

Figure 6.14: Average seasonal outflow from the basin during 1981-2017

b) Historical Annual Flow (1981-2017)

394. From the historical annual flow of the study area it is found that the outflow of the basin has been reduced gradually after 2000. Before 2000, the annual flow was 16,000 – 22,000 Mm³ while it has been reduced to 9,000 – 14,000 Mm³ in the recent years.

c) River Water Flow and UFFL and PUFFL

395. It is estimated that the environmental flow of the Shitalakhya River is about 92.2 m³/s and average dry season flow is about 83 m³/s. The existing UFFL and PUFFL fertilizer factories of the Ghorasal have been withdrawing a total of about 0.5833 m³/s (2,100 t/h; UFFL-1100 t/h and PUFFL-1000 t/h) from the Shitalakhya. The proposed GPUFP will require 0.5667 m³/s (2,040 t/h, Gross intake), which is only 0.61% of the environmental flow and only 0.68% of the average dry season flow of the Shitalakhya River.

396. Waste water from the fertilizer factories are disposed to lagoons and it creates adverse effect on the components of the ambient environment. NH³ mixed water injects into the lagoon and after dilution and settling down, this water discharges into the Shitalakhya River without due treatment. So, this contaminated water also harms the aquatic fauna and degrading the naturality of the Shitalakhya River. Gradually, it hampers the Aquatic Ecosystem of the Shitalakhya River. It also causes a number of diseases (e.g., respiratory problem, vomiting, belly swollen, etc.) among the villagers who lives nearby the lagoon.

d) Navigability of the Project Site River Section

397. After analyzing the average minimum water level of 1981-2017 and longitudinal profile of the river, it is found that throughout the year the Shitalakhya maintains a minimum of more than 4 m depth in the whole reach of the river as shown in Figure 6.15. The relatively inert geo-morphological characteristics of the river made fairly suitable water depths for navigation. Moreover, due to its lesser fluvial activity, riverbank erosion is negligible and shifting of the thalweg or navigation channel from one bank to the other is not dynamic in nature. These characteristics of the river have facilitated the growth of industries, commercial centers, power plants and fertilizer factories on either side of its banks. The chainages (Ch 0.00km at

Lakhpur; Ch 8.40 km near UFFL and Ch 47.65 km at Demra) are considered for analyzing long profile of the river section.

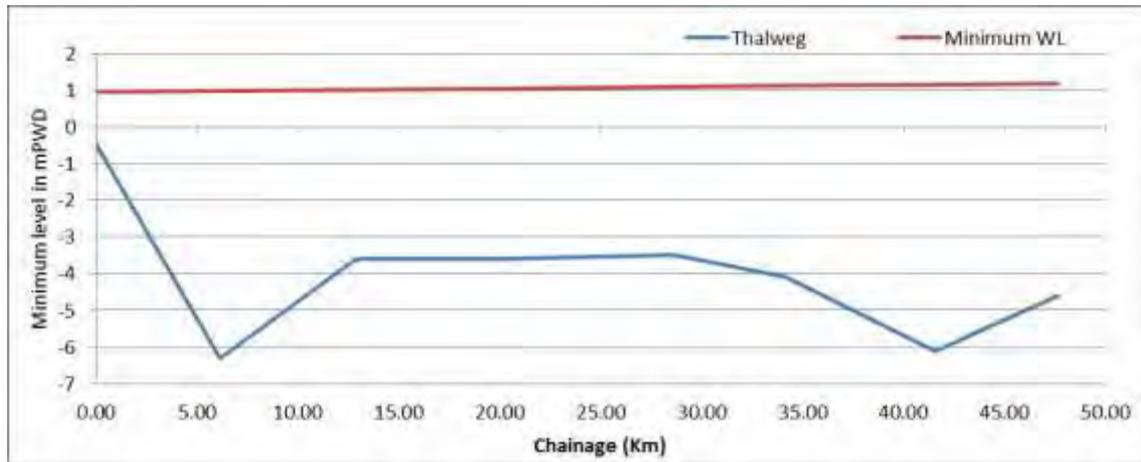


Figure 6.15: Long profile of the Shitalakhya River from Lakhpur to Demra

Groundwater Uses

398. In UFFL and PUFFL, Ground water is usually used in the colonies as potable use while potable purpose in the Factory is met up by treated river water. Some treated river water is also used as potable water in the colonies. It is reported from the DPHE that the average depth of the shallow tube well in the project area is 61 m (200 ft). BWDB data reveals that groundwater level of Polash Upazila is about 6.5 m below the ground surface. Drawdown effect of groundwater is started at Ghorasal area due to extensive withdrawal by the industries and the local inhabitants. Now-a-day, people around the factory area are using not only hand pump but also using motor pump to extract Ground water below 50-60 m from the ground level.

6.2.6 Hazards

Natural Hazards

399. Bangladesh is a natural hazard prone country due to its geographical and deltaic location. In addition to that, the land characteristics of the country, its climatic condition and the impact of climate change make the country more vulnerable to natural hazards. The mostly occurred natural hazards are: cyclone with storm surge, tornado, flood, coastal and river bank erosion, landslides, water logging, drought and earthquake. However, the hazard profile is different for different parts of the country.

400. The location of the proposed Project site is situated in the central zone of the country. Analyzing the location, it is observed that the nearby Shitalakhya River is not very much sand braided river and the bank of this river is comparatively less erosion prone. Additionally, the topography of the Project site indicates that it is not situated in the floodplain and therefore, the site is not very much prone to flood either. Landslides occurs only in the hilly areas of Bangladesh which is far away from the project site. On the other hand, the coastal region is mostly prone to cyclone and storm surges and coastal erosion. Moreover, the North-Western part of the country is prone to drought due to the scarcity of water. According to the seismic zone, the Project site falls under Zone-II which holds the middle class of risk with seismic

coefficient of 0.15 among the three zones. Although the Project site is at the middle class of risk zone, earthquake hazard is more of a regional concern than that of the local, as Bangladesh is surrounded by regions of high seismicity. It should be mentioned, that the tectonic activities of the surrounding regions beyond the border are the main causes of frequent earthquake in Bangladesh.

Chemical Hazards (Health Concern)

401. There are two Urea fertilizer factories located in the Project Site. Hazardous situations can occur due to hoses coming loose or bursting when the chemicals/materials are being transferred from one tank to another. Personal exposures to ammonia and acute respiratory effects were reported in workers at the factory. Urea plant workers had higher mean exposure to ammonia and prevalence of acute respiratory symptoms than did workers in the ammonia plant. The symptoms with highest prevalence in the urea plant were chest tightness and cough. Forced vital capacity (FVC) and Forced Expiratory Volume (FEV1) decreased significantly across the work shift among urea plant workers. The higher level of exposure to ammonia in the urea plant was associated with an increased prevalence of respiratory symptoms and an acute decline in lung function.

402. On the other hand, there are two gas-based captive Power Plants (8 MW each) for the daily electricity use of the existing fertilizer factories. As the Power Plants are natural gas based, hence, formation of SO₂ is insignificant and pollution of air is negligible.

6.2.7 Climate and Meteorology

403. The project Site is located in Dhaka Division. According to Köppen Climate classification, it falls under 'Aw' category which is characterized by tropical wet and dry climate. Here, it experiences hot and humid summer and dry winter. According to climate characteristics, Bangladesh is divided into 7 different climate sub-regions. The study area of the project falls under "G", which is the south-central climate zone of the country (**Figure 6-16**).



Figure 6.16: Climatic zone of the proposed Urea Factory

404. The summary of the analysis of the climatic and meteorological parameters are discussed in the following sections:

Temperature

405. Temperature data of Dhaka Station from Bangladesh Meteorological Department (BMD) for 34 years (from January 1987- December 2017) has been analyzed to see the monthly variation of the maximum temperature which is between 28.48°C to 37.14°C. The monthly variation of the minimum temperature is 9.5°C to 24.9°C. The maximum recorded temperature in Dhaka station was 39.6°C, which occurred on March, 1999 and April, 2009. On January 1995, the minimum temperature was recorded as 6.5°C in Dhaka. The warmest month of the year is April and the coldest month of the year is January. **Figure 6-17** shows the maximum, minimum, average of maximum and average of minimum temperature of Dhaka station from 1987 to 2017 (Source: BMD).

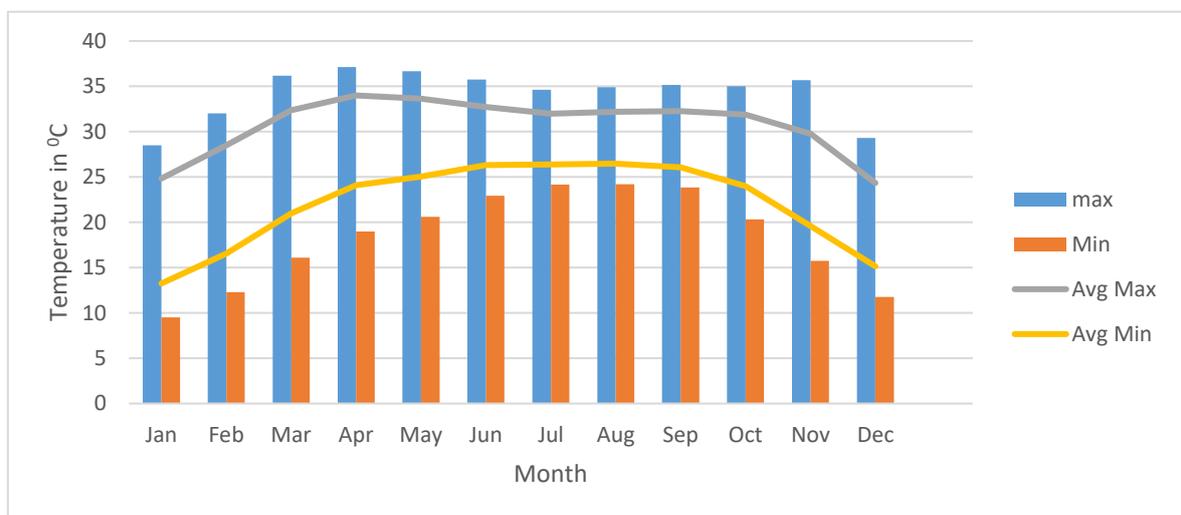


Figure 6.17: Monthly maximum, minimum and average temperature (1987-2017)

Rainfall

406. Monsoon is a prominent season in this area. The average monthly rainfall during monsoon (June-September) season from 1980-2017 is 332 mm/month. The variance in the maximum rainfall during monsoon season is 836 mm/month to 552 mm/month, whereas the variance in the minimum rainfall is 136 mm/month to 59 mm/month. The maximum 836 mm/month rainfall was recorded during September of the year 2004. Annual average rainfall is 2066 mm/year and the highest recorded yearly rainfall was 3028 mm in the year 1984. The driest period of the year is winter when the average monthly rainfall varies from 21 mm/month to 7.21 mm/month. **Figure 6-18** shows the maximum, minimum and average rainfall from 1980-2017.

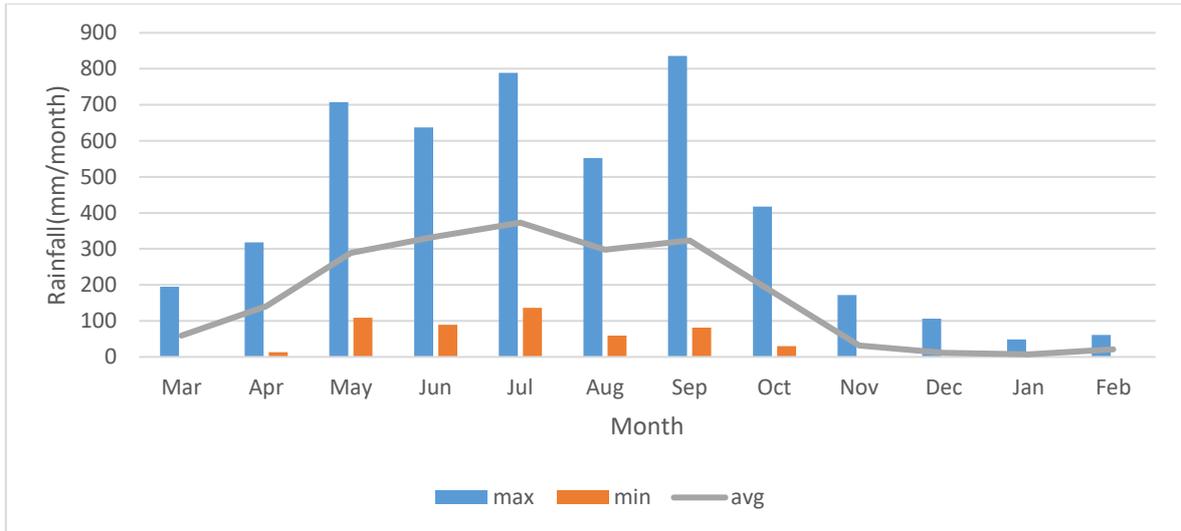


Figure 6.18: Monthly Maximum, Minimum and Average Rainfall

407. The drainage system of the area is based on the Shitalakhya River (Figure 6.19). There are many drainage canals in and around the Project site falls into the river carrying the rainfall runoff as storm water. During torrential rainfall, the drainage system of the UFFL and PUFFL sometimes fail to accommodate storm water draining into the river. At that time, the factory premise as well as the emergency Urea stack (when fertilizer production is in peak level) on the road becomes flooded. As a result, much damage occurs to Urea pile and count substantial financial loss.

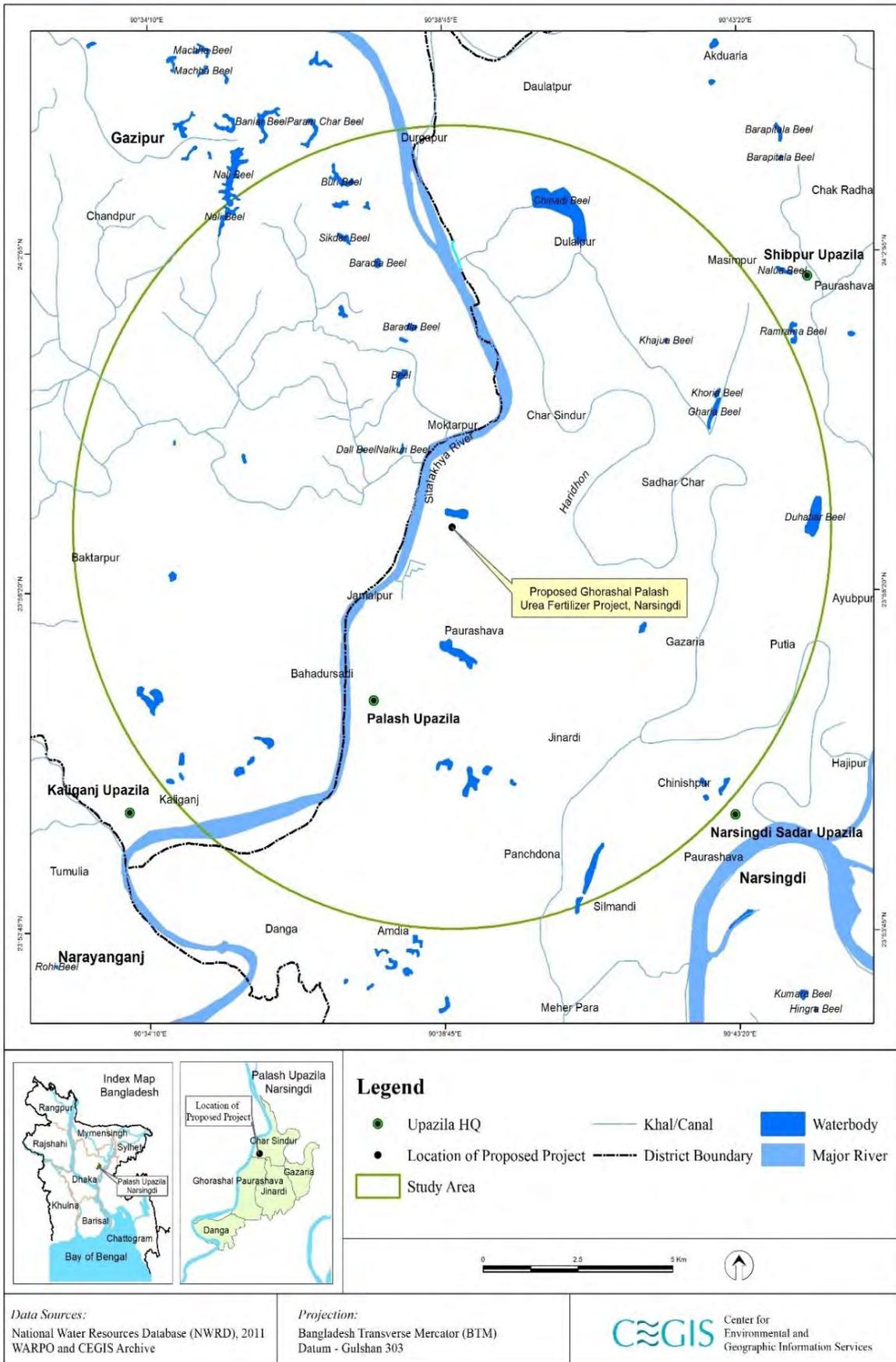


Figure 6.19: Drainage system network of the study area

Humidity

408. The average relative humidity remains higher during the monsoon season. The variance in the average relative humidity throughout the year is 82.61% to 61.29%, whereas during monsoon the variance is 83.77% to 82.40%. Figure 6-20 shows the maximum, minimum and average relative humidity of Dhaka station from January 1988 to January 2018.

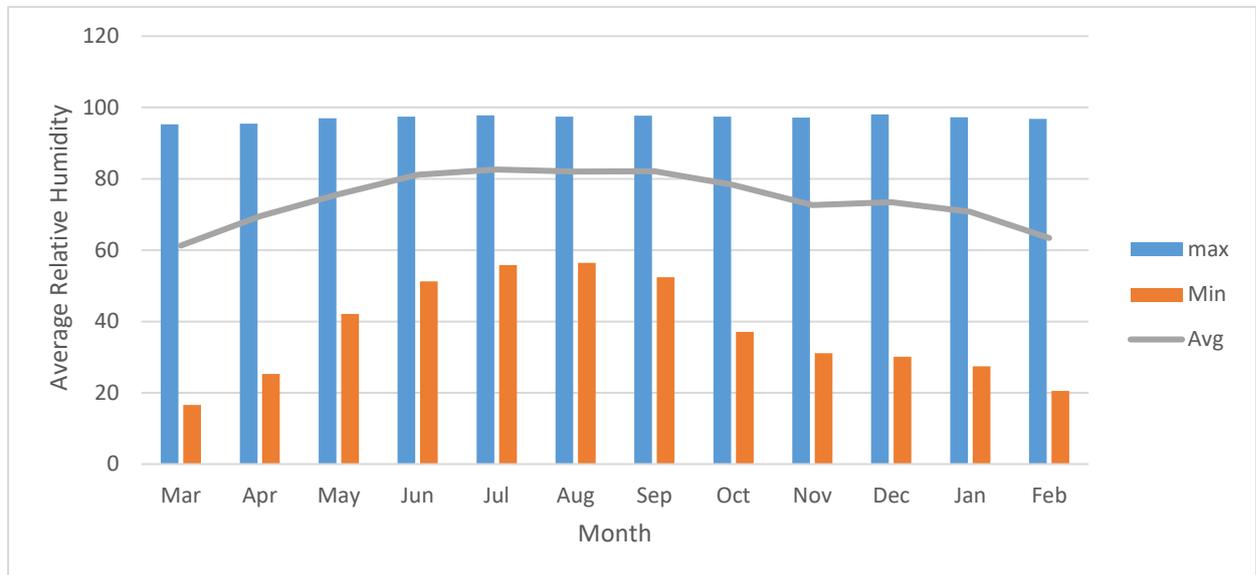
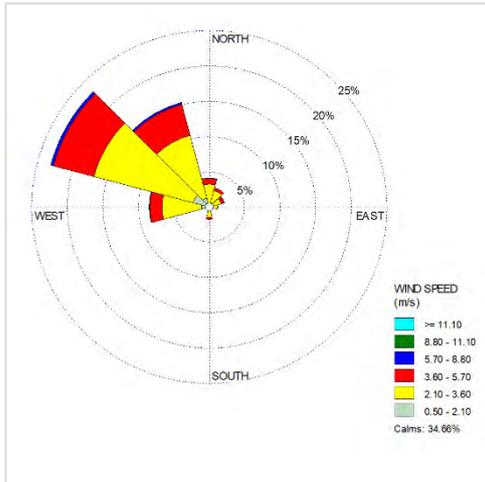


Figure 6.20: Maximum, Minimum and Average Relative Humidity (1988-2018)

Wind Speed and Direction

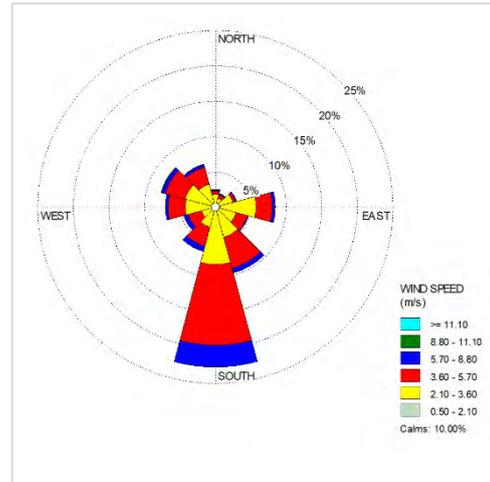
409. The direction of wind varies depending on the seasons. Therefore, whole year has been categorized into four clusters of months and these are: Cluster-1 which is called winter: December-February, Cluster- 2 which is called Pre-Monsoon: March to May, Cluster- 3 which is called Monsoon: June to September, and Cluster- 4 which is called Post Monsoon: October to November. Wind speed data and direction have been collected from the Dhaka BMD station at a height of 10 m from the ground level. During the months of clusters 1 and 4 wind direction is predominantly from northwest to southeast direction, inclined towards East and for clusters 2 and 3 it is predominantly from South and southeast to North and northwest. In cluster 1 calm wind prevails for 34.66% of total period, similarly it is 10.0% for cluster 2, 11.42% for cluster 3, and 53.56% for cluster 4, respectively. Figure 6.21 (a, b, c and d) presents the wind speed and direction graphically round the year.

Winter (December to February)



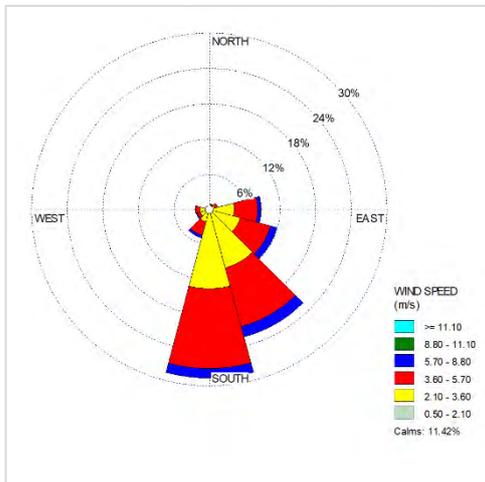
Cluster-1

Pre-monsoon (March to May)



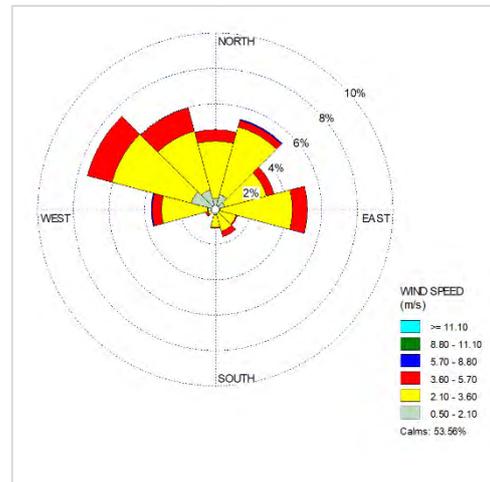
Cluster-2

Monsoon (June – September)



Cluster-3

Post- Monsoon (October – November)



Cluster-4

Figure 6.21: Wind rose at Dhaka station

410. The Figure 6.22 shows wind speed and direction round the year for 2018 based on data collected at Dhaka Station and calm wind prevails for 24.8 % time of the year.

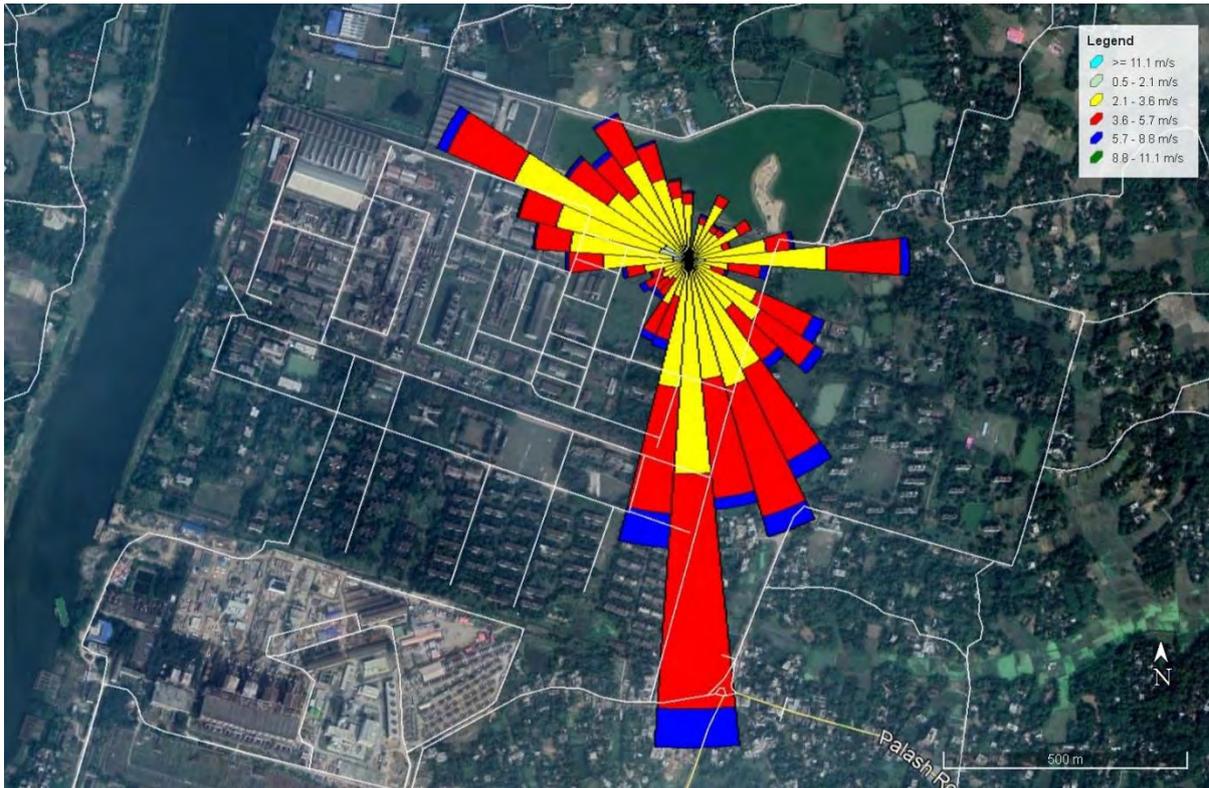


Figure 6.22: Annual wind rose for 2018

6.2.8 Ambient Air Quality

411. The ambient air quality of the airshed of the proposed Project area has been monitored primarily. A systematically designed air quality surveillance monitoring program was formed on account of impact assessment on air environment due to proposed project activities. The basic consideration for designing the air quality sampling locations were representativeness of the airshed, sensitivity of the locations, duration of monitoring and monitoring of all relevant and important pollution parameters (ECR 1997 and subsequent amendments).

412. The parameters selected for presenting the ambient air quality are Suspended Particulate Matter (SPM), Particulate Matter (PM₁₀ & PM_{2.5}), Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO_x), Carbon Monoxide (CO), Ozone (O₃), Ammonia (NH₃), Hydrogen Sulphide (H₂S) and Volatile Organic Carbon (VOC). The design of the network of ambient air quality monitoring stations in the study area was done based on the following criteria:

- Meteorological conditions basically the wind direction
- Topography on the study area
- Representation of the regional background levels
- Sensitivity of the areas
- Influence of the existing sources
- Major human settlements in the study area

413. The surrounding area of the proposed Project site is semi-urban in nature and consists of major industrial set up along with existing power plants. Considering all these factors, the existing and potential future emission sources of air quality of the project site

airshed monitoring is immensely necessary. Due to the unavailability of monitoring station at nearby the proposed Project Site, the closest CAMS No. 4 (Gazipur Station) of DoE recorded data were studied to get a general overview about the air quality in the proposed project airshed. The measured station data along with the national standards for the major air quality parameters are given in **Table 6-8** below. Data results indicate that concentration of NO₂ (ppb), PM_{2.5} (in µg/m³) and PM₁₀ (in µg/m³) significantly exceeded the National Ambient Air Quality Standard during the winter months. However, the concentration of air particulate matters remain below the maximum allowable limit in the rainy season because of the flushing with rain water. It should be noted that the average rainfall during the monsoon varies between 129 mm and 388 mm. The rest of the parameters were found within the permissible limit, and less likely to pose any significant health hazard to the local residents.

Table 6.8: Ambient air quality in January and July, 2018 at CAMS-4

Parameter	Unit	NAAQS	Summary	CAMS-4 (Gazipur)	
				Lat.: 23.99N, Long.: 90.42E	
				January 2018	July 2018
SO ₂ - 24 hr	ppb	140	Average	1.42	15.9
			Max	4.80	35.7
			Min	0.26	3.87
NO ₂ - 24 hr	ppb	53	Average	45.1	1.65
			Max	76.6	3.89
			Min	16.8	0.66
CO- 1 hr	ppm	35	Average	DNA	DNA
			Max	DNA	DNA
			Min	DNA	DNA
CO- 8 hr	ppm	9	Average	DNA	1.41
			Max	DNA	2.69
			Min	DNA	0.38
O ₃ - 1 hr	ppb	120	Average	DNA	3.50
			Max	DNA	8.81
			Min	DNA	1.14
O ₃ - 8 hr	ppb	80	Average	DNA	DNA
			Max	DNA	DNA
			Min	DNA	DNA
PM _{2.5} - 24hr	µg/m ³	65	Average	208	28
			Max	271	74.5
			Min	123	7.76
PM ₁₀ - 24hr	µg/m ³	150	Average	300	52.8
			Max	423	117
			Min	203	21

Note: CAMS- Continuous Air Monitoring Station; NAAQS- National Ambient Air Quality Standard; DNA*- Data Not Available due to malfunction of the analyzer/sensor (Source: CASE project-Monthly Air Quality Monitoring Report, January and July 2018)

414. In addition to this air quality has been monitored in the Project site. After reconnaissance of the area and observing the topographical features and review of the available meteorological data and local conditions, the sampling sites were chosen which will be the representative of the project area airshed. A network of five ambient air-sampling locations has been selected for assessment of the existing status of air environment within the study zone (Figure 6.23).



Figure 6.23: Ambient air sampling locations

415. Monitoring stations were installed at least 15 m distance from local sources. The height of sampling points was kept between 4-6 m (free from obstructions). Ambient air quality was monitored inside the Project site for continuous 24 hours for each of the location. During sampling period, the weather was sunny and the wind direction was from North-West to South-East. Table 6.9 shows the monitoring result of the ambient air quality at the sampling locations. Maximum ambient air quality monitoring results were found within the standard limit of ECR, 1997 as well as of IFC, 2007 standard except SPM and PM_{2.5}. Exceedances of SPM were observed in four locations out of five locations and PM_{2.5} were observed in two locations situated peripherally. In case of NO_x, the IFC standard stands for annual and 1-hr where the monitoring data recorded for 24hrs. However, the ambient NO_x data will be within the standard limit of IFC annual standard.

Table 6.9: Ambient air quality in the project airshed

Sam pling Point	Concentration of Different Parameters in Ambient Air ($\mu\text{g}/\text{m}^3$)									
	SPM	SO ₂	NO _x	CO	O ₃	NH ₃ *	H ₂ S*	PM ₁₀	PM _{2.5}	T VOC
AQ-1	257	7.4	35.2	0.38	24.6	34.8	<10	126.4	58.2	41.46
AQ-2	245.2	8.5	42.4	0.87	38.7	108.2	<10	119.4	53.5	<4.2
AQ-3	189.2	7	38.7	0.75	26.8	36.5	<10	96.7	48.6	157.1
AQ-4	293.4	9.2	48.6	0.98	37.7	733	<10	140.8	76.7	227.92
AQ-5	293.8	8.3	40.3	1.15	30.5	173.5	<10	145.2	74.8	59.37
ECR, 2005	200	365	100	10000	157	3480	280	150	65	-
	8-Hr	24-Hr	Annual	8-Hr	8-Hr	Max	Max	24 Hr	24 Hr	-
IFC, 2007	-	20	40	-	100	-	-	150 (IT-1)	75 (IT-1)	
		24 Hr	Annual		8-Hr	-	-	24-Hr		

Sam pling Point	Concentration of Different Parameters in Ambient Air ($\mu\text{g}/\text{m}^3$)									
	SPM	SO ₂	NO _x	CO	O ₃	NH ₃ *	H ₂ S*	PM ₁₀	PM _{2.5}	T VOC

Notes: *Schedule – 8(Standards for Odor) of ECR 1997 has been used; This monitoring was conducted by - Respirable Dust Sampler (Model-Envirotech India APM-460BL) and Fine Particulate Sampler (Model-Envirotech APM-550)

416. The monitoring results are a good representative of the status of the proposed Project airshed. Presently, the area is semi-urban in nature and consists of major industrial set up along with existing UFFL and PUFFL, Power Plants and brick kilns etc. Existing road dust from the paved and unpaved road, vehicular movement, emission from the fertilizer and power plant industries, pollen, emission from the lagoons and windblown dust from agricultural lands and exposed earth, domestic cooking are the potential sources of air pollution at present.

6.2.9 Odor

417. Odor can be defined as the “perception of smell” or in scientific terms as “a sensation resulting from the reception of stimulus by the olfactory sensory system” (CPCB 2008). Whether pleasant or unpleasant, Odor is induced by inhaling air-borne volatile organics or inorganic component. Odor emission often consists of a complex mixture of many odorous compounds but for fertilizer factories ammonia (NH₃) is the main chemical components that produce strong pungent smell for the human.

418. In ECR 1997, the major chemical constituent of odor are identified and fixed their limit at Schedule-8 which has been shown in Table 6.10 especially for NH₃ and H₂S.

Table 6.10: Standard for Odor of ECR, 1997: SCHEDULE – 8

Parameter	Chemicals	Standard Limit (ppm)	Maximum Limit ($\mu\text{g}/\text{m}^3$)
Ammonia	NH ₃	1 – 5	3480
Hydrogen Sulfide	H ₂ S	0.02 – 0.2	280

419. Odor is one of the major environmental and social problem encountered by the local inhabitants living adjacent to the existing Fertilizer Factories. Particularly, those communities who live around the Lagoon are experiencing serious nuisance by the odor of NH₃.

420. Because of the significant environmental hazards of NH₃, National Pollutant Inventory, (DEH, 2004) and AP-42 (USEPA, 1998) has estimated typical release of NH₃ into the water from Urea Manufacturing process. Around 0.0199 kg/hr/source of NH₃ release from fugitive sources from a Urea Fertilizer factory (NPI, 2004: Table-9). It is mixed with the water and release to the lagoon. Volatile gas NH₃ is lighter than air and tends to rise, because of this fact it generally does not settle in low-lying areas. According to Aneja. V.P. et.al. in 2001, average emission flux of NH₃ from a lagoon is 40.7-120.3 $\mu\text{g}/\text{m}^2\text{-min}$ of fertilizer factories. During the field measurement the quantity of NH₃ and H₂S and Total VOC has been presented in Table 6.11.

Table 6.11: Quantity of odors component at different sampling location

Sampling Point	NH ₃	H ₂ S*	Total VOC
AQ-1	34.8	<10	41.46
AQ-2	108.2	<10	<4.2

AQ-3	36.5	<10	157.1
AQ-4	733	<10	227.92
AQ-5	173.5	<10	59.37
ECR, 1997	3480	280	-
(Schedule -8, Rule-12)	Max	Max	-

421. The people who lives near the lagoon suffer a lot due to unpleasant odor which generates from contaminated water and ammonia gas. Ammonia is a colourless and highly irritating gas with a sharp suffocating odor. It dissolves easily in water to form ammonium hydroxide solution which can cause irritation and burns. Gradually, it hampers the entire Aquatic Ecosystem of the Shitalakhya River. It also causes a lot of diseases among the villagers who live nearby the lagoon. The diseases are bronchitis, allergy, eye irritation, skin diseases, belly swollen, even lung cancer, etc.

6.2.10 Acoustic Environment

422. Excessive noise generation from industrial activities, vehicle movements, chattering, chirping of birds etc., might have noticeable negative impacts on surrounding environment. Continuous high noise or impulse noise may cause health hazards to both the people living in the area and the workers.

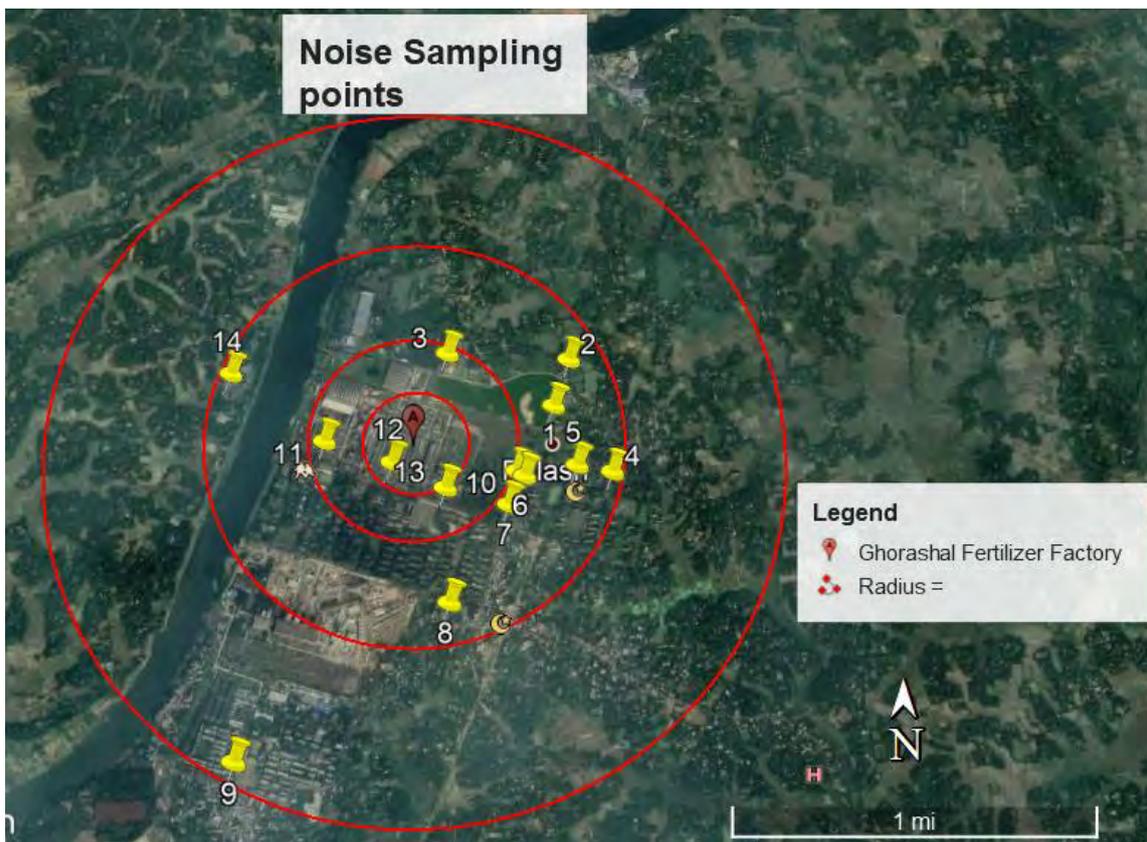


Figure 6.24: Sampling points of noise levels around the project site

423. Among the fourteen samples collected, thirteen of those were recorded within one km radius around the proposed project area (Figure 6.24). Only one sampling point was located at 1.75km distance from the center of the proposed GUFF. Noise levels varied between 48.1 dBA to 78.1 dBA during the day time and 42.7 dBA to 65.7 dBA during night time. The noise levels at all of the sample locations showed a comparatively higher variability in daytime (std

dev. 8.31) compared to night time (std dev. 6.66), which is usual considering the higher variations of daytime activities at different noise generation sources.

424. As per the ECR, 2006 and IFC 2007, the permissible level of noise were exceeded in several receptors point where the noise level were recorded. Characteristics of the receptors or the place sensitivity, source type and distance from the sources are the key for recorded noise level in the study area. The major sources of noise are plant operation, winds and chirping of birds, vehicle movement, whistles/horns of buses and trucks, gas transmission, industrial activities, public gathering etc. Table 6.12 shows the noise level in different places during day and night period and its compliance status with respect to ECR, 2006 and IFC, 2007. Noise levels at the UFFL and PUFFL colonies and in front of the TGTDCL's mosque are found exceeded the standards.

Table 6.12: Measured day and night time noise levels in and around the project site

Sl. No.	Name of the Location	Location Types	Measured Noise dB(A)	ECR, 2006	IFC, 2007	Compliance Status	
1	South east Corner of the Lagoon	commercial	Day	62.4	70	70	Yes
			Night	56.8	60	70	Yes
2	North east corner of the lagoon	commercial	Day	62.0	70	70	Yes
			Night	54.9	60	70	Yes
3	North west corner of the lagoon	commercial	Day	63.4	70	70	Yes
			Night	58.7	60	70	Yes
4	PUFFL colony school	Silent	Day	48.1	50	55	Yes
			Night	42.7	40	45	No
5	PUFFL colony mosque	Silent	Day	60.2	50	55	No
			Night	43.1	40	45	No
6	PUFFL colony entrance gate	Residential	Day	55.0	55	55	Yes
			Night	46.8	45	45	No
7	GUFFL main entrance gate	Industrial	Day	75.6	75	70	No
			Night	54.7	70	70	Yes
8	In front of the Titas gas distribution mosque	Commercial	Day	78.1	70	70	No
			Night	65.7	60	70	No
9	In front of Ghorasal PP entrance gate	commercial	Day	68.4	70	70	Yes
			Night	56.8	60	70	Yes
10	In front of PUFFL entrance gate	Industrial	Day	56.9	75	70	Yes
			Night	46.7	70	70	Yes
11	In front of Ghorasal training institute	Industrial	Day	61.5	75	70	Yes
			Night	54.4	70	70	Yes
12	In front of officers club	Industrial	Day	60.8	75	70	Yes
			Night	52.7	70	70	Yes
13	Road side Corner of GFFL school field	Industrial	Day	55.3	75	70	No
			Night	51.6	70	70	No
14	Nargana purbo para school	Silent	Day	56.3	50	55	No
			Night	46.2	40	45	No

6.2.11 Surface and Ground Water Quality

Surface Water Quality

425. Physical parameters such as Temperature, pH, DO, TDS, Total Hardness and Total Alkalinity were analyzed as a part of evaluating the water quality of the river water passes beside the Project site. Physical quality of the Shitalakhya is presented in Table 6.13.

Table 6.13: Physical quality of the Shitalakhya River

Sl. No.	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	Temperature (°C)	24.2	23.0	29.8	29.7	30.0	2
2	pH	7.4	8.1	7.2	7.0	6.5-8.5	1
3	Dissolve Oxygen (mg/L)	6.1	6.2	5.3	3.8	≥5	1
4	Total Dissolved Solids (mg/L)	288	264	290	274	1000	1
5	Total Hardness as CaCO ₃ (mg/L)	175	192	44	71	200-500	1
6	Total Alkalinity as CaCO ₃ (mg/L)	201	202	54	60	-	

426. Physical characteristics of Shitalakhya River water is quite good except for DO. According to the Table 6.13, it was found that water temperature varied 23-24°C in dry period, which increased a bit in the wet season. These changes are usual and all comply with the DoE standards (6.5-8.5). The pH value also meets the standards as it ranges in between 7.0-8.1.

427. DO is the amount of oxygen dissolved in a waterbody such as river, lake or stream. It is vital for underwater life as aquatic creatures need to breathe. From the Table 6.13 analyzed on the physical parameters of Shitalakhya River, it is known that the Value of Dissolved Oxygen was observed to be lower in the Wet Season than in the Dry Season. In 2018, the values were 6.2 and 3.8 in Dry and Wet season respectively. In 2017, the values were 6.1 and 5.3 in Dry and Wet season respectively. In 2017, the value of DO went below the standards (5 mg/L). Several reasons might have contributed to the reduction of DO level.

428. There is no mention of the standard value for Total Alkalinity in the Environment Conservation Rules. But, various sources state that Total Alkalinity as CaCO₃ should be within 20-200 (mg/L) to maintain the buffer state. The stabilized pH level also indicates that the buffer state is maintained in the Shitalakhya River. Based on the result, it was found that, total alkalinity in all the observed seasons complied with the range of 20-200 mg/L.

429. Biochemical oxygen demand is the measure of the quantity of oxygen used by the microorganisms during the oxidation of organic matter in that sample. Aerobic biological organisms break down the organic material present in a waterbody at a certain temperature. In the Shitalakhya River, the BOD range is 3.2-3.8 mg/L in the dry season of 2017 and 2018 respectively and 3.2-8.0 mg/L in the wet seasons of the respective years. For inland surface water quality, the acceptable limit considered by DoE is 10.0 mg/L for BOD (ECR' 2017 Draft Version), Table 6.14.

430. Chemical oxygen demand is an indicative measure of the quantity of oxygen, which can be consumed by reactions of oxidizing soluble and particulate organic matter in water. Similar to BOD, it provides an indication to the assessment of discharging wastewater will have on the surrounding environment. In the dry season, the COD range is 5.6-8.0 mg/L and in the wet season, it is 5.7-9.2 mg/L in the Shitalakhya River. The permissible limit of COD for inland surface water is 25 mg/L (ECR' 2017 Draft Version). The Shitalakhya River showed

good quality of water in terms of its oxygen demand for decomposing inorganic nutrients available in the waterbody.

Table 6.14: Organic Pollution status of Shitalakhya River

Sl. No.	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	BOD (mg/L)	3.2	3.8	8.0	3.2	≤10	1
2	COD (mg/L)	5.6	8.0	9.2	5.7	25	1

431. Among the chemical parameters, Ammonium (NH_4^+), Chloride (Cl^-), Sulfate (SO_4^{2-}), Silica (as SiO_2), Total Iron was determined using methods of volumetric analysis. Data is presented in the Table 6.15.

Table 6.15: Chemical quality of the Shitalakhya River

SL	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	Ammonium NH_4^+ (mg/L)	10	0.3	0.35	0.09	1.5	1
2	Chloride (mg/L)	22	8	4.8	8.2	150-600	2
3	Sulfate (mg/L)	1	4	10.5	4.2	400	2
4	Silica (mg/L)	25.2	24	6	5.7	-	-
5	Total Iron (mg/L)	0.01	0.05	0.5	0.09	2	2

432. Values for Chloride, Sulfate and Total Iron are well within the standards appraised by DoE (ECR' 2017 Draft Version). Sulfates are discharged into water from mines and smelters and from Kraft pulp and paper mills, textile mills and tanneries. The low concentration of Sulfates indicates the water quality (in the vicinity of the project area) is not polluted by chemical wastes of these types of industries. Values for Chloride, Sulfate and Total Iron are well within the standards in this area.

433. Only in the dry season of 2017, the value of NH_4^+ (10) was beyond the limit. The levels of NH_4^+ , was well above the limits starting from January 2017 to April 2017. In fact, the recorded levels of NH_4^+ from January to April were 5.0 mg/L, 10.0 mg/L, 5.0 mg/L & 3.8 mg/L. All of these values are well above the standards mentioned in the ECR. Therefore, in the dry period, Shitalakhya River has an issue of high ammonia.

434. There is no standard value for Silica in water. But there is a significant drop of value of Silica between the dry and wet season. In March, April, May and June, the recorded amount of Silica was 26.7 mg/L, 21.0 mg/L, 16.0 mg/L and 5.2 mg/L respectively. This indicates that in the dry season there were more Silica in the River of Shitalakhya than in the wet season. High upstream water might dilute Silica concentration vastly.

Groundwater Quality

435. Water quality was checked for drinking water at several locations around the Project site especially at the north side of the lagoon where communities resides the most. Water samples were collected from various depths below the ground level. Here, depths of less than 40m have been termed as 'Shallow' and depths of more than 40m have been termed as 'Deep' tube wells.

436. The value of pH, NH_4^+ and NO_3^- were analyzed to determine the chemical characteristics of drinking water available in the region of the proposed Project site. The detail field observation is presented in Table 6.15.

437. The value of pH, NH_4^+ and NO_3^- at all the observed locations are within the standard values. This indicates that the groundwater available in that area is suitable for drinking water purposes after disinfection only.

Table 6.16: Water quality of the observed tube-wells around the project site

No.	Location	Category	Depth (m)	Dry season pH		Wet season pH		Dry season NH ₄ ⁺		Wet season NH ₄ ⁺		Dry season NO ₃ ⁻		Wet season NO ₃ ⁻	
Standards				6.5-8.5				1.5 mg/L				10 mg/L			
Observation Year				2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
1	North of Lagoon	Deep	75	6.4	7.3	6.4	7.3	0.2	0.1	0.1	0.1	1.4	0.4	0.4	0.4
2	Fouzi Jute Mill	Deep	63	6.9	7.2	6.9	7.2	0.4	0.1	0.1	0.1	2.8	0.4	0.4	0.5
3	Deep Tube well no. 6	Deep	150	6.1	6.7	6.1	6.7	1.2	0.2	0.1	0.2	6.0	0.8	1.3	0.8
4	North of Lagoon	Shallow	15	6.7	7.1	6.7	7.1	1.3	0.1	0.1	0.2	1.4	0.4	0.6	0.6
5	North of Lagoon	Shallow	21	7.0	7.2	7.0	7.2	0.4	0.9	0.1	0.1	1.1	0.5	0.5	0.4

6.2.12 Effluent Analysis Report

438. The physical parameters of Temperature, Color, pH, DO, Total Dissolved Solids (TDS), and Total Suspended Solids (TSS) were analyzed as a part of evaluating the quality of the effluent discharged into the Shitalakhya River/lagoon around the Project site. Data of Physical parameters are presented in the Table 6.17.

Table 6.17: Physical quality of the effluents of Ghorasal Fertilizer Factory Ltd.

Sl No	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	Temperature (°C)	25.3	22.0	29.5	30.2	40-45	4
2	pH	7.7	7.9	7.3	7.0	6.0-9.0	1
3	DO	6.7	6.4	5.6	6.9	4.5-8	4
4	Total Dissolved Solids	390	300	284	330	2100	4
5	Suspended Solids	18	10	10	62	100	1
6	Color	Not Objectivable	Not Objectivable	Not Objectivable	Not Objectivable	-	-

439. All the physical parameters were found to comply with the DoE standards. It is stated in Draft ECR 2017, Schedule 8 that the temperature of the effluent to be discharged into the river must not be greater than by 3°C than the temperature of the river water. Temperature of river water in Shitalakhya varies from 22°C to 30°C (Mottalib et al., 2016). So, the temperature of the effluent must be within 25-30°C. The recorded temperature of the effluent complies with this standard as well. The rest of the parameters such as pH, DO, TDS and Suspended solids were also complied with the ECR Standard (Table 6-18) (Water Quality Standard for Fertilizer Factory). The color of the effluent was unobjectionable in every aspects.

440. Analysis of organic pollution was also performed to check the condition of effluent quality. The values and analysis are presented in Table 6.18. Values of BOD are within the standard values mentioned in the ECR. The values in dry period are less than the values in wet period in 2017. The BOD values were 7.4 mg/L and 6.9 mg/L respectively in the dry and wet season in 2017. In 2018, there was not much difference from the values that were recorded in 2017.

441. A similar trend was observed in case of COD values. The values exhibit a decline in 2017 from the dry period to wet period. COD values went down from 12.3 mg/L in dry period to 9.7 mg/L in wet period. However, in 2018, the values are stabilized and are 7.8 mg/L & 7.2 mg/L in dry & wet period respectively.

442. After doing a trend line analysis, it was observed that both BOD and COD values increase rapidly in dry season, but stay relatively constant over the wet period.

Table 6.18: Organic pollutants in the effluent quality, Urea Fertilizer Factory Ltd, Ghorasal, Narsingdi

Sl.No.	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	BOD	7.4	7.0	9.0	6.9	30	1
2	COD	12.3	7.8	9.7	7.2	200	1

443. Methods of volumetric and gravimetric analysis were performed to determine the amount of the following chemical pollutants present in the effluent- Ammoniacal Nitrogen (NH₃-N), Chloride as NaCl, Sulphate, Phosphate, and Iron. The observed data analysis is presented in Table 6.19.

Table 6.19: Chemical quality of the effluents of Ghorasal Fertilizer Factory Ltd.

SL	Parameters	Dry Season (February)		Wet Season (July)		Standard Value	Reference
		2017	2018	2017	2018		
1	NH ₃ -N	22.4	7.0	4.8	0.75	40	1
2	Chloride as NaCl	88.7	15.4	16.4	23.0	600	1
3	Sulphate (SO ₄ ²⁻)	3.4	3.3	8.9	3.5	400	3
4	Phosphate (PO ₄ ³⁻)	1.2	0.5	1.2	0.8	2	3
5	Iron	0.03	0.18	0.35	0.07	2	4

444. It is observed from the data presented in Table 6.18 that chemical parameters of effluent water are well within the ECR standards. The amount of NH₃-N shows a rapid declination between the dry period and wet period. In 2017 February, the amount was 22.4 mg/L and in July, the value went down to 4.8 mg/L. The same trend can be observed in 2018. The value in the dry period was 7.0 mg/L and the value in wet period went down to 0.75 mg/L.

445. Values of Phosphate also exhibits a similar trend. In both 2017 & 2018, the amount of PO₄ present in the sample was 1.52 mg/L. In the wet period, the values were 0.54 mg/L and 0.62 mg/L respectively.

446. Amount of Chloride exhibited maximum values in the dry period of 2017. It was well within the limits of ECR values.

6.2.13 Communication System

447. The proposed Project site is accessible by three different modes of communication. These are: roads, railway and waterway. One of the major regional highway (R-301) from Tongi to Ghorashal via Kaliganj passes through the project area. Another important regional highway adjacent to the project area is the Dhaka Bypass road which is a shorter route between Dhaka-Chittagong highway and the Jamuna Bridge. From these regional roads, there are Upazila roads to access the GPUFP project site.

448. Ghorashal Railway Station is the nearest railway facilities from the GPUFP and the distance from the site is about 5 km in the south. The Shitalakhya River is a scheduled navigation route which provides 22 km of water ways. **Figure 6.25** shows the photographs of different communication systems and **Figure 6.26** shows the map of the same system for accessing the project area.



Photo: Village road communication system



Photo: Water way beside the proposed Project site

Figure 6.25: Photographs of the communication systems

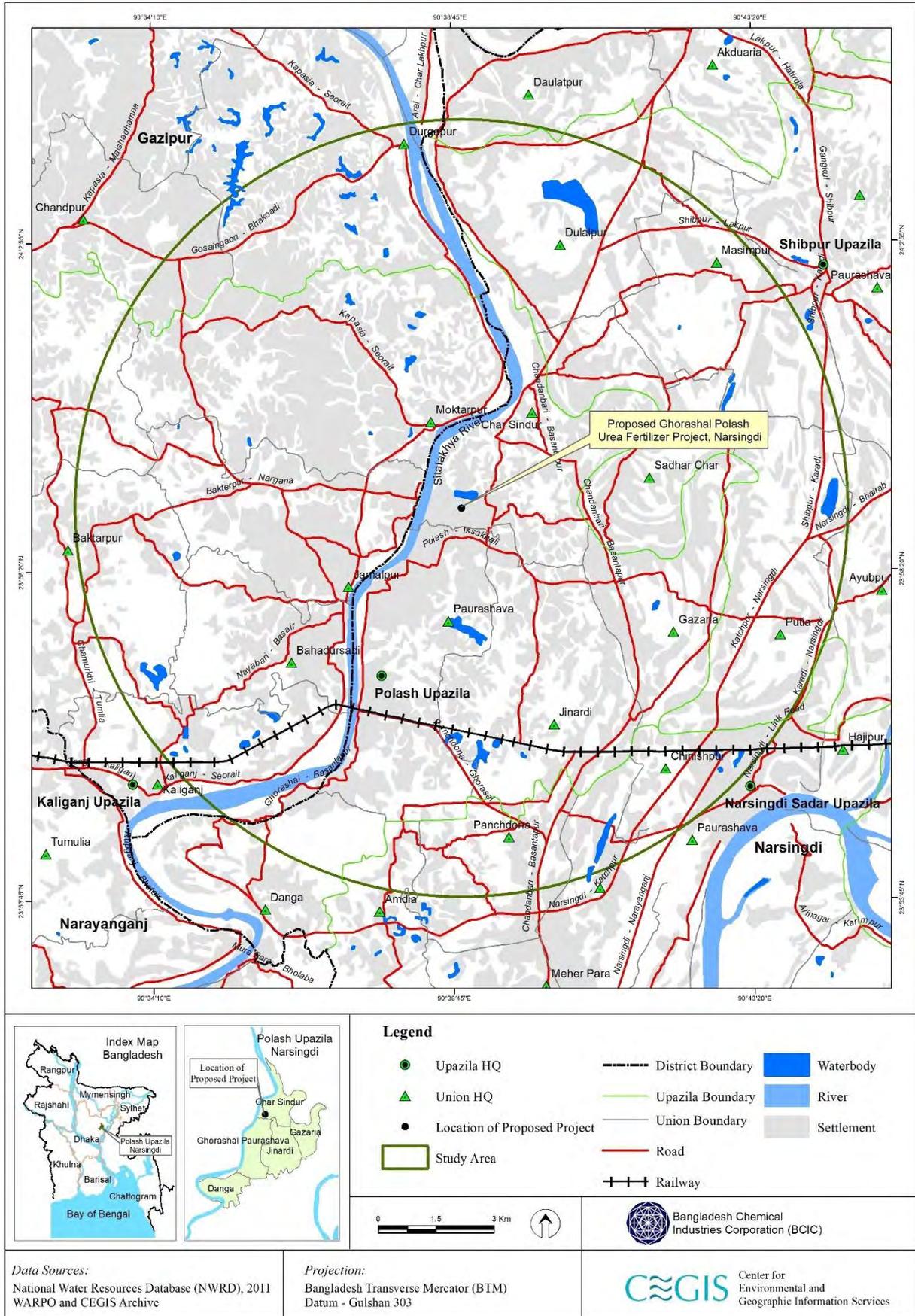


Figure 6.26: Road, railway and water ways networks of the study area

6.3 Biological Environment

6.3.1 Agriculture Resources

Farming Practices

449. Farming practices largely depend on the cropping seasons. The Kharif-I season starts from March and ends in June. This season is characterized by the uncertainty of weather of alternating dry and wet spells. Vegetables, HYV Aus and Jute crops are grown in this season. The Kharif-II season starts from July and ends in October. The Kharif-II season comprises wet and cloudy environment and heavy rainfall but uneven distribution, low solar radiation, high temperature and humidity. Only T. Aman rice, both local and HYV, are grown under rainfed condition.

450. The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield. Wide range of crops are grown in this season. In the study area, HYV Boro, Rabi crops such as Wheat, Kheshari, and Mustard and winter vegetables are grown. HYV Boro and wheat are grown under irrigated condition.

Cropping Pattern and Intensity

451. The project area has been considered within the boundary of the existing project site. There are no crop land within the project area. However, the outside of the project area are mainly cropland and rural settlement. The most prominent cropping pattern of the outside of the project area (study area) is Fallow – HYV. Aman – Rabi crops which covers about 25% of net cultivated area (NCA), then Fallow – Fallow – Boro which covers about 21% followed by others. The cropping intensity of the study area is 203%. The detailed cropping pattern and cropping intensity by land type in the study area is presented in Table 6.20.

Table 6.20: Present cropping pattern by land type in the study area

Land type	Kharif-I	Kharif-II	Rabi	Area (ha)	% of NCA
	(Mar-Jun)	(Jul-Oct)	(Nov-Feb)		
High land (F0)	Vegetables	HYV Aman	HYV Boro	954	7
	HYV Aus	HYV Aman	Vegetables	1,567	11
	Vegetables	Vegetables	Vegetables	924	7
Medium high land (F1)	Fallow	HYV. Aman	Rabi crops	3,519	25
	Jute	Fallow	HYV Boro	1,932	14
Medium low land (F2)	Fallow	LT. Aman	HYV Boro	2,226	16
Low land (F3)	Fallow	Fallow	HYV Boro	3,012	21
Total				14,134	100
Cropping intensity				203 %	

Source:CEGIS estimation from field information, 19-21th December, 2018.

Cropped Production and Damage

452. The project area comprises of shrubs, trees, a number of old civil structures like buildings, etc. Crop lands are situated around 1 to 1.5 km away from the site. In the study area, the total cropped area is about 28,761 ha of which rice is about 62% and the non-rice is about 38%. Total annual crop production is about 120,720 tons after loss of 4,745 tons. Among the crop production, rice production is about 49,462 tons (40%) and non-rice is about 71,258

tons (60%). Crop production loss occur due to periodically pollution (industrial wastes), drought, shortage of surface water, pest and disease infestation etc. Details are presented in Table 6.21.

Table 6.21: Crop production, damage and production loss of the study area

Crop name	Crop area	Damage free area		Damaged area		Total Production	Production loss
		Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
HYV Aus	1,567	1,202	2.8	365	1	3,731	657
HYV Aman	6,040	6,040	2.4	-	-	14,496	-
LT. Aman	2,226	2,226	2	-	-	4,452	-
Boro	8,124	6,080	3.8	2,044	1.8	26,783	4,088
Total rice	17,957	15,548	-	2,409	-	49,462	4,745
W. Vegetables	2,491	2,491	15	-	-	37,365	-
S. Vegetables	2,862	1,878	12	-	-	22,536	-
Rabi crops	3,519	3,519	1.8	-	-	6,334	-
Jute	1,932	1,932	2.6	-	-	5,023	-
Total non-rice	10,804	9,820	-	-	-	71,258	-
Total	28,761	25,368	-	2,409	-	120,720	4,745

Source:CEGIS estimation from field information, 19-21th December, 2018.



Figure 6.27: Seed bed (HYV Boro) of Khanepur village under Polash Upazila

Inputs used in the study area

453. Seed, labor, fertilizer, pesticide and irrigation are the major inputs for crop production.

Seeds, Labors, Fertilizers and Pesticides

454. The major fertilizers used in this area are Urea, TSP, MP and Gypsum. The use of pesticides depends on the degree of pest infestation. According to local farmers, the major insects are aphids, stem borer, green leaf hopper and rice bug. Local farmers reported that they are using different types of pesticides such as Diazinon, Dursban, Ferterra, etc. Farmers also use branches of trees, bamboo and jute sticks etc. to make favorable perches for birds in fields with standing crops. The birds eat the insects which help control infestation. In this process, the crops are protected without applying pesticides. Detailed information on seed, labor, fertilizer use, pesticides doses are presented in Table 6.22.

Table 6.22: Seed, labor, fertilizer and pesticide use in the crop fields

Crops name	Seed (kg/ha)	Labor (No./ha)	Farmers using fertilizer (Kg/ha)				Pesticide using by farmers	
			Urea	TSP	MP	Gypsum	No. of application	Liq. (ml/ha) approx
HYV Aus	50-55	140-160	130	50	40	30	1	400-500
HYV Aman	40-50	160-170	160	80	60	40	2	600-700
Lt. Aman	50-60	140-180	130	50	40	30	1	300-400
HYV Boro	50-60	160-180	200	100	70	40	2	500-600
Vegetables	2-4	120-160	200	100	80	-	1-2	600-700
Jute	7-8	130-140	80	20	0	0	1	300-400
Rabi crops	60-100	80-100	50-80	50-120	50-80	-	2	400-500

Source: CEGIS estimation from field information, 19-21th December, 2018.

Irrigation

455. Both surface and ground water are being used for irrigation in the crop land. The T Aman crop is grown mainly under rainfed condition. Sometimes, supplementary irrigation is provided during HYV Aman. In dry season, Boro rice, Vegetables and Rabi crops are grown with the help of irrigation. Local people reported that, the Ghorasal Power Plant cooling water (BADC canal) is also being used as a source of surface water irrigation while irrigation done in nearby places through Low Lift Pump (LLP) from the Shitalakhya River. In addition, Saldah beel and Jeerkuri beel are also being used for irrigation purposes in Khanepur village under Polash Upazila. Detailed crop wise irrigated area is presented in Table 6.23.

Table 6.23: Crop wise irrigated area

Crop Name	Study area					
	Irrigation			Irrigation		
	(Surface water)			(Ground water)		
	Irrigated area	% of NCA	Low Lift Pump	Irrigated area	% of NCA	STW/ DTW
	(ha)		(Tk/ha)	(ha)		Wells (Tk/ha)
HYV Boro	2,468	17	10,500	5,656	40	12,000
Vegetables	1,048	7	8,000	1,443	10	8,500
Rabi crops	1,276	9	8,000	2,243	16	8,500

Source: CEGIS estimation from field information, BADC, 20th December, 2018.

6.3.2 Fisheries Resources

Introduction

456. The Project site is devoid of any kind of fisheries activities because it is a raised land situated within the boundary of the PUFFL. However, the Shitalakhya River that passes less than a half km west side of the proposed site has fisheries potential. But the river has multiple functions of both in-stream and off-stream uses including industrial, power plant, irrigation, navigation and domestic uses. The river is also a receiving end of the effluents carrying contaminants from the industries, power plant and other point and non-point sources. These phenomena exert detrimental impacts on aquatic biodiversity including fisheries resources. The study area contributes nearly 3,546 tons of fisheries to the national fish production.

Habitat Characteristics

457. The seasonal and perennial Beels (depressions) along with floodplains of the study area become connected to the Shitalakhya River during pre-monsoon through a number of drainage canals (Khals). The Shitalakhya River, perennial in nature, feeds water to the floodplain in the wet season and supports fisheries in this area. Alteration of river morphology, confinement effect on lateral migration of Beel and river fish breeders, water pollution and above all, over fishing of river and Beel habitats have contributed to decline of fisheries.

458. Connectivity is usually restored on the onset of monsoon and Beels become inundated earlier followed by the vast floodplains. These seasonal and perennial waterbodies function as fresh water fish habitats. Open water fish habitats that are found in the study area are; (i) river, (ii) Khal, (iii) Beel and (iv) floodplain (Figure 6.28). A number of Beels such as Chinadi Beel, Buri Beel, Nali Beel, are perennial in nature as well as many seasonal Beels, e.g Bagdi Beel, Nargana Beel, etc. serve as fish over wintering refuges, mother fishery, feeding and breeding grounds of the study area.

459. The dominant fish culture practice of the study area is the improved extensive culture in commercial fish ponds though there is a recent introduction of excavated ponds merely for intensive fish culture. In most cases, two cycles of fish culture is practiced in commercial ponds as the pond water availability period is 40-45 weeks annually supplemented with irrigation though one cycle of fish culture practice is seen in the homestead or traditional pond particularly during wet season. Statistics of Polash Upazila fisheries is given in following Table 6.24.

Table 6.24: Fisheries statistics of Polash Upazila

Particulars	Quantity	Particulars	Quantity	Particulars	Quantity
Pond	2,718 nos.	Fish production	3,170 tons	Fish whole seller	03 nos.
River	02 nos.	Fish demand	3,474 tons	Fish retailer	12 nos.
Drainage canal	02 nos.	Fishermen	350 nos.	Fry seller	15 nos.
Beel (depression)	15 nos.	Fish farmers	1,987 nos.	Fish Arat	09 nos.
Nursery farm	09 nos.	Fisher Assoc.	01 no.	Hat/Bazar	21 nos.
Fry production/yr	41.9 Lakh	Farmer Assoc.	08 nos.	Ice factory	04 nos.

Source: Upazila Fisheries Office, Polash, 2016.

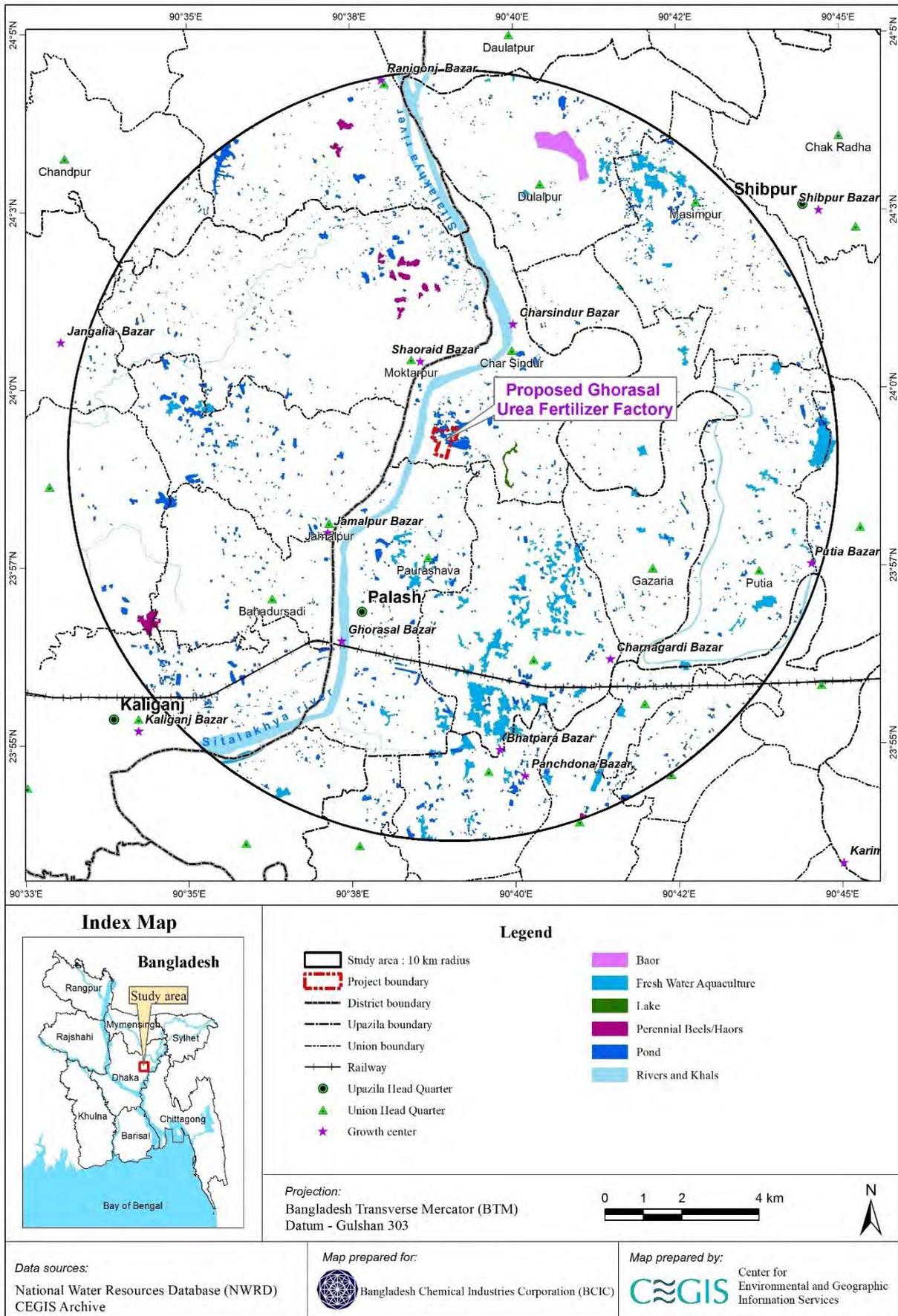


Figure 6.28: Fish habitats of the study area

Fisheries Habitat

460. The estimated overall fish habitats of the study area accounts as 7,016 ha. In totality, capture fishery constitutes of about 6,352 ha (about 90%) and the rest is shared by the culture fishery. Among the fish habitats, floodplain occupies the most, about 80%, followed by cultured fish pond, river and Khal, Beel and Extensive Fish Pond as shown in Figure 6.29 below. Of the capture habitats, floodplain occupies the most around 80%, followed by river and Khal 10% Semi intensive fish pond 9% and Beel 1% respectively. Table 6.25 presents the distribution of fish habitats.

Table 6.25: Analysis of fish habitat area of the study area

Sl. No.	Fishery Type	Habitat Type	Study Area (Ha)	Project Area (Ha)
1	Capture Fishery	River and Khal	649	-
2		Beel	69	-
3		Floodplain	5,622	-
		Lake	12	-
		<i>Sub-Total=</i>	<i>6,352</i>	<i>-</i>
4	Culture Fishery	Semi-intensive Fish pond	649	-
5		Extensive Fish Pond	15	-
		<i>Sub-Total=</i>	<i>664</i>	<i>-</i>
		<i>Grand Total=</i>	<i>7,016</i>	<i>-</i>

Source: CEGIS estimation using field data, NWRD of WARPO archived in CEGIS, Imagery

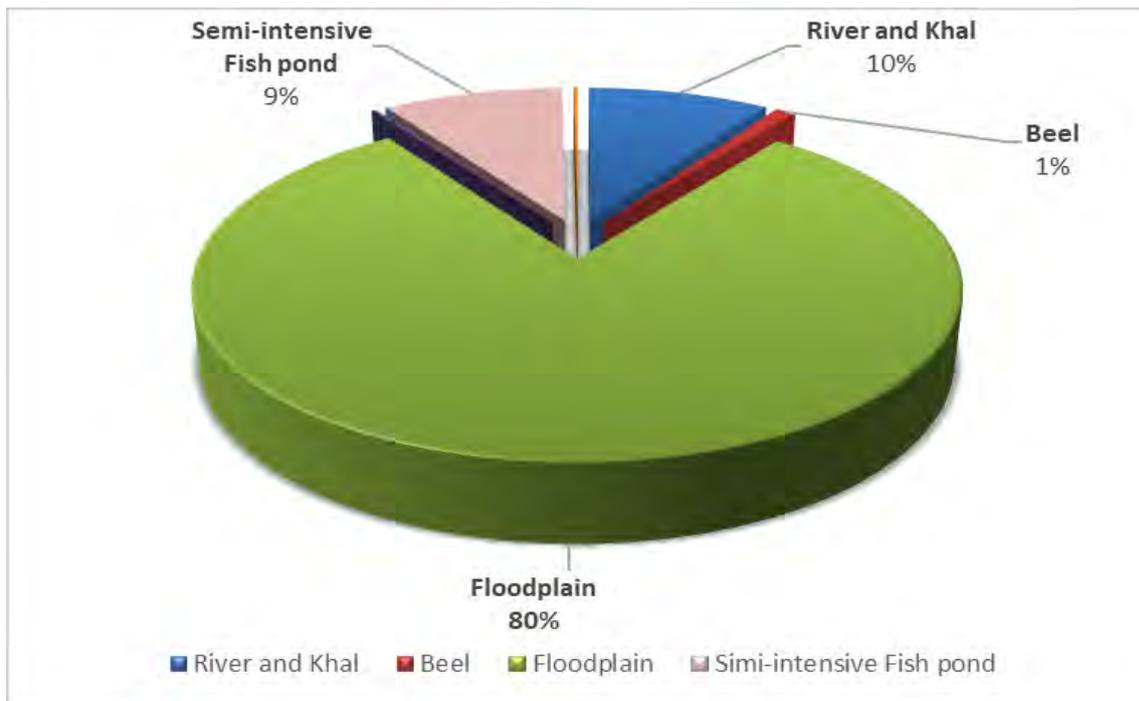


Figure 6.29: Percentage of fish habitat area in the study area

*Riverine fish habitat**Floodplain fish habitat***Figure 6.30: Photographs of fish habitats in the study area***Climatic Factors and Fisheries*

461. Climatic parameters that have influence on fish culture practices in case of both capture and culture fisheries include temperature, rainfall, wind speed, evaporation and humidity. Climatic factors can directly affect the fish population by altering their physical habitat and their physiology and life cycle by altering growth rate, development, reproductive capacity and mortality. These factors also have direct impact on the behavior of fish population and often reflected in the migration pattern as well as feeding and breeding patterns. Moreover, the climatic factors also affect the fish community indirectly by changing species diversity and composition, growth as well as the physiology by altering thermal tolerances, metabolism/assimilation and food consumption. Under the Köppen climate classification, Dhaka has a tropical wet and dry climate with a distinct monsoon season.

*Commercial fish pond**Culturable fish pond***Figure 6.31: Culture fish habitat***Present Affect Pattern of Culture Fish*

462. In the study area, mainly Common Carp, Rui, Silver Carp, Grass Carp, Tilapia, Thai Punti are usually cultured. But, these cultured fishes of nearby culture pond are affected badly due to NH_3 gas which is injected or disposed into lagoon water when factory becomes shutdown. This happens by seepage of lagoon water into those culture fish ponds. This event causes death toll to fish largely along with other aquatic organisms. Among the fishes, Silver Carp and Common Carps are the most victim as they float on the surface most of the time though other fishes are also affected severely. Within two (02) km buffer area from the project site, there are two (02) Beels namely Jeerkuri and Saldah Beel located on the northeast of the site. The Jeerkuri Beel was fragmented into ponds where fishes are being cultured but

was passively affected by discharge of NH₃ into the lagoon. On the other hand, the Saldah is a seasonal Beel that contains water for nine (09) months and is abundant with small indigenous species of fish. The production of culture fish increased in the last 18 months due to lockout of fertilizer factory.

Fish Production

463. The yearly production of the capture fishery resources in the study area is derived from river and Khal, Beel and floodplain. The yearly production of culture fishery resources is derived mainly from the Extensive Fish Pond. The fish farmers around the lagoon earned BDT 4-4.5 lakh per year by selling fish from one hectare of pond during normal operation of the urea plant. The estimated total fish production of the study area is about 3,546 tons, where culture fishery contributes the most amounting to 67% and the rest is shared by the capture fishery. The yearly production of different fish habitats is presented in Table 6.26 for 2018.

Table 6.26: Fish production assessment

Sl. No.	Fishery Type	Habitat Type	Yield/production (MT)		
			Study Area	% of Production	Project Area
1	Capture Fishery	River and Khal	48	1	-
2		Beel	30	1	-
3		Floodplain	1108	31	-
4		Lake	1	0	-
<i>Sub-Total=</i>			<i>1187</i>	<i>33</i>	<i>-</i>
4	Culture Fishery	Semi-intensive Fish pond	2,338	66	-
5		Extensive Fish Pond	21	1	-
<i>Sub-Total=</i>			<i>2,359</i>	<i>67</i>	<i>-</i>
<i>Grand Total=</i>			<i>3,546</i>	<i>100</i>	<i>-</i>

Source: CEGIS analysis using FRSS, 2016-17 published data and on-field calculation

Fisheries Diversity Species Composition and Biodiversity

464. Local fishermen reported that the fish biodiversity has been declining over the years. The major factors responsible for the downturn of the species diversity are: (i) abstraction of river water for different industrial use; (ii) reduction of fish habitats; (iii) deteriorating water as well as habitat quality; (iv) increasing fishing pressure; (iv) obstruction in fish migration routes; (vi) aggradation of riverine habitats due to geo-morphological processes; (viii) alteration of fish breeding grounds; (ix) transformation of beel habitat into paddy fields and (x) expansion of culture fishery. The capture habitats of the study area are dominated by small indigenous species (SIS) of fish. It is reported that in the Shitalakhya river major carp and SIS fishes which were once in abundance is now rather meager. Indicative fish species of the study area is given as follows:

465. The riverine major fish species are: Kalibaus (*Labeo calbasu*), Chital (*Notopterus chitala*), Juary/Joya (*Aspidoparia jaya*), Tit punti (*P. ticto*), Boro baim (*Mastacembelus armatus*), Batasi (*Pseudeutropius atherinodes*), Golsha (*Mystus cavasius*), Narkali chela (*Salmostoma bacaila*), Kaski (*Corica soborna*), Tengra (*Mystus tengara*), Ayer (*Sperata aor*), Kajoli (*Ailia punctata*), Ghero (*Clupisoma garua*), Kaikya (*Xenontedon cancila*), Chanda (*Chanda nama*), Bele (*Glossogobius giuris*), Golda chingri (*Macrobrachium rosenbergii*), Gura chingri (*Leander styliferus*), Taki (*Channa punctatus*).

466. The floodplain and beel fish species include: Meni (*Nandus nandus*), Shol (*Channa striatus*), Taki (*C. punctatus*), Punti (*Puntius spp.*), Shingi (*Heteropneustes fossilis*), Magur (*Clarias batrachus*), Bujuri tengra (*Mystus vitatus*), Foli (*Notopterus notopterus*), Guchi baim (*Mastacembelus pancalus*), Kolisha/chopra (*Colisa fasciatus*), Boicha (*C. lalia*), Boal (*Wallago attu*), Koi (*Anabas testudineus*), Rui (*L. rohita*), Katol (*Catla catla*), Gura chingri (*Leander styliferus*), etc.

467. Culture fish species include: Common carp (*Cyprinus carpio*), Rui (*Labeo rohita*), Katol (*Catla catla*), Kalibaus (*Labeo calbasu*), Mrigel (*Cirrhina mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idela*), Mirror carp (*C. carpio.*), Thai pangus (*Pangasius sutchi*), Tilapia (*Tilapia mossambicus*), Nilotica (*Tilapia nilotica*), Sharpunti (*Puntius sarana*), etc.

468. Rarely available fish species of the study area include: Rani, Tara baim, Baghayer, Shilong, Potka, Kanpona, Cheka, Chebli, Kajoli, Napitkoi, Nephtani, Chital, etc.



Mixed catch of study area



Prawn

Figure 6.32: Fish species composition of catches

Fish Migration

469. The Shitalakhya River functions as longitudinal fish migration for a number of fish species of which dominants are Kalibaus, Chital, Golda Chingri, Ayer etc. A number of Khals, such as Haridhon Khal, Nagda Khal, Naljuri Khal etc. connecting the floodplains and beels to the rivers and act as major arteries of lateral fish migration of river and beel breeders into the study area. The fish species that migrates laterally include Tengra, Punti, Chingri, Bele etc. Many fish species migrate horizontally to these waterbodies as part of their life cycle. Fish migration is usually restored during pre-monsoon to some extent and largely during peak monsoon.

Fish Habitat Degradation

470. River water quality has been degrading due to discharge of untreated or improperly treated effluents of cement factory, power plant, fertilizer factory, paper and pulp industry, dying factory, etc. Power plant also contributes in deteriorating the water quality by raising local water temperature at the effluent disposal end. At the same time, it entertains some fish species those prefer velocity. The discharge of industrial effluents and municipal wastes into the neighboring rivers, dust and cement from the cement factory contaminate river water. Cumulative effects of all contaminants along with inadequately treated or untreated effluents of the proposed plant may cause fatality to fish species along with other aquatic eco-elements. Local people as well as fishermen reported that suffocating fishes are seen occasionally

particularly during dry season when water remains very low and suspected the release of untreated effluents and gaseous substances from the fertilizer factory are responsible for such death toll of fish. Mostly affected fish include carps, Bata, Ayeer etc.

Fishermen Status and Effort

471. There are several fishermen villages around the study area, namely (i) Alinagar; (ii) Betua; (iii) Raban; (iv) Nasra, and all these villages are situated along the Shitalakhya River. There are about 100 households of fishermen who carry out their livelihoods by catching fish in different habitats. Increasing pressures on open water fish habitats, such as, river and beel during the dry season and floodplain during wet season by the amateur fishermen those come from the Muslim caste, has created severe pressure on the professional life and economic condition of the fishing community those are traditionally Hindus. Pollutants from various point and non-point sources are responsible for the decline of fish growth and fish production. Various types of gears that are used for catching fish are Moi net, khora net, seine net, cast net, lift net, push net etc.

6.3.3 Ecological Resources

472. Vegetation and wildlife communities of aquatic and terrestrial ecosystems are key components of ecological resources. Both the study area and project site contains diverse types of flora and fauna. The identified major ecosystems include homestead/settlements, crop-field, roadside vegetation, woodland, Sal forest, river, seasonal wetlands and ponds etc.

The Bio-ecological Zone

473. The International Union for Conservation of Nature (IUCN), Bangladesh has divided the whole country into 25 Bio-ecological Zones in context of biological diversity (Nishat et al. 2002). The study area falls under two Bio-ecological Zones: a) Brahmaputra-Jamuna Floodplain and b) Madhupur Sal Tract (Figure 6.33). The project component site mainly comprises terrestrial ecosystem having moderate biodiversity. The Department of Environment (DoE)'s report revealed that the Sitalakhya river near the proposed fertilizer industry was declared as Ecologically Critical Area (ECA) during 2009 (DoE 2015) to improve water quality of the river. This river is also a habitat for vulnerable Gangetic River Dolphin (*Platanista gangetica*). The IUCN red list conservation status of the terrestrial and aquatic flora and fauna are given in Appendix 6-1.

Ecosystem of the Study Area

a) Terrestrial Flora

474. The major terrestrial flora can be categorized based on ecosystems of the study area:

- Homegarden;
- Crop-field;
- Roadside;
- Woodland; and
- Sal forest.

Homestead Flora

475. The major plant species found in this ecosystem during field visit were: Palmyra Palm (*Borassus flabelifer*), Jackfruit (*Artocarpus heterophyllus*), Coconut (*Cocos nucifera*), Papaya

(*Carica papaya*), Aam (*Mangifera indica*), Queen's crepe-myrtle (*Lagerstomia speciosa*), Rain Tree (*Albizia saman*), Papuan wattle (*Acacia auriculiformis*), Eucalyptus (*Eucalyptus citriodora*), Bamboo (*Bambusa Spp.*) etc. Besides these, there were some herbs and shrubs also existent in this ecosystem.

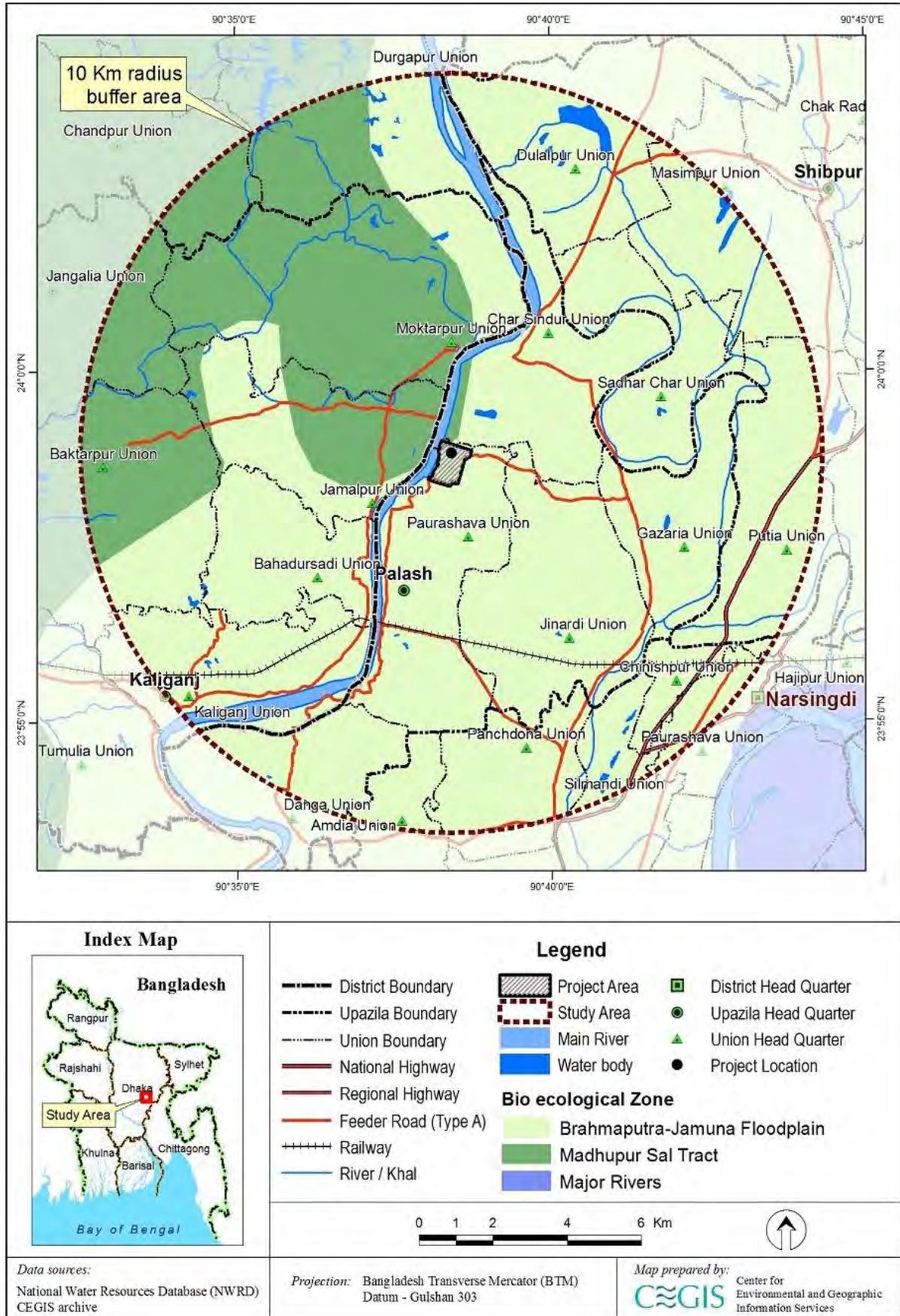


Figure 6.33: Bio-ecological zone of the study area

Crop-field Flora

476. This ecosystem supports vegetations in association with the crop varieties like rice, jute, pineapple, etc. Detailed information on cropping pattern is available in the agricultural section of this report. Different species of weeds like *Echinochloa colonum*, *Paspalum distichum*, *Heliotropium indicum*, *Dryopteris Sp*, *Nicotiana plumbaginifolia*, *Croton bonplandianum*, *Chynodon dactylon*, *Panicum repens*, *Cheratopteris Sp*, *Heliotropium indicum*, *Amaranthus spinosus*, *Centipeda orbicularis* and *Cyperus Sp*. were found during the field visit. This type of vegetation provides feeding habitats to wildlife.

Roadside Flora

477. The slopes and edges of the roads function as roadside ecosystem. The forest department and villagers planted trees under the social forestry program with the aim to generate financial benefits as well as protection of roads from soil degradation. Strip plantation with the mixture of exotic and local species on both sides of the railway line was implemented by the Bangladesh Railway. The major species found during field visits were Rain Tree (*Albizia saman*), Mahogany (*Swietenia mahagoni*), Eucalyptus (*Eucalyptus citriodora*), Goraneem (*Melia azadirachta*), Sil Koroï (*Albizia procera*), Bamboo (*Bambusa tulda*), Akashmoni (*Acacia auriculiformis*) and Sisu (*Dalbergia sissoo*) etc.

Woodland Flora

478. Woodland ecosystem mainly observed in the premises of industrial units, power plants, offices within the study area. This ecosystem was dominated by monoculture plantation. Some of the major species were: Mahogany (*Swietenia mahagoni*), Rain Tree (*Albizia saman*) and Papuan Wattle (*Acacia auriculiformis*). Addition to the tree species, mosses, ferns and lichens of different species were also available. This ecosystem supports the community by providing timber, fuel wood and also protection from natural disasters like tornado, cyclone, etc.

Sal Forest Flora

479. The forest, which is quite remarkable comprises of Sal or Gajari as a major species. However, due to poor coppicing capability and poor management practices their population has now become very limited. Majority of the area has been replanted by short rotation exotic species and some have been brought under social forestry or participatory agroforestry schemes. Biodiversity has declined rapidly and many animal species have become locally extinct. The abundant plant species of this ecosystem include: Sal (*Shorea robusta*), Koroï (*Albizia spp.*), Raintree (*Albizia saman*), Sissoo (*Dalbergia sissoo*), Bohera (*Terminalia belerica*), Horitaki (*Terminalia chebula*), Kanchan (*Bauhinia acuminata*), Polash (*Butea monosperma*) etc.

b) Aquatic Flora

480. The aquatic ecosystem consists of different wetlands such as rivers, canals, ponds and ditches. The wetlands were divided into two types based on the duration of inundation namely: i) Seasonal wetland, and ii) Perennial wetland. The inundated area supports numerous hydrophytes in this study area i.e Lily (*Nymphaea nouchali*), Helencha (*Enhydra fluctuans*), Lotus (*Nelumbo nucifera*) etc. Other dominant aquatic species were Water Hyacinth (*Eicchornia crassipes*), *Ipomoea aquatica*, *Ludwigia repens*, *Pistia strateotes*, *Salvinia natans* and *Azolla pinnata* etc.

c) Terrestrial Fauna

Homestead Fauna

481. The homestead vegetation plays an important role in sheltering a variety of wild animals. Among them, the major ones were: Common Toad (*Duttaphrynus melanostictus*), Cricket Frog (*Fejervarya limnocharis*), Common Tree Frog (*Polypedates maculates*) under amphibian group; Common Garden Lizard (*Calotes versicolor*), Bengal Monitor (*Varanus bengalensis*), Common Skink (*Mabuya carinata*) as reptiles; Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Blue Rock Pigeon (*Columba livia*), Coppersmith Barbet (*Megalaima haemacephala*) and Black-hooded Oriole (*Oriolus xanthornus*) under avifauna; Common Mongoose (*Herpestes edwardsii*), Small Indian Mongoose (*Herpestes auropunctatus*), Asian Palm Civet (*Paradoxurus hermaphroditus*), Common House Rat (*Rattus rattus*), Irrawaddy Squirrel (*Callosciurus pygerythrus*), Greater Short-nosed Fruit Bat (*Cynopterus sphinx*) and Indian Pipistrelle (*Pipistrellus coromandra*) as mammals.

Crop-field Fauna

482. The faunal diversity of this ecosystem is a mixture of terrestrial and aquatic wildlife as the crop fields have both terrestrial and aquatic habitats. The major wild fauna of this ecosystem are: Indian Bullfrog (*Hoplobatrachus tigerinus*) as amphibian; Checkered Keelback (*Xenochrophis piscator*) and Buff-striped Keelback (*Amphiesma stolata*) under reptiles; of the avian fauna Black Drongo (*Dicrurus macrocercus*), Crested Serpent Eagle (*Spilornis cheela*), Brahminy Kite (*Heliastur indus*), White-breasted Kingfisher (*Halcyon smyrnensis*), Pied Kingfisher (*Ceryle rudis*) and Brown Fish Owl (*Ketupa zeylonensis*) available in this type of ecosystem. Of the mammals, Little Indian Field Mouse (*Mus booduga*), Common Mongoose (*Herpestes edwardsii*) and Bengal Fox (*Vulpes bengalensis*) were observed during the major field investigation.

Roadside Fauna

483. This ecosystem consists of following wildlife such as Common Tree Frog (*Polypedates maculates*) and Ornate Microhylid (*Microhyla ornata*) under amphibians; Common Garden Lizard (*Calotes versicolor*), Bengal Monitor (*Varanus bengalensis*), Common Skink (*Mabuya carinata*), Checkered Keelback (*Xenochrophis piscator*) and Buff-striped Keelback (*Amphiesma stolata*), etc. under reptiles. Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*), Blue Rock Pigeon (*Columba livia*), Coppersmith Barbet (*Megalaima haemacephala*) and Black-hooded Oriole (*Oriolus xanthornus*), etc. frequently found among the avifauna; and Common Mongoose (*Herpestes edwardsii*), Large Indian Civet (*Viverra zibetha*), Little Indian Field Mouse (*Mus booduga*), Irrawaddy Squirrel (*Callosciurus pygerythrus*), and Indian Pipistrelle (*Pipistrellus coromandra*), etc. were observed mammals within the bushes and undergrowths of roadside vegetation.

Woodland Fauna

484. The major woodland fauna includes Common Garden Lizard (*Calotes versicolor*), Common Skink (*Mabuya carinata*), etc. under reptiles; Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Red-vented Bulbul (*Pycnonotus cafer*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*) under avifauna; and

Irrawaddy Squirrel (*Callosciurus pygerythrus*) and Indian Pipistrelle (*Pipistrellus coromandra*) as mammalian species.

Sal Forest Fauna

485. This ecosystem supports a variety of wildlife, such as Rhesus macaque (*Macaca mulatta*), Barking deer (*Muntiacus muntjac*), Common Langur (*Semnopithecus entellus*), Fishing cat (*Prionailurus viverrinus*), Common Mongoose (*Herpestes edwardsii*), Irrawaddy Squirrel (*Callosciurus pygerythrus*), and Indian Pipistrelle (*Pipistrellus coromandra*), and Bengal Fox (*Vulpes bengalensis*) etc. under mammals; Common Garden Lizard (*Calotes versicolor*), Bengal Monitor (*Varanus bengalensis*), under reptiles; Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Oriental Magpie Robin (*Copsychus saularis*), Spotted Dove (*Streptopelia chinensis*) and Black-hooded Oriole (*Oriolus xanthornus*), etc. under avian fauna; Common Palm Civet (*Paradoxurus hermaphroditus*) habituated in forests, and plantations, farmed areas and human habitations, Sal and mixed-evergreen forests in the study area. Figure 6.34 shows the photographs of the terrestrial ecosystem elements.

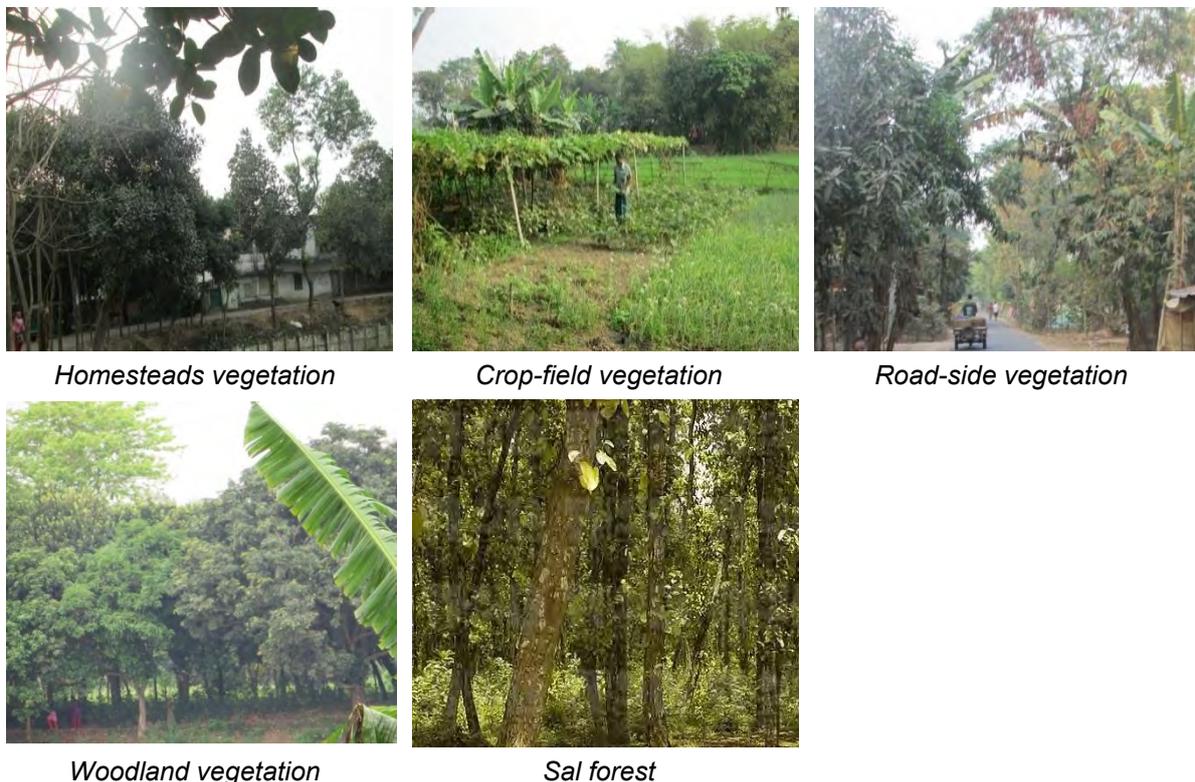


Figure 6.34: Terrestrial vegetation of the study area

d) Aquatic Fauna

486. The lifecycle of aquatic fauna within the study area depends on the natural fluctuations of water and connection with the Sitalakhya River and other wetlands during monsoon. The Skipper Frog (*Euphlyctis cyanophlytis*), Indian Pond Heron (*Ardeola grayii*), Little Egret (*Egretta garzetta*), Cattle Egret (*Bubulcus ibis*), White-throated Kingfisher (*Halcyon smyrnensis*), Common Kingfisher (*Alcedo atthis*), Asian Openbill (*Anastomus oscitans*), Little Cormorant (*Microcarbo niger*) and River Dolphin (*Platanista gangetica*) were seen during the field investigation. Figure 6.35 shows the photographs of the aquatic ecosystem elements.



Sitalakhya River System



Wetland in Kanthaliapara of Polash, Narsingdi

Figure 6.35: Views of aquatic ecosystem*Ecosystem of the Project Area*

a) Flora of the Project Area

Terrestrial Flora

487. The proposed site was a terrestrial land dominated by woody species such as Mahogany (*Swietenia mahagoni*), Rain Tree (*Albizia saman*) and Papuan Wattle (*Acacia auriculiformis*). Woodland ecosystem mainly observed in the project component area as well as in the surrounding areas of the project site. Apart from woody species, there were some herbs and shrub species found during the field visit. The undergrowth vegetation includes tall grasses, local herbs, and creepers. A few numbers of small fruit yielding trees were also found. Winter vegetable crops such as Beans, Onion, Eggplant, Sweet potato, Daikon Radish, Cauliflower, Dhundul and Tomatoes were also observed (please see the agriculture section for more details). According to the local people's opinion, crop and fruit yielding plants were damaged for the last couple of years due to ammonia emission from the existing fertilizer industry.

Terrestrial Fauna

488. Abundance of grasses, seasonal herbs, creepers and trees support good habitat in terms of roosting and nesting for local birds like Munia (*Lonchura punctulata*), Larks (*Alaudala spp.*), Flycatchers (*Myiarchus crinitus*), Cape starling (*Lamprotornis nitens*), Dove (*Zenaida macroura*), Domestic pigeon (*Columba livia domestica*), Spotted dove (*Spilopelia chinensis*), Shalik (*Acridotheres tristis*), Black drongo (*Dicrurus macrocercus*) etc. Two major types of fox species Bengal Fox (*Vulpes bengalensis*) and Golden Jackal (*Canis aureus*) are most abundant within the proposed industry site. In addition to this, some other faunal species are common dwarf mongoose (*Helogale parvula*), rats and snakes etc available within the project area. Surprisingly, one rare species called Civet Cat (*Viverra zibetha*) was available according to the local people. Most of the wild dwellers are habituated with the present noise limit generated from existing fertilizer industry.

Aquatic Flora

489. The existing fertilizer industry area has a lagoon aquatic ecosystem which was used for liquid ammonia storage and discharge. Therefore no aquatic vegetation is available there because of the excessive ammonia effect. In addition to this, the Sitalakhya River flows close to the proposed industry where waste water, warm water and untreated water is currently

released. In Sitalakhya River, some aquatic plants like Kochuripana (*Eichhornia crassipes*) and Topapana (*Pistia stratiotes*) were observed during the field visit

Aquatic Fauna

490. Some of the observed birds found in the waterbodies of Sitalakhya River during the field visit were little egret (*Egretta garzetta*), large egret (*Ardea alba*) and little black cormorant (*Phalacrocorax sulcirostris*). (To know more about the fishery resources see the fishery resources section of this report). In addition to this, endangered River Dolphin in Sitalakhya River near the proposed fertilizer industry was occasionally observed by the locals when waste water discharge was low.

Biomass and Carbon Stock in Trees of the Project Site

491. A total of eight plots were established within the project bounding site. All the plots were 10x10m except one road side plot which is 20x5m. All the individual tree species >5cm were identified. Later, diameter at breast height (1.37 m) and height was measured in the field. Total biomass of trees were estimated by adding above and below ground biomass. A non-destructive method of biomass and carbon estimation was applied in this study. A generic allometric model developed by Chave et al. (2014) was used for measuring the biomass because of its wide acceptability in measuring tropical region tree biomass. Below ground biomass was calculated considering 15% of above ground biomass (Mac-Dicken 1997). After calculating biomass, carbon content was calculated based on the assumption that carbon content is 50 percent of the woody biomass (Brown 1997). Above Ground Biomass (AGB) is identified as Y and carbon was calculated on a per-hectare (ha) basis. The model for above ground biomass estimation is as follows:

$$AGB=0.0673 \times (\rho D^2 H)^{0.976}$$

Where, Y = above ground biomass in Kg; H = Height of the trees in meter; D = Diameter at breast height (1.37m) in cm; ρ = Wood density (i.e. Wood density is the oven dry mass per unit of green volume) in units of g/cm³.

492. Table 6.27 shows the total biomass and organic carbon stock. Total average biomass and carbon stock of the investigated plots were 2479 and 1239 t/ha respectively. There was no strong variation existent in the biomass and carbon stock of the investigated transect (Table 6-27). However, plot- 5 has the highest amount of biomass (700 t/ha) and carbon (350 t/ha) among all the observed plots. This is because of the presence of large size trees. Among the observed tree species Mahagony (*Swietenia macrophylla*) has the highest amount of biomass (1,816 t/ha) and carbon (1,044 t/ha). All the other species has less amount of biomass and carbon storage because of less density of those species. Hence, it can be said that because of massive tree felling, a large amount of carbon will release to the atmosphere which will contribute to global warming.

Table 6.27: Total average biomass and carbon stock

Plot	AGB (t/ha)	BGB (t/ha)	Total Biomass (t/ha)	AGC (t/ha)	BGC (t/ha)	Total Carbon (t/ha)
1	173.66	26.05	199.71	86.83	13.02	99.85
2	331.88	49.78	381.66	165.94	24.89	190.83
3	182.43	27.36	209.79	91.21	13.68	104.90
4	191.55	28.73	220.28	95.77	14.37	110.14
5	609.05	91.36	700.40	304.52	45.68	350.20

Plot	AGB (t/ha)	BGB (t/ha)	Total Biomass (t/ha)	AGC (t/ha)	BGC (t/ha)	Total Carbon (t/ha)
6	102.27	15.34	117.61	51.14	7.67	58.81
7	177.90	26.69	204.59	88.95	13.34	102.29
8	387.17	58.08	445.25	193.59	29.04	222.62
Total	2155.90	323.39	2479.29	1077.95	161.69	1239.64

Note: AGB-Above ground Biomass, BGB-Below ground biomass, AGC-Above ground carbon, BGC-Below ground carbon

Table 6.28: Species wise average biomass (t/ha) and carbon (t/ha) stock in the sampled plots

Species	AGB (t/ha)	BGB (t/ha)	Total Biomass (t/ha)	AGC (t/ha)	BGC (t/ha)	Total Carbon (t/ha)
<i>Acacia auriculiformis</i>	104.58	15.69	120.27	52.29	7.84	60.14
<i>Terminalia arjuna</i>	28.71	4.31	33.02	14.36	2.15	16.51
<i>Syzygium cumini</i>	28.49	4.27	32.77	14.25	2.14	16.38
<i>Albizia saman</i>	177.19	26.58	203.77	88.60	13.29	101.89
<i>Swietenia macrophylla</i>	1816.92	272.54	2089.46	908.46	136.27	1044.73

Note: AGB-Above ground Biomass, BGB-Below ground biomass, AGC-Above ground carbon, BGC-Below ground carbon

6.4 Social Environment

493. Baseline scenario on the state of socio-economic environment is sketched out for the study area. The clipped areas were matched with the existing administrative boundaries and in doing so, the required data were collected from both primary and secondary sources. Here, methods for primary data collection include Rapid Rural Appraisal (RRA), Key Informant Interviews (KIIs), Group Discussions (GDs), Observation and Informal Consultations. On the other hand, relevant secondary data/information were collected from Population and Housing Census, 2011 (BBS, 2012).

6.4.1 Area and Location

494. Unions located into the delineated study for the proposed fertilizer plant were considered for assessing the Socio-Economic baseline condition. Thus, the study area includes 22 unions under 5 Upazilas of two districts: Gazipur and Narsingdi.

6.4.2 Population

Demography

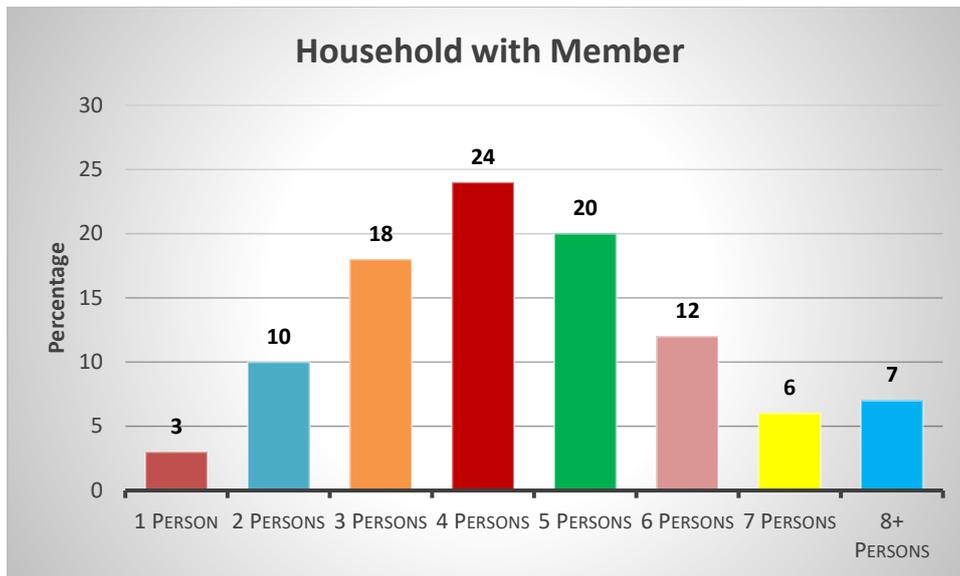
495. The study area has a population of 526,463 (BBS, 2012) comprising of 114,503 households. Of the total population; 261,856 (49.7%) are male and 264,607 (50.3%) female. The average population density is 2,088 per square kilometer which is more than double compared to national average (1,055), Table 6.29. Most of the households, about 69%, (Figure 6.36) in the study area comprises of four or more members. The average size is 4.6, which is slightly higher than the national average of 4.46 (BBS, 2012).

Table 6.29: Basic demographic profile of the study area

District	Upazila	Unions/ Paurasavas	HHs ⁷	Population			HH size	Populati on density [sq. km]
				Male	Female	Total		
Gazipur	Kaliganj	Bahadursadi	6,659	15,511	16,303	31,814	4.8	1709
		Baktarpur	3,325	6,957	7,421	14,377	4.3	1111
		Jamalpur	7,323	16,400	16,404	32,804	4.5	1652
		Jangalia	1,088	2,535	2,657	5,192	4.8	785
		Kaliganj Paurashava	8,219	20,580	17,842	38,422	4.7	1456
		Moktarpur	8,691	19,400	19,735	39,135	4.5	1049
	Kapasias	Chandpur	601	1,408	1,380	2,788	4.6	732
		Durgapur	3,574	7,681	8,326	16,007	4.5	956
Narsingdi	Narsingdi Sadari	Amdia	1,922	4,731	4,644	9,375	4.9	2078
		Chinishpur	5,516	12,880	12,559	25,440	4.6	10672
		Narsingdi Paurashava	6,804	15,873	16,150	32,024	4.7	2150
		Panchdona	5,720	13,507	13,168	26,675	4.7	2491
		Silmandi	3,276	7,848	7,277	15,125	4.6	3301
	Polash	Char Sindur	5,959	12,817	13,354	26,171	4.4	1902
		Danga	4,916	11,609	11,191	22,800	4.6	2659
		Gazaria	5,693	12,829	13,330	26,159	4.6	1968
		Ghorasal Paurashava	6,755	14,803	15,447	30,250	4.5	2250
		Jinardi	6,755	14,803	15,447	30,250	4.5	1190
	Shibpur	Dulalpur	4,648	10,187	11,030	21,218	4.6	475
		Masimpur	3,076	6,938	7,508	14,446	4.7	1587
		Putia	9,533	21,412	21,800	43,212	4.5	2458
		Sadhar Char	4,449	11,146	11,633	22,779	5.1	1302
Total/Average			114,503	261,856	264,607	526,463	4.6	2088

Source: BBS, 2012.

⁷ HHs refers to households



Source: BBS, 2012

Figure 6.36: Distribution of households by household members

Ethnic Community

496. In Bangladesh there are about 45 different indigenous communities living in the lowlands and hill areas. According to the BBS, 2012 six ethnic communities namely Bamon, Coach, Garo, Barmon, Chakma and Marma are living in the study area. A total of 395 households was found where 2,013 ethnic people are living. Each tribal group possesses separate identities, specific racial backgrounds, different languages, and distinct heritage and culture. The largest group in the study area is Barman. The ethnic groups differ in their social organization, marriage customs, birth and funeral rites, food and other social customs from the people of the rest of the country. The other ethnic communities are scattered in 5 upazilas. However, it is verified that there are no ethnic communities within the DIA (Direct Impact Area) of this project.

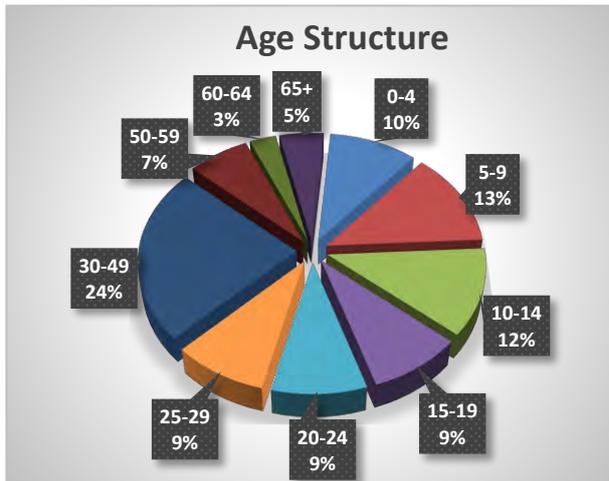
Age Structure

497. The highest number of population (24%) in the study area belong to the age category of 30 to 49 years old. Only 3% people are in 60 to 64 years category. The population data when analyzed to ascertain the size of (potentially) active and working population, shows that 61% population are in the age bracket of 15-64 and can be classified under this category. A small percentage (5%) is of 65 years and above. The categorization is made on the basis of International Labour Organization (ILO) reference for opting out potential labour force and dependent population (Ralf Hussmanns et. al, 1992⁸). Population of 15 to 64 years category is considered as labour force whereas, populations below 14 years and above 65 years are considered as dependents. Thus, the average dependency ratio⁹ in the study area is 63% (BBS, 2012), or almost 63 persons are dependent on 100 working people. The national

⁸Ralf Hussmannset. al, 1992; *Surveys of economically active population, employment, unemployment and under employment*; International Labour Organization, Geneva.

⁹ Total dependency ratio= $\frac{\text{number of people aged 0-14 \& those 65 and above}}{\text{number of people aged 15-64}} \times 100$

dependency ratio (% of working-age population) is 52%, according to the World Bank¹⁰. Figure 6.37 and Figure 6.38 shows the age structure and categorical age structure of the local community.



Source: BBS, 2012

Figure 6.37: Age structure of the studied population

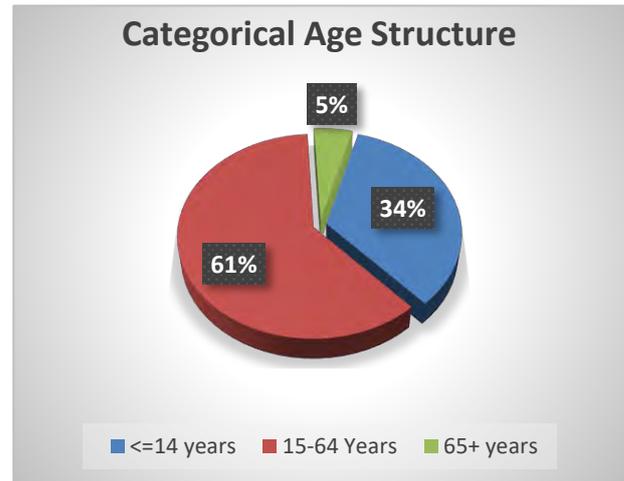


Figure 6.38: Categorical distribution of studied population

6.4.3 Land Holding Category

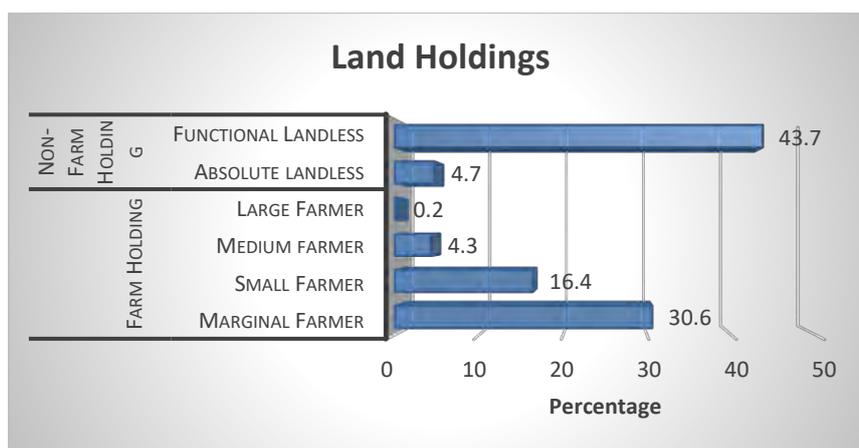
498. The Census of Agriculture, 2008 conducted by BBS classified land holdings into two broad categories- one is farm-holdings¹¹ and another is non-farm holdings¹². The study area shows that out of total holdings 51.5% is farm-holder and the rest 48.5% is non-farm holders.

499. According to BBS 2008 data on land holding distributions in the study area 4.7% households are absolute landless i.e. they have no lands either homesteads or cultivated. 43.7% households belong to functional landless category, who have land up to 0.04 acres. Among them 41.7% households have only homestead lands and 2% have homestead plus farm land within the limit of 0.04 acre. These households mainly own land adjacent to their homestead and these are used as kitchen garden that are primarily maintained by the female members for household consumption. Figure 6.39 shows the land holding category of the study area.

¹⁰<http://data.worldbank.org/indicator/SP.POP.DPND?view=map>

¹¹A farm holding is defined as being an agricultural production unit having cultivated land equal to or more than 0.05 acre.

¹² Non-farm holding includes landless households and households having lands up to 0.04 acre.



Source: The Census of Agriculture, 2008, BBS

Figure 6.39: Households by land holdings

500. On the other hand, farm holding distribution shows that 30.6% households belong to marginal farmer (0.05 to 0.99 acre), 16.4% belong to small farmer (1.00 to 2.49 acre), 4.3% belong to medium farmer (2.5 to 7.49 acre) and 0.2% belong to large farmer (7.5+ acre) categories. It is evident that land fragmentation decreases the holding size; therefore large and medium farmers are gradually being converted to marginal farmers.

501. Field findings show that increasing industrial initiatives have purchased and/or acquired local lands which in turn, decreased the large and medium holdings and pushed many households into small and marginal categories. The same also contributed to marginalization of small landowners many leading to the status of landless. In the process of land acquisition by industrial houses the land losers often failed to purchase another parcel of land with the compensated money, as the value of land drastically went up with the as industries flourished in the region.

6.4.4 Land Price

502. The land prices of different types of lands have been collected from the local people. People of different areas, occupations, ages have provided indications about the land price. The areas are mostly in urban and industrial areas and as a result land price is higher. But, people living within the close vicinity of the northern and southern side of the fertilizer plant opined that, the land price is comparatively lower than the other two side (East and West) because, people are unwilling to buy land in these areas because of the unpleasant odor coming out of the open lagoon that spread over the adjacent locality following the wind direction. The average land prices in the different areas is presented below. It is seen that commercial and homestead land prices are high. Table 6.30 presents the land price of the study area.

Table 6.30: Land Price of the study area

Land classes	Minimum - Maximum Land Price (Taka/Decimal)
Agricultural land	200,000 – 300,000
Homestead land	350,000 – 5000,000
Commercial land	1,000,000 – 1,200,000

Source: CEGIS field work, 2018

6.4.5 Occupations and livelihoods

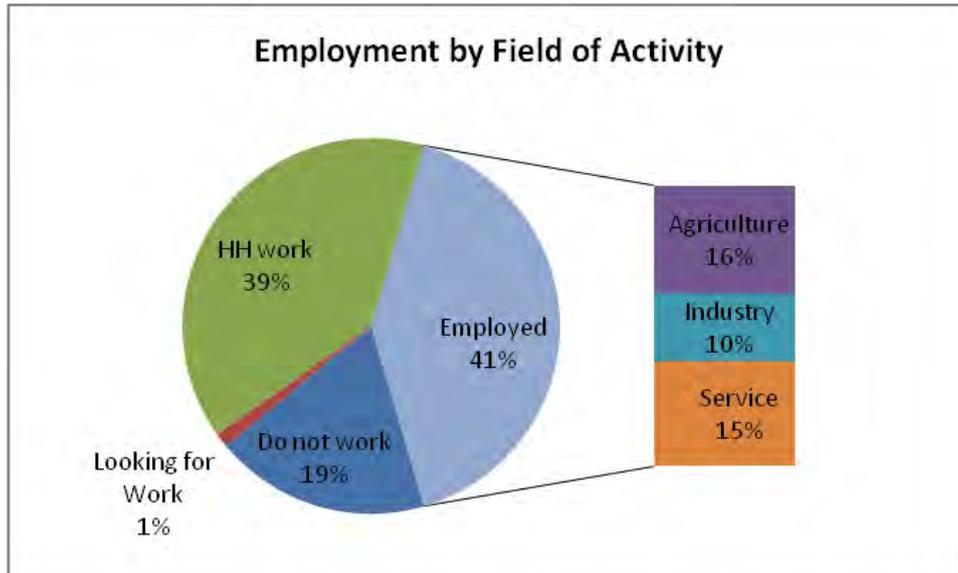
503. Out of a total of 526,463 population, 155,331 (29.5%) are economically active which include 80,139 (41.4%) employed, 836 (0.4%) are looking for work, and 74,356 (38.4%) engaged in household work. Here household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming etc. Therefore, women participation in direct income generating activities (employed category) is negligible. The employed category also includes child labour as it was accounted from 7 years old population. Therefore, non-attending children aged between 7 to 15 years were included in this category. Figure 6.40 shows the employment status of the area.



Source: BBS, 2012

Figure 6.40: Employment Status

504. Distribution of employed population at reference period of the 2011 census shows that 16% are engaged in agricultural activities, 10% in industry and 15% in service. Agricultural activities includes broadly crop farming, fishery and livestock and poultry farming. The scope of employment in agricultural sectors is gradually decreasing as urbanization and industrial initiatives are converting farm land into human settlements and industrial enterprises. Data confirms that land used for agriculture is about 49%, for settlement is about 39%, for industry is 10.38% and other. Field findings suggest that land use for settlements and industry is increasing. Employment in industrial sector (10%) is gradually increasing compared to the agriculture (16%) and service (15%) sectors. People stated that this contribution shall be increased if favorable assistances (infrastructure, power and gas supply) are ensured. Figure 6.41 shows the employment status by field of activities of the area.

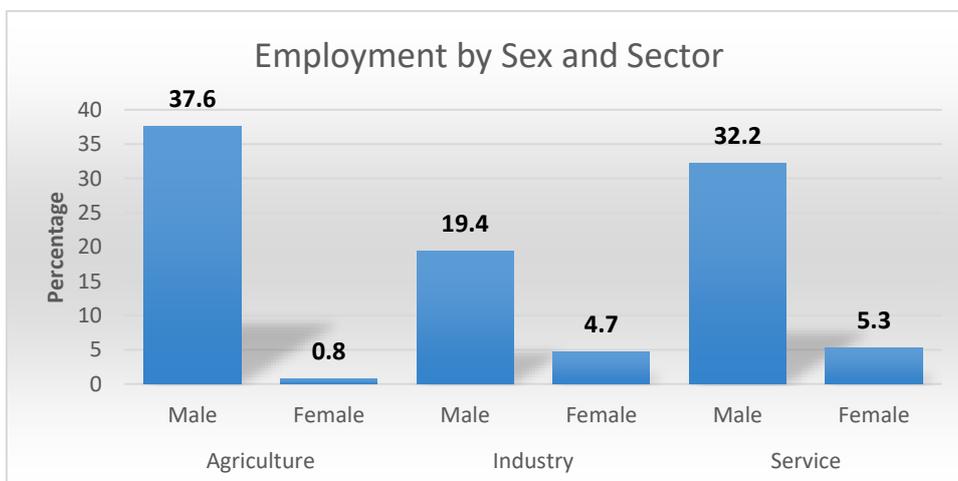


Source: BBS, 2012

Figure 6.41: Employment status by field of activities

6.4.6 Labor Market and Wage Rate

505. Data confirms that agriculture, industry and service are the primary sectors generating employment for the local people. Field findings also suggest that people who are not permanently employed tend to engage themselves in the above noted sectors in the forms of agricultural laborers, industrial worker, earth workers, cleaners and some as fishers. In agricultural and industrial sectors most of the laborers come from the local villages. There are a number of trained groups who are working contractually for fertilizer plant projects for instances, as plumber, mechanic, earth-worker etc. These trained laborers are organized and work under a group leader called “Sarder”.



Source: BBS, 2012

Figure 6.42: Distribution of population by sex and field of activity

506. The above Figure 6.42 demonstrates that female participation in industry and service sectors is higher (10%) than that of agriculture (0.8%). According to our field research women involved in the industrial sector mostly work in textile industries.

507. Wage level varies regarding type of work. In the agricultural sector, laborers get daily wages in the range of Taka 400-500, whereas in industrial sector mostly textiles workers receive per day/per production basis. However, the trained group working for fertilizer plant received comparatively higher wages. The following Table 6-31 shows the present wage rate in the study area.

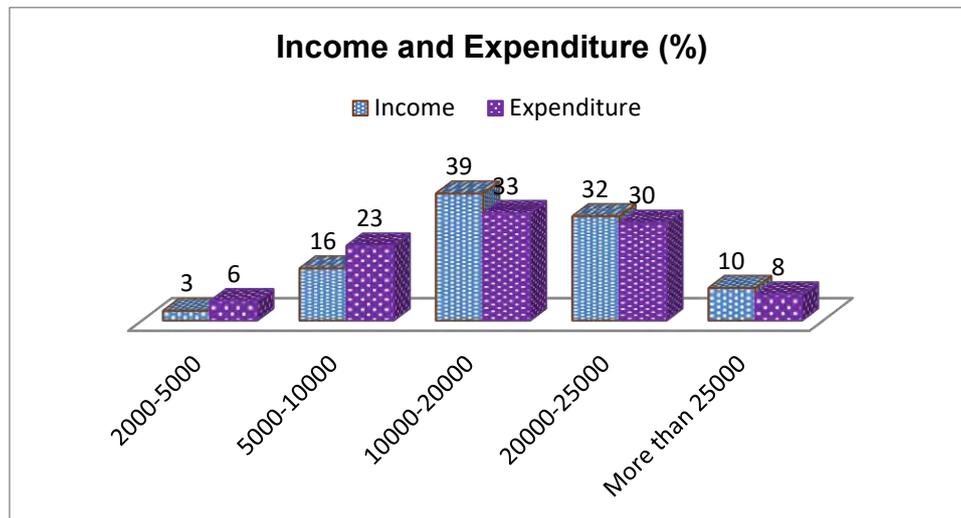
Table 6.31: Availability of Labour and Wage Rate of the Study Area

Type of Activities	Type of labor	Availability	Wage (Taka)	
			Max.	Mini.
Farming	Male	Medium	500	400
	Female	Low	350	300
Non farming	Male	High	600	400
	Female	Medium	400	350

Source: CEGIS field visit, 2018

Income and Expenditure

508. Household Primary data on income and expenditure suggests that households in the lower income groups are spending much more than their income, thus saving practically nothing and are potentially in a debt trap. Households with an income above Tk. 10,000 and above have indicated some savings. This trend increases with households in higher income brackets. The scenario of income and expenditure is shown in the following **Figure 6.43**.



Source: CEGIS field work, 2018

Figure 6.43: Distribution of Household by income and Expenditure

Self-Assessed Poverty

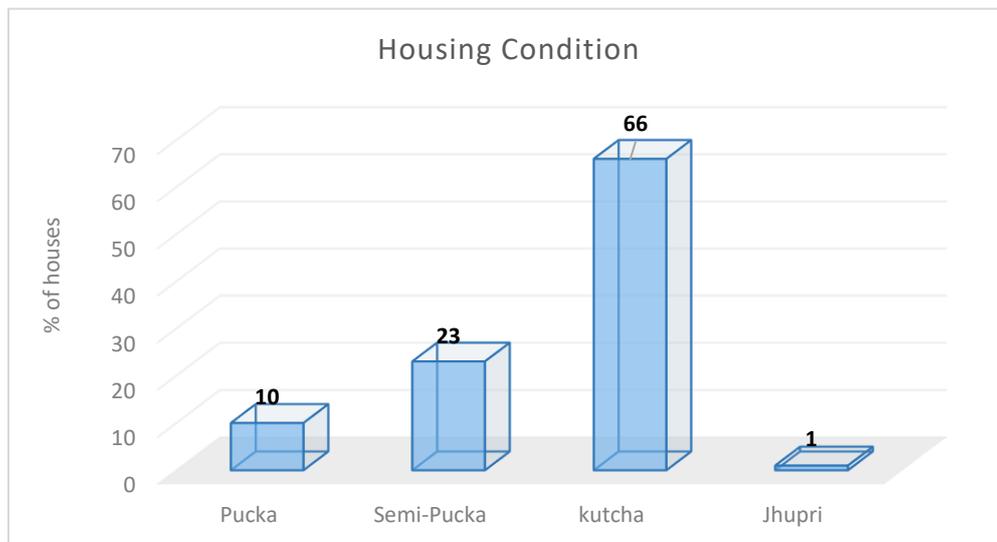
509. The poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption by the inhabitants within three different categories namely deficit, balanced and surplus. It is observed that about 19% of the households on average are under the poverty line, 23% are above the poverty line and the remaining 59% in the “balanced” situation.

6.4.7 Status of Women

510. Field observation suggests that the whole study area is a highly male dominated area. Roles of women in both decisions making at household level and economic contribution to household income are inconsequential. Traditional belief is very strong here that generally males make all major household decisions and at the same time they contribute to household income more than females. Very few women work as day laborer but in that case wage discrimination is very common. Women's mobility in the rural area is mostly localized except when they go for medical treatments, fetching water, farming activities, and visiting relatives. (CEGIS field work, 2018).

6.4.8 Housing Condition

511. The study area shows the predominance of kutcha¹³ houses (66%) compared to other three types of houses such pukka¹⁴, semi-pukka¹⁵ and jhupri¹⁶. 23% houses are semi-pukka, 10 pukka and one percent is still jhupri. Most of the pukka houses are located in municipal areas, whereas semi-pukka are predominant at the peripheral areas of municipality. Kutcha houses are predominant in the rural area (**Figure 6.44**).



Source: BBS, 2012

Figure 6.44: Housing condition in the study area

¹³Kutcha: Walls: Organic materials like jute stick, catkin grass, straw, and bamboo mats. Split are bamboo framing. In some areas wall are made by earth. Foundation: Earthen plinth with bamboo or timber posts. Roof: Thatch-rice or wheat or maize straw, and catkin grass, with split bamboo framing;

¹⁴Pukka: House which is made by fully concrete, cement, and iron.

¹⁵Semi-pukka: Walls: Bamboo mats, CI sheet, Timber or bamboo framing. In some areas wall are made by earth, sometimes part or full brick. Foundation: Earthen plinth; Brick perimeter wall with earth infill; Brick and concrete also use. Roof: CI sheet with timber or bamboo framing

¹⁶Jhupri: House which consist mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floor, thatch or CI sheets are used as roofing materials. There is no monolithic joint between the wall and the roof.

6.4.9 Traffic and Transport

512. The road network in the study area is developed. One of the main highways of Bangladesh Dhaka-Sylhet highway crosses over the study area. At the same time, two of the busiest railway lines (Dhaka-Chittogram and Dhaka-Sylhet) passes over the study area. There is also a railway station at Narshindi Shadar. The Shitalakkha River also passes through the study area but no passenger vessel is navigating there except Cargo vessels which only carries and transports industrial goods.

513. During the field survey it was observed that roadway is the main mode of communication through the study area. People of the study area generally use Mini Bus, CNG, Auto Rickshaw and Rickshaw for their regular internal movement. There is no intercity bus terminal at Polash Upazila. As a result, people need to go to Narshingdi Sadar for availing intercity bus services.

6.4.10 Access to Health Service Facilities and Health Seeking Behavior

514. Access to health services and facilities refer to availability and adequacy of supply, affordability, physical accessibility and socio-cultural acceptability. Field data shows that each Upazila has a Health Complex (UHC) at the upazila level and one district hospital in Narshingdi Sadar. Besides, there are a few community clinics at the union level and several private health service providers also provide services to the local people. The Polash Upazila Health Complex is within half kilometer of the project area. People stated that now a days the existing services are accessible to rural poor people but, for common diseases still a substantial number of population tends to receive services from the local chemists and/or “village doctors” either self-educated or locally trained who have some basic knowledge about health and medicines. However, people complained that none of the hospitals have special unit for treating respiratory diseases although this disease is predominant in the Ghorasal Paurasava area; even the fertilizer industry has no such facility for the affected people. A tendency was found among the local people to go to Dhaka for better treatment for non-communicable diseases. There are two medical centres at UFFL and PUFFL respectively. The employees and their family members of these two factories have access into these two medical centres.

515. Field findings show that, the most prevailing disease at the direct impact area is skin disease. On the other hand, respiratory disease such as Asthma is alarming in Ghorasal Paurasava particularly in 1 no. ward. The disease became epidemic due to contaminated air with ammonia absorbent led by the fertilizer industry particularly at the time of releasing gas. This contamination infects mostly children and pregnant women. The local people mentioned a few cases of child deaths due to respiratory syndrome.

6.4.11 Utility Services

Sanitation Facility

516. In the study area about 32.9% households use non-sanitary latrines, 43.9% use non water-sealed sanitary latrines and 19.4% use sanitary water-sealed latrines (BBS, 2012). Field findings confirmed that non-sanitary latrines are predominant among kutcha houses and the non-water sealed sanitary latrines are seen across kutcha, semi-pucka and pucka households. Water-sealed sanitary latrines are available predominantly in pucka houses. However, there are 4% houses, which have no sanitation facilities but their members tend to use sanitary facilities on shared basis and in some cases use open spaces.

Drinking Water Facility

517. Collection of drinking water from tube-well is predominant (92%) throughout the study area. Supply of “tap water” is mainly used in municipal areas on rental basis. This supply system is dependent on abstraction of ground water. However, 3% households are still depending on open waterbodies as sources of drinking water. On the other hand, in the past the main source of water for drinking and other household uses for both fertilizer plants were their own treatment plant. About five years ago three deep tube wells were installed into the residential area of UFFL and one in the PUFFL. But till now at UFFL a limited amount of treated water is being used for household purpose for fulfilling the demand of water. People of the study area opined that for the last few years they have been facing problem to collect drinking water from hand set tube wells during the dry season. To get rid from this situation in recent years most of the households installed motorized water collection system which is locally called *Sama* and its average depth is 150 m. to 200 m.

Electricity

518. Data shows that about 84.5% households are under grid electricity coverage. Besides, there is a private power producer (quick rental) within the study area. The study area has access to both and benefited from generated power which in turn improved the standard of living for the people.

6.4.12 Population Migration

519. During the field visit, the local people stated that in recent years a trend of in-migration of laborers for agricultural sector is seen. In the industrial sector a number of in-migrant laborers are working, but this trend is gradually increasing. On the other hand, primary survey data revealed that there were small numbers of international out migrants (about 2%) that tends to go to Middle East.

6.4.13 Cultural and Archaeological Resources

520. The CEGIS study team has visited the project area and surrounding two km. area which is considered for assessing the direct impact of the proposed project. The proposed fertilizer plant will be constructed at the existing land of PUFFL. There are some cultural and community based organizations formed by the PUFFL officers and staffs like officers association, ladies club, employees club, PUFFL central monument and PUFFL freedom fighters association building are within the Project site. Beside these, no cultural resources and sensitive spaces are found in the area.

7. Environmental and Social Impacts

7.1 General

521. The existing UFFL and PUFFL are the age-old Urea Fertilizer Plants and have been in operation for more than 48 years and 32 years respectively. A new, modern, energy efficient and higher capacity Urea Fertilizer Plant has been planned in place of UFFL and PUFFL. The proposed Project will augment the current urea production with stipulated life time of 20 years. The proposed major activities will involve construction of labor-shed for labour accommodation in the project site or renting accommodation, site preparation, transportation of machinery and ancillaries, storage of equipment and materials for construction, civil works, erection of ammonia processing plant, ammonia tank, urea processing plant, steam turbine, GEG, jetty construction, civil structures demolition (including removal of foundation), segregation of hazardous materials and their transportation to on-site disposal pit, construction of gas pipeline, etc. Land acquisition is not required for the construction of the Project and for the improvement of access road. These activities will have diversified impacts on the environment and socio-economy with different natures and magnitudes. Among the impacts from the proposed activities, some are temporary or short-term in nature and limited to pre-construction and construction period, and others are permanent in nature during the operation period.

522. Based on the experience of other similar types of projects like power plant, gas pipeline, many of the environmental issues are mainstreamed in the project design (e.g., energy efficient modern machinery, minimize NO_x emission by installing GEG Power Plant, lower the relative water requirement for condenser cooling and minimize thermal effluent using open recirculation cooling, decrease specific-relative fuel requirement, etc.). Elevated noise level from the operation of heavy equipment, felling of trees during site preparation, and labor camp induced sanitation and social stress are the significant impacts of the construction works. A large number (about 3,750) of small to big trees will be cut down during site preparation which may hamper the dependent ecosystem and lead to loss of bird and other wildlife habitats. The overall positive impact of the project during operation is the augmentation of the production capacity of the urea fertilizer and improving the socio-economic condition and lifestyle of the country's population, reduction in effluent in the Shitalakhya River, which will facilitate in restoring habitats of fish species and easing habitat for others aquatic organisms along with benthic habitats.

7.2 Impact Assessment Methodology

523. Potential environmental and social impacts were identified on the basis of the review of feasibility reports, field visits, environmental quality baseline monitoring, ecological and fisheries surveys, and stakeholder consultations. The significance of potential impacts was assessed using the criteria and methodology given below.

7.2.1 Sensitivity of Receptor

524. The sensitivity of a receptor has been determined based on the review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding areas. Each detailed assessment has defined sensitivity in relation to the

topic. Criteria for determining receptor sensitivity of the Project’s potential impacts are outlined in **Table 7-1**.

Table 7.1: Criteria for determining sensitivity of the receptors

Sensitivity Level	Criteria for Sensitivity Determination of Receptors
Very High (4)	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High (3)	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium (2)	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low (1)	Vulnerable receptor with good capacity to absorb proposed changes and/or good opportunities for mitigation

7.2.2 Impact Magnitude

525. The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) Compliance to Legal Standards before Mitigation Measures.

526. The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 7-2**.

Table 7.2: Parameters for determining magnitude of impact

Parameter	Major (4)	Moderate (3)	Minor (2)	Minimal (1)
Duration of potential impact	Long term (more than 15 years)	Medium Term (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Potential impact requires a year or so for recovering with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains almost constant
Compliance to Legal Standards before Mitigation Measures	Breaches national standards and or international guidelines/ obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential	Occurs under typical operating	Occurs under worst case	Occurs under abnormal,	Unlikely to occur

Parameter	Major (4)	Moderate (3)	Minor (2)	Minimal (1)
impacts occurring	or construction conditions (Certain)	(negative impact) or best case (positive impact) operating conditions (Likely)	exceptional or emergency conditions (occasional)	

7.2.3 Assigning Significance

527. Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in **Table 7-3**.

Table 7.3: Significance of Impact Criteria

Magnitude of Impact	Sensitivity of Receptors			
	Very High (4)	High (3)	Medium (2)	Low (1)
Major (4)	Critical (16)	Major (12)	Moderate (8)	Minor (4)
Moderate (3)	Major (12)	Major (9)	Moderate (6)	Minimal (3)
Minor (2)	Moderate (8)	Moderate (6)	Minor (4)	Minimal (2)
Minimal (1)	Minor (4)	Minimal (3)	Minimal (2)	Minimal (1)

Source: https://www.researchgate.net/.../222825624_Impact_significance_determination-Back_to_Basic

Color Legend:

Red (13-16)	≡ Catastrophic/ Critical	:Action with follow-up Verification & Validation by Authority needed before allowing work
Orange (9-12)	≡ Major	:Action needed under follow-up supervision before allowing work
Yellow (6-8)	≡ Moderate	: Need maintaining with routine monitoring and reporting
Blue (4)	≡ Minor	: Only for awareness
Green (1-3)	≡ Minimal	: No action needed to start work

7.2.4 Abatement Measures

528. The abatement or embedded control measures are those which are already considered by the Proponent in designing the project and selecting the equipment and machinery. The proposed Project has been designed with the state-of-art technology considering abatement measures against possible flue gas emission and discharge of different kinds of liquid wastes. The impact assessment has been done by considering the abatement measures for its authenticity. The major abatement measures are noted below:

- Desulphurization: Sulphur present in the natural gas feedstock will be desulphurized to a level less than 0.05 vol. ppm before used as feedstock.
- Reforming: The flue gas temperature in the primary reformer is about 1050°C which is reduced to 190°C in flue gas heat recovery section. The flue gas blower will take the flue gas to the stack.
- Secondary reformer: After cooling to 360°C from 998°C, the gas flows to the high temperature carbon monoxide (CO) converter.
- Carbon Monoxide Conversion: The heat content of the effluent from the high

temperature CO converter is recovered in the methanator trim heater, in the CG waste heat boiler and in the BFW heater not release in the ambient environment.

- After reforming, about 13.47% CO present in the gas (dry basis) will reduce to approx. 0.3 vol% and temperature will reduce to 228°C.
- Carbon dioxide removal: After treating through carbon dioxide removal process it will come down to 0.05 vol. %.
- Methanation: The left over carbon dioxide and monoxide will be treated through mechanization process and it will form Methane. At this process the carbon dioxide and monoxide together will reduce to less than 5 ppm and the inlet temperature 300°C will be reduced to 42°C at the outlet point.
- Ammonia Synthesis: Compression and synthesis loop will protect poisoning against Water and carbon dioxide and in addition any risk of plugging the equipment in the loop with ammonium carbonate. The remaining ammonia in the purge gas will be sent to chiller and the liquid ammonia thus formed will be separated in the purge gas separator and returned to the bottom of the ammonia separator, the remaining ammonia in the purge gas will be water wash in the purge gas absorber. Washed gas will be sent to the hydrogen recovery system. The recovered hydrogen rich gas will be sent to recycle loop. The off gas will be used as fuel.
- Ammonia convertor: Inert gases accumulating in the refrigeration system are vented from ammonia accumulator. Ammonia is condensed in the vent gas chiller and separated in the vent gas separator. The gas which still contains some ammonia is sent to ammonia recovery unit.
- Ammonia recovery: Inert and let down gas is introduced to the gas absorber and ammonia is washed out with water. The off gas from hydrogen recovery unit system and the gas absorber are mixed and send to fuel header.
- Steam System: The major part of waste heat available is utilized for production of high pressure steam.
- Flare and Vent System: Two separate headers in the Ammonia plant are provided. One is flammable blowout gases without ammonia, the other is blowout gases with ammonia. The flammable blow out gases without ammonia is sent to the vent Stack and it is vented to the atmosphere without burning. In addition to the flammable out gas from the Ammonia Plant, released flammable natural gas from the utility system is also sent to the Vent Stack in the Ammonia plant and discharged to the atmosphere without burning.
- The Main Flare Stack shall receive blowout gas only from header for blowout gases including Ammonia. The main Flare Stack shall include the seal drum, dry seal, pilot burner, ignition system, local ignition panel. In order to evaporate liquid ammonia and avoid the deposition of ammonium carbonate, the seal drum shall be equipped with the steam coil.
- During the normal operation, quantity of blow out gases is zero and very small. In case of upset condition, the quantity of blowout gases is zero or very smaller. In case of upset condition and or during start up and shut down operation of the plant, large quantity of blowout gases is released.
- Dust emission from Urea Plant: With the proven wet scrubbers, an efficiency of over 99.5% can be reached at all time, which means that the atmospheric emission

of urea dust from the granulator stack and from the cooler stack can meet the most stringent air pollution legislation.

- Process condensate: The urea solution plant having process condensate treatment section possesses hydrolyzer and distillation tower for recovering urea and ammonia contained in the process condensate avoiding any discharge of pollutants from the plant.
- Open drain system: The chemical contaminated water which is mainly mixed with ammonia and carbonate is collected from the following urea melt and granulation plant drain lines, such as sampling, pump seal and tank overflow which are connected to Process Condensate Treatment (PCT) system.
- Effluents: No liquid effluents are released by the plant into the sewers. It will be passed through the Effluent Treatment Plant (ETP).
- Solid disposal: No solid wastes are disposed off in the open environment, all material spills are internally collected and recovered into the process.

7.3 Selection of IECs

529. A list of Important Environmental and Social Components (IESCs) or Valued Environmental Components (VECs) has been selected for assessing the impacts of the proposed fertilizer factory. **Table 7.4** presents a list of IESCs/VECs by resources considered under the study.

Table 7.4: IESCs/VECs for impact assessment

Sl. No.	IESCs/VECs
A. Physical Environment	
	A1. Land Resources/ Water Resources/ Hydrology/ Meteorology/ Air Quality/ Noise/ Waste Management
	• Land use
	• Hazardous and non-hazardous waste
	• Sewage/ Solid waste management facilities
	• Ambient air quality
	• Ambient noise
	• Surface water availability
	• Surface water quality
	• Ground water level
	• Ground water pollution
	• Drainage congestion
	• Waterway traffic
B. Biological Environment (Ecology/Fisheries/Agriculture)	
	B1. Ecological Resources
	• Faunal habitat and biodiversity
	• Aquatic habitat
	• Aquatic resources mortality
	• Terrestrial vegetation cover
	• Food chain
	• Species of conservation significance
	a) Fisheries Resources
	• Fish habitat

Sl. No.	IESCs/VECs
	<ul style="list-style-type: none"> • Fish mortality
	<ul style="list-style-type: none"> • Heavy metal accumulation in fish
	<ul style="list-style-type: none"> • In-water noise level
	b) Agriculture Resources
	<ul style="list-style-type: none"> • Crop production
	<ul style="list-style-type: none"> • Soil quality
C. Socio-Economic Environment ((Socio-economy)	
	<ul style="list-style-type: none"> • Employment generation
	<ul style="list-style-type: none"> • Land requirement and dispersion of dust
	<ul style="list-style-type: none"> • Economic activities
	<ul style="list-style-type: none"> • Community/Public health and safety
	<ul style="list-style-type: none"> • Occupational health and safety
	<ul style="list-style-type: none"> • Cultural conflicts
	<ul style="list-style-type: none"> • Burden on utility services
	<ul style="list-style-type: none"> • Communicable Health hazard and risk
	<ul style="list-style-type: none"> • Gender based violence
	<ul style="list-style-type: none"> • Transportation of raw materials

7.4 Summary of Assessed Impacts

530. The potential impacts of the project and their significances have been assessed using the methodology described in Section 7.2 above. A summary of these impacts and their significance is presented in **Table 7.5**.

Table 7.5: Potential Impacts and their Significance

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Pre-Construction Phase (A)								
Physical Environment (Land Resources/Hydrology/Meteorology/Air Quality/Noise/Waste Management)								
Demolition of civil structures	Hazardous and non-hazardous waste generation	A1. Approximately 27,400 tons of debris will be generated due to demolition of civil structures including 15 tons of asbestos cement sheet [Para: 220] which would create burden on the ambient environment.	Waste management plan and precautionary measures have been taken in the Demolition Plan.	High (3) Sensitivity to the receptor (ambient environment) is considered 'High' as it has little capacity to absorb the burden of demolition generated hazardous and non hazardous waste.	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : Minr (2) [Hazardous Waste and Ship Breaking Waste Management rules 2011] Likelihood : Majr (4) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	Major Adverse (9) Sensitivity of the receptor is found 'High' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Adverse'.	<ul style="list-style-type: none"> ▪ Demolition waste (debris and rubbles) should be carried away by covered dump trucks to the landfill area. ▪ A confinement area should be developed for temporary storage of asbestos cement sheet and rods. ▪ Auction of asbestos cement sheet and rods and carry away the sheets and rods by the Vendor. ▪ Water spraying for dust suppression during demolition and debris hauling. 	Minor Adverse (4) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minor (2); the resultant significance is 'Minor Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ Asbestos containing waste material should be managed following Hazardous Waste and Ship Breaking Waste Management rules 2011 guideline and deposited with proper labeling and packaging. ▪ Asbestos washed water should be collected in a scientific pit and release in the open environment with due treatment. ▪ The labour contractor must follow the OHSAS 18000/18001 guidelines. 	
Demolition of civil structures and Materials Handling, Clearing of	Ambient air quality	A2. SPM and PM _{2.5} levels in the base condition are already exceeded the standard (Para: 403]. Ambient	Fencing of the project site.	Medium (2) Sensitivity of the receptor (ambient air)	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Minr (2)	Moderate Adverse (6) Sensitivity of receptor	<ul style="list-style-type: none"> ▪ Carry out regular dust suppression system at the work site and 	Minimal Adverse (2) Changes in sensitivity

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
vegetation and transportation activities		air quality might be deteriorated further due to emission of exhaust gas and dust (SPM, PM ₁₀ and PM _{2.5}) resulting from the use of machinery and equipment for structure dismantling and demolition activities, as well as from circulation of vehicles on the area and cleaning activities.		quality) is considered as 'Medium' as Project site being located beside the river and having wide range of vegetation cover so it has some natural capacity of absorbing or assimilating dust and generous emission of exhaust gas.	Legal Comp. : Majr (4) [National Water Rules 2017] Likelihood : Majr (2) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> vehicle movement path; Introducing vehicular speed limit for controlling dust dispersion. Ensure using of modern and fuel efficient machinery to avoid incomplete combustion of fuel. Work site should be surrounded by the gunny sack/tarpaulin/net for safety issue as well as for controlling flying of dust. 	and magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) and Magnitude: Minor (2); the resultant significance is 'Minimal Adverse'.
	Ambient Noise Level	A3. Noise levels at the UFFL and PUFFL colonies and in front of the TGTDCCL's mosque are already exceeded the standards [Para: 412]. Noise emissions resulting from the use of machinery and equipment, structure demolition and	Limited during the day time	High (3) Sensitivity to the receptor (ambient noise level) is considered 'High' as the vulnerable receptor has little capacity to	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mini (1) Legal Comp. : Mod (3) [National Water Rules 2017] Likelihood : Mod (3)	Moderate Adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'.	<ul style="list-style-type: none"> Use of modern and low noise generating bulldozer for dismantling of civil structures. Construction of boundary wall around the Project site. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		circulation of vehicles on the project area would further degrade the noise level.		absorb proposed changed.	As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> ▪ Use low noise generating equipment and process in different activities. ▪ Reduce impulse noise and whistle of vehicles. ▪ Introduce speed limit within and around the Project site. 	Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Site preparation	Landuse	A4. The Project site, which was mostly the leftover part of existing factory, possesses about 3,750 small to big trees (mostly sapling) [Para: 221]. Ecologically dominant existing industrial land use [Para: 360] would be changed to core industrial landuse.	Not available	High (3) Sensitivity to the receptor is considered 'High', as the remodeling of existing industrial fallow landuse to newer one with fewer vegetation.	Moderate (3) Impact Duration : Mod (3) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : N/A (1) [Social forestry Rules, 2004] Likelihood : Majr (4) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	Major Adverse (9) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Adverse'.	<ul style="list-style-type: none"> ▪ Land optimization should be done during engineering design and vegetation clearance should be limited to as low as possible. ▪ Plantation program should be provisioned as per Forest Department and DoE's Guidelines in the open spaces as per plot layout plan. 	Minimal Adverse (1) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: High (3) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Dredging activities for filling up of lagoon and ponds with dredged materials of the Shitalakhya River	Waterway traffic	A5. Dredging activities in the waterways [Para: 223] would cause conflict with other traffic operation, may create congestion or lead to accidents or disturbance to fishermen.	No abatement measure is considered.	Medium (2) Sensitivity to the receptor is considered 'Medium' as the vulnerable receptor has little capacity to absorb proposed changes.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Minr (2) [Social forestry Rules, 2004] Likelihood : Mod (3) As such the resultant impact magnitude is (12/5= 2.4~2) 'Minor'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Dredging should be started after obtaining permission from the competent authority. A complete Dredging Survey should be conducted. Notification to communities and river users prior to initiation of dredging. Installation of buoys in the area to alert river vessels passing the dredging site. A complete dredging plan should be disseminated to the river users. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Moderate (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Biological Environment (Ecology/Fisheries/Agriculture)								
Site preparation (vegetation clearance, filling up lagoon and pond with	Faunal habitat and biodiversity	A6. The Project site is a vegetated area, which facilitate the wildlife habitat particularly for Bengal Fox and a Near Threatened species,	Not available	Very High (4) Sensitivity to the receptor is considered 'Very High', as the wildlife	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3)	Major Adverse (12) Sensitivity of receptor is found 'Very High'	<ul style="list-style-type: none"> Avoid killing of wildlife during vegetation clearance. Wildlife pass should be created for their 	Moderate Adverse (6) Changes in magnitude with implementation

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
dredged materials)		Large Indian Civet (<i>Viverra zibetha</i>) along with others [Para: 476]. These animals would be affected severely due to site preparation. A7. Roosting and nesting scope of birds would be reduced [Para: 476]. These specialized functions of birds would be hampered significantly.		habitat and flora and faunal biodiversity would be severely vulnerable. This issue has little capacity to absorb changes or minimal scope of mitigation.	Legal Comp. : Minr (2) [Social forestry Rules, 2004] Likelihood : Majr (4) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Adverse'.	<ul style="list-style-type: none"> unscarred escaping to nearby similar habitat. Land optimization during engineering design and vegetation clearance should be limited to as low as possible. Bush cover should be created around the Project area and also outside the project site to create suitable habitat. 	on of suggested mitigation measures. Sensitivity: High (3) and Magnitude: Minor (2); the resultant significance is 'Moderate Adverse'.
Vegetation clearance	Terrestrial Vegetation Cover	A8. Loss of valuable timber plantations (about 3,750 no. of trees from sapling to adult) within the project area [Para: 221] would release carbon to the atmosphere.	Not available	High (3) Sensitivity to the receptor is considered 'High', as the vulnerable receptor has little capacity to absorb changes or limited scope of mitigation.	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : Minr (2) [Social forestry Rules, 2004] Likelihood : Mod (4) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	Major Adverse (9) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Moderate'. The	<ul style="list-style-type: none"> Vegetation clearance should be limited to Project Layout area. Green belt should be developed with native plants for creating vegetation cover surrounding the Project area. 	Moderate Adverse (6) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: High (3) and

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
						resultant impact significance is 'Major Adverse'.	<ul style="list-style-type: none"> Plantation should be done around the playground, dormitory, roadside, etc. outside the project site under Corporate Social Responsibility (CSR). This will also enhance the capacity to absorb more carbon from the atmosphere. 	Magnitude: Minor (2); the resultant significance is 'Moderate Adverse'.
Dredging activities for filling up of lagoon and ponds with dredged materials of the Shitalakhya River	Fish habitat	A9. Benthic fish habitat especially their nests during breeding period would be damaged due to removal of dredged materials of about 2,26,700 m ³ (Para: 223).	Not available	Medium (2) Sensitivity of the receptor is considered 'Medium' because nests of some benthic species would be wiped out but have some capacity to absorb changes (take shelter in other places) or moderate	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Mod (3) Legal Comp. : Minr (2) [National Water Rules 2017] Likelihood : Majr (4) As such the resultant impact magnitude is (14/5= 2.8~3) 'Moderate'.	Moderate Adverse (6) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> Dredging activity should avoid the breeding period (June to August) of fish; Survey should be done before selecting the dredging alignment for avoiding important area of interest from fishery point of view. River users should be aware of dredging 	Minimal Adverse (2) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) and Magnitude: Minor (2); the resultant

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
				scope of mitigation.			activity before starting dredging.	significance is 'Minimal Adverse'.
Dredging activities for filling up of lagoon and ponds with dredged materials of the Shitalakhya River	Food chain	A10. Loosened contaminated bed materials (sediment) [Para: 223] may pose threat to the intervened natural environment (e.g., release of heavy metals into aquatic environment and may enter into the food chain through bio magnification while absorption of heavy metals by fish through respiratory organs and uptake by skin and bio accumulates).	No abatement measure is considered.	High (3) Sensitivity to the receptor is considered 'High', as contaminated bed materials might affect aquatic environment including fish fauna. This issue has little capacity to absorb changes or limited scope of mitigation.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) Likelihood : Mod (3) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	Moderate Adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> Bed materials should be tested in the laboratory to determine toxicity levels before dredging and disposal. If heavy metals are found in the dredged materials, dredging action in the concerned alignment and disposal in the wetland should be avoided for limiting contamination. 	Minimal Adverse (2) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Social Environment (Socio-economic)								
Demolition of infrastructures and scraping	Employment generation	A11. Generation of employment opportunity for about (400-60 exptraite= 340) local [Para: 355] and in-migrated people of different working	The proponent is committed to employ local people during demolition of	High (3) Sensitivity of the receptor is considered 'High' because livelihood of a	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Majr (4) Reversibility : Mod (3) Legal Comp. : Minr (2) [Bangladesh Labour Act	Major Beneficial (9) Sensitivity of receptor is found 'High' while	<ul style="list-style-type: none"> Local people particularly the Project-affected Persons (PAPs) directly or indirectly should be given priority 	Major Beneficial (12) Changes in magnitude with implementati

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		levels and expertise during demolition of infrastructures and scraping, which would promote livelihood.	infrastructures and scraping.	large number (about 340) of people would be generated.	(BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Major (4) As such the resultant impact magnitude is (15/5= 3) 'Moderate'.	the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Beneficial'.	<ul style="list-style-type: none"> in employing workforces in different Project activities. Labour wage should be fixed based on the labour market and commodity prices of the area. Gender issue should be considered in employing labour. EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. 	on of suggested enhancement measures. Sensitivity: High (3) and Magnitude: Major (4); the resultant significance is 'Major Beneficial'.
Demolition of infrastructures and scraping	Occupational health and safety	A12. During demolition work there is a probability of accidental risk for labors which will significantly impact the health of the working personnel. Besides, congested living in possible small spaces may cause the break	There is a bindings of maintaining rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II from the lender part.	Medium (2) Sensitivity of the receptor is considered 'Medium' as even after maintaining abatement measures demolition	Minor (2) Impact Duration : Minor (2) Spatial Extent : Minor (2) Reversibility : Mod (3) Legal Comp. : Minor (2) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'.	<ul style="list-style-type: none"> Ensure rigorous standards for occupational health and safety are in place. Establish Occupational Health and Safety (OHS) procedures taking into account the 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		out of contagious disease like diarrhea, dysentery, skin diseases, scabies, etc.		activities have every chance of accidental events and have chance of break out of diseases.	(ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Mod (3) As such the resultant impact magnitude is (12/5= 2.4~2) 'Minor'.	The resultant impact significance is 'Minor Adverse'.	<p>inherent risks for this type of project</p> <ul style="list-style-type: none"> ▪ Occupational Health and Safety (OHS) Plan to be implemented based on ECP 13: Workers Health and Safety and World Bank Group's Environment, health and Safety (EHS) Guidelines. ▪ Contractor should establish a labor grievance mechanism and documenting its use for complaints. ▪ EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. ▪ Contractor should also follow relevant IFC 	Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<p>Performance Standard (PS) like PS-3 on Resource Efficiency and Pollution Prevention and PS-4 on Community Health, Safety, and Security.</p> <ul style="list-style-type: none"> ▪ Safety training for all workers should be ensured prior to commencing the work. 	
Site preparation	Employment generation	A13. Generation of employment opportunity for about 600 local skilled, semi-skilled and unskilled people during site preparation [Para: 355], which would promote livelihood.	The proponent is committed to employ local people during demolition of infrastructures and scraping	High (3) Sensitivity of the receptor is considered 'High' because livelihood of a large number (about 600) of people would be generated.	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Major (4) Reversibility : Moderate (3) Legal Comp. : Minor (2) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III]	Major Beneficial (9) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Moderate'. The resultant impact significance	<ul style="list-style-type: none"> ▪ Local people particularly the Project-affected Persons (PAPs) directly or indirectly should be given priority in employing workforces in different Project activities. ▪ Labour wage should be fixed based on the labour market and commodity 	Major Beneficial (12) Changes in magnitude with implementation of suggested enhancement measures. Sensitivity: High (3) and Magnitude: Major (4); the resultant

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					Likelihood : Major (4) As such the resultant impact magnitude is (15/5= 3) 'Moderate'.	is 'Major Beneficial'.	prices of the area. <ul style="list-style-type: none"> Gender issue should be considered in employing labour. EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. 	significance is 'Major Beneficial'.
Transportation with respect to equipment and materials procured and Site receiving, Handling and Warehousing	Occupational health and safety	A14. Transportation of construction materials may have different types health and safety issues including safety from increased traffic, accidents and health hazard from flying of sand and dust from the carriers, etc. [Para: 344]	Not available	Medium (2) Sensitivity of the receptor is considered 'Medium' because safety issue and health hazard of transport crews and labours have some capacity to absorb changes or moderate scope of mitigation.	Minor (2) Impact Duration : Minimal (1) Spatial Extent : Major (4) Reversibility : Minimal (2) Legal Comp. : Minimal (2) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Moderate (3)	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Schedule of deliveries of material/ equipment should be fixed during off-peak hours. Depute flagman for traffic control. Arrange for signal light at night. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					As such the resultant impact magnitude is (12/5= 2.4~2) 'Minor'.			
Temporary Works (needed by the contractor) [Refer: Section 4.10]	Occupational health and safety	A15. During temporary work (i.e. warehouse construction, labor-shed construction, utility service development and fire safety work etc.) [Para: 230] there is a probability of accidental risk for labors which will significantly affect the health of the working personnel. Besides, congested living in possible small spaces may cause the break out of contagious disease like diarrhea, dysentery, skin diseases, scabies, etc.	No abatement measure is considered.	Medium (2) Sensitivity of the receptor is considered 'Medium' because safety issue and health hazard of temporary works having potential of accidental event and health hazard have some capacity to absorb changes or moderate scope of mitigation.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : Minr (2) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Minr (2) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Ensure rigorous standards for occupational health and safety are in place. Establish Occupational Health and Safety (OHS) procedures taking into account the inherent risks for this type of project. Contractor should establish a labor grievance mechanism and documenting its use for complaints. EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Construction Stage (B)								
Physical Environment (Land Resources/Hydrology/Meteorology/Air Quality/Noise)								
Construction of building, infrastructure, Utility, unit, NH ₃ plant and Urea Plant along with Power Plant	Ambient air quality	B1. Ambient air quality might be deteriorated due to emission of particulate matter from construction works and material storage and transportation of construction vehicles.	Fencing of the project site.	Medium (2) Sensitivity of the receptor is considered as 'Medium' as the vulnerable receptors have some capacity to absorb the proposed changes or moderate opportunities for mitigation.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Mod (3) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Minr (2) As such the resultant impact magnitude is (12/5= 2.2~2) 'Minor'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Carry out regular dust suppression system at the work site and vehicle movement path; Introducing vehicular speed limit for controlling dust dispersion. Ensure using of modern and fuel efficient machinery to avoid incomplete combustion of fuel. Work site should be surrounded by the gunny sack/tarpaulin/net for safety issue as well as for controlling flying of dust. 	Minimal Adverse (1) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Do	Ambient Noise Level	B2. Noise emissions resulting from the use of machinery and	Use of low noise generating	High (3)	Minor (2) Impact Duration : Minr (2)	Moderate Adverse (6)	<ul style="list-style-type: none"> Use modern, low noise generating equipment and process, reduce 	Minimal Adverse (2)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		equipment and vehicle circulation for piling and other construction activities.	equipment and process.	Sensitivity to the receptor is considered 'High', as the vulnerable receptor has little or no capacity to absorb proposed changes or limited opportunities for mitigation.	Spatial Extent : Minr (2) Reversibility : Mini (1) Legal Comp. : Mod (3) [National Water Rules 2017] Likelihood : Mod (3) As such the resultant impact magnitude is (1/5= 2.2~2) 'Minor'.	Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Moderate'.	<ul style="list-style-type: none"> impulse noise and whistle of vehicles Noise hood should be used where applicable. Noise generating equipment and machinery should be provided with silencer. 	Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Extraction of Ground Water (GW) for construction work	Ground Water Level	B3. Drawdown induced lowering of ground water level may cause crisis of household level availability of groundwater through hand tube well [Para: 386].	The proponent is committed to use surface water for all construction purposes instead of ground water.	Very High (4) Sensitivity of the receptor is considered 'Very High' because extraction of ground water will be high only at construction phase have some limited	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [National Water Act, 2013]	Moderate Adverse (8) Sensitivity of receptor is found 'Very High' while the magnitude is assessed as 'Minor'. The resultant impact	<ul style="list-style-type: none"> The EPC contractor should ensure use of surface water avoiding groundwater withdrawal. The proponent should encourage and facilitate introduction of Rainwater Harvesting System (RHS) as a substitute for 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
				capacity to absorb changes by recharge or moderate scope of mitigation.	Likelihood : Major (4) As such the resultant impact magnitude is $(12/5 = 2.4 \sim 2)$ 'Minor'.	significance is 'Minor Adverse'.	<ul style="list-style-type: none"> other local users of GW as part of CSR. Monitoring should be considered as one of the important components during ground water extraction. Water supply system should be leakage proof. 	Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Project construction [Construction Period peak time local workforce is of about 4,000 and 1,530 officials]	Consumptive water requirement (for drinking, washing, bathing, etc.)	B4. Considering the water consumption of 50 litre/capita/day (IFC, 2007) for 4000 workers, 1530 EPC and BCIC officials will require about 275 m ³ of water per day. This may create extra pressure on the already depleted groundwater source and may lead to ground water mining.	The Proponent is committed to make available adequate consumptive water facilities for the official, personnel and workers to be involved in the Project activities through Reverse Osmosis (RO) of surface water from the Shitalakhya as the ground	High (3) Sensitivity is considered "High", as the drinkable and other consumptive water is scarcely available in the Project site except the ground water source. (Receptor is ground water)	Minor (2) Impact Duration : Minor (2) Spatial Extent : Minor (2) Reversibility : Minor (2) Legal Comp. : Minor (2) [ECR, 1997] Likelihood : Minor (2) As such the resultant impact magnitude is $(10/5 = 2)$ 'Minor'.	Moderate adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> Considering the poor quality of surface water and low availability of ground water, it is suggested to avoid abstraction of ground water for non-potable and other uses in the labor camp instead it is recommended to continue with Reverse Osmosis (RO) Plant throughout the Project period. Effective and efficient use of 	Minimal Adverse (1) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) Magnitude: Minimal (1); the resultant

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
			water is scarce.		The required water for consumptive use will be distributed through pipeline system from the RO Plant. But the sludge of the RO Plant may be contaminant to the environment merits sludge management.		<ul style="list-style-type: none"> water should be ensured. Reuse of water with due treatment in suitable water use area. Sludge collection sump should be built. 	significance is 'Minimal Adverse'.
Do	Sewage/ solid waste management facilities	B5. Considering sewage waste generation rate of 0.29 kg/person/ day (CCAC Municipal Solid Waste Initiative; www.unep.org/ccac) for 4,000 labours in the camp and 1530 EPC and BCIC officials in the site for about three (03) years [Para: 355], about 2,400 m ³ of sewage/ organic solid waste would be generated which would require sound management. Failure of management may pollute the	<p>EPC Contractor will appoint Labour Contractor, who maintains ILO Guidelines having international standard of sewage management expertise of the workers and others.</p> <p>Solid waste generated during construction will be segregated in following category:</p>	<p>Medium (2)</p> <p>Sensitivity is considered 'Medium', as the improper management of sewage may be the source of diseases to the officials, consultants and workers and to local inhabitants and messy outlook. (Receptor is office personnel, workers and local inhabitants).</p>	<p>Minor (2)</p> <p>Impact Duration : Minr (2)</p> <p>Spatial Extent : Minr (2)</p> <p>Reversibility : Minr (2)</p> <p>Legal Comp. : Minr (2) [ECR, 1997]</p> <p>Likelihood : Minr (2)</p> <p>As such the resultant impact magnitude is (10/5= 2) 'Minor'.</p> <p>The Proponent will build 3-year full scale capacity</p>	<p>Minor adverse (4)</p> <p>Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.</p>	<ul style="list-style-type: none"> The tentatively required dimension of sewage/organic solid waste tank should be 1,750 m³ capacity of organic solid waste in three years. The tank should be septic tank for better absorption of liquid by the soil. Maintain hygienic condition of the water closet (WC) for the next person's use. Dismantling of septic tank should be done 	<p>Minimal Adverse (1)</p> <p>Changes in sensitivity and magnitude with implementation of suggested mitigation measures.</p> <p>Sensitivity: Low (1)</p> <p>Magnitude: Minimal (1); the resultant significance</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		<p>surrounding environment, lose aesthetic value and may cause diseases to labours and local inhabitants.</p> <p>Generation of solid waste (kitchen waste) of about 1,500 kg/day for about 5,530 workers and Project officials) [Para: 355] from the official dorms and labour camp.</p>	<p>Compostable</p> <p>Re-cycleable</p> <p>Land fill</p> <p>Accordingly, three facilities will be developed for above categories, i.e., Composting facility, Re-cycle facility and landfill facility.</p> <p>No untreated liquid waste will be discharge to any waterbody.</p> <p>EPC contractor will develop Sewage treatment Plant.</p>	<p>Latrines and septic tanks are close (within 100 m) to the workforce accommodation facilities and about 2 km away from the community settlement.</p>	<p>septic sewage tank for the people involved in different Project activities.</p>		<ul style="list-style-type: none"> ▪ with proper care and release gases arrested in the tank carefully for avoiding casualty. ▪ Proper sanitation should be maintained according to environmental standards. 	<p>is 'Minimal Adverse'.</p>
Waste water and storm water management	Drainage congestion	B6. Drainage congestion may be happened due to blockage of temporary drainage	Temporary drainage system has been provisioned.	<p>Low</p> <p>(1)</p> <p>Sensitivity of the receptor is</p>	<p>Moderate</p> <p>(3)</p> <p>Impact Duration : Minr</p> <p>(2)</p>	<p>Minimal adverse</p> <p>(3)</p>	<ul style="list-style-type: none"> ▪ A well engineering designed and modern drainage 	<p>Minimal adverse</p> <p>(1)</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		facilities by the construction debris and bore hole mud water along with lack of regular monitoring.		considered 'Low' as temporary drainage system will minimize the drainage problem.	Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [National Water Act, 2013] Likelihood : Mod (3) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	Sensitivity of receptor is found 'Low' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> system should be introduced. Regular Maintenance of the drainage network should be ensured. Clearing of drainage network should be done regularly. 	Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Disposal of construction waste during Project Component construction	Soil, air and water quality	B7. Indiscriminate and unplanned disposal of solid and liquid waste may affect local environment (soil, air and water) adversely.	Temporary storage and housekeeping of construction solid and liquid waste.	Medium (2) The sensitivity is considered 'Medium' as vulnerable receptor (environmental elements) has moderate opportunities for mitigation.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [ECR, 1997] Likelihood : Minr (2) As such the resultant impact magnitude is	Minor adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Implement ECP 1 Waste Management. Siting of fuel and hazardous material storage sites, including refueling facilities, batching plants and construction yards are to be located inside the flood embankments. Hazardous waste will be disposed of following 	Minimal Adverse (1) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					(10/5= 2) 'Minor'. Hazardous waste will be disposed of following environment friendly and ISM system by designated contractors. Good housekeeping will be adopted to reduce generation of construction wastes and the potential water pollution.		<ul style="list-style-type: none"> environment friendly manner by designated contractors. Good housekeeping will be adopted to reduce generation of construction wastes and the potential water pollution. 	Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Biological Environment (Ecology/Fisheries/Agriculture)								
Pile driving during Jetty construction	Species of conservation significance	B8. In case of pre-cast pile driving activities following concern may arise: Overpressure and sound from pile driving activities will harm riverine animals, including dolphins [Availability of Dolphins mentioned in Para: 461].	There is very little chance of using pre-cast driven piles. Jetty will be developed on cast in-situ type pile driving with vibratory hammer.	High (3) Sensitivity is considered High as vulnerable receptor (Species of conservation significance/dolphin) has little capacity to absorb proposed changes.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [ECR, 1997] Likelihood : Mod (3) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'. As Pile driving activity is envisaged minimum noise generation.	Moderate adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> In case of pre-cast pile driving activities following measures will be applicable: Pile driving will be completed using Best Management Practices for Pile Driving and Related Operations. Conferring with appropriate organizations to determine the preferred timing 	Minimal Adverse (2) The reason for the change in residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity:

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							and methods of the pile driving.	Medium (2) Magnitude: Minimal (1)
Pile driving during Jetty construction	In-water noise level	B9. Most of the piles will be cast in-situ type. So, underwater noise from piling activities will be remote. In case of pre-cast pile driving activities following concern may arise: Noise from in-water construction along with pile driving generates intense underwater sound pressure waves that will adversely affect riverine organisms including vocalization and behavior of fish, dolphins and other animals [Para: 453 and Para: 461].	There is very little chance of using precast driven piles. Jetty will be developed on cast in-situ type pile driving.	High (3) Sensitivity is considered 'High' as vulnerable receptor (noise-sensitive aquatic animals and swim bladderless fishes) has little capacity to absorb proposed changes.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [ECR, 1997] Likelihood : Minr (2) As such the resultant impact magnitude is (10/5= 2) 'Minor'. As Pile driving activity is not envisaged generation of noise shall be minimal.	Moderate adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> ▪ In case of pre-cast pile driving activities following measures will be applicable: ▪ Use of vibratory hammers instead of impact hammers ▪ Monitoring of underwater noise levels and use of underwater air bubble curtains, metal or fabric sleeves to surround the piles to reduce noise levels if required. ▪ A large bubble curtain consists of a hose with drilled holes, supplied with compressed air. The hose is placed on the river bed and the air escaping from 	Minimal Adverse (2) The reason for the change in residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) Magnitude: Minimal (1)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significanc e Prior to Mitigation	▪ Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ the holes forms the bubble screen. [Single bubble curtain reduce noise by: 12 dB (SEL), 14 dB (peak); Double bubble curtain by 17 dB (SEL), 21 dB (Peak)] ▪ Hydro Sound Damper consists of fishing nets with small balloon filled with gas and foam - tuned to resonant frequencies fixed to it. It can be applied in different ways. [Hydro Sound Damper reduce noise by 4 - 14 dB (SEL)] ▪ Setting up cofferdam which consists of a rigid steel tube surrounding the pile. Once the pile is stabbed into the cofferdam, the 	

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significanc e Prior to Mitigation	▪ Mitigation and Enhancement Measure	Residual Significance
							<p>water is pumped out. [Cofferdam up to 22 dB (SEL) and 18 dB (Peak)]</p> <ul style="list-style-type: none"> ▪ Conduct pile driving during low tides in intertidal and shallow subtidal areas. ▪ Implement seasonal restrictions when necessary to avoid construction-related impacts to habitat during species' critical life history stages (e.g., spawning and egg development periods). ▪ Reduce sound pressure impacts during pile installation by using wood or concrete piles, rather than hollow steel piles which produce intense, sharp spikes of 	

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ sound that are more damaging to fish and dolphins having air cavities. ▪ Underwater noise during piling activities could be carried out with a hydrophone sensor which is normally placed in a water column at least 1 metre deep, with the sensor located at a depth of 0.5 metre above bottom of the water column. 'Reference sound levels from pile driving normally are reported at a fixed distance of 10 meters'. 	
Movement of construction materials carrying vessels	Species of conservation significance	B10. Risk of dolphin collision with construction vessels in the river.	Construction vessels will follow Shitalakhya River (Navigation Route Class III) being used	High (3) Grazing of dolphin in and around the proposed jetty site is found nominal. Most	Minor (2) Impact Duration : Minor (2) Spatial Extent : Moderate (3)	Moderate adverse (6) Sensitivity of receptor is found 'High' while the	<ul style="list-style-type: none"> ▪ Restrict the vessel speeds. ▪ Restrict boat movement within safe distance around the construction site if river width 	Minimal Adverse (2) The reason for the change in residual significance

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
			<p>for the decades.</p> <p>Moreover, collision with dolphin by vessels plying in the river has not been reported.</p>	<p>congregations of dolphins are observed in the confluence of the pool areas.</p> <p>The sensitivity is considered High as the receptor (endangered species/ dolphin) has little capacity to absorb proposed changes.</p>	<p>Reversibility : Minor (2)</p> <p>Legal Comp. : Minor (2) [ECR, 1997]</p> <p>Likelihood : Moderate (3)</p> <p>As such the resultant impact magnitude is (12/5= 2.4~2) 'Minor'.</p>	<p>magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.</p>	<p>permits. Avoid areas where Dolphins are known to congregate (particularly the river pool areas and scouring sites).</p>	<p>is because of the change in magnitude with implementation of suggested mitigation measures.</p> <p>Sensitivity: Medium (2)</p> <p>Magnitude: Minimal (1)</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Social Environment (Socio-economic)								
Project construction	Employment generation	B11. Generation of employment will be maximum 4,000 people of different working levels and expertise during Project components construction [Para: 355], which will promote livelihood facilities in and around the study area.	The proponent is committed to employ local people of skilled, semi-skilled and unskilled people of over 18 years old.	Very High (4) Sensitivity of the receptor is considered 'Very High' as creation of new employment of about 4,000 local people temporarily.	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Major (4) Reversibility : Minr (2) Legal Comp. : Mod (3) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Mod (3) As such the resultant impact magnitude is (14/5= 2.8~3) 'Moderate'.	Major Beneficial (12) Sensitivity of receptor is found 'Very High' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Beneficial'.	<ul style="list-style-type: none"> Local people particularly the Project-affected Persons (PAPs) directly or indirectly should be given priority in employing workforces in different Project activities. Labour wage should be fixed based on the labour market and commodity prices of the area. Gender issue should be considered in employing labour. EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. 	Major Beneficial (9) Changes in magnitude with implementation of suggested enhancement measures. Sensitivity: Very High (4) and Magnitude: Moderate (3); the resultant significance is 'Major Beneficial'.
Project construction	Economic activity	B12. Increased economic activity due to involvement of about 4000	No abatement measure is considered.	Medium (2)	Moderate (3)	Moderate Beneficial (6)	<ul style="list-style-type: none"> The Proponent should ensure accessibility of workforce in 	Moderate Beneficial (8)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		workers at peak time and about 1530 officials in the Project site, selling of local construction materials, traders, food supply, etc. This will improve the local socio-economic condition and life style.		Sensitivity is considered 'Medium', as local farmers, producers, traders and other services will involve more local people other than 4,000 people/workers involved in the Project component's construction. Considering the potential economic activities during Project construction, life style of the local people, thus the sensitivity for the receptors (Lifestyle) are kept medium.	Impact Duration : Minr (2) Spatial Extent : Majr (4) Reversibility : Minr (3) Legal Comp. : Mod (3) [IFC PS-II, and Equator Principle-III] Likelihood : Majr (4) As such the resultant impact magnitude is (16/5= 3.2~3) 'Moderate'.	Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Beneficial'.	<ul style="list-style-type: none"> ▪ shopping activities in the local market place. ▪ Ensured timely payment of the labour for facilitating rolling of money. ▪ Emphasizing purchasing of commodities locally for giving benefit to local farmers, producers, traders including small shops within the project area. ▪ 	The change in magnitude with implementation of suggested enhancement measures. Sensitivity: Medium (2) Magnitude: Major (4)
Movement of heavy equipment and construction vehicle	Community health and safety	B13. Little increase of equipment carrying heavy vehicle movement of on the road may cause noise and vibration affecting workers, project	Most of the construction materials and plant equipment will be transported	High (3) Sensitivity is considered High as vulnerable receptor (community) has	Minor (2) Impact Duration : Minr (2) Spatial Extent : Mod (3)	Moderate adverse (6) Sensitivity of receptor is found 'High'	<ul style="list-style-type: none"> ▪ Construction vehicle movement near settlements will be limited to day time mostly. ▪ High noise producing 	Minimal Adverse (2) The reason for the change in residual

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		staff and the nearby community. Most of the construction materials and plant equipment will be transported using water vessels.	using water vessels. Movement of Heavy Vehicle shall be mostly confined to project area which is away from the local community.	little capacity to absorb proposed changes.	Reversibility : Minr (2) Legal Comp. : Minr (2) [ECR, 1997] Likelihood : Minr (2) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'. Six (06) lane access road will be constructed [two (02) lane already constructed] which is passing mainly through non habitat area.	while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> ▪ equipment will be provided with mufflers or acoustic hood/enclosures. ▪ Install acoustic enclosures around generators and install temporary noise control barriers where appropriate to reduce noise levels. ▪ Fit high efficiency mufflers to appropriate construction equipment. ▪ Notify affected communities in advance regarding major noisy operation. ▪ Implement Noise Management Plan. 	<p>significance is because of the change in magnitude with implementation of suggested mitigation measures.</p> <p>Sensitivity: Medium (2) Magnitude: Minimal (1)</p>
Quarry/ borrowing activities for civil structure	Land requirement and dispersion of dust	B14. Quarry/ borrowing activities for river protection works and associated pilling up of extracted	A required quantity of area will be designated by the Proponent.	Medium (2) The sensitivity is considered 'Medium' as	Minor (2) Impact Duration : Minr (2)	Minor adverse (4) Sensitivity of receptor is found	<ul style="list-style-type: none"> ▪ Burrow/quarry areas will be developed close to the project area for extraction of 	<p>Minimal Adverse (1) The reason for the</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		earth may require additional land and after being dried up dust particles may be dispersed.	Excavated earth may be used for land filling.	vulnerable receptor (land and air quality) has moderate opportunities for mitigation.	Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [ECR, 1997] Likelihood : Minl (1) As such the resultant impact magnitude is (9/5= 1.8~2) 'Minol'.	'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> earth material and aggregates for river protection works. No private lands or agriculture lands will be used for burrowing. Minimize volume of burrowing material by using dredged material generated from the associated component of the Project. Control of dust and associated air pollution by application of watering method. 	change in residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity: Low(1) Magnitude: Minimal (1)
Project Construction	Occupational health and safety	B15. Injuries to the workers, even casualty or life loss in case of accident may be held during transportation of machinery and equipments from the ship to site and their installations.	MHI's own Safety Guidelines	Medium (2) Sensitivity is considered 'Medium', as during temporary works may cause accidents. As such the sensitivity for the receptors (workers) are kept medium.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : Minr (2) [Bangladesh Labour Act (BLA),	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is	<ul style="list-style-type: none"> Proper health and safety training on hazard identification and how to handle hazardous equipments must be provided to the workers before starting any construction activities. Ensure rigorous standards for 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					<p>2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III]</p> <p>Likelihood : Minr (2)</p> <p>As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.</p>	<p>'Minor Adverse'.</p>	<ul style="list-style-type: none"> ▪ occupational health and safety are in place. ▪ Establish Occupational Health and Safety (OHS) procedures taking into account the inherent risks for this type of project. ▪ An on-site medical team should be set up and emergency first-aid kit should be at hand in case of any accidental injuries (burns, cuts, broken bones etc.). ▪ The workers should use the appropriate PPEs. ▪ Ensure workers hygiene and health status. Conduct monthly health check-ups to monitor their health condition and provide 	<p>Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ appropriate treatment for any ailments. ▪ Need proper danger signs/posters to prevent accident from occurring at the construction site. ▪ Contractor will establish a labor grievance mechanism and documenting its use for complaints about unfair treatment or unsafe living or working conditions without reprisal. ▪ Provide health insurance for employees for the duration of their contracts. ▪ Provide insurance for accidents resulting in disabilities or death of employees for the 	

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> duration of their contracts EPC Contractor should abide by the rules and regulations of BLA, 2006; ILO, 1998; EP-III and IFC PS-II. 	
Do	Cultural conflicts	B16. Immigrant workers will come from different parts of the country and abroad having cultural diversity, so there will be possible cultural conflicts among workers, and between communities and workers.	Accommodation facility for the labours is provisioned for 1,700 (about 30%) persons out of 5,530 persons workers and EPC and Project officials [Para: 354].	Medium (2) Sensitivity is considered 'Medium', as conflicts may arise between the local community and the construction workers, which may be related to religious, cultural or ethnic differences, or based on competition for local resources. As such the sensitivity for the receptors (conflict) are kept medium.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Mod (3) [Bangladesh Labour Act (BLA), 2006, ILO Declaration on Fundamental Rights and Principles (ILO, 1998), IFC PS-II, and Equator Principle-III] Likelihood : Minr (2) As such the resultant impact	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> To avoid the conflict the EPC contractor will have to develop following things: Project-level Grievance Redressal Mechanism (GRM). Worker Code of Conduct in local language(s). Provision of cultural sensitization training for workers regarding engagement with local community. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					magnitude is (12/5= 2.4~2) 'Minor'.			
Do	Increased burden on public service provision (utility services)	B17. The presence of construction workers and service providers can generate additional pressure on the provision of public (utility) services, such as water, electricity, medical services, education and social services [Para: 354].	The proponent will construct labor-shed for in-migrant and expatriate workers of about 1.700 persons and develop separate utility services for them during construction period.	Medium (2) Sensitivity is considered 'Medium', as labor influx will increase burden on public service during contraction phase, in the Project adjacent area. As such the sensitivity for the receptors (public utility services) are kept medium.	Minor (2) Impact Duration : Mini (1) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Mod (3) [Remote Area Power Supply System (RAPSS) Guidelines, 2007] Likelihood : Minr (2) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> ▪ Workers' camps to include wastewater disposal and septic tank system for managing human excreta. ▪ Identification of authorized water supply source and prohibition of use from other community sources. ▪ Separate service providers for community and workers' camp/ construction site. ▪ Worker Code of Conduct on water and electricity consumption. ▪ Contingency plans for temporary rise in demand for utilities and public service provision. ▪ The Proponent should widen the 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> existing road passes beside the PUFFL Colony for easy communication of the local people. The Colony will be built in the present Ghorasal Fertilizer Factory Ltd. For the new plant. Through the Colony an access road up to the Shitalakhya River could be constructed. 	
Do	Increased risk of communicable diseases	B18. Increased interactions between the incoming workforce and the local community may result in increasing rates of communicable diseases, including sexually transmitted diseases (STDs) and HIV/AIDS.	MHI's own Safety Guidelines	High (3) Sensitivity is considered 'High', as workforce has high susceptibility to the local community in terms of communicable diseases, in the Project adjacent area. As such the sensitivity for the	Minor (2) Impact Duration : Mini (1) Spatial Extent : Mod (3) Reversibility : Major (4) Legal Comp. : Mod (3) [EHS Guidelines of IFC, 2007] Likelihood : Minor (2)	Moderate Adverse (6) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> To avoid the risk of communicable diseases, the EPC contractor will: Establish or upgrade health centers at camp and construction site. Ensure awareness raising programs like public health 	Minimal Adverse (2) Changes in sensitivity and magnitude with implementation of suggested mitigation measures.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
				receptors (communicable diseases) are kept 'High'.	As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.		<ul style="list-style-type: none"> ▪ impacts from labor influx. ▪ Introduce community sensitization campaigns on STDs among the workers and local community. ▪ Implement HIV/AIDS education program. ▪ Develop worker Code of Conduct in local language(s). 	Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Do	Gender based violence	B19. Construction workers are predominantly younger males. Those who are away from home on the construction job are typically separated from their family and their normal sphere of social control. This can result is inappropriate behavior, such as sexual harassment of women and girls and illicit sexual	MHI's own Safety Guidelines	Medium (2) Sensitivity is considered 'Medium', as women workforce have moderate susceptibility to the abuse and stalking by the male workforce.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Mod (3) Legal Comp. : Mod (3) [EHS Guidelines of IFC, 2007] Likelihood : Minr (1)	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> ▪ To avoid the risk of abuse, the EPC contractor will: ▪ Ensure awareness raising programs like sexual harassment impacts from male labor. ▪ Introduce community sensitization campaigns on STDs among the 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1);

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		relations with minors from the local community.			As such the resultant impact magnitude is (11/5=2.2~2) 'Minor'.		<ul style="list-style-type: none"> ▪ workers and local community. ▪ Implement HIV/AIDS education program. ▪ Develop worker Code of Conduct in local language(s). 	the resultant significance is 'Minimal Adverse'.
Do	Public safety	B20. Increased Traffic on local roads will affect access to the trading center and, houses close to the road, deteriorate safety (especially the school children), spillage of fuels and chemicals, and damage to infrastructures and properties due to vibration.	No abatement measure is considered.	Medium (2) Sensitivity is considered 'Medium', as the receptors have some capacity to absorb proposed change or moderate opportunities for mitigation.	Moderate (3) Impact Duration : Minr (2) Spatial Extent : Mod (3) Reversibility : Mini (1) Legal Comp. : Mod (3) [EHS Guidelines of IFC, 2007] Likelihood : Minr (2) As such the resultant impact magnitude is (11/5=2.2~2) 'Minor'.	Moderate adverse (6) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> ▪ Contractor will implement traffic management plan to ensure uninterrupted traffic movement during construction. ▪ Restrict truck deliveries, where practicable, to day time working hours. ▪ Restrict the transport of oversize loads. ▪ Enforce on-site speed limit, especially close to the sensitive receptors, schools, health centres, etc. 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> Implement ECP 10: Traffic Management Inspect structures within the close proximity of construction site for damages. 	
Do	Health safety	B21. Operation of heavy equipment and transport vehicles will cause noise and vibration affecting workers and the nearby population.	No abatement measure is considered.	<p>High (3)</p> <p>Sensitivity is considered 'High', as the receptors have little capacity to absorb proposed change or limited opportunities for mitigation.</p>	<p>Moderate (3)</p> <p>Impact Duration : Minr (2)</p> <p>Spatial Extent : Mod (3)</p> <p>Reversibility : Mini (1)</p> <p>Legal Comp. : Mod (3) [EHS Guidelines of IFC, 2007]</p> <p>Likelihood : Mod (3)</p> <p>As such the resultant impact magnitude is (12/5= 2.4~2) 'Minor'.</p>	<p>Major Adverse (9)</p> <p>Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Major Adverse'.</p>	<ul style="list-style-type: none"> Construction activities near settlements will be limited to day time only (8AM – 6PM). High noise producing equipment will be provided with mufflers or acoustic hood/enclosures. Install acoustic enclosures around generators and install temporary noise control barriers where appropriate to reduce noise levels. Fit high efficiency mufflers to appropriate 	<p>Minor Adverse (4)</p> <p>Changes in magnitude with implementation of suggested mitigation measures.</p> <p>Sensitivity: Medium (2) and Magnitude: Minor (2); the resultant significance is 'Minor Adverse'.</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ construction equipment. ▪ Notify affected communities in advance regarding major noisy operation. ▪ Implement Noise Management Plan 	
Operation Phase (C)								
Physical Environment (Land Resources/Hydrology/Meteorology/Air Quality/Noise)								
Operation of the total urea plant with occasional shutdown, Power Plant operation with other utilities operation	Ambient air quality	C1. Ambient air quality might be deteriorated due to emission of NH ₃ , NO _x , PM ₁₀ , PM _{2.5} SO ₂ and CO.	<p>Modern, energy and water efficient and leak-proof technology has been selected:</p> <p>Ammonia Plant: Haldor Topsoe A/S (HTAS), Denmark</p> <p>Urea Plant: Saipem S. p. A., Italy</p> <p>Granulation Plant: TKFT</p> <p>CO₂ Recovery from Primary Reformer:</p>	<p>Medium (2)</p> <p>Sensitivity is considered 'Medium', as the proponent has already considered environment friendly technologies for avoiding gaseous emission.</p>	<p>Minor (2)</p> <p>Impact Duration : Mjar (4)</p> <p>Spatial Extent : Minr (2)</p> <p>Reversibility : Minr (2)</p> <p>Legal Comp. : Minr (2) [EHS Guidelines of IFC, 2007]</p> <p>Likelihood : Mini (1)</p> <p>As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.</p>	<p>Minor Adverse (4)</p> <p>Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.</p>	<ul style="list-style-type: none"> ▪ Regular monitoring of emission should be conducted. 	<p>Minimal Adverse (2)</p> <p>Changes in magnitude with implementation of suggested mitigation measures.</p> <p>Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.</p>

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
			MHI (Para: 236]					
Project operation	Ambient Noise Level	C2. Noise generation from cooling tower, boiler, ST, GEG, NH ₃ Plant, Urea Plant and other utility services Hearing complexity and loss along with increase blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from rotator machineries at exceedance level.	Modern and efficient machinery will be used	Medium (2) Sensitivity is considered 'Medium', as the proponent has already considered environment friendly technologies for avoiding noise generation.	Minor (2) Impact Duration : Mjar (4) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) [Noise Control Rules, 2006 and ECR,EHS Guidelines of IFC, 2007] Likelihood : Mini (1) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> ▪ Regular monitoring of noise should be conducted. ▪ Noise hood should be installed where applicable. ▪ Plantation program should be implemented for attenuating noise. 	Minimal Adverse (2) Changes in magnitude with implementati on of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Water intake from the Shitalakhya River	Surface water availability	C3. Gross water intake would be about 0.567 m ³ /s and net water intake for the operation of the Project would be about 0.283 m ³ /s whereas lowest discharge of the	The specific relative consumption of water (0.583 m ³ /s) is less with respect to production of urea in previous	Low (1) Sensitivity to the receptor is considered 'Low' as the design life of the factory is 20 years.	Moderate (3) Impact Duration : Majr (4) Spatial Extent : Majr (4) Reversibility : Mod (3)	Minimal Adverse (3) Sensitivity of receptor is found 'Low' while the magnitude is assessed as	<ul style="list-style-type: none"> ▪ System loss during plant operation should be minimized as much as possible. ▪ Regular O&M should be conducted; 	Minimal Adverse (2) Changes in magnitude with implementati on of suggested

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		Shitalakhya River is about 83 m ³ /s in dry season. This indicates that the impact of the project would be bare minimum on the surface water availability [Para: 301].	plants (UFFL and PUFFL) in the the selected technology for GPUFP [Para: 301].		Legal Comp. : Minr (2) [National Water Act, 2013] Likelihood : Majr (4) As such the resultant impact magnitude is (17/5= 3.4~3) 'Moderate'.	'Moderate'. The resultant impact significance is 'Minimal Adverse'.	<ul style="list-style-type: none"> Regular monitoring of dry season water flow should be ensured. Cooling water should be reused with due treatment. Rainwater Harvesting System should be installed in the factory level. 	mitigation measures. Sensitivity: Low (1) and Magnitude: Minor (2); the resultant significance is 'Minimal Adverse'.
Ground Water abstraction mainly for potable water of colony and Plant officials during emergency period	Ground Water Level	C4. Drawdown induced lowering of ground water level may cause crisis of household level availability of groundwater through hand tubewell.	The proponent has provisioned the use of surface water for the operation of the plant including potable water for the Plant officials.	Medium (2) Sensitivity of the receptor is considered 'Medium' because extraction of ground water will be very limited at operation phase have some capacity to absorb changes by recharge or moderate scope of mitigation.	Moderate (3) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Minr (2) [National Water Act, 2013] Likelihood : Minr (2) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	Moderate Adverse (6) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> The proponent should encourage and facilitate introduction of Rainwater Harvesting System (RHS) as a substitute for other local users of GW as part of CSR. Monitoring should be considered as one of the important components during ground water extraction. 	Minimal Adverse (1) Changes in sensitivity and magnitude with implementation of suggested mitigation measures. Sensitivity: Low (1) and Magnitude: Minimal (1); the resultant significance

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							<ul style="list-style-type: none"> ▪ Water supply system should be leakage proof. ▪ Aquifer recharge could be an effective option through groundwater injection well¹⁷ if groundwater drawdown effect is observed. ▪ Whole colony should be supplied with purified surface water for potable use. 	is 'Minimal Adverse'.
Storm water management	Drainage congestion	C5. Drainage congestion may be occurred due to generation of excessive storm water resulting from climate change induced erratic rainfall. In consequence of this the urea stack/pile may be	A well designed, high capacity and modern drainage system has been provisioned under this project.	Medium (2) Sensitivity of the receptor is considered 'Medium' as proper maintenance can reduce the problem.	Minor (2) Impact Duration : Majr (4) Spatial Extent : Minr (2) Reversibility : Minr (2)	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant	<ul style="list-style-type: none"> ▪ Regular O&M works and cleaning of drainage system should be conducted for preventing from congestion. ▪ Plinth level of urea pile should be raised at safer 	Minimal Adverse (2) Changes in magnitude with implementation of suggested

17 The U.S. Environmental Protection Agency (EPA) regulates around 850,000 underground injection wells through its Underground Injection Control program under the Safe Drinking Water Act: <https://www.americangeosciences.org/critical.../what-underground-injection-wells-use>.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		inundated and damaged.		New factory will have enough capacity to resolve drainage problem in construction phase.	Legal Comp. : N/A (1) Likelihood : Minr (2) As such the resultant impact magnitude is (11/5= 2.2~2) 'Minor'.	impact significance is 'Minor Adverse'.	height or construction of 'Killa' with shed for piling up of urea urea for avoiding torrential rainfall induced wet and damage to urea bag.	mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
Drainage of rejected water and effluents, into the Shitalakhya	Surface water quality	C6. During the operation, huge volume of drainage water will be generated. In addition, all the process will also generate effluents mixed with chemicals (urea, nitrate, NH4+) and various lubricants. Disposal into water might changes the water quality largely.	Drainage system, Lagoon, Waste Water Treatment Plant (WSTP) and Effluent Treatment Plant (ETP)	Medium (2) River and adjacent pond water quality will be polluted extensively if the water is not treated well enough. Ecosystem might loss its full functionality for the long term dumping of untreated effluents.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Mini (1) Likelihood : Minr (2) As such the resultant impact magnitude is (9/5= 1.8~2) 'Moderate'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> ▪ Storm mixed drainage and treated effluents should be disposed into the lagoon first where natural treatment will also remove some nutrients from the waste water; ▪ The lagoon water then be disposed into the Shitalakhya river slowly; ▪ Monitoring of the functionality of the WWTP, ETP and the drainage network. 	Minimal adverse (2) (Both biological and natural treatment will reduce the impact vastly)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Biological Environment (Ecology/Fisheries/Agriculture)								
Water intake from the Shitalakhya River	Habitation of aquatic organisms	C7. Raw water abstraction through intake pumps with the designed velocity (0.51 m/s) may destabilize habitation of aquatic organisms including fish and causing the alterations to substrates and aquatic community structure and diversity. Low velocity tolerant species become trapped and died. This will continue.	The specific relative consumption of water is less with respect to production of urea in previous plants (UFFL and PUFFL; production was 900 TPD; water intake 0.583 m ³ /s) in the selected technology for GPUFP (production 2,800 TPD; water intake 0.567 m ³ /s). [Para: 301]	Medium (2) Sensitivity of the receptor is considered 'Medium' as river water withdrawal would be little less or equal in the new plant than that of the existing situation.	Moderate (3) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Mod (3) Legal Comp. : Minr (2) Likelihood : Majr (4) As such the resultant impact magnitude is (16/5= 3.2~3) 'Moderate'.	Moderate Adverse (6) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> ▪ Water intake pipe diameter should be increased to reduce intake velocity to around 0.3 m/s for avoiding fish entrainment. ▪ Double layer strainer of adequate mesh size should be installed around the intake point for . Regular monitoring of dry season water flow should be ensured. ▪ Cooling water should be reused with due treatment. ▪ Rainwater Harvesting System should be installed in the factory level. ▪ System loss during plant operation should be minimized as 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							much as possible.	
	Fish mortality	C8. Water intake at the rate of 0.567 m ³ /s would generate velocity of about 0.51 m/s at (considering 24 m diameter of pipeline) that point may cause entrainment of fish which cannot sustain the resultant velocity.	NA	High (3) Sensitivity of the IEC is assessed as 'High' because there are small sized fishes move along the bank susceptible to the given intake water velocity and have limited option of mitigation.	Major (4) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Mod (3) Legal Comp. : Minr (2) [National Water Rules 2017] Likelihood : Majr (4) As such the resultant impact magnitude is (16/5= 3.2~3) 'Moderate'.	Major Adverse (12) Magnitude of impact on the IEC is assessed as 'Major' as fish mortality through intake would occurred for a considerable area and recovering time would be at least one six months if intake will be stopped.	<ul style="list-style-type: none"> ▪ Maintaining minimum water velocity of 0.3 m/s during pre-monsoon and monsoon period ▪ Strainer with 6 mm mesh size should be placed before the intake of water; ▪ An additional reservoir should be constructed with regulated canal for conserving fish when dry down of the basin required. ▪ Acoustic Air Bubble Curtain using perforated pipe should be installed as a deterrent system for fish in order to be avoiding from water intake point. 	Minimal (-2) Implementati on of mitigation measure would reduce the magnitude of impact. Sensitivity: High- 3 Magnitude- Minimal-2

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Effluent discharge	Fish and other aquatic resources	C9. Fishery resources and others aquatic organisms along with benthic habitats may degrade along with the Gangetic River Dolphin [Para: 461].	The proponent has provisioned WWTP and ETP.	Medium (2) Sensitivity of the receptor is considered 'Medium' as river water withdrawal would be little less or equal in the new plant than that of the existing situation.	Moderate (4) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Minr (2) Likelihood : Minr (2) As such the resultant impact magnitude is (13/5= 2.6~3) 'Moderate'.	Moderate Adverse (8) Sensitivity of receptor is found 'High' while the magnitude is assessed as 'Major'. The resultant impact significance is 'Major Adverse'.	<ul style="list-style-type: none"> Minimize NOx emission by using low NOx burner. Ensure proper operation of Effluent Treatment Plant (ETP) Reuse of treated water 	Minimal Adverse (2) Changes in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) and Magnitude: Minimal (1); the resultant significance is 'Minimal Adverse'.
	Heavy metal accumulation in fish	C10. Detritus feeders, marginal small fishes, planktivores and even predator fish would become susceptible to accumulate trace heavy metal.	NA	Medium (2) Sensitivity of the IEC is assessed as 'Medium' because mentioned fish species would accumulate heavy metals but it can be controlled through taking	Major (4) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Mod (3) Legal Comp. : Majr (4) [National Water Rules 2017]	Moderate Adverse (8) Magnitude of impact on the IEC is assessed as 'Moderate' as damage to habitat would occurred for a considerable area and	<ul style="list-style-type: none"> Keep functional ETP and do continuous monitoring for maintaining the accepted limit of heavy metal values in effluent 	Minimal (-1) Implementation of mitigation measure would reduce the magnitude of impact. Sensitivity: Low- 1

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
				action of mitigation measures.	Likelihood : Majr (4) As such the resultant impact magnitude is $(18/5=3.6\sim 4)$ 'Major'.	recovering time would be at least one year.		Magnitude- Minimal-1
Urea Plant Operation	Crop production	C11. Burning of tender plant and their leaves due to NH ³ emission in turn would affect the crop yield and reduce the crop production.	NH ₃ vented with inerts is minimized in the selected technology as quantity of air required for passivation is much less than other technologies.	Medium (2) Sensitivity to the receptor is considered 'Medium', as the crop fields are located distantly, amount of crop fields are minimum but vulnerability to crops is moderate.	Minor (2) Impact Duration : Mini (1) Spatial Extent : Mod (3) Reversibility : Minr (2) Legal Comp. : Mini (1) Likelihood : Minr (2) As such the resultant impact magnitude is $(9/5=1.8\sim 2)$ 'Moderate'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> ▪ Regular maintenance of the machineries of the plant may help in avoiding the abnormal condition of releasing NH³ gas. ▪ Change of landuse from crop field to aquaculture is suggested. 	Minimal adverse (2) The reason for changing in residual significance is because of implementation of suggested measure of aquaculture instead of crop cultivation would reduce the sensitivity. Sensitivity: Low (1) Magnitude : Minor (2)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Sludge to Shitalakhya river	Surface water quality	C12. Sludge from water treatment plant enriched with high Iron. Direct dumping into river will affect the irrigation water availability and the aquatic ecosystems largely.	WWTP/ETP is provisioned.	Medium (2) River water quality will be polluted extensively if the sludge (sludge from pre- treatment plant and oil separation plant) is not treated well enough and disposed properly. Ecosystem might lose its full functionality for the long term dumping of sludge into rivers.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Mini (1) Likelihood : Minr (2) As such the resultant impact magnitude is (9/5= 1.8~2) 'Moderate'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Outsourcing into various still factory for the selling of iron rich sludge from the pre-treatment of wastewater; Reuse of the recycled water for the process again, gardening, and into the drainage network; Management of oil separation sludge according to the Hazardous Waste and Ship Waste Rules 2011. 	Minimal adverse (2) (Selling iron rich sludge into still factory and waste management by regulations of 2011 will minimize the impacts extensively.)
Ammonia and Urea Plant Operation	Surface water quality	C13. Process leakage and other spills of urea, ammonia, lubricants and oils will come into the surface runoff and later into drainage system. This could degrade the river water quality.	WWTP/ETP is provisioned.	Low (1) Very low amount and then could be diluted into lagoons and rivers. Sensitivity to the receptor is considered 'Low', as the vulnerable	Minor (2) Impact Duration : Majr (4) Spatial Extent : Mod (3) Reversibility : Mini (1) Legal Comp. : Mini (1)	Minor Adverse (2) Sensitivity of receptor is found 'Low' while the magnitude is assessed as 'Minor'. The resultant impact significance is	<ul style="list-style-type: none"> Inspection of the plants and its installation every day for any kind of leakage and its immediate repairmen; Collection of the spills and process loss chemicals separately and managed it either 	Minimal adverse (1) (Regular inspection and separate management of the chemical and oily materials must reduce the chance of

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
				receptor has good capacity to absorb proposed changes or good capacity for mitigation.	Likelihood : Mini (1) As such the resultant impact magnitude is (10/5=) 'Minor'.	'Minor Adverse'.	through ETP or disposed into other confined areas;	degrading river water quality.)
Dispatch of Urea	Surface water quality	C14. Increase of barges and water vessels might affect the surface water quality by bilge and ballast water. Increase of coolant, lubricants and oils are the main concern by this water into rivers.	No abatement measures present	Medium (2) Tidal influence of Shitalakhya river might reduce the bilge and ballast water effect in short period.	Minor (2) Impact Duration : Minr (2) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Mini (1) Likelihood : Minr (2) As such the resultant impact magnitude is (9/5= 1.8~2) 'Moderate'.	Minor Adverse (4) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Minor Adverse'.	<ul style="list-style-type: none"> Disposal of bilge and ballast water into the rivers is strictly prohibited; Handling of bilge and ballast water following the national/international rules of BIWTA/DoE; Aware the barge crews about the negative impacts of bilge and ballast water; 	Minimal adverse (2) (Application of suggested measures and following the rules and regulations properly will reduce the risk of oil and lubricant pollution into the Shitalakhya River.)
Social Environment (Socio-economic)								
Project Operation	Occupational health and safety	C16. Injuries to the workers, even casualty or life loss in case of accident may be held during operation of urea	NA	Very High (4) Sensitivity is considered 'Very High', as accidental event	Minor (2) Impact Duration : Major (4)	Moderate Adverse (8) Sensitivity of receptor is found 'Very	<ul style="list-style-type: none"> Need contingency fund for affected people to address accidental issues during operational period 	Minimal adverse (2) The reason for the change in

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		plant and dispatch of urea.		may be occurred during operation of the Urea Plant. As such the sensitivity for the receptors (workers' safety) are kept very high.	Spatial Extent : Minr (2) Reversibility : Majr (4) Legal Comp. : Mini (1) Likelihood : Mini (1) As such the resultant impact magnitude is (12/5= 2.4~2) 'Moderate'.	High while the magnitude is assessed as 'Minor'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> • Ensure proper emergency response team and facilities in place • Proper awareness program about possible accidents should be ensured and regular evacuate training for the employees • PIU will establish a grievance mechanism and documenting its use for complaints about unfair treatment or unsafe living or working conditions without reprisal. 	residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) Magnitude: Minimal (1)
Do	Impact on Public Health and Safety	C17. In case of any serious accident, the Plant may become a risk factor for those people who are living/working adjacent to it. Particularly, it may cause safety risk to the nearby residential areas,	NA	Very High (2) Sensitivity is considered 'Very High', as during operation of the Project may cause accidents. As such the sensitivity for the receptors (public	Minor (2) Impact Duration : Majr (4) Spatial Extent : Minr (2) Reversibility : Majr (4) Legal Comp. : Mini (1)	Moderate Adverse (8) Sensitivity of receptor is found 'Very High while the magnitude is assessed as 'Minor'. The resultant	<ul style="list-style-type: none"> • Need contingency fund for affected neighboring people to address accidental issues during operational period • Ensure proper emergency response team and facilities in place 	Minimal adverse (2) The reason for the change in residual significance is because of the change in magnitude

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
		school and offices. It is apprehended that fatalities may take place if any accident occurs.		health) are kept very high.	Likelihood : Mini (1) As such the resultant impact magnitude is (12/5= 2.4~2) 'Moderate'.	impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> Proper awareness program about possible accidents should be ensured for the neighboring people PIU will establish a grievance mechanism and document its use for complaints about unfair treatment or unsafe living or working conditions without reprisal. 	with implementation of suggested mitigation measures. Sensitivity: Medium (2) Magnitude: Minimal (1)
Project Operation	Employment generation	C18. Generation of employment opportunity for about 126 officials and significant number of technicians and workers at different levels people at different operation levels (i.e. Urea production, Jetty operation, dispatch of urea,etc.) will be required which would promote livelihood for local people.	NA	Medium (2) Sensitivity is considered 'Medium', as during temporary works may cause accidents. As such the sensitivity for the receptors (workers) are kept medium.	Moderate (3) Impact Duration : Mod (3) Spatial Extent : Mod (3) Reversibility : Mod (3) Legal Comp. : Minor (2) Likelihood : Major (4) As such the resultant impact magnitude is (15/5= 3) 'Moderate'.	Moderate beneficial (6) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Moderate'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> In employing workforces in different operational activities, it is suggested to involve largely the local people particularly the Project-affected Persons (PAPs) directly or indirectly. In employing workforces in operation phase, it is suggested to involve largely the 	Moderate beneficial (8) The reason for the change in residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2)

Activities	IESCs/ VECs	Impact and Risk from various activities	Abatement Measures	Sensitivity of the Resources/ Receptors	Magnitude of the Impact	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
							permanent employee who are working at PUFFL at present.	Magnitude: Major (4)
Operation Phase	Transportation of raw materials	C21. For dispatching produced urea about 600 trucks will mobilize every day which may increase traffic and accidents within the area.	The proponent will develop separate truck stand and access road for dispatching the urea.	Medium (2) Sensitivity is considered 'Medium', as dispatching the urea will create traffic congestion temporarily, in the Project adjacent area. As such the sensitivity for the receptors (traffic) are kept medium.	Major (4) Impact Duration : Mod (3) Spatial Extent : Minr (2) Reversibility : Minr (2) Legal Comp. : Minr (2) Likelihood : Majr (4) As such the resultant impact magnitude is (19/5= 3.8~4) 'Major'.	Moderate Adverse (8) Sensitivity of receptor is found 'Medium' while the magnitude is assessed as 'Major'. The resultant impact significance is 'Moderate Adverse'.	<ul style="list-style-type: none"> The movement of vehicles in the project area should be restricted during peak hours. No vehicular movement should be made during school time (9:00 a.m. to 16:00 p.m.) and on the days of weekly markets (Haatbars). 	Minimal adverse (2) The reason for the change in residual significance is because of the change in magnitude with implementation of suggested mitigation measures. Sensitivity: Medium (2) Magnitude: Moderate (3)

Note: * According to Article 19 of National Water Rules 2017 (Small and medium industries should collect license from Zila Committee for installing shallow tubewell; and for installation of deep tubewell or use of submergible pump, license should be collected from WARPO)

7.5 Impact on the Surface Water Flow

7.5.1 Option development

531. For the assessment of water availability of the Shitalakhya River, the models (hydrological and hydrodynamic) have been simulated for four scenarios; baseline condition, future without project, future with project and other developments including the consideration of upstream flow reduction and climate change impacts. The following **Table 7.6** presents the detail descriptions of scenarios.

Table 7.6: Detail description of option development

Scenario	Condition	Implication
Base condition	Average (1 in 2.33 year return period) of last 36 years (1981 – 2017)	<ul style="list-style-type: none"> Model has been derived for the existing situation considering historical hydrological and meteorological data (water level, GW level and rainfall and air temperature) for the year 1981 through 2017. Present water demand (agriculture, domestic, industrial etc.) has been assessed and integrated in the model.
Option 01 (Without project scenario)	Future without project scenario considering Climate change	<ul style="list-style-type: none"> Model has been simulated for the next 20 years (2017-2037) considering without project with climate change condition. The change in upstream flow due to climate change has been considered during model setup. Future domestic, industrial and agricultural water demand has been assessed and incorporated in the model.
Option 02 (With project)	Future with project considering Climate change and future water demand	<ul style="list-style-type: none"> Model has been simulated for the next 20 years (2017-2037) considering future climate change condition. Water abstraction (0.567 m³/s) for the GPUFP has been included into the model. The change in upstream flow due to climate change has been considered during model setup. Future domestic, industrial and agricultural water demand has also been incorporated in the model.
Option 03 (With project)	Future with project considering Climate change, reduction of upstream flow and future water demand	<ul style="list-style-type: none"> Model has been simulated for the next 20 years (2017-2037) considering future climate change condition. Water abstraction (0.567 m³/s) for the GPUFP has been included into the model. The upstream flow is considered to be reduced by 25% in future. Future domestic, industrial and agricultural water demand has also been incorporated in the model.
Option 04 (With project)	Process Plant	<ul style="list-style-type: none"> Model has been simulated for the next 20 years (2017-2037) considering. Frequency analysis has been done to see future level of water

7.5.2 Climate change impact on the Ganges, Brahmaputra and Meghna basins

532. CEGIS has carried out water availability assessment for the Ganges, Brahmaputra and Meghna basins under different climate change scenarios (A1B, A2 and B1). The study was financed under the Abu Dhabi Dialogue Knowledge Forum Small Grants Program (ADDFK-SGP) of the World Bank and coordinated by the International Centre for Integrated Mountain Development (ICIMOD), Nepal. Based on this study, it was found that about 8% of monsoon flow and about 17% dry season flow of the Brahmaputra River will increase by 2050. Change of monthly flow of the Brahmaputra River is given in **Table 7-7**.

Table 7.7: Changes of monthly flow of the Brahmaputra River in percentage

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Percentage change of monthly flow	11.1	16.3	24.3	1.6	0.6	-2.6	7.8	14.2	12.8	16.9	17.2	17.8	9

533. From the historical data analysis, it is found that the annual flow of the Brahmaputra River is increasing due to climate change but flow of the Old Brahmaputra River is decreasing which is mainly due to the change in off-take morphology of the Old Brahmaputra River. It is estimated that around 268 Mm³ flow reduced per year in the Old Brahmaputra River (Figure 7-1).

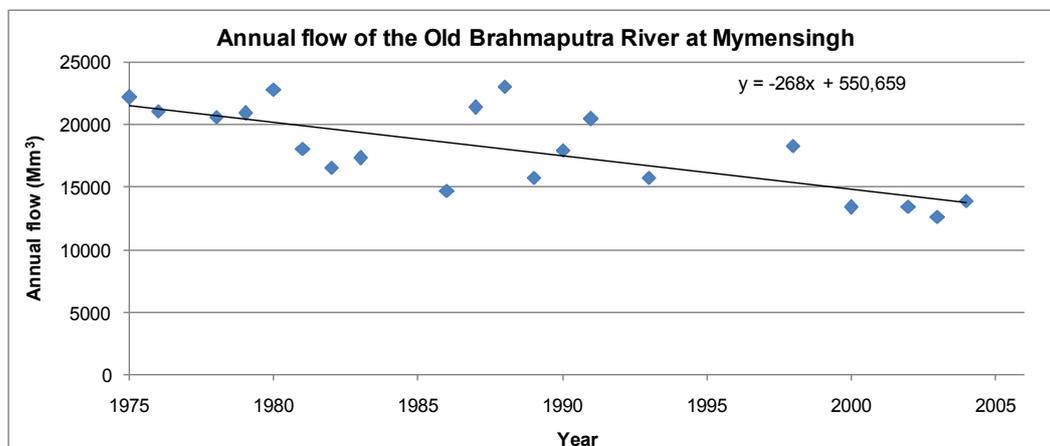


Figure 7.1: Historical annual flow of the Old Brahmaputra River at Mymensingh

534. For assessment of water availability of the Shitalakhya River, the models (hydrological and hydrodynamic) has been simulated for four scenarios; base condition, future without project considering climate change, future with project considering climate change and future water demand, and future with project considering climate change, future water demand, and reduction of upstream flow.

7.5.3 Climate Change Impact on Water Balance

535. The precipitation and temperature are assumed to be changed in future under different climate change scenarios. To understand the climate change impact for the next 20 years (2017-2037), the model was run for RCP 4.5 scenario and the results are shown in **Table 7.8**.

Table 7.8: Climate change impact on water availability in the catchment area

Sl. No.	Hydrological parameters	Base condition (mm)	Climate change condition (mm)	Difference (mm)	Percentage of change
1	Precipitation	2055	2255	(+) 200	(+)10
2	Evapotranspiration	776	795	(+)19	(+) 2.4
3	Percolation	575	593	(+)18	(+) 3
4	Surface Runoff	874	1006	(+)132	(+)15
5	Base flow	83	40	(-) 43	(-) 52

(+) indicates increasing and (-) is for decreasing

536. The climate change impact on annual water balance for the study area is given in **Table 7-8** for climate change scenario RCP 4.5 in 2050s. The annual average rainfall for the study area will be 2255 mm which is about 10% more than the base condition. The surface runoff also increases (15%) as there is an increase in annual rainfall. There is a little increase in annual evapotranspiration (19 mm) which is mainly due to the increase of temperature. There is also a bit increase in annual percolation due to climate change. However, the base flow will be decreased by 52% as ground water extraction rate will be increased in future.

7.5.4 Water yield

537. The generated water yields were estimated and compared with the base condition to assess the impact of climate change on water availability. Water yield is the net amount of water that contributes to stream (water yield = surface runoff + lateral flow + base flow - total loss - abstraction). The monthly water yield for the base and climate change condition is given in **Figure 7.2**.

538. The availability of water will increase during February to June as there is an increase in rainfall during that period. During the dry period (November-January), the water availability will decrease due to climate change by 2050s.

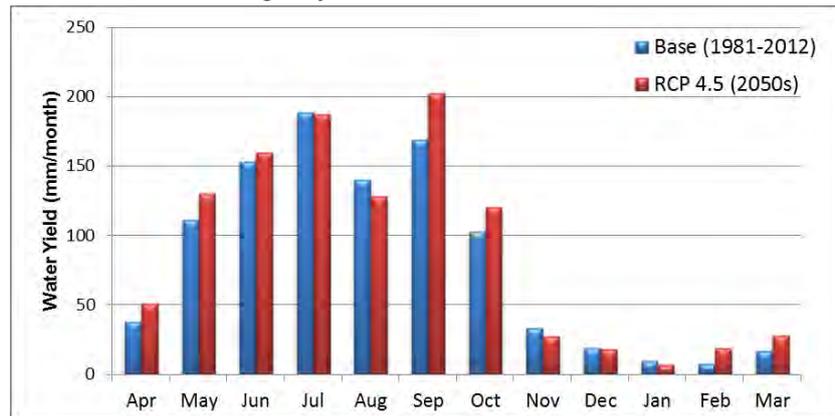


Figure 7.2: Climate change impact on monthly water yield for climate scenario RCP 4.5 by 2050s

539. Variations of seasonal water yield due to climate change scenario RCP 4.5 by 2050s are shown in **Table 7.9**. The table shows increase in seasonal water yield during the dry season and pre-monsoon as 36% and 22%, respectively. Water yields during pre-monsoon and monsoon are almost similar to the base condition.

Table 7.9: Climate Change impact on seasonal water yield by 2050s for scenario RCP 4.5

Season	Water Yield during base (mm)	Change in water yield due to CC (%)
Pre-monsoon (Apr-May)	149	22
Monsoon (Jun-Sep)	651	4
Post-monsoon (Oct-Nov)	135	9
Dry (Dec-Mar)	52	36

540. **Water level:** Frequency analysis has been done using Gumbel Distribution method (Gumbel, 1958)¹⁸ with respect to maximum and minimum water level shown in **Table 7-10**. The key observation is that this river is tidally influenced under the low flow regimes such that reverse flow (down stream flow) will tend to maintain constant water level despite of surface water (0.556 m³/s) withdrawal from river for the cooling purposes of the Project. As a result, hydrological analyses for different options indicate that the changes of average minimum water level are insignificant.

Table 7.10: Statistical analysis on maximum and minimum water level for different return period

Return Period (year)	Maximum Water Level (mPWD)				Minimum Water Level (mPWD)			
	Base condition	Option 1 (Without project scenario)	Option 2 (with project considering Climate change and future water demand)	Option 3 (with project considering Climate change, reduction of upstream flow and future water demand)	Base condition	Option 1	Option 2	Option 3
2.33	6.62	6.79	6.77	6.29	0.94	0.99	0.92	0.91
5	7.19	7.40	7.40	6.84	0.85	0.90	0.84	0.81
10	7.66	7.89	7.90	7.29	0.78	0.83	0.77	0.74
20	8.12	8.37	8.39	7.72	0.71	0.77	0.70	0.66
30	8.38	8.64	8.67	7.97	0.67	0.73	0.66	0.62
50	8.70	8.98	9.02	8.28	0.61	0.68	0.61	0.57
100	9.14	9.44	9.49	8.69	0.55	0.62	0.54	0.50

7.5.5 Monthly average discharge for different scenarios

541. The average monthly discharge of the Shitalakhya River at project site varies from about 84 m³/s to 1,181 m³/s for the base condition. The highest discharge occurs during the month of July and the lowest in January. The average monthly flow of the Shitalakhya River at the project site for different condition is given in **Table 7-11**.

¹⁸Gumbel EJ (1958) Statistics of Extremes, Columbia University Press, New York, USA

Table 7.11: Average Monthly flow at project area on Shitalakhya River

Month	Base Condition (Flow, m ³ /s)	Option 1 (Without Project Scenario) (Flow, m ³ /s)	Option 2 (With Project Considering Climate Change And Future Water Demand) (Flow, m ³ /s)	Option 3 (With Project Considering Climate Change, Reduction Of Upstream Flow and Future Water Demand) (Flow, m ³ /s)
January	83.39	100.13	98.96	96.8
February	83.71	100.46	98.95	96.7
March	90.01	107.18	104.27	102.2
April	111.76	125.74	124.98	121.2
May	202.60	211.64	211.75	181.3
June	563.69	555.85	556.03	435.9
July	1181.43	1275.22	1275.12	891.5
August	1177.86	1339.54	1339.38	889.4
September	1066.69	1205.27	1205.42	808.8
October	692.91	807.62	807.45	527.4
November	170.98	192.57	192.26	157.1
December	109.09	125.73	125.19	116.9

542. As the dry season flow of the Brahmaputra River is expected to change due to climate change, the dry season flow to the Shitalakhya River may also change, depending on the off-take morphology. The difference of dry season flow between Option 1, Option 2 and Option 3 is insignificant because after withdrawing 0.567 m³/s of river water for the Project, reverse flow will mount up from downstream and maintain the constant water level of the Shitalakhya River. Furthermore, flooding would be increased immediately which may increase the flood flow in the Shitalakhya River for Option 1 and Option 2. However, flood flow will be reduced in Option-3 because the Shitalakhya River receives 25% less water from the Old Brahmaputra River.

7.5.6 Assessment of Environmental flow (E-flow)

543. The increasing demand for river water conflicts with the environmental needs for sustaining flows during drought and low flow periods, leads to competition between water demand and river flow needs. Tennant (or Montana) method (1976) is the most common hydrological method to assess the environmental flow requirements as percentage of mean annual flow. According to Bari and Marchand (2006)¹⁹, the monsoon flow requirement with respect to environmental flow for flushing is 200% of the mean annual flow, while dry season requires 20% of mean annual flow for the good condition of aquatic habitat.

544. E-flow requires for flushing is about 922 m³/s for the base condition, while about 1,181 m³/s (21.9 % more) flow is available shown in **Table 7.12**. Similarly, during monsoon the E-flow will also adequate for Option 1, Option 2 and Option 3.

545. During dry season, E-flow for base condition is 92.2 m³/s whereas 83.4 m³/s is available which is partially sufficient for the good condition of aquatic habitat. However, due to climate change impact in 2050s, dry season flow of the Shitalakhya River will be increased for Option 1 and Option 2. Consequently, environmental flow will be increased in that period. Dry

¹⁹ Bari, M F and Marchand, M. 2006. Introducing Environmental Flow Assessment in Bangladesh: Multidisciplinary Collaborative Research. BUET-TU Delft.

season flow for those scenarios (Option 1 and Option 2) is fairly available to meet the E-flow in future.

546. Besides, Option 3 is considered as worse scenario whereas, E-flow is also sufficient (31% more flow is available) during dry period.

Table 7.12: Environmental flow requirement of Shitalakhya River

Seasons	Base condition		Option 1		Option 2		Option 3	
	E-flow (m ³ /s)	Available flow (m ³ /s)	E-flow (m ³ /s)	Available flow (m ³ /s)	E-flow (m ³ /s)	Available flow (m ³ /s)	E-flow (m ³ /s)	Available flow (m ³ /s)
Dry season (20%)	92.2	83.4	102.4	100.1	102.3	98.9	73.8	96.7
Monsoon (200%)	922.4	1181.4	1024.5	1339.5	1023.3	1339.4	737.6	889.4

547. The environmental flow for the Shitalakhya River during dry season is expected not to be a major concern as there is a tidal influence during that period. Even, if water is diverting from this river, downstream flow (tide) will even out the withdrawal and maintain a constant water level. Besides, the major part of the diverted amount will return to the river as return flow after the condenser cooling process.

548. The observations on above analyses as follows:

- Flow of the Shitalakhya River is expected to be increased in near future due to climate change and adequate flow will be available at the project site.
- Abstraction of surface water at the rate of 0.567 m³/s for condenser cooling and other operational purposes will have no or slight impact on availability of water in Shitalakhya River for the next 20 years.
- Monsoon flow will be increased in 2050s which may intensify the flood level in and around the study area.
- Dry season flow and water level will also increase in future which will further facilitate the navigation.
- In options 2 and 3, without considering climate change, both dry and wet season flows will roughly be reduced by 10%. The E-flows in option 2 would be 920.7 m³/s (available flow 1,205 m³/s) and in option 3 would be 664 m³/s (available flow 800 m³/s). So even without climate change, the flow would be sufficient during monsoon season and dry period (considering tidal impact).

7.5.7 Option-4

549. The design life is 20 years for the process plant subject to appropriate maintenance and replacement for items such as catalysts, furnace tubes and mechanical seals which have shorter life duration and will require replacement during the life of the Process Plant. The operating time of the proposed Project is 330 days per annum.

550. At present, approximately 0.583 m³/s of surface water from the Shitalakhya River is used for different cooling water systems, boiler and cooling blow down, etc. of both UFFL and PUFFL. Raw water withdrawal from the Shitalakhya River would be about 0.567 m³/s (2,040 t/h) (Design value) for the Project; after storage tank it would be about 0.322 m³/s (1,159 m³/h); and after clarified water tank it would be about 0.283 m³/s (1,020 t/h).

551. The Model was developed and simulated to make a comparison between without project and with project condition. Analysis of hydrological regime has been performed with supplements from developing hydrodynamic and hydrologic model using SOBEK 1D to assess the impact of pump extraction at the project location.

552. The SOBEK modelling suite is an implicit, finite difference model for the computation of unsteady flow, which is developed by Deltares of the Netherlands. The overall approach of hydrological and hydrodynamic modelling is given in **Figure 7.3**.

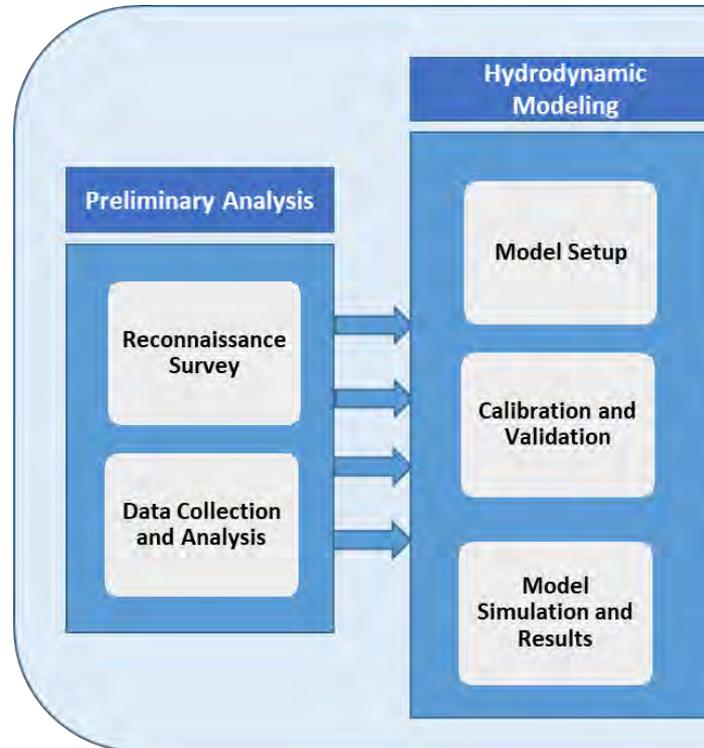


Figure 7.3: Overall approach of the modeling

553. It is to be noted here that, all the pump stations near the study location have been considered in the model. The overall model schematization looks like below (Figure 7.4):

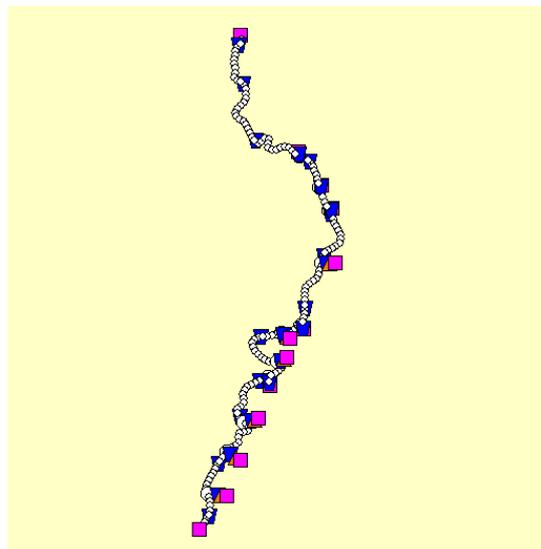


Figure 7.4: Schematized Model in SOBEK

554. The model result shows that there will be no significant change in water availability due to pumping in that area. In the Figure 7.5 below, it can easily be seen that no significant change in highest flood level has been observed due to extraction of water with pump. The same thing happened in the case of lowest flood level, where a minimum water level was always observed in the water extraction of pump (Figure 7.6).

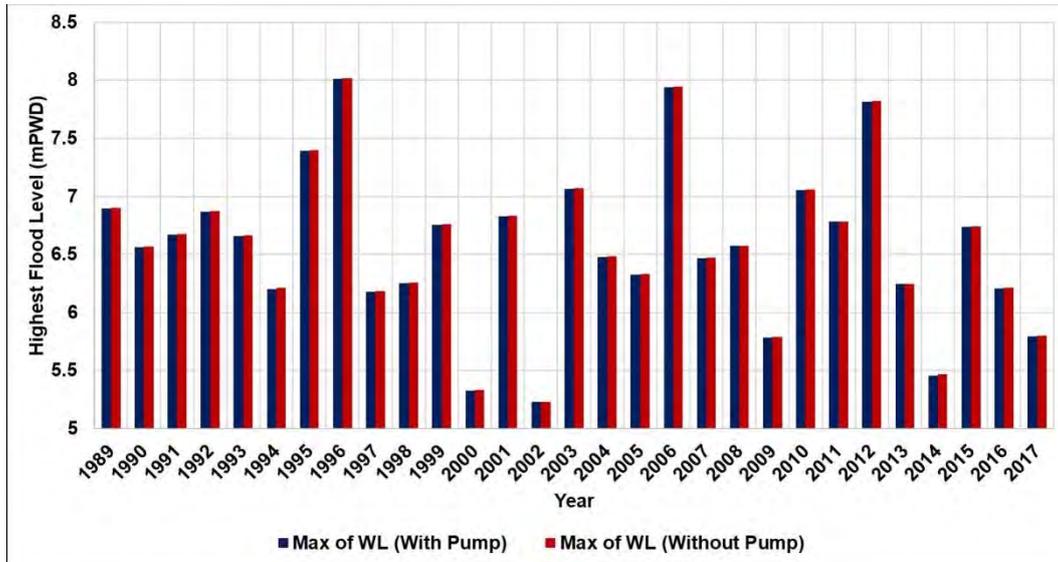


Figure 7.5: Highest Flood Level With and Without Pump

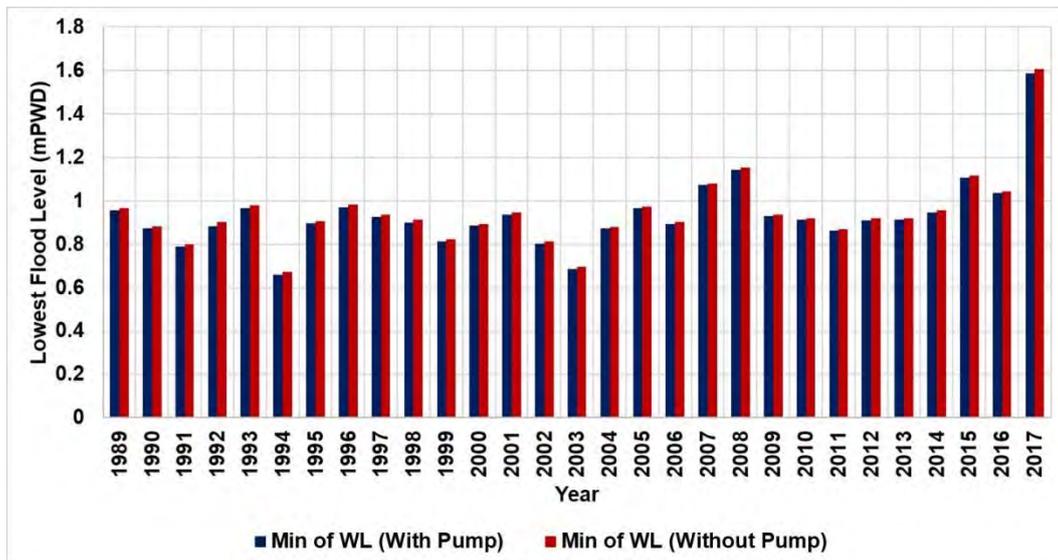


Figure 7.6: Lowest Flood Level With and Without Pump

555. The annual maximum discharge also shows no significant change due to extraction of ground water using intake pump. Also, E-flow required for flushing is about 922 m³/s during monsoon for the base condition, while about 1013 m³/s (20% more) flow is seen available shown as in **Figure 7.7** below. Also, in case of maximum discharge it also shows no significant change.

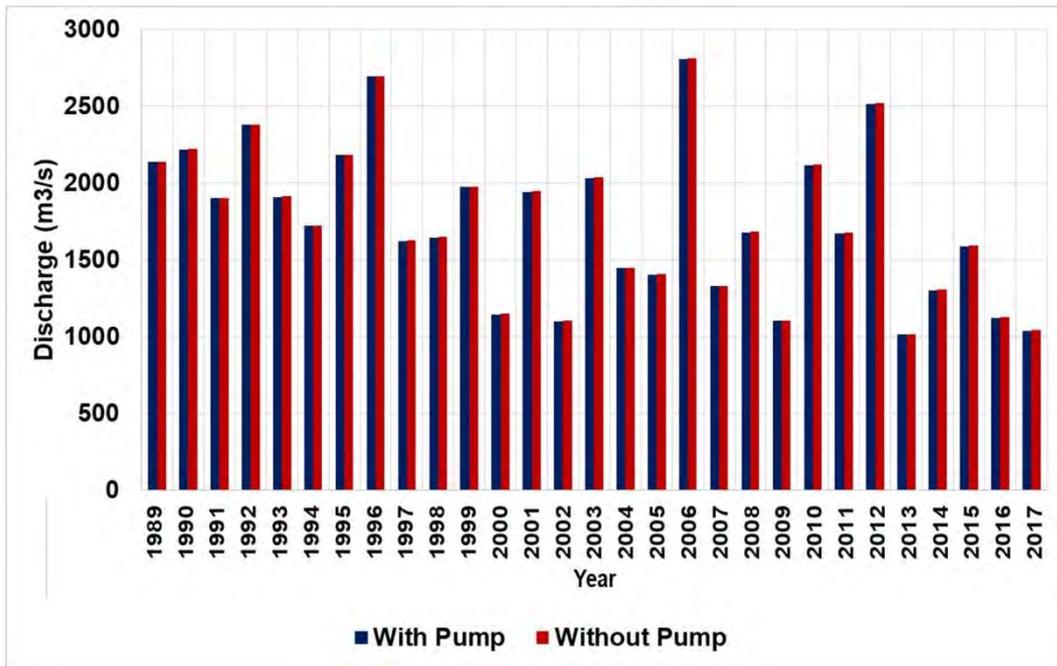


Figure 7.7: High Discharge Rate With and Without Pump

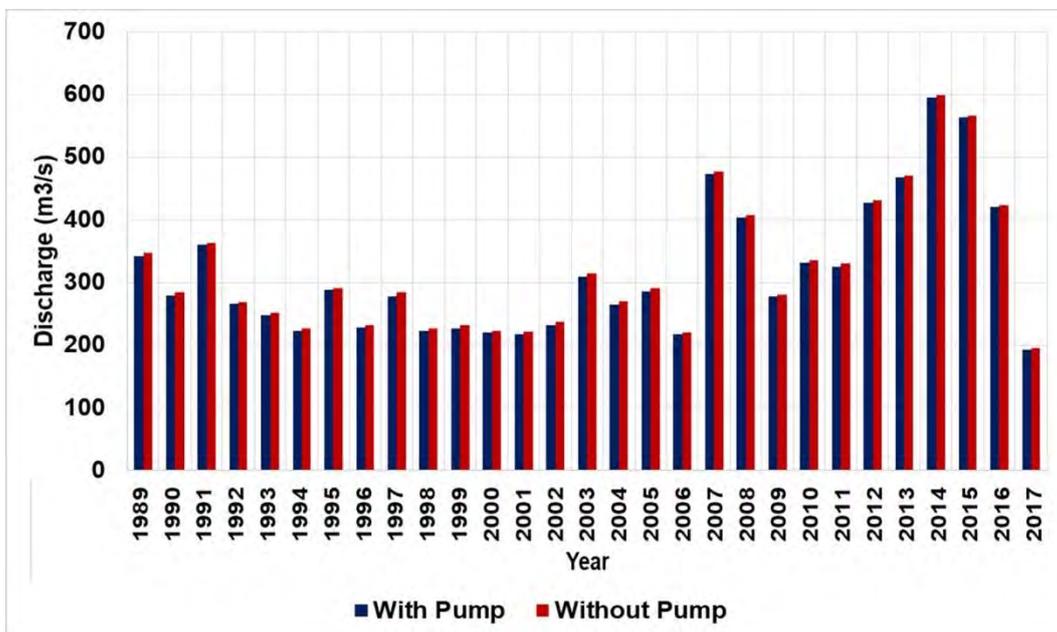


Figure 7.8: Low Discharge Rate With and Without Pump

556. Also, E-flow required for flushing is about 92.2 m³/s during monsoon for the base condition, while about 192.5 m³/s (48% more) flow is seen available as in **Figure 7.8**. Also, in case of minimum discharge it also shows no significant change.

557. Frequency analysis has been done to assess the future water availability with existing pumping rate. Results of frequency analysis are tabulated below:

558. For discharge and water level, four methods (Normal distribution, Log Normal, Log Pearson Type III, Gumbel) have been applied for frequency analysis and compared against each other for the ease of selecting the best method for frequency. In case of frequency analysis result for both minimum (Table 7.13) and maximum discharge (Table 7.14) it has

been seen that, gumbel frequency distribution gives the maximum result hence the outcome of gumbel distribution will be considered.

Table 7.13: Frequency Analysis of Minimum Discharge

Return Period	Normal	Log-n	LP3	Gumbel
2	317	302	300	299
5	407	391	390	394
10	454	448	449	456
20	493	501	505	516
50	537	568	577	594
100	566	617	631	652
200	592	667	686	711
500	625	732	760	787

Table 7.14: Frequency Analysis of Maximum Discharge

Return period	Normal	Log-n	LP3	Gumbel
2	1,751	1,679	1,682	1,668
5	2,178	2,156	2,159	2,116
10	2,401	2,458	2,461	2,412
20	2,585	2,738	2,741	2,697
50	2,792	3,091	3,094	3,065
100	2,931	3,352	3,355	3,342
200	3,057	3,610	3,613	3,617
500	3,210	3,950	3,953	3,980

559. From the above table, it has been seen that, following the gumbel distribution the minimum discharge with pumping condition after 100 year becomes 652 m³/s and maximum discharge after 100 year becomes 3,342 m³/s.

Table 7.15: Frequency Analysis of Highest Flood Level

T	Normal	Log-n	LP3	Gumbel
2	6.57	6.54	6.53	6.46
5	7.16	7.15	7.15	7.07
10	7.46	7.49	7.50	7.48
20	7.72	7.79	7.81	7.87
50	8.00	8.13	8.18	8.38
100	8.19	8.37	8.44	8.76
200	8.36	8.60	8.68	9.13
500	8.58	8.88	8.99	9.63

Table 7.16: Frequency Analysis of Lowest Flood Level

T	Normal	Log-n	LP3	Gumbel
2	0.93	0.92	0.92	0.91
5	1.07	1.05	1.05	1.05
10	1.14	1.13	1.13	1.15
20	1.20	1.20	1.20	1.24
50	1.27	1.27	1.29	1.36
100	1.31	1.33	1.35	1.45
200	1.35	1.38	1.40	1.54
500	1.40	1.45	1.48	1.65

560. From the above table, it has been seen that, following the gumble distribution the minimum water level with pumping condition after 100 year becomes 1.45 mPWD and maximum water level after 100 year becomes 8.76 mPWD.

7.6 Impact on Ambient Noise during Operation Period

561. Generation of noise from different sources of the Project like utilities, Ammonia Plant, Urea Plant, Granulation Plant, Power Plant and gas transmission line are the major social and environmental concerns for the employees and residential as well as for the passers-by. It is envisaged that the noise level would be increased due to the operation of cooling tower, boiler for steam generation, compressor, RMS, GEG and ST Power Plant operation, primary and secondary reformers, synthesis plant etc. The generated noise will be propagated to the adjacent areas both inside and outside the project boundary. Increasing noise level at the susceptible places may affect the community as well as the wildlife. To assess the noise level, around 13 sensitive receptor points have been selected considering the impact potentiality and susceptible points around the Project site (Figure 7.9). However, a noise propagation modeling has been conducted in order to understand the level of noise dispersed around the project site during operation stage.

562. The noise propagation simulation has been done by using SoundPlan Essential 3.00 software developed by SoundPLAN GmbH. SoundPLAN GmbH is the widely used modeling software for noise propagation simulation in research and consultancy services. A number of standard processes can be calculated through this SoundPlan model. The ISO-9613 calculation process is used for this modeling purpose. Different factors were considered for predicting the noise level at the receiver end, such as the amount of noise generating from the sources, in association with the vehicular transportation on the access road, etc. The model considers the average temperature, 28°C and average relative humidity 80%.

563. As per the specification of the compressor, turbine, reformer, cooling tower, boiler engine, etc. collected from BID Document, noise to be generated from the sources are given below in Table 7.17, which has been used for this modeling study. The land type of the project site has been marked as flat and plain land having vegetation coverage and civil buildings in and around the Project site.

Table 7.17: Noise Generation from different components of the proposed Project

Facility and Zone	Noise Limit Level, dB(A)
Process Compressor/ Turbine/Steam Turbine Generator	95 at one (1) m from source
Rotating machines other than Process Compressor, Turbine, and Steam Turbine Generator	90 at one (1) m from source
Reformer	85 at one (1) m from source

564. During operation period, the project area will be bounded by 2.5m with 0.5 m barbed wire high brick boundary. Most of the fallow areas inside the Project boundary will be covered by greenery. Boundary wall, structure and green belt will protect dispersion of noise level from the sources. Considering the noise level attenuation measures, the modeling study has been conducted. The results of noise modeling have been shown in Figure 7.10 and Figure 7.11.