NE	-	-	2	-
Hibiscus rosa sinensis	Jaba	Malvaceae	NE	-	2	3	2
Hibiscus tilliaceus	Bola	Malvaceae	NE	-	-	-	3
Herritiera fomes	Sundari	Sterculiaceae	NE	-	-	-	1
Ixora coccinea	Rangan	Rubiaceae	NE	1	-	1	-
Mangifera indica	Aam	Anacardiaceae	DD	6	6	7	3
Manilkara zapota	Safeda	Zapotaceae	NE	1	1	1	1
Mimusops elengii	Bakul	Zapotaceae	NE	-	1	-	-
Moringa oleifera	Sazna	Moringaceae	NE	-	-	2	-
Musa sp	Kola	Musaceae	NE	6	-	10	-
Nypa fruticans	Gol	Palmae	LC	-	-	2	-
Phoenix sylvestris	Khejur	Palmae	NE	12	10	24	25
Phylanthus acidus	Naul/Orboroi	Euphorbiaceae	NE	-	-	2	-
Pongamia sp	Koroj	Leguminosae	NE	-	-	2	3
Psidium guajava	Peyara	Myrtaceae	NE	2	8	17	2
Punica granatum	Dalim	Lythraceae	LC	-	-	4	-
Quisqualis indica	Madhabilata	Combrataceae	NE	-	-	4	-
Sonneratia apetala	Kewra	Lyrthaceae	LC	-	-	3	-
Spondius pinnata	Amra	Anacardiaceae	NE	1	-	-	-
Swietenia mehagoni	Mehogani	Meliaceae	NE	11	17	1	2
Syzygium cumini	Jaam	Myrtaceae	NE	-	2	2	-

Species Name	Local Name	Family	IUCN Global Conservation Significance	Location and No. of Plants			
				Borni	Kalekarber Dighi	Chalkghona	Rajnagar
Syzygium samarengense	Jamrul	Myrtaceae	NE	1	-	-	-
Tamarindus indica	Tentul	Leguminosae	NE	2	2	1	1
Terminalia catapa	Kathbadam	Combrataceae	NE	5	-	1	-
Zizyphus mauritiana	Kul	Rhamnaceae	NE	-	2	4	2
Elaeis guineensis	Palm Oil	Palmae	NE	-	4	-	-
Nyctanthes arbor-tristis	Shewly	Oleaceae	NE	-	-	4	-

Source: CEGIS Field Monitoring, April 2014 and June 2014

Note: Conservation Significance "NE"=Not Evaluated; "LC"=Leased Concern; "DD"=Data Deficient (According to The IUCN Global Red List of Threatened Species, 2015)

Table E.2: Occurrences of Butterflies in the study area

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																															
		Apr 2014				**Jul 2014**				**Oct 2014**				**Jan 2015**				**Apr 2015**				**Aug 2015**				**Oct 2015**				**Jan 2016**			
		R	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**
Common Albatross	*Appias albina*																									*	*	** *	* *				
Blue Tiger	*Tirumala hamata*										* *	*																*					
Lime Butterfly	*Papilio demoleus*								*				*		*		*												*				
Chocolate Argus	*Junonia hedonia*					*		*						*																			
Common albatross	*Appias albina*																			*													
Common Cerulean	*Jamides celeno*											*																					
Common Crow	*Euploea core*					*		*	*	*	*		*				*		*							*	*	*	*				
Common Emigrant	*Catopsilia pomona*									*	*	* *	*		*	*																	
Common Gull	*Cepora nerissa*										*																						
Common Leopard	*Papilo phalantha*										*	*																					
Common palmfly	*Elymnias hypermnestra*										*	*			*		*		*									*	*				
Common Pierrot	*Castalius rosimon*										*		*			*																*	
Common Rose	*Pachliopta aristolochiae*												*					*				*					*	*					
Common Sailor	*Neptis hylas*																	*															
Dainty Grass-blue	*Zizula hylax*										*	*												*	*		*	**					
Danaid Eggfly	*Hypolimnas misippus*															*																	
Evening Brown	*Melanitis leda*								*						*		*			** *													*
Foscus Swallowtail	*Papilio fuscus*																																
Grey Pansy	*Junonia atlites*										*											*											
Indian sunbeam	*Curetis thetis*												*						*														
Lemon Pansy	*Junonia lemonius*										*					*																	
		NS	NS	NS	NS																												

Common Name	Scientific Name	Time and locations for Occurrence of Butterfly species																															
		Apr 2014				**Jul 2014**				**Oct 2014**				**Jan 2015**				**Apr 2015**				**Aug 2015**				**Oct 2015**				**Jan 2016**			
		R	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**	**R**	**B**	**K**	**C**
Mangrove Jewel	*Hypochrysops epicurus*						*		**																								
Stripped Tiger	*Danaus genutia*									*		*															**		*				
Orchard Swallowtail	*Papilio aegeus*					*	**													*													
Pale Grass Blue	*Pseudozizeeria maha*																		**	**													
Three spot Grass Yellow	*Eurema blanda*									*	**		*																				
Peacock pansy	*Junonia almana*										**								*								***		*			*	
Rice Swift	*Borbo cinnara*										**	*	**				*																
Small Grass-yellow	*Eurema smilax*						**									*			*	**		**		**	*								
Spotted Pea-blue	*Euchrysops cnejus*																																
Swamp Tiger	*Danaus affinis*																*			*													
Common Red Eye	*Matapa aria*																											*				*	

Table E.3: Benthos species composition and abundanceof the study area (Apr 2014)

Benthos Species Name	Passur River at Harbaria	Passur River at Akram Point	Passur River at Hiron Point	Passur-Maidara Confluence point at Project site	Kalekarber Dighi
	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)
Order: Coleoptera					
Corixa semistriata	-	-	-	-	++
Dubiraphia vittata	++	-	++	++	+
Helichus basalis	+	+	+	-	-
Phytobius waltoni	-	-	-	-	+
Promoresia tardella	-	-	-	+	-
Order: Crustacea					
Bathynella natans	-	-	-	-	+++
Gammarus fasciatus	+++	++	+	+++	-
Palaemonetes paludosus	++	++	++	++	+
Polyphemus pediculus	-	-	-	-	++
Order: Diptera					
Ablabesmyia mallochi	+++	++	++	+++	-
Atrichopogon sp.	-	-	-	-	+++
Brillia flavifrons	-	+	+	-	-
Cricotopus vierriensis	+	-	-	+	+
Cryptochironomus fulvus	++	+	++	++	-
Dicrotendipes fumidus	-	+++	-	-	-
Microtendipes pedellus	-	-	-	+	+
Orthocladius dorenus	-	-	-	++	-
Pericoma pseudoexquisita	-	-	-	-	++
Polypedilum flavum	+	+	+	+	-
Sublettea coffmani	+	-	-	-	-
Tribelos jucundum	-	-	-	++	-
Order: Ephemeroptera					
Acentrella Alachua	+	+	-	+	-
Baetis Pluto	+	+	+	+	-
Baetis scambus	-	-	-	-	+++
Cloeon dipterum	-	-	-	-	++
Drunella lata	-	-	-	+	+
Heterocloeon amplum	-	+	+	-	-
Iswaeon anoka	+	+	-	+	-
Plauditus cestus	+	+	+	-	-
Order: Gastropoda					
Amnicola taylori	-	-	-	-	+++
Ancylus lacustris	-	-	-	-	+++
Bithynia leachii	-	-	-	-	++
Cerithidea cingulata	+	+	+	++	+
Clithon ocualamensis	-	+	+	-	-
Helisoma anceps	+	+	+	+	-
Hydrobla jenkinsi	-	-	-	-	+++

Benthos Species Name	Passur River at Harbaria	Passur River at Akram Point	Passur River at Hiron Point	Passur-Maidara Confluence point at Project site	Kalekarber Dighi
	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)	1st QM (Apr 2014)
Laevapex fuscus	++	+	++	++	-
Limnaea truncatula	-	-	-	-	+++
Micromenetus dilatatus	+++	+	+	+++	+
Plicarcularia leptospera	-	++	++	-	-
Valvata cristata	-	-	-	-	++
Valvata macrostoma	-	-	-	-	+++
Order: Hemiptera					
Belostoma sp.	+++	+++	+++	+++	-
Microvelia umbricola	-	-	-	-	++
Naeogeus ruficeps	-	-	-	-	+
Order: Megaloptera					
Corydalus cornutus	+	+	+	+	-
Nigronia fasciatus	+	+	+	-	
Nigronia serricornis	-	+	-	-	-
Sialis lutaria	-	-	-	-	++
Order: Odonata					
Boyeria grafiana	+	-	+	+	-
Epicordulia princeps	++	++	++	+++	+
Lanthus parvulus	-	+	-	-	-
Order: Oligochaeta					
Limnodrilus hoffmeisteri	+++	+	++	+++	-
Limnodrilus profundicola	-	-	-	+	++
Tubifex heterochaetus	+	-		+	+
Tubifex tubifex	+	+	+	+++	+++
Order: Bivalvia					
Corbicula fluminea	-	+	+	-	-
Elliptio complanata	-	+	-	-	-
Order: Plecoptera					
Eccoptura xanthenes	+	-	-	+	-
Haploperla brevis	-	-	-	+	-
Leuctra hippopus	-	-	-	-	++
Order: Trichoptera					
Brachycentrus lateralis	+	-	-	-	-
Ceratopsyche alhedra	-	-	+	-	-
Ithytrichia lamellaris	-	-	-	-	+++
Micrasema bennetti	+	-	-	+	-
Molanna blenda	-	-	-	+	++
Total nos. of present species	**28**	**29**	**26**	**31**	**32**

Note: '+++' Common; '++' Occasional; '+' Rare; '-' Not detected, NS = Not Surveyed

Source: Field Monitoring, April 2014

Table E.4: Species composition and abundance of Phytoplankton in last Monitoring season

Phytoplankton Species Name	Species Abundance (Unit/Liter)									
	Passur River at Harbaria		Passur River at Akram Point		Passur River at Hiron Point		Passur-Maidara confluence point at Project site		Kalekarber Dighi	
	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)
Class: **Bacillariophyceae**										
Chaetoceros pendulus	33	3	21	2	-	NS	30	3	-	-
Chaetoceros socialis	25	5	20	1	-	NS	28	2	-	-
Coscinodiscus stellaris	19	-	18	-	15	NS	10	-	6	-
Coscinodiscus excentricus	19	2	18	2	19	NS	20	4	12	5
Coscinodiscus granii	30	-	31	-	34	NS	32	1	5	-
Coscinodiscus lineatus	44	1	39	1	47	NS	40	2	-	-
Coscinodiscus marginatus	21	-	16	-	18	NS	24	1	-	-
Coscinodiscus tumidus	10	-	17	8	6	NS	15	9	4	2
Cyclotella bodanica	14	-	-	17	12	NS	-	15	-	4
Cymbella gracilis	28	3	22	2	20	NS	31	3	-	-
Cymbella parva	-	-	-	-	-	NS	-	-	15	4
Gyrsigma distortum	20	2	24	3	23	NS	19	1	4	-
Melosira arenaria	20	4	23	2	20	NS	25	2	-	-
Melosira granulata	34	-	30	-	35	NS	25	-	8	-
Melosira moniliformis	36	1	33	1	39	NS	45	3	12	-
Melosira sol	18	-	23	-	20	NS	26	2	-	-
Melosira undulate	27	2	20	1	25	NS	30	4	-	-
Melosira varians	28	1	25	-	22	NS	29	1	-	-
Navicula bacillum	16	-	24	2	21	NS	19	-	-	-
Navicula brekkaensis	25	3	22	1	14	NS	28	3	-	-
Navicula grimmei	10	-	13	2	11	NS	8	-	3	-

Phytoplankton Species Name	Species Abundance (Unit/Liter)									
	Passur River at Harbaria		Passur River at Akram Point		Passur River at Hiron Point		Passur-Maidara confluence point at Project site		Kalekarber Dighi	
	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)
Navicula halophila	-	-	-	-	-	NS	-	-	28	5
Nitzschia acicularis	17	1	10	-	13	NS	20	1	-	-
Nitzschia alpina	-	-	-	-	-	NS	-	-	16	1
Nitzschia sigma	25	3	-	2	-	NS	-	3	-	-
Pinularia gibba	-	-	-	-	-	NS	-	-	-	1
Pinularia viridis	-	-	-	-	-	NS	-	-	-	3
Surirella fastuosa	29	5	-	3	-	NS	-	5	-	-
Surirella robusta	22	-	-	17	15	NS	-	16	-	6
Synedra ulna	25	-	-	28	21	NS	-	26	-	7
Class: **Chlorophyceae**										
Chlorella vulgaris	7	-	-	6	8	NS	-	10	-	-
Closterium costatum	16	2	-	1	-	NS	-	3	-	-
Closterium lagoense	10	3	-	2	-	NS	-	4	-	9
Closterium moniliferum	-	-	-	-	-	NS	-	-	29	7
Cosmarium botrytis	-	-	-	-	-	NS	-	-	38	3
Cosmarium obsoletum	-	-	-	-	-	NS	-	-	35	8
Cosmarium ocellatum	-	-	-	-	-	NS	-	-	10	2
Oedogonium crispum	-	-	-	-	-	NS	-	-	27	2
Pediastrum duplex	-	-	-	-	-	NS	-	-	29	5
Pediastrum simplex	-	-	-	-	-	NS	-	-	37	11
Pediastrum tetras	-	-	-	-	-	NS	-	-	29	2
Scenedesmus bijuga	-	-	-	-	-	NS	-	-	52	6
Scenedesmus granulatus	-	-	-	-	-	NS	-	-	33	9
Spirogyra crassa	-	-	-	-	-	NS	-	-	18	3

Phytoplankton Species Name	Species Abundance (Unit/Liter)									
	Passur River at Harbaria		Passur River at Akram Point		Passur River at Hiron Point		Passur-Maidara confluence point at Project site		Kalekarber Dighi	
	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)
Spirogyra ellipitica	-	-	-	-	-	NS	-	-	14	1
Ulothrix zonata	-	-	-	-	-	NS	-	-	21	1
Uronema elongatum	-	-	-	-	-	NS	-	-	35	5
Class: **Cyanophyceae**										
Anabaena fuellebornii	-	-	-	-	-	NS	-	-	17	-
Anabaena orientalis	-	-	-	-	-	NS	-	-	109	9
Anabaena variabilis	-	-	-	-	-	NS	-	-	31	5
Aphanocapsa variabilis	-	-	-	-	-	NS	-	-	11	-
Calothrix fusca	-	2	-	-	-	NS	15	3	6	-
Calothrix castellii	-	8	-	5	7	NS	9	-	14	-
Gloeocapsa granosa	-	-	-	-	-	NS	-	-	15	3
Lyngbya lutea	-	2	-	1	-	NS	10	3	19	3
Lyngbya lutea	-	9	-	6	10	NS	-	10	-	19
Lyngbya confervoides	-	3	-	1	-	NS	15	4	-	-
Lyngbya corticicola	-	1	-	-	-	NS	9	2	-	-
Lyngbya rubida	-	-	-	-	-	NS	-	-	36	-
Microcoleus chthonoplastes	-	2	-	-	-	NS	10	-	-	-
Nostoc hatei	-	-	-	-	-	NS	-	-	55	2
Nostoc punctiforme	-	-	-	-	-	NS	-	-	43	12
Oocystis pusilla	-	2	-	2	-	NS	12	3	8	-
Oscillatoria amoena	-	2	-	2	-	NS	18	3	10	-
Oscillatoria annae	-	-	-	-	-	NS	-	-	25	3
Oscillatoria curviceps	-	-	-	-	-	NS	-	-	31	5
Oscillatoria limosa	-	-	-	1	-	NS	10	2	7	-

Phytoplankton Species Name	Species Abundance (Unit/Liter)									
	Passur River at Harbaria		Passur River at Akram Point		Passur River at Hiron Point		Passur-Maidara confluence point at Project site		Kalekarber Dighi	
	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)
Oscillatoria princes	-	1	-	-	-	NS	4	-	-	-
Oscillatoria subbrevis	-	3	-	4	-	NS	12	2	18	1
Oscillatoria tenuis	-	3	-	3	-	NS	21	5	9	-
Schizothrix lamyi	-	5	-	3	3	NS	2	-	9	-
Spirulina gigantea	-	-	-	-	-	NS	-	-	27	5
Spirulina major	-	1	-	-	-	NS	8	1	16	2
Spirulina subsalsa	-	-	-	-	-	NS	6	-	8	1
Class: **Dinophyceae**										
Ceratium dens	-	13	-	21	19	NS	9	-	-	-
Ceratium extensum	-	9	-	15	13	NS	7	-		-
Ceratium furca	-	2	-	3	-	NS	4	-	-	-
Ceratium horridum	-	-	-	2	-	NS	6	-	-	-
Ceratium massiliense	-	-	-	1	-	NS	3	-	-	-
Ceratium tripods	-	18	-	29	28	NS	10	-	-	-
Peridinium granni	-	1	-	2	-	NS	10	-	-	-
Class: **Xanthophyceae**										
Centritractus belanophorus	-	-	-	-	-	NS	15	2	4	-
Total Population: (Unit/liter)	**628**	**128**	**449**	**205**	**538**	**-**	**729**	**164**	**1,048**	**182**
Total Species Count	**51**	**29**	**51**	**27**	**51**	**-**	**51**	**30**	**56**	**33**

Note: '-' = Not detected; 'NS' = Not Surveyed

Source: Field Monitoring, April 2014 and July 2014

Table E.5: Species composition and abundance of zooplanktons

Zooplankton Species Name	Species Abundance (Unit/Liter)									
	Passur River at Harbaria		Passur River atAkram Point		Passur River at Hiron Point		Passur-Maidara confluence point at Project site		Kalekarber Dighi	
	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)	1st QM (Apr 2014)	2nd QM (Jul 2014)
Class: **Cladocera**										
Alona costata	-	-	-	-	-	NS	-	-	25	10
Alona guttata	-	-	-	-	-	NS	-	-	11	5
Bosmina coregoni	-	-	-	-	-	NS	-	-	19	3
Ceriodaphnia laticaudata	-	-	-	-	-	NS	-	-	11	4
Daphnia similis	-	-	-	-	-	NS	-	-	22	6
Diaphanosoma beuchtembergianum	-	-	-	-	-	NS	-	-	3	-
Diaphanosoma brachyurum	-	-	-	-	-	NS	-	-	7	2
Evadne tergestina	4	2	1	1	3	NS	6	1	-	-
Moina brachiata	-	-	-	-	-	NS	-	-	21	3
Class: **Copepoda**										
Calanopia thompsoni	8	-	10	1	11	NS	15	3	7	-
Calanus helgolandicus	7	2	6	1	9	NS	10	3	-	-
Corycaeus flaccus	12	2	9	2	8	NS	14	3	19	3
Cyclops nanus	-	-	-	-	-	NS	-	-	35	11
Cyclops vernalis	-	-	-	-	-	NS	-	-	14	3
Diaptomus gracilis	-	-	-	-	-	NS	-	-	17	5
Heliodiaptomus latifi	-	-	-	-	-	NS	-	-	9	1
Lucifer typus	7	2	9	2	-	NS	15	2	-	-
Mesocyclops hyalinus	-	-	-	-	-	NS	-	-	33	8
Microsetella rosea	10	-	7	-	9	NS	12	3	-	-
Oithona rigida	14	3	9	3	11	NS	17	2	2	3

Oncaea venusta	4	1	2	-	3	NS	4	2	7	2
Class: **Protozoa**										
Favella taraikaensis	3	-	-	-	-	NS	5	2	-	-
Class: **Rotifera**										
Brachionus angularis	-	-	-	-	-	NS	-	-	22	9
Brachionus havanensis	-	-	-	-	-	NS	-	-	20	5
Brachionus urceolaris	-	-	-	-	-	NS	-	-	6	1
Keratella tropica	-	-	-	-	-	NS	-	-	29	7
Notholca sp.	-	-	-	-	-	NS	-	-	8	2
Trichocerca cylindrical	-	-	-	-	-	NS	-	-	15	3
Total Population: Unit/liter	**69**	**12**	**53**	**10**	**54**	**-**	**98**	**21**	**362**	**96**
Total Species Count	**9**	**6**	**8**	**6**	**8**	**-**	**9**	**9**	**23**	**21**

Note: '-' Not detected; 'NS' = Not Surveyed

Source: Field Monitoring, April 2014 and July 2014