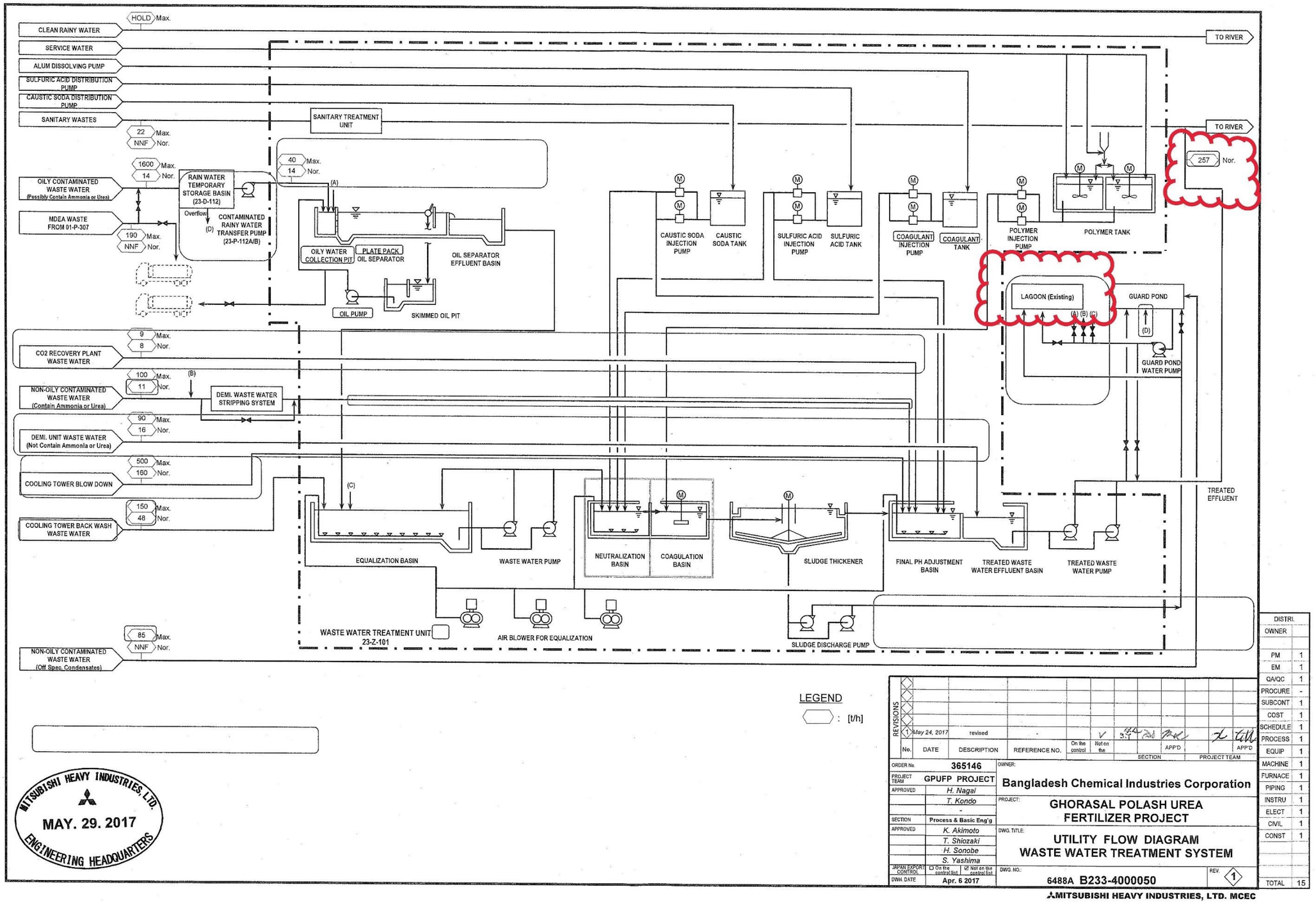


Figure 5.11: Utility flow diagram for waste water treatment system

5.4.11 Fire Fighting Unit

341. The Project has the provision of strong fire-fighting system having (i) Fire fighting system for gas firing; and (ii) Fire fighting system for liquid and solid firing. The systems are designed according to NFPA (National Fire Protection Association) codes and standards of Bangladesh.

342. In the Plant, three kinds of flammable gases such as Natural Gas, Hydrogen Gas and Ammonia Gas are handled. These flammable gases are vented or flared from the provided stacks in safe location in the Plant. These flammable toxic gases are monitored by the gas detection system in the Plant.

5.4.12 Ammonia Storage and Handling System

343. Ammonia Storage Tank with an effective/working capacity of 10,000 metric tons (MT) with Refrigeration Unit will be provided. A sump pit will be provided to collect waste water in the unit and to be sent to Waste Water Treatment System. There is a provision of ammonia leak detection system. The Ammonia Storage Flare Stack will be located outside the dike area in the safe zone. The capacity of ammonia transfer system from the Ammonia Storage Tank to Urea Plant is designed to feed liquid ammonia from the storage tank to Urea Plant.

5.4.13 Bulk Urea Storage and Handling System

344. The Bulk Urea Storage and Handling System is comprised of following facilities:

- Product granulated urea transfer conveyors including tripper car from Urea Plant to Bulk Urea Storage House (BUSH)
- Reclaiming System
- Magnetic Separator
- Bulk Urea Storage House with humidity controller (Air heating)
- Product granulated urea transfer conveyors from BUSH to urea bagging facility
- 50 kg bag bagging system with empty bag storage and palletizing machine
- Bagged urea storage house
- Truck Loading Facility
- Barge Loading Facility
- Railway Wagon Loading Facility.

345. Total capacity of BUSH is net 100,000 ton. BUSH is provided with a full portal reclaimer at 350 ton/h rated cpacity to feed reclaimer side conveyor.

346. The palletized bagged urea is manually de-palletized and delivered to truck loading station by lift trucks or portable conveyor. The de-palletized urea bags can be transferred from palletized urea bags storage area to Burge Loading facilities or Railway Loading facilities.

347. The product loading facility to railway wagon has enough space for loading of bagged urea to railway wagons at five points simultaneously. The bagged urea shall be manually loaded to railway wagons by using the portable conveyors. The bulk urea handling system is shown in Figure 5.12.

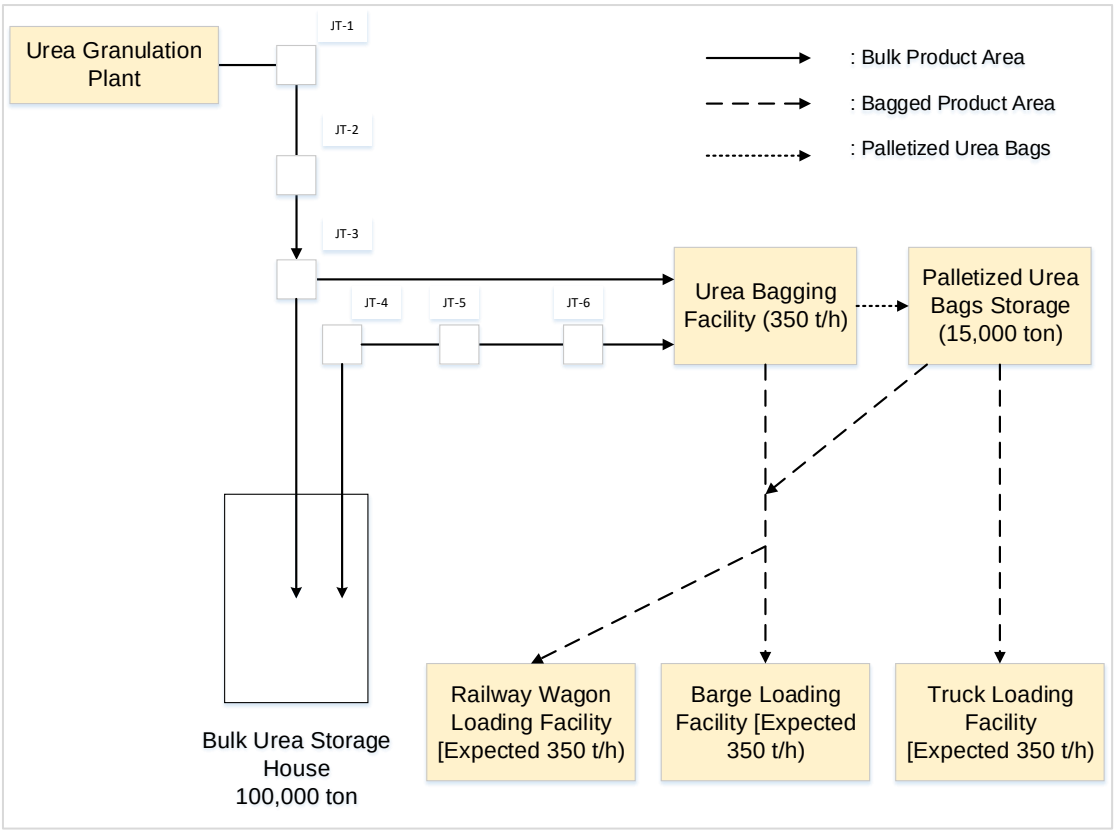


Figure 5.12: Base Flow Scheme of Bulk Urea Handling System

5.4.14 Jetty Equipment

348. Jetty will be constructed on the left bank of the Shitalakhya River by following the Water Act, 2013. In that case it will be constructed inside the land with keeping proivision of mooring of required barges. The dimension of the jetty is as follows: length is 45.6m and width is 9.6m (Size of Jetty may finalize during basic engineering stage). Considering 5m depth from the ground level, the quantity of excavated soil will be about 2,200 m^3. This soil can be used for levelling the Project site or in filling up the lagoon. The bagged urea product, can be transferred to the jetty area by covered conveyors and manually loaded into river going barges by using Burge Loading facilities. Barge Loading facilities contain two units having design capacity of 175 ton per hour each (Total 350 t/h) which is considered as expected capacity since manual operation is required for loading. BCIC has applied to BIWTA seeking permission of construction of new and modern jetty in place of earlier jetties (*Appendix 5.2*).

5.4.15 Fuel Requirement and Performance

349. According to the agreement, Titas Gas Transmission and Distribution Company Ltd. (TGTDCL) is presently supplying about 64.7 MMCFD (UFFL- 48 and PUFFL- 16.7 MMCFD) natural gas at normal supply condition (*Appendix 5.3*) and ensured to supply about 70 MMCFD (UFFL- 52 and PUFFL- 18 MMCFD) natural gas at maximum supply conditions through the existing gas network and the proposed Regulating Metering Station (RMS).

350. More than 32 years have already been elapsed since start-up of the factory in November, 1985. It has been over three decades, and the capacity of many equipment/ machineries have deteriorated due to aging and prolonged operation. This has caused a sharp rise in down time, usage ratio, maintenance frequency and adverse effect on the productivity.

Due to an outdated design and old technology the plant is not producing the desired output in terms of production and energy efficiency. The usage ratio of natural gas of PUFFL is about 49.8 MCF/MT of urea and UFFL is about 32.4 MCF/MT of urea. The proposed GPUFP is designed with modern and improved technology and as energy efficient. The performance or efficiency of the proposed Project will be increased by about 126% from the PUFFP and about 47% from the UFFL.

5.5 Material Storage and Handling

5.5.1 Hazardous Waste

351. Hazardous waste disposed at PUFFL includes soot removed from the cleaning of the boilers operating on fuel gas. There is no facility available for storage of hazardous waste at the plant. Currently, hazardous liquid waste is discharged and dumped into the lagoon located close to the plant on the North. The demolition of the civil structures in the demarcated area will generate debris including asbestos cement sheet. Adding asbestos to cement makes it highly toxic. The debris will be dumped in a designated area in a confinement or else take away outside of the Project Site through selected Vendors. A secured onsite asbestos sheet disposal facility should be constructed until Vendor is selected to take away outside the Project site. It is estimated that about 27,400 tons of debris and rubbles including over 550 sheets of asbestos (about 15 tons) will be generated and needs removal from the demarcated area of the PUFFL. Condensate is generated at gas regulating and metering stations, which requires proper handling and storage if RMS is shifted to other place.

5.5.2 Non-Hazardous

352. Other solid wastes generated would include kitchen waste, cardboard, paper, plastic and garden wastes. Amongst these cardboard, paper and plastic wastes is being handed over to scrap dealers whilst kitchen and garden wastes is going to designated landfill area of the Ghorasal Municipality. The same practice shall be made after proposed new Plant construction. The annual estimated kitchen waste generation in the labour camp considering resident labour of 1,700 during construction period would be about 160 MT. Considering household size of 4.6 and 350 staff in the Colony would generate about 1.25 ton/day of kitchen and municipalwaste and about 0.15 ton/d from the administrative building and other offices. Municipal wastes generated in the housing colony will be stored in designated garbage disposal areas (made of concrete) for collection by the Ghorasal Municipality waste collection system.

5.5.3 Material Handling Conditions

353. Material as ammonia and urea that would be produced in the proposed factory would be handled in following ways:

a) Bagged urea transported by urea barge loading;

b) Bagged urea transported by urea truck loading;

c) Bagged urea transported by urea railway wagon loading; and

d) Ammonia bottling.

5.6 Solid and Liquid Waste and Air Emission

5.6.1 Solid Waste

Solid Hazardous Waste:

354. During the design stage itself due care will be taken to select the process technologies generating minimum solid wastes so that their handling, treatment and disposal do not cause any serious impact on the existing land environment. Also, efforts will be made to recycle some of the spent catalysts by way of returning to the original supplier for reprocessing.

355. The following wastes shall be generated from the Complex:

1) Spent Catalyst
2) ETP Sludge
3) Waste Oil (Dealt in liquid hazardous waste)

Spent Catalyst and Management:

356. Spent catalysts form the major part of the solid wastes generated in the proposed fertilizer complex. The hazardous solid wastes generated during demolition of the existing Plant are mainly spent catalyst wastes: Catalytic wastes include nickel, iron, iron oxide/ chromium oxide, copper oxide/ zinc oxide and aluminium oxide. A list of catalysts with their composition, life, volume and density to be used for GPUFP is attributed in Table 5.6.

Table 5.6: List of catalysts, composition, life, volume and density used for GPUFP

Sl. No.	Section	Catalyst Composition (Wt%)		Catalyst Life (Years) Expected	Catalyst Volume (m^3)	Bulk Density (kg/m^3)
1.	Hydrogenator (TK-261)	NiO MoO_3 Al_2O_3	2.3 9.8 Balance	5	7.7	500
2.	Sulfur Absorber (HTZ-5)	ZnO	99-100	2 x 2	2 x 20.3	1,300
3.	Primary Reformer (R-67R-7H)	Ni NiO MgO Al_2O_3	12-15 0-3 25-30 60-65	3 - 5	4.8	900
4.	Primary Reformer (R-67-7H)	NiO MgO Al_2O_3	15-20 20-25 55-60	3 - 5	27.1	900
5.	Secondary Reformer (RKS-2)	NiO MgO Al_2O_3	7-13 25-30 60-70	>10	3.1	1,100
6.	Secondary Reformer (RKS-2-7H)	NiO MgO Al_2O_3	7-13 25-30 60-70	>10	23.6	900
7.	High Temp. CO Converter (TK-20)	$Mg(Al_2O_2)_2$ Al_2O_3	95-100 0-5	5	4.4	900
8.	High Temp. CO Converter (SK-201-2)	Fe_2O_3 Cr_2O_3 CuO	80-90 8-13 1-2	5	47.4	1,200

Sl. No.	Section	Catalyst Composition (Wt%)		Catalyst Life (Years) Expected	Catalyst Volume (m^3)	Bulk Density (kg/m^3)
9.	Low Temp. CO Converter (LSK-2)	ZnO Al_2O_3 CuO $CuCO_3$	18-31 25-43 18-24 2-5	5	5.2	1,100
10.	Low Temp. CO Converter (LSK-823)	Cu Zn Al Cs C and O	<38 22 +/- 2 6 +/- 2 <1 Balance	5	65.6	1,200
11.	Methanator (PK-7R)	Ni NiO Al_2O_3	25-30 1-5 60-70	10	18.2	550
12.	Ammonia Converter (KM1R)	Fe Oxides K_2O, Al_2O_3,CaO, SiO_2	91-95 5-9	>10	14.2	2,200
13.	Ammonia Converter (KM1)	Fe, FeO K_2O, Al_2O_3,CaO, SiO_2	89-93 7-11	>10	47.4	2,800

Source: MHI (EPC Contractor)

357. The following strategies may be recommended for the management of spent catalysts (applicable for spent catalysts of both existing PUFFL and proposed GPUFP):

- On-site management: This includes submerging pyrophoric spent catalysts in water during temporary storage and transport until they can reach the final point of treatment to avoid uncontrolled exothermic reactions.
- Off-site management: The spent catalysts could be sent to the manufacturers for regeneration/ recovery; or to waste disposal companies that can recover the heavy metals through recovery and recycling processes.

ETP Sludge and Waste Oil and Management:

358. The following strategies are recommended for solid and liquid waste management:

- The provisions of Hazardous Waste and Ship Breaking Waste Management Rules, 2011 will be complied with for spent catalysts.
- The ETP Sludge (minor generation) shall be used as manure.
- The Waste Oil generated shall be sold to authorized agencies/vendors.

359. About 15 tons of asbestos tin sheet material will also be generated during demolition and removed from the demarcation area. This material will be temporarily stored in the laydown area for taking away from the site with due auction process or buried in a scientifically made trench in a designated area.

Solid Non-Hazardous Waste:

360. During construction, large amount of construction waste that includes unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from labor sheds, packaging materials, used home appliances,

etc will be produced. Moreover, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc. may be produced as solid waste during this stage. Wastes generated during demolition of the existing civil structures of the site including wastes (e.g., scrap iron, wooden frames, glass canvas, etc.), and some other solid wastes (e.g., from construction camps). Non-hazardous solid waste will be disposed of at designated sites. Scrap material will be sold out and the remaining waste will be collected by the Ghorasal Municipality for final disposal to designated landfill sites.

5.6.2 Liquid Waste

Oily Water:

361. Waste oil and oil contaminated water is collected in a spill wall or into an oil trap of a pit for each potential source of oily water. The major potential sources of oil are: (i) Compressor; and (ii) Different pump glands. Oil is skimmed manually at each pit periodically and further removed in oily water separator prior to discharging to the open environment, the Shitalakhya River.

Sanitary Sewage Handling:

362. The maximum number of workforce provisioned in the Project is about 4,000, which will be engaged in the construction phase. Organic soild waste generated from such a huge workforce will need a separate management and thus knowing the amount of the same is essential.

363. Considering solid waste generation rate of 0.29 kg/person/ day[3] for maximum number of 4,000 labours in the camp for about two (02) years, an estimated amount of about 1,740 m^3 of organic solid waste would be generated which would require sound management. Failure of management may pollute the surrounding environment, lose aesthetic value and may cause diseases to labours and local inhabitants. Managing of such a big septic tank and disposal of waste would be cumbersome and unhygienic.

364. There is a provision of septic tank for a building or cluster of buildings or connect to existing septic tank depending upon the layout to be decided during detailed engineering for the new buildings.

365. The sludge removal from the septic tanks is expected to be done once a year or as per the requirement of local laws and regulations by the Project Proponent. As such cleaning of the septic tank would be much convenient to manage, hygienic and environmentally sound.

5.6.3 Air Emissions

366. Air emissions will include those from the operation of construction equipment and machinery, vehicles transporting construction materials to the site and construction debris out of the site. If construction equipment such as stone (aggregate) crushers is used at the site, this may result in emission of particulate matter during its operation. Since construction of the proposed GPUFP would involve significant earthworks, an increase in particulates in the air from wind-blown dust will also be a concern, especially considering the close proximity of the high school and the staff colony (and also the residential area) to the project site. Moreover, demolition activities will also be a source of dust dispersion. During the operation phase, air

[3] CCAC Municipal Solid Waste Initiative; www.unep.org/ccac

emissions will also be generated due to the operations of the existing UFFL, Ghorasal Power Station (GPS) units (nearby to the project site) and new GPUFP.

367. The Ammonia-Urea complex has a number of stacks (at least three) for burning the ammonia released from the process and ammonia storage tanks in stacks provided with flare fueled by natural gas. Only source of ammonia that enters into the atmosphere is from the urea granulator fluidized by air. This exhaust air is treated in a scrubber with water. The technology employed is proven in commercial plants of similar size and complexity. This system has been provided in the proposed urea granulation unit and expected level of ammonia emission will be about 130 mg/Nm^3 air. The contractor shall guarantee the emission level of 150 mg/Nm^3 air. This exhaust air will be discharged to atmosphere from the stack of 50 meter height and the ammonia present shall be dispersed in the atmosphere by diffusion. Ammonia present at the ground level will be around 1 ppm and this does not affect human health.

368. Ammonia emission level of 50 mg/Nm^3 from granulation vent stack can be achieved theoretically only by installing an additional scrubbing system by scrubbing with dilute sulfuric acid. The scrubbing produces ammonium sulfate solution which poses serious disposal problems along with corrosion. But this system having proper disposal of ammonium sulfate solution is yet to be common in commercial plants of similar capacity (2800 TPD, granular urea).

369. The World Bank's guidelines of 50 mg/Nm^3 ammonia in stack exhaust is a target value and not a value that has been achieved in commercial plants of similar size and complexity now in operation. For the plants in Bangladesh, they shall be required to comply with the standards currently laid down by the Department of Environment (DoE) of Bangladesh. Bangladesh does not have a discharge standard for ammonia gas as such from ammonia-urea plants as well as from urea granulator exhaust stack.

370. The technical specification of the contract for this project stipulates that the process, system and equipment shall be proven for at least two years commercial operation in plants of similar size and complexity.

371. **Feed and Fuel:** The plant feed is natural gas (NG) which will be available at plant battery limit. The fuel gas for the reforming and steam boiler is part of the total natural gas delivered at the battery limit. Natural gas would be used as fuel gas in the following areas:

- Reformer fuel of ammonia reformer and start-up heater;
- Boiler fuel;
- Pilot fuel of flare stacks; and
- Gas engine generator.

372. **Chemicals:** Caustic Soda (NaOH) and Sulphuric Acid (H_2SO_4) would be supplied to the plant by tank lorry or other measures.

373. **Noise Limits:** Design guide and noise limits of different machineries are as follows:

- Design guide**:**For each rotating equipment (used for normal operation)

Facilities and Zones	Limit Level, dB(A)
For Process Compressor/ Turbine/Steam Turbine Generator	95 at one (1) m from source
For rotating machines other than Process Compressor, Turbine, and Steam Turbine Generator	90 at one (1) m from source

For reformer (used for normal operation)

Facilities	Limit Level, dB(A)
For Reformer	85 at one (1) m from source

For Plant Area (used for normal operation)

Facilities	Limit Level, dB(A)
At plant boundary	75 at day time 70 at night time

5.6.4 Atmospheric Emissions

374. Air effluent emission control in principle shall be in accordance with, International Finance Corporation (IFC), EHS Guidelines and The Environment Conservation Rules, 1997. Substances in gaseous emission are listed below in Table 5.7:

Table 5.7: Comparison of Project air emissions with standards

Parameter	Unit	Emission Source	Effluent Limitation as Design Basis[4]	Bangladesh Regulation[5]	EHS Guidelines, IFC 2007[6]
Ammonia[7]	mg/Nm^3	Granulation process unit Vent Stack (Dry basis)	150	-	50
NO_2	mg/Nm^3	Primary Reformer Furnace (Dry basis)	300 (3 vol % 02)	-	300
		Auxiliary Boiler (Dry basis)	150 (3 vol % 02)	150	300
Particulate Substance	mg/Nm^3	Auxiliary Boiler (Dry basis)	100	100	50
Particulate Substance (Urea Dust)	mg/Nm^3 (Wet basis)	Granulator Vent Stack	50	150	50

[4] *Notes: At normal operation excluding ab-normal operating condition such as start-up, Shut down or low load operation.*

[5] *As per "The Environment Conservation Rules, 1997, Schedule-12, (E) Boiler of Industrial Unit" As per The Environment Conservation Rules, 1997, Schedule-12, (A) Fertilizer Plant"*

[6] *As per 'IFC EHS Guidelines, Air Emission Levels for Nitrogenous Fertilizers Manufacturing Plants"*

7 Regarding ammonia emission from the Granulation stack, MHI has completed same size of urea fertilizer plant in recent years as the following figures: (a) In Oman: 160mg/Nm³; (b) In Tatarstan: 160mg/Nm³; and In Turkmenistan: 160mg/Nm³. In case that 50mg/Nm3 which is IFC standard is applied, an additional acid scrubbing facility needs to be installed. An additional sulfuric acid line with its storage tank also needs to be installed and supplied to acid scrubber. About 10-40% ammonium sulphate solution will be produced in the process as by-product. Since ammonium sulphate solution cannot be treated in waste water treatment system, it shall be asked 3rd party company for treatment who can treat ammonium sulphate solution with the proper way such as incinerator. In addition, high corrosion issues for equipment, piping and instruments should be occurred in case of leakage troubles of ammonium sulphate solution. So, this acid scrubbing facility is not common facility in the world at this moment. Please also note that IFC standard is not mandatory figure but desirable target. The recent fertilizer plants which MHI has completed in Turkmenistan, Tatarstan, Oman, Malaysia and Algeria do not have this acid scrubbing facility due to above reason. And Turkmenistan and Tatarstan projects were financed by JBIC/NEXI same as well this GPUFP project.

5.7 Construction

375. Site Preparation: The major site preparation works are: (i) Filling of the existing lagoon and the pond either by dredged earth from the Shitalakhya River or by carried earth from other area; (ii) Removing and dumping of debris that will be generated due to dismantling of the existing structures in proper place; and (iii) Piling of the area where required. In addition to these, site preparation will also include a proper planning of drainage system to avoid any kind of water logging.

5.7.1 Construction Labor Camp

376. Ghorasal is an industrial area located in Ghorasal Municipality. Many workers, skilled or unskilled, from different parts of Bangladesh come to Ghorasal for work. They live in rented houses on monthly basis locally available and work in the industries. Because of this, renting out houses/rooms has become a lucrative additional source of monthly income of the local people. During site visit and discussion with the local BCIC authority, it is learnt that the EPC contractor will arrange accommodation facilities for about one-third of all workers (native and expatriate) numbering about 1,700 with utility services (e.g. water, electricity and sanitation facilities) inside the project boundary. In case of emergency, EPC Contractor can rent houses around the project site.

5.8 Human Resources Required During Construction and Operation

377. The estimated number of workers required during (i) Demolition; (ii) Site Preparation; (iii) Construction and (iv) Commissioning phases are as follows:

- Demolition Phase: During demolition phase, EPC contractor is expected to have manpower of around 400 at peak time, including unskilled, skilled, supervisors, engineers, management staffs, etc. Among the manpower, expatriate employees will be around 60.
- Site Preparation Phase: During site preparation, EPC contractor is expected to have manpower of around 600 at peak, including unskilled, skilled, supervisors, engineers, management staffs, etc. Among the manpower, expatriate employees will be around 100.
- Construction Phase: During construction, EPC contractor is expected to have manpower of around 4,000 at peak, including unskilled, skilled, supervisors, designers, engineers, management staffs, etc. Among the manpower, expatriate employees will be around 1,500 and MHI employees will be around 30.
- Commissioning Phase: During commissioning, EPC Contractor will employ 2,700 persons as expected peak number. Among the manpower, expatriate employees will be around 600, MHI employees will be around 100 and the rest will be local.

5.9 Emission Monitoring System

378. The flue gas emission will be collected at different points (e.g., stack) in every hour by maintaining standard sampling procedure. The collected sample will be analysed in the chemical analytical laboratory for knowing the emission status of NOx, PM10 and NH3 in particular and compare with the Bangladesh Standard as well as the IFC Standard. Analyzed result will be distributed to all of the plant managers for taking necessary action if exceedance is found.

5.10 Environmental Quality Monitoring System

379. The Proponent is suggested to install two temporary portable ambient air quality monitoring stations (to monitor NOx, PM_{10} and NH_3) are recommended in the Project impact area. The locations of the stations will be based on the dispersion modeling output of maximum ground level concentrations in downwind directions. Noise level will be monitored at the sensitive locations in order to comply with the ECR Compliance Standard. Continuous Monitoring System for water quality monitoring should be installed at the discharge point of WWTS/ETP. The monitoring parameters would be as per Schedule 12 of ECR, 1997 and applicable IFC, 2007 Guidelines for the fertilizer factories.

6. Description of Baseline Environment

6.1 Introduction

380. The baseline condition has been defined considering the environmental perspective where the environmental sector has been differentiated into three types and these are: Physical Environment, Biological Environment and Social Environment. The Physical environment consists with meteorological, hydrological, topological, geological components and processes, hazards, land use and land cover pattern, water resources and land resources. The Biological environment includes agricultural resources, livestock resources, fisheries resources and ecosystems with aquatic and terrestrial flora and fauna. The social environment includes gender, cultural activities, economic status, livelihoods etc. of the people residing in the study area. The study area has been delineated as 10 km radius area from the center of the proposed Project site. Both primary and secondary data were used to delineate the baseline condition.

6.2 Physical Environment

6.2.1 Land Resources

Agro-ecological Zones (AEZs)

381. The study area has fallen into two agro-ecological zones (AEZs), namely: i) Old Brahmaputra Floodplain (AEZ-9) and Madhupur Tract (AEZ-28) (FAO/UNDP 1988 and BARC; 2012). The study area belongs to 61% Old Brahmaputra Floodplain (AEZ-9) and 39% Madhupur Tract (AEZ-28). The distribution of AEZs in the study area is shown in Figure 6.1.

Land Use and Land Cover

382. The study area of the proposed Project is considered 10 km radius from the project site. The project area is about 45 hectare (ha) having old buildings and a large open space with vegetation cover ranges from herbs to big trees. Possession of such vegetation leading the Project site as ecologically dominant area. The land use of the total study area is 31,457 ha of which agriculture land is 14,134 ha. The remaining areas are covered by Rural settlements including homestead, Water bodies including Rivers, Khals, Beels, Ponds, Fresh Water Aquaculture; Orchards and forest and Others (Brickfield, Dump sites/Extraction sites, Built-up-Non-Linear). Detailed land use of the study area is presented in Figure 6.2 and land cover areas of such land uses are presented inclusters in Table 6.1.

Table 6.1: Present land cover areas of the study area by land use cluster

Land Use Cluster	Land Cover Area (ha)	Percent (%) of Gross Area
Agriculture Land	14,134	45
Rural Settlements	12,958	41
Water Bodies (Rivers, Khals, Beels/Haors, Ponds, Fresh Water Aquaculture)	2,257	7
Orchards and Forest	276	1
Others (Brickfield, Dump sites/ Extraction sites, Build-Up-Non-Linear)	1,545	5
Road	286	1
Total/Gross	**31,457**	**100**

Source: Image analysis done by CEGIS, 2018

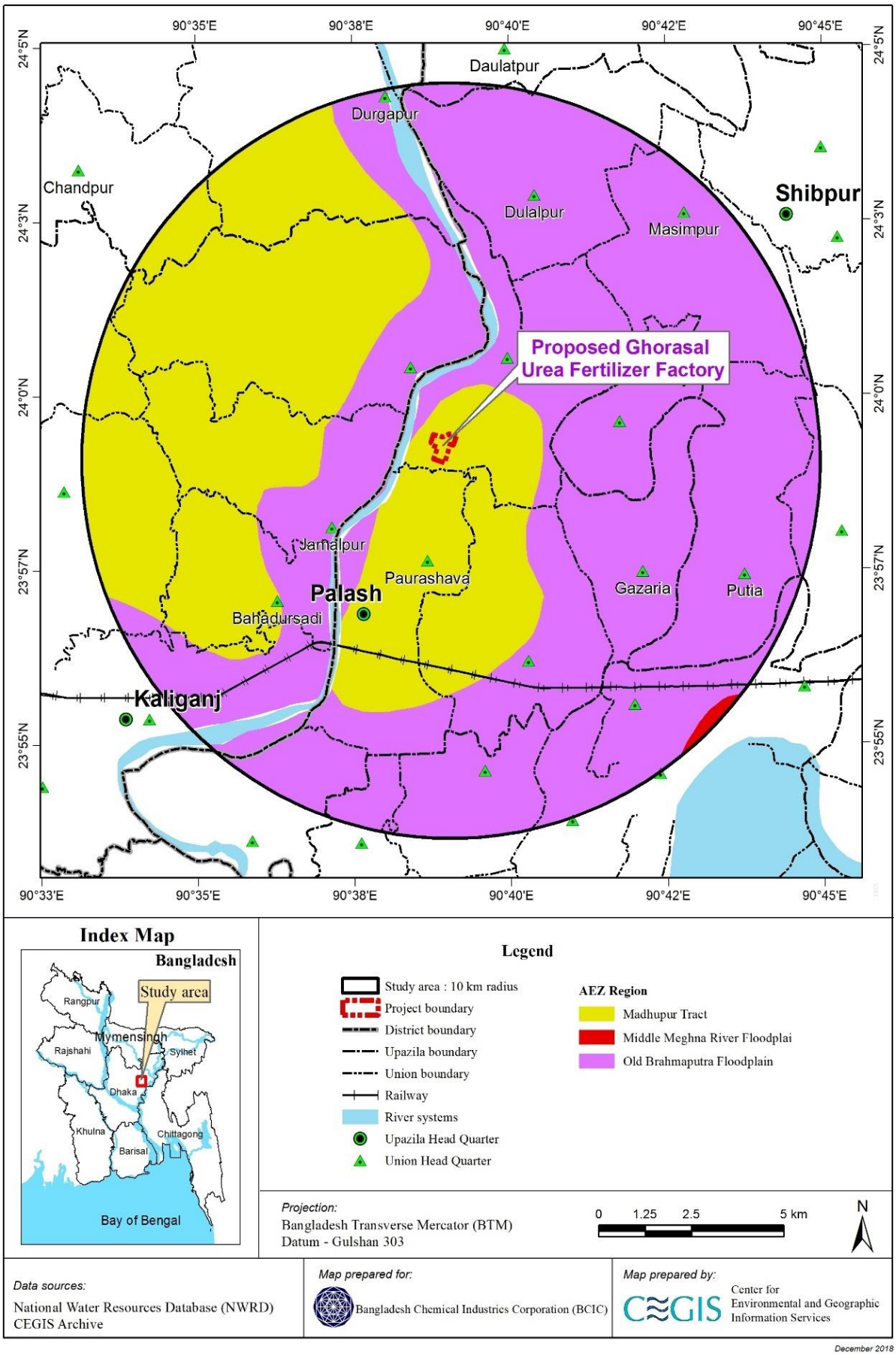


Figure 6.1: AEZ of the study area

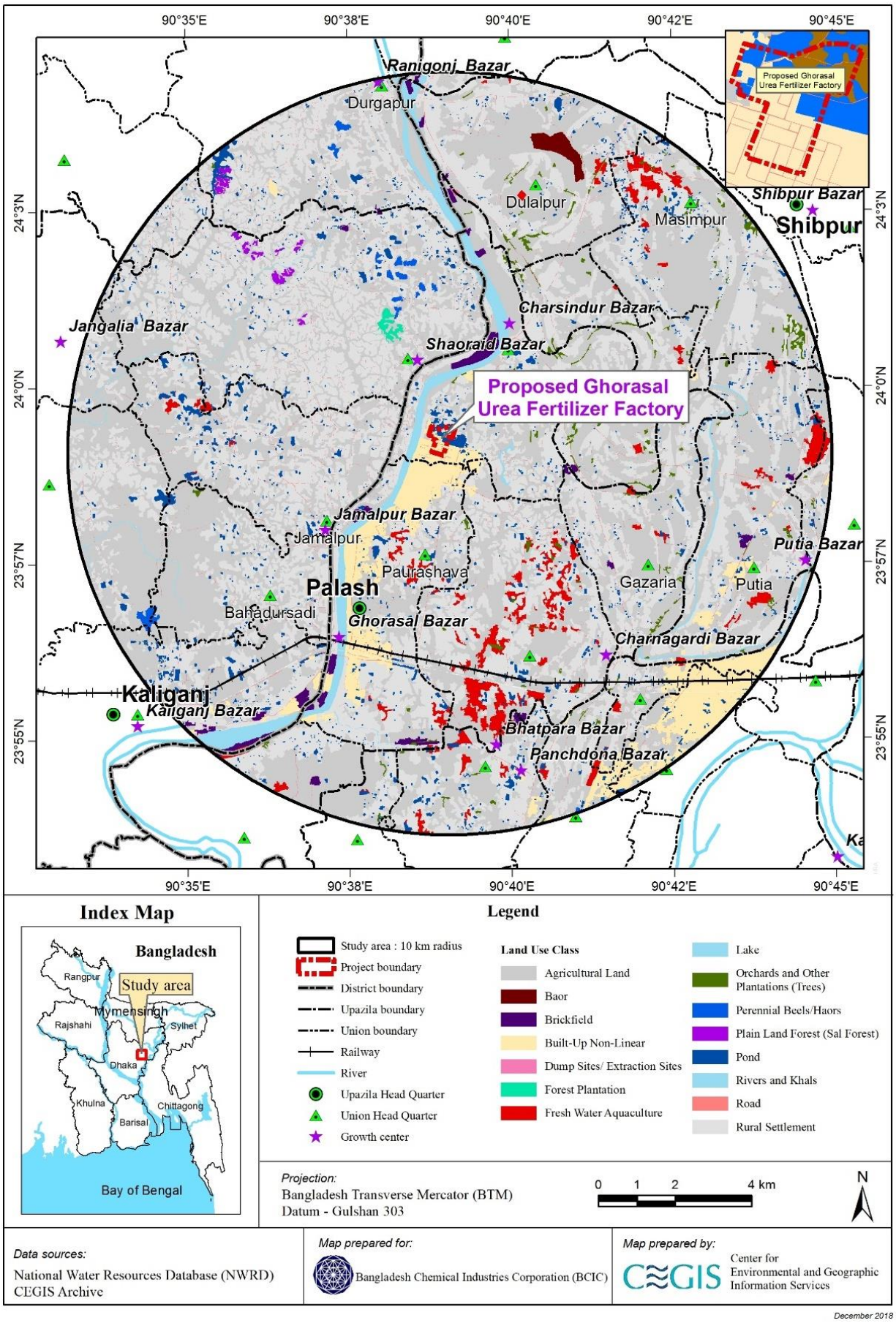


Figure 6.2: Land use map of the study area

Soil Texture

383. Soil texture is the relative proportions of sand, silt and clay. The dominant soil texture of the study area is loam (45%) followed by clay and clay loam (28%) and (26%) respectively.The detailed top soil texture of the study area is presented in Table 6.2.

Table 6.2: Top soil texture of the study area

Soil texture	Area (ha)	% NCA
Clay	3,996	28
Clay Loam	3,725	26
Loam	6,413	45
Total	**14,134**	**100**

Source: Soil Resource Development Institute (SRDI), 1997

Soil Quality

384. The proposed Ghorasal-Polash Urea Fertilizer project area has fallen in Ghorasal Union under the Polash Upazila. There are five soil series in this area are: Tejgaon, Sayek, Payati, Kolma, and Khilga. Table 6.3 shows that the soils of this area are low status of Organic Matter (OM). There are very high in Calcium (Ca), Phosphorus (P), Potassium (K), Iron (Fe) and Manganese (Mn); high in Sulphur (S) content; medium in Zinc (Zn) and Magnesium (Mg); Nitrogen (N) content in the soil is very low.

Table 6.3: Soil quality based on plant nutrient of the study area

Parameters	Unit	Max	Min	Average
pH	-	6.1	5.2	6
OM (Organic Matter)	(%)	0.9	0.1	1
Active acidity	Meq/100g	0.3	0.1	0
Ca (Calcium)	Meq/100g	9.8	2.9	6 **
Mg (Magnesium)	Meq/100g	3.54	0.85	2*
K (Potassium)	Meq/100g	1.2	0.38	1**
N (Nitrogen)	µg/g	42	27	35
P (Phosphorus)	µg/g	54	6	30 **
S (Sulphur)	µg/g	62	10	36
B (Boron)	µg/g	0.7	0.1	0
Fe (Iron)	µg/g	227	50	139 **
Mn (Manganese)	µg/g	49	8	29 **
Zn (Zinc)	µg/g	4	2	3*

Source: Soil Resource Development Institute (SRDI), 1997

385. Six (06) soil samples were collected from three locations, two layers for each location, of the study area during 19.12.2018 to 21.12.2018. These soil samples have been analyzed through the laboratory of Soil Resources Development Institute (SRDI), Dhaka for testing the Soil texture, Soil reaction (pH), Organic Matter (OM), Nitrogen (N), Phosphorus (P), Potassium (K), Sulphur (S), Chromium (Cr), Cadmium (Cd) and Lead (Pb). The result of soil analysis is given in Table 6.4.

Table 6.4: Analytical result of soil samples

Location	Sampling Layer	OM	pH	Total N (%)	P µg/g	K	S µg/g	Pb µg/g	Cd µg/g	Cr µg/g
Lagoon (Khanepur)	Upper Layer	0.76	4.0	0.04	1.89	0.09	87.09	22.5	0.00	29.25
	Lower Layer	0.84	4.3	0.04	1.09	0.09	261.5	15.51	0.01	40.00
Agriculture Field, Khanepur	Upper Layer	2.6	4.6	0.15	2.45	0.14	3.39	14.25	0.34	33.75
	Lower Layer	2.1	5.1	0.12	2.41	0.12	9.28	13.00	0.00	32.25
Agriculture Field, Nargana, Kaliganj	Upper Layer	2.44	5.1	0.14	1.23	0.13	17.07	12.25	0.10	41.50
	Lower Layer	1.77	5.6	0.10	1.54	0.12	21.39	12.00	0.00	44.50
Optimum level, SRDI, Bangladesh		-	-	0.27-0.36	15.8-21.0	0.27-0.36	22.5-30.0	-	-	-
Critical limit, SRDI, Bangladesh		-		0.12	7.00	0.12	10.00	-	-	-
DoE Standard Value (Bangladesh)		-	-	-	-	-	-	100	1.5	100

Source: Lab analysis done by SRDI for CEGIS, 2019

386. From the analyzed result, it has been observed that the texture of all soil sample is silt loam. In the lagoon area, Organic Matter contents (OM) are low. The pH levels were found which are very strongly acidic. On the other hand, Nitrogen (N), Phosphorous (P) and Potassium (K) level is very low but Sulphur (S) content is medium but Lagoon (Khanepur) Lower Layer is too high. All the parameters are within the optimum level, except the lower layer of Sulphur. It is also observed that, Lead (Pb), Cadmium (Cd) and Chromium (Cr) level are within the DoE standard.

387. In the agricultural land, Organic Matter contents (OM) are medium level and pH levels were found slightly acidic to strongly acidic in nature. On the other hand, Nitrogen (N), Phosphorous (P) and Potassium (K) level is very low to low but Sulphur (S) content is very low to medium level. All the parameters are within the optimum level. However, heavy metal concentrations of Chromium (Cr), Cadmium (Cd) and Lead (Pb) are within the DoE standard in agricultural land. Therefore, it is summarized that soil quality of the agriculture land is suitable for crop cultivation.

6.2.2 Topography

388. The study area mostly lies in a flat topography. Presently, the area is dominated by agricultural practices followed by settlements, industries, fishing during the wet season. The ground elevation gently lowers from East to West. The Project site is situated at the elevation ranges between 7-12 m PWD (Figure 6.3). The entire study area is vulnerable to occasional riverine flood. Information collected from the PUFFL authority, there was no record of flooding inundation after 1998 devastating flood. The topographic map envisages contour lines of the site. The project site has been developed, and it is a flat land with a large lagoon.

6.2.3 Geology

Physiography

389. Physiographically, the proposed Project site falls in the Madhupur tract and is surrounded by the Old Brahmaputra floodplain and the Young Brahmaputra and Jamuna

floodplain (Figure 6.4). The area is located in the central part of the Bengal basin– an extensive alluvial plain of the quaternary sediments laid down by the Ganges-Brahmaputra-Meghna river system.

390. The surface of the area is covered by paludal deposit. The thickness of this section ranges from seven (07) to nine (09) meters. It is composed of Holocene river alluvium, meander, inter-stream, swamp deposit, marsh clay and peat. Immediate below this section underlies 16,000 m thick sequence of quaternary sediments. Lithology shows that the area comprises of alternation of sand/silt and clay sequences.

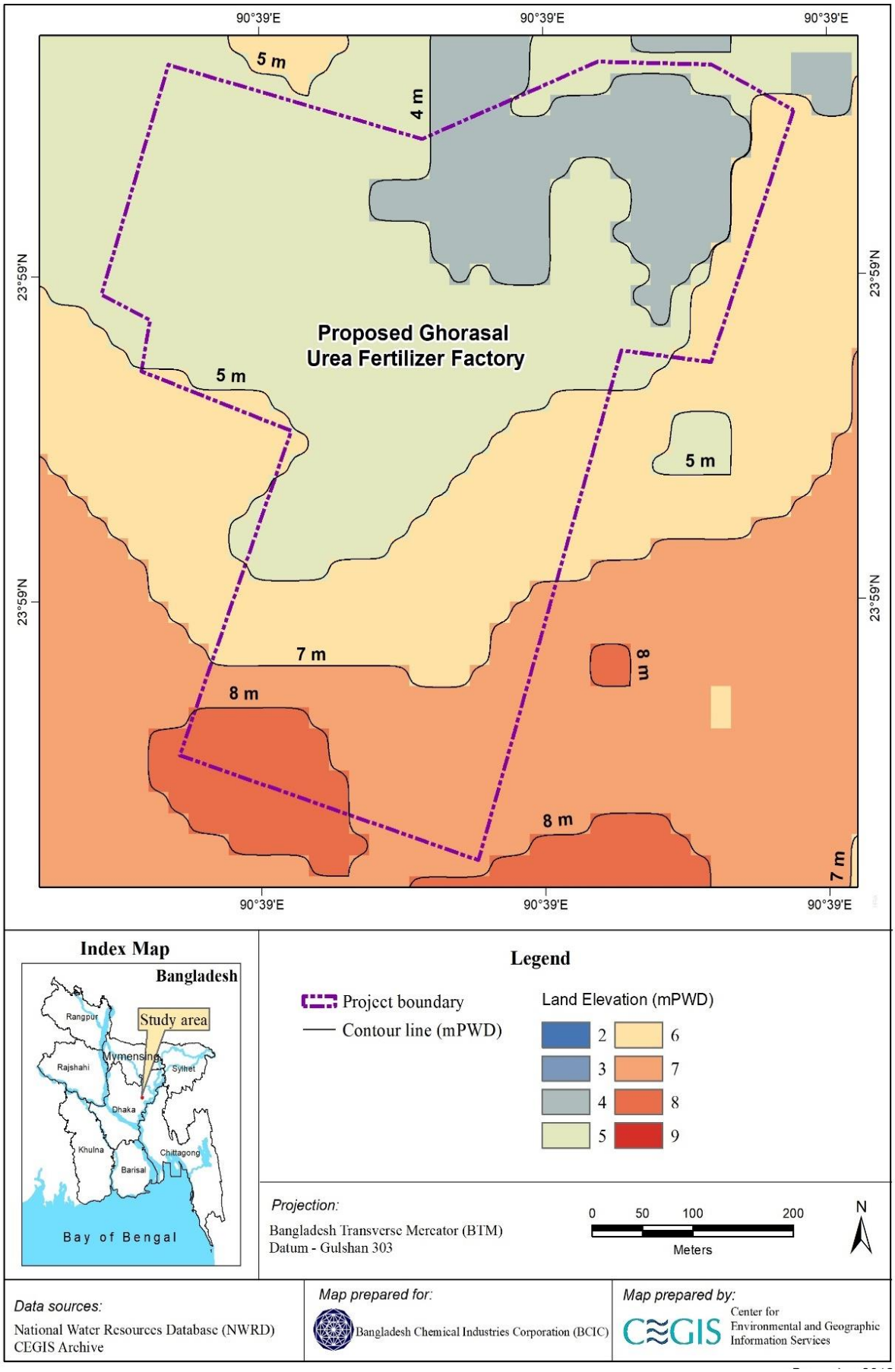


Figure 6.3: Topographic map of the proposed Project Site

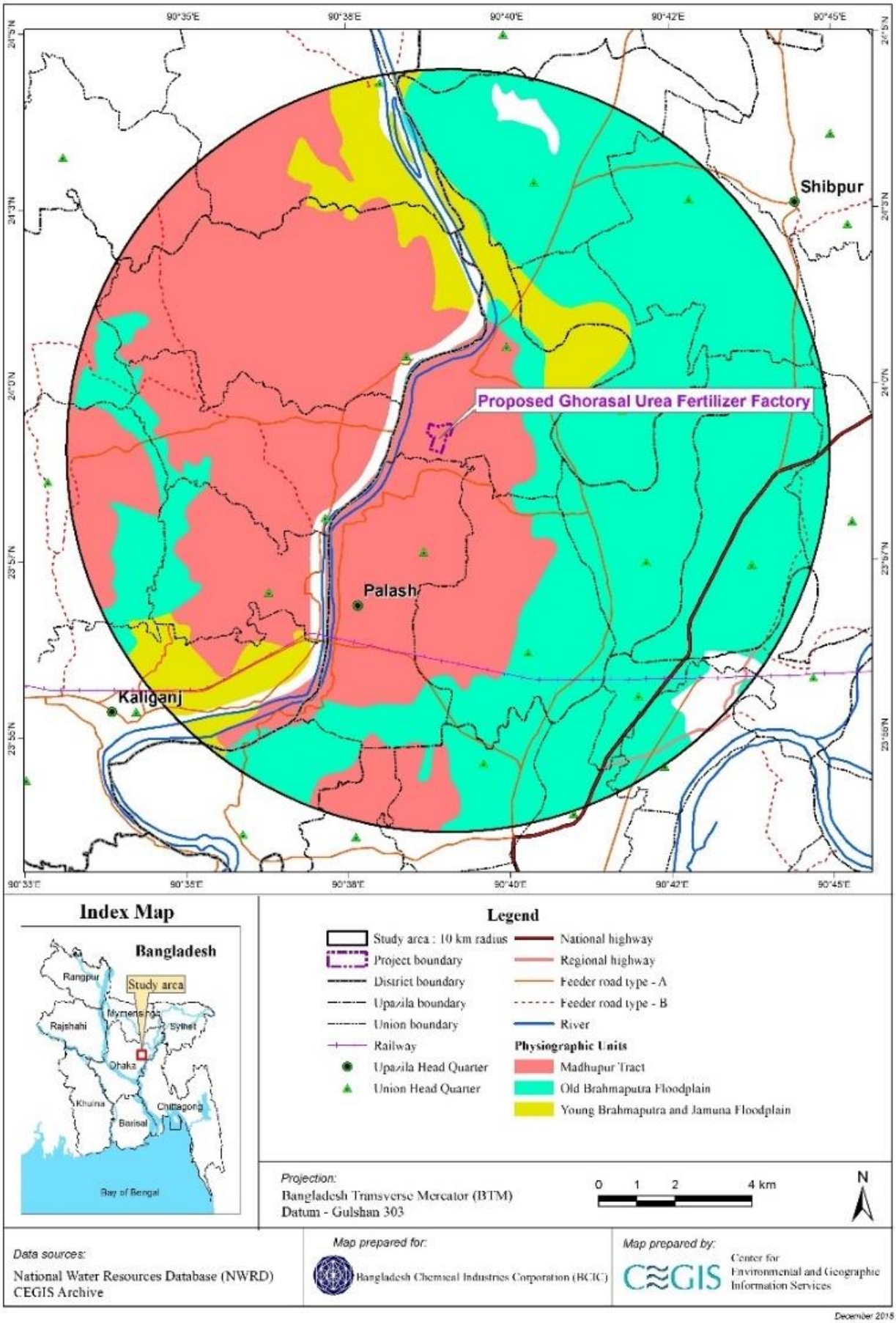


Figure 6.4: Physiographic map of the proposed Project Site

Surface Geology

391. The proposed Project site is situated on the Madhupur Tract (Figure 6.5). The surface is mostly covered with brown mottled clay, but sometimes covered with recent alluvium. The thickness of the Madhupur clay is seven to nine (07-09) meters thick. Below this layer, there is about 10,000 meters thick Tertiary sediment.

392. As per tectonic classification, the project area falls under Madhupur Tripura threshold of eastern platform flank of the Bengal basin. Tectonically this area is inactive and no apparent major structure like fault or fold exists in the region that might be geologically significant (Figure 6.6).

Figure 6.5: General Geological map of Bangladesh showing study area

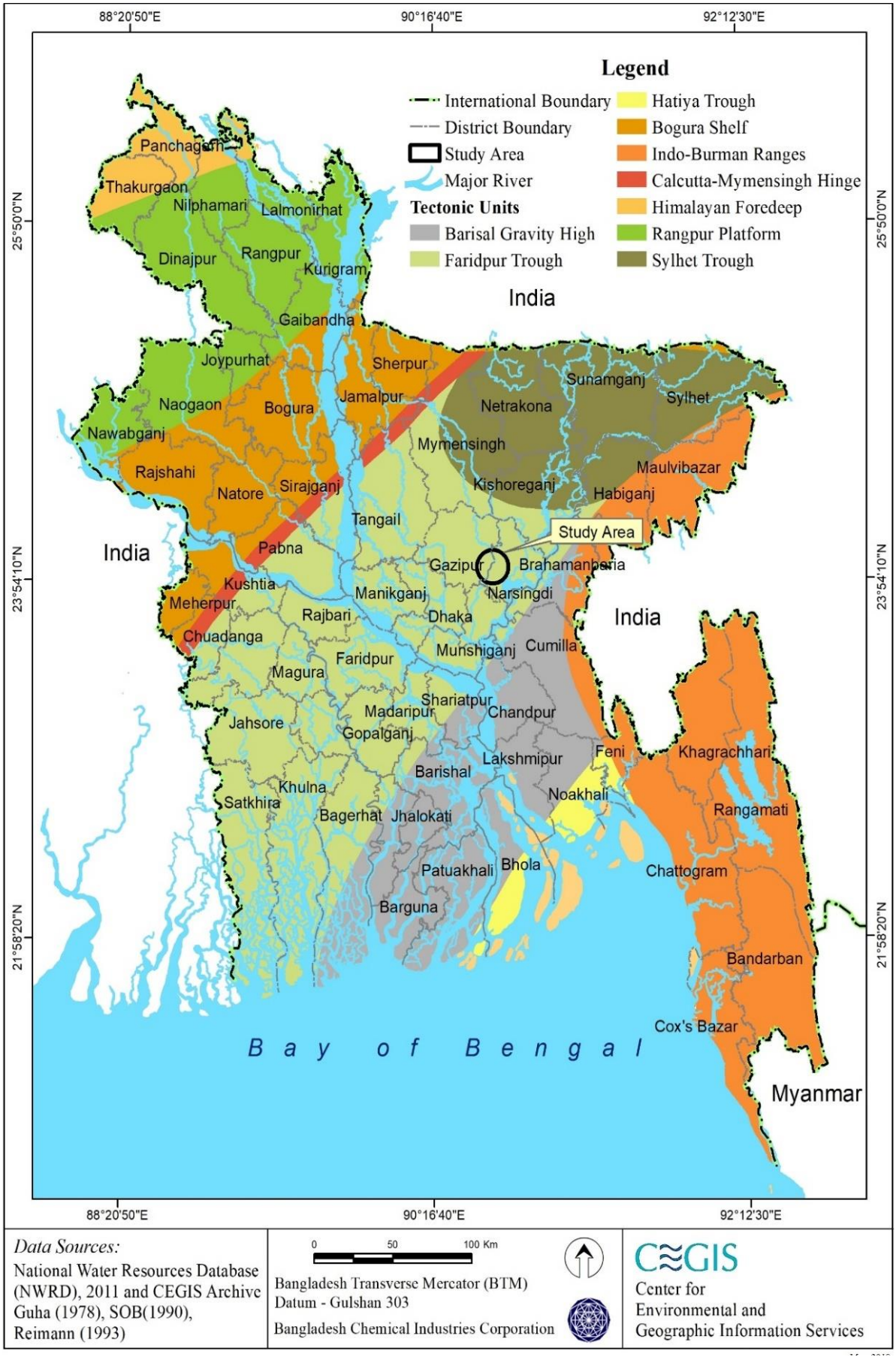


Figure 6.6: Generalized tectonic map of Bangladesh showing study area

6.2.4 Seismicity

393. Seismically Bangladesh is been divided into three zones. The country is divided into three seismic zones with zone coefficient Z equal to 0.075 (Zone 1), 0.15 (Zone 2), and 0.25 (Zone 3) g (acceleration due to gravity) (BNBC Map 1993).

394. The proposed GUFFP falls under zone-2 (Figure 6.7). This zone has the mediocre vulnerability for earthquake in Bangladesh with a risk of possible earthquake of magnitude 6 (on Richter scale).

Figure 6.7: Seismic zoning map for Bangladesh

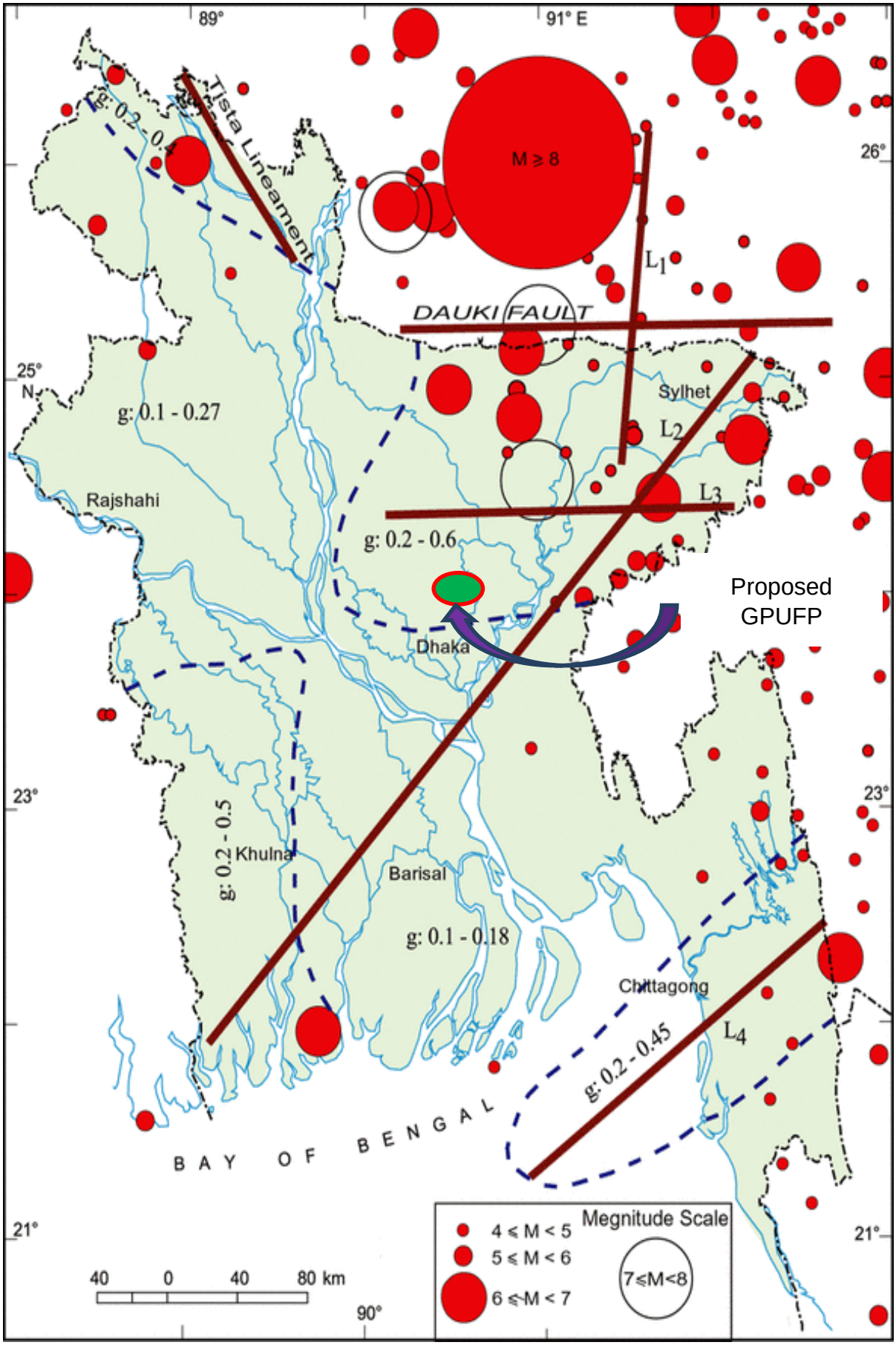


Figure 6.8: Seismic intensity map of Bangladesh showing project site

395. Details of seismic intensity and the historical records of earthquakes in and around Bangladesh are presented in Figure 6.8 and Table 6.5.

Table 6.5: List of major earthquakes in past 450 years

Sl. No.	Year	Source Area	Magnitude (Richter Scale)	Depth (Km)
1	1548	Sylhet	-	-
2	1664	Shillong-Plateau	-	-
3	1762	Chittagong-Arakan	-	-
4	1858	Sandway, Myanmar	6.5	-
5	1869	Cachar, India	7.5	48
6	1885	Sirajganj, Bangladesh	7	72
7	1897	Assam, India	8.1	60
8	1906	Calcutta, India	5.5	-
9	1912	Mandalay, Myanmar	7.9	25
10	1918	Srimangal, Bangladesh	7.6	14
11	1930	Dhubri, India	7.1	60
12	1934	Bihar, India-Nepal	8.3	33
13	1938	Mawlaik, Myanmar	7.2	60
14	1950	Assam, Himalaya	8.6	25
15	1954	Manipur, India	7.4	180
16	1975	Assam, India	6.7	112
17	1984	Cachar, India	5.7	4
18	1988	Bihar, India-Nepal	6.6	65
19	1997	Sylhet, Bangladesh	5.6	35
20	1997	Bangladesh-Myanmar	5.3	56
21	1999	Maheskhali, Bangladesh	4.2	10
22	2003	Rangamati, Bangladesh	5.6	-
23	2011	Sikim, India	6.9	-

396. Although several earthquakes of magnitudes 4 to 7 were reported in neighboring locations, no major earthquakes were reported in the proposed study area. However, the possible effects of a high magnitude earthquake in adjacent locations should not be overlooked and soil engineering properties at the project site needs to be examined in detail.

6.2.5 Water Resources and Hydrology

397. Polash area has become the potential industrial hub for its strong and favorable industrial infrastructure. About 28% of industrial product and its raw material of Bangladesh comes from Polash industrial zone. All the industries need water for their production purposes. The sources of water for the industries are mainly groundwater, surface water and rain water. The surface water sources includes river, khals and waterbodies (e.g. Baor, Lake, Perennial Beels etc.). However, the industries are using the surface water from the Shitalakha River. Total length of the Shitalakha River is about 110.9 km where in the study area it covers 22.6 km. There are other waterbodies like Baor, Lake, Perennial Beels, Rivers and Khals. The description of waterbodies under the study area is given in the Table 6.6 and methodology of data collection is given in Table 6.7. Further, the spatial distribution of water resources system has been presented in Figure 6.9.

Table 6.6: Breakdown of waterbodies area of the study area

Water Bodies	Area (Ha)
Baor	68
Lake	12
Perennial Beels	69
Ponds	15
Rivers and Khals	653
Grand Total	**817**

Source: NWRD of WARPO archived in CEGIS

Table 6.7: Methodology to collect data on water resources

Parameter	Data Sources	Methodology
Surface Water hydrology		
Dryand wet season water level	BWDB	Mean monthly water level data has been collected from BWDB database
Drainage system	CEGIS	Data has been gathered through image analysis and physical observation
Ground water hydrology		
Water table	BMD and field investigation	Data has been collected from secondary sources and from different locations of the study area.

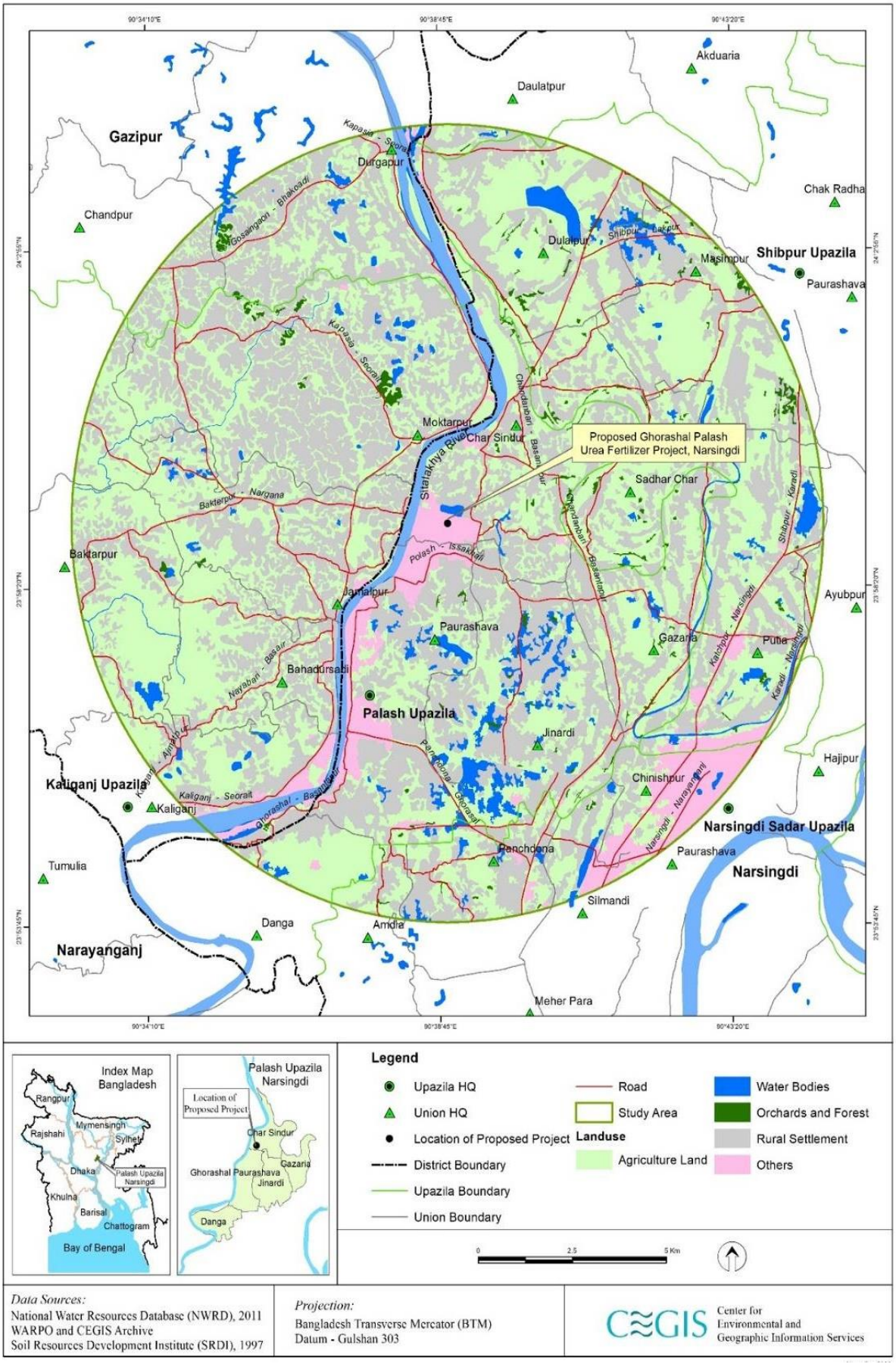


Figure 6.9: Water resources system

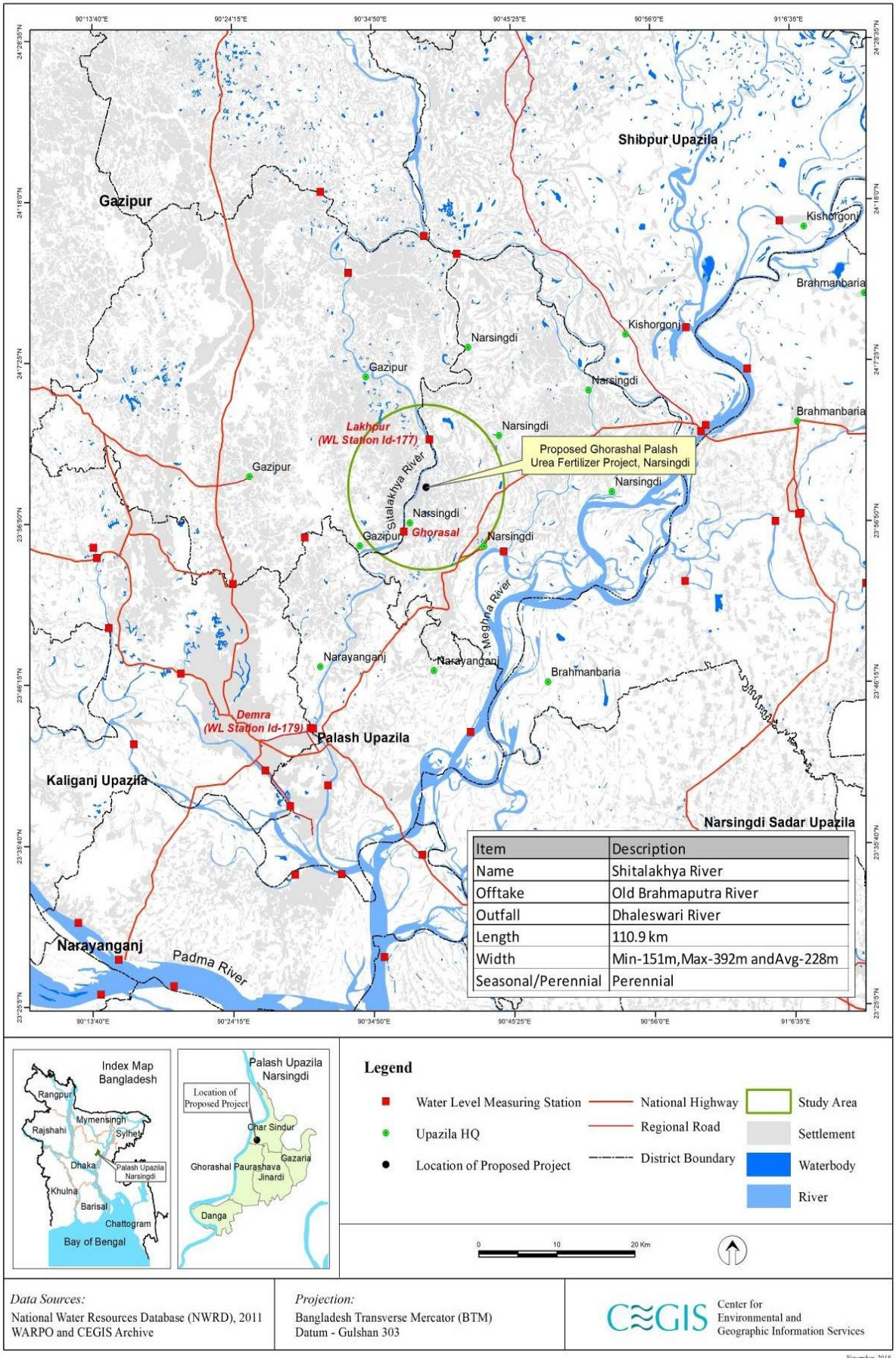


Figure 6.10: Water level measuring station of BWDB

Surface Water Resources

398. The Shitalakhya River flows in close proximity of the proposed site of the project, is a distributary of the Old Brahmaputra River (Figure 6.9). It receives fresh water flow from the Old Brahmaputra and the Lower Banar River. The off-take of the Shitalakhya River is Old Brahmaputra River at Monohordi Upazila under Narsingdi district and drains into the Dhaleswari River in Narayanganj district. Due to the desertion of the original link to the Old Brahmaputra River, the Shitalakhya River receives most of its freshwater flow presently through the Lower Banar River as shown in Figure 6.9. The relatively inert geo-morphological characteristics of the Shitalakhya River ensures fairly suitable water depths for navigation, throughout the year.

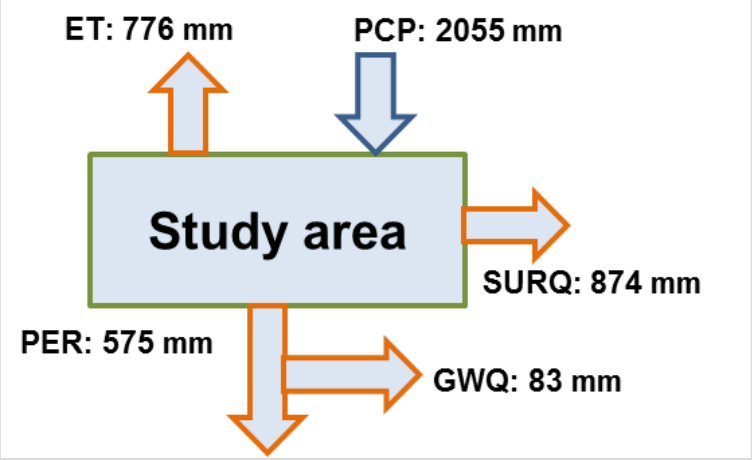
Surface Water System

399. The Shitalakhya is a tidal river and the maximum average variation of water level is 20 cm between high tide and low tide. The river is perennial in nature and the average lowest discharge is during dry season (January) with a flow of 83 m^3/s and the average lowest water level during low tide is 0.94 mPWD close to the study area. The average highest flow is observed during the rainy season (Jul- Sept) and varies from 1,181 m^3/s to 1,066 m^3/s and the average maximum water level during the high tide is 6.62 mPWD. There is no other significant surface water system found around the project area except Shitalakhya River.

400. The river inundates nearby agricultural lands during monsoon and remains navigable round the year. The tendency of the river erosion is very low. Based on water availability and navigation facilities, a large number of industries were established along its banks both up and downstream. Bangladesh Inland Water Transport Authority (BIWTA) declared this river as a class III route of Bangladesh as the relatively inert geo-morphological characteristics of the Shitalakhya River guarantee fairly suitable water depths for navigation, throughout the year.

Water Balance during Base Condition (1981-2017)

401. Water balance is the assessment of water resources and its use in the system. The main principle of water balance is that the difference between total incoming water and total losses should equal to the storage change in the system. The calibrated and validated model has been simulated for the period of 1981 to 2017 to estimate the availability of water for the study area. The simulation results of the annual and monthly water balance for the study area are shown in Figure 6.11.



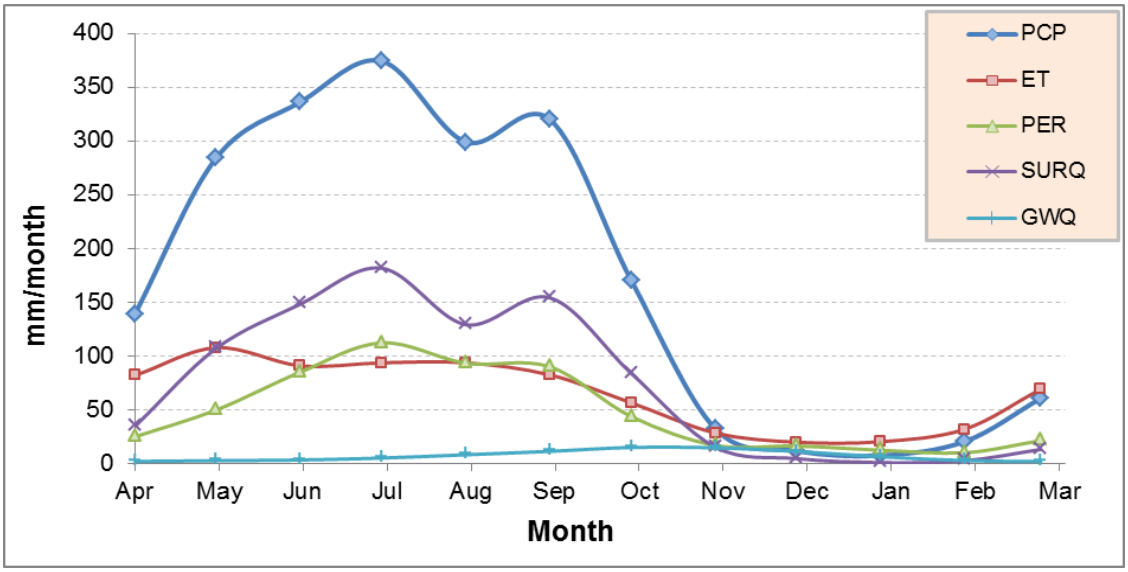


Figure 6.11: Water balance of the study area (a) annual and (b) monthly for the period 1981-2017

402. The average annual rainfall is 2,055 mm. The monsoon starts from April and reaches its peak in July. There is a decreasing trend of rainfall during the month of August, a slight increase in September and then rapidly decrease again. The maximum monthly precipitation is about 375 mm.

403. Rainfall in watersheds/catchments is the main inflow whereas the evapo-transpiration and percolation and other abstractions are losses. The balance contributed into the river as surface runoff and subsurface flow. The annual actual evapo-transpiration of the area is 776 mm which is 37% of the annual rainfall. The evapo-transpiration is maximum during April and May and which is about 107 mm per month. The evapo-transpiration rate is minimum during November to February. The percolation rate for the study area is 575 mm per year which is 28% of the annual rainfall. The percolation rate follows similar trend like rainfall and the maximum rate is 112 mm per month. After the losses of water through evapo-transpiration and percolation, the remaining water contributes to stream flow as overland flow and lateral (subsurface) flow. Around 43% (874 mm) of rainfall contributes to stream flow through surface runoff while the lateral flow is negligible only 83 mm.

Water Level Analysis

404. The Shitalakhya is a tidal river where the dry season tidal range is about 20 cm which reduces to a few centimeters during the monsoon. The average maximum and minimum water level varies seasonally from 5.42 m to 1.15 m in Dermra Station and 5.95m to 1.28 m in Lakhpur Station of BWDB respectively at the project site during the base condition. Generally, the river reaches its highest water level in the months between July and September and the lowest in the months between January and March. The water level measuring stations of the study domain is given in Figure 6.10. Water level data of Demra and lakhpur stations are given below in Figure 6-12 and in Figure 6-13 respectively.

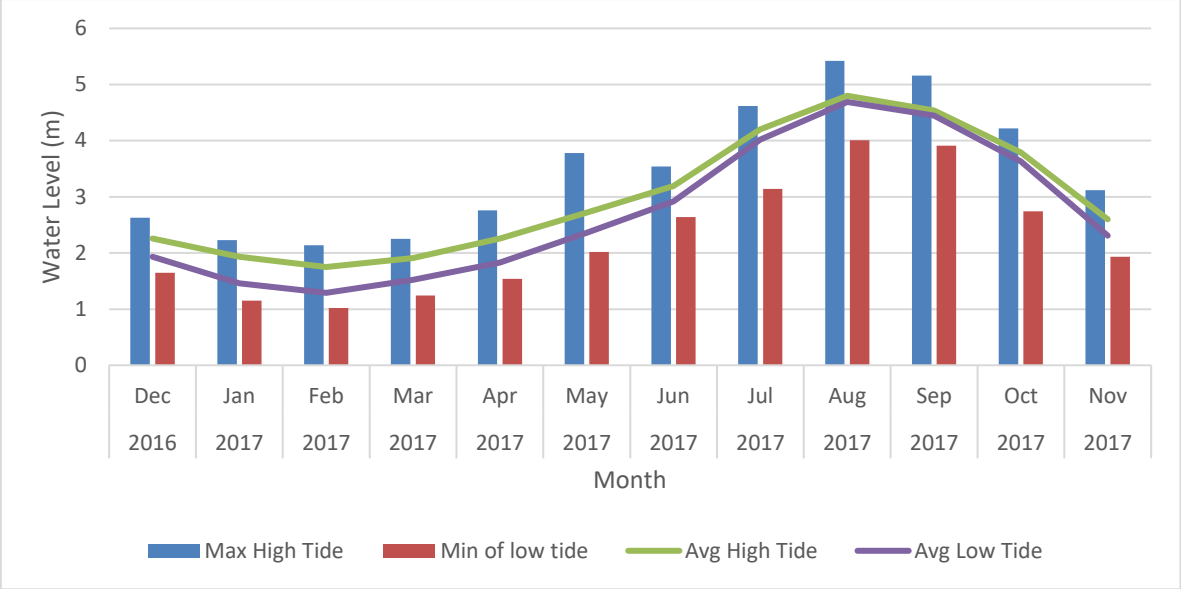


Figure 6.12: Water level at Demra station in 2017

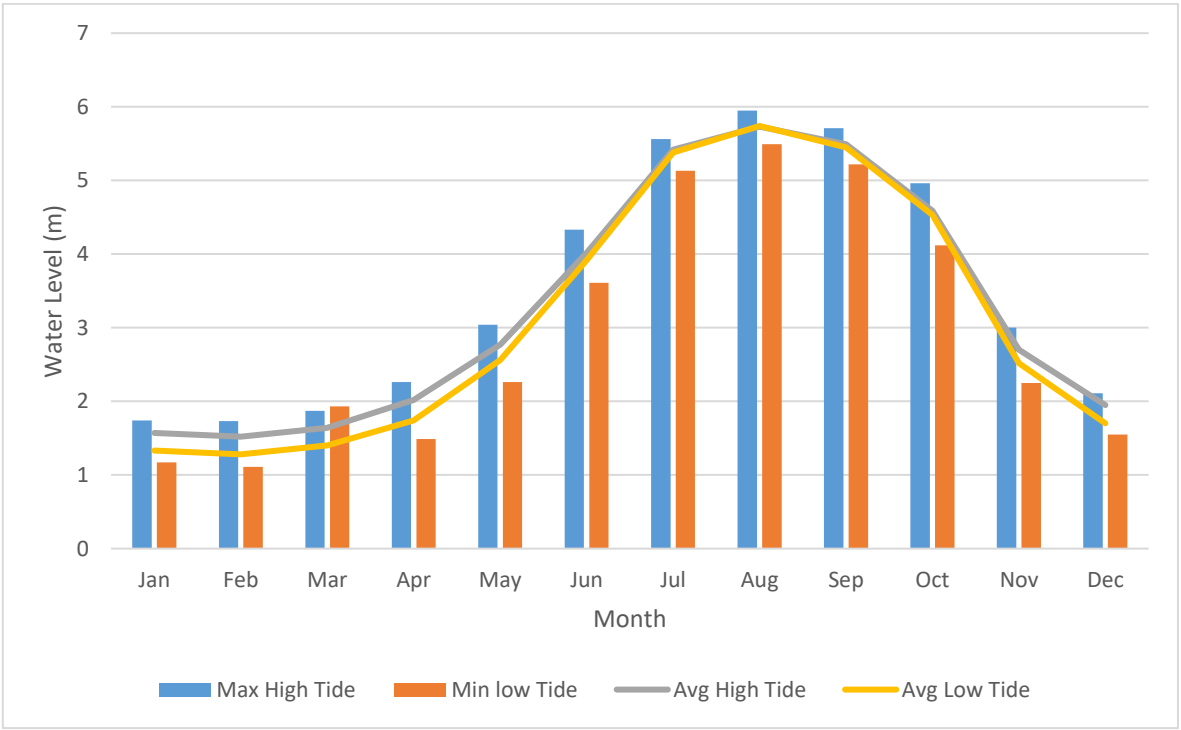


Figure 6.13: Water level at Lakhpur station in 2017

Discharge analysis

a) Average Seasonal Flow (1981-2017)

405. The annual discharge distributed seasonally in Shitalakhya is about 7% (980 Mm^3) in dry (December-March), 6% (842 Mm^3) in pre monsoon (April-May), 72% (10,545 Mm^3) in monsoon (June-September), and 16% (2,300 Mm^3) in post-monsoon (October-November) seasons. The flows are mainly concentrated during the monsoon period (highest) and pre monsoon (lowest), as shown in Figure 6.14.

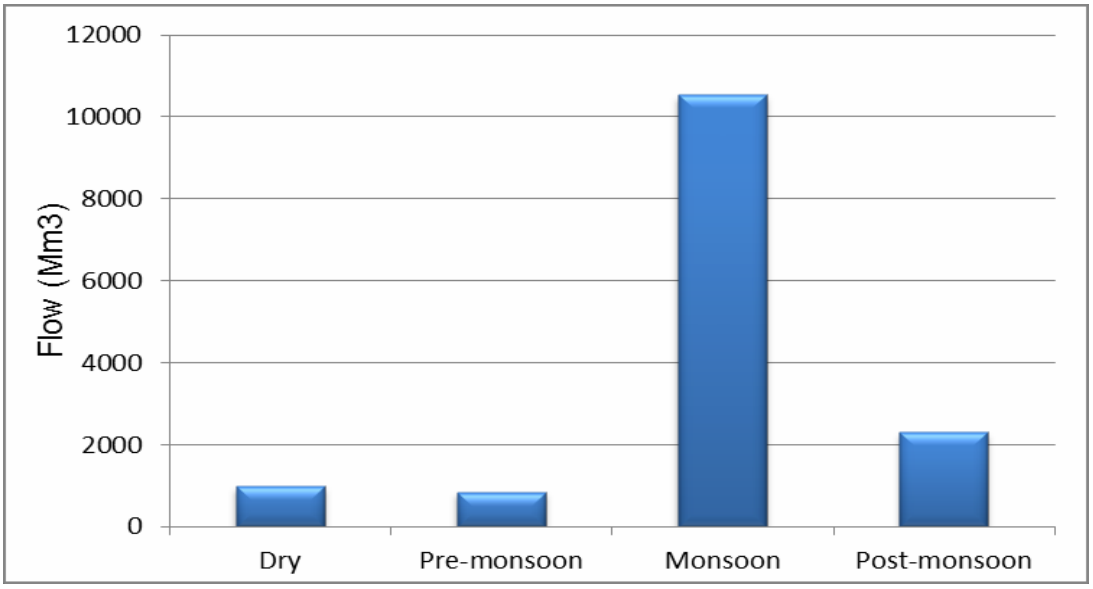


Figure 6.14: Average seasonal outflow from the basin during 1981-2017

b) Historical Annual Flow (1981-2017)

406. 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 Mm^3 while it has been reduced to 9,000 – 14,000 Mm^3 in the recent years.

c) River Water Flow and UFFL and PUFFL

407. It is estimated that the environmental flow of the Shitalakhya River is about 92.2 m^3/s and average dry season flow is about 83 m^3/s. The existing UFFL and PUFFL fertilizer factories of the Ghorasal have been withdrawing a total of about 0.5833 m^3/s (2,100 t/h; UFFL-1100 t/h and PUFFL-1000 t/h) from the Shitalakhya. The proposed GPUFP will require 0.5667 m^3/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.

408. Waste water from the fertilizer factories are disposed to lagoons and it creates adverse effect on the components of the ambient environment. NH^3 mixed water injects into the lagoon and after dilution and settling down, this water discharges into the Shitalkhya 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

409. 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.

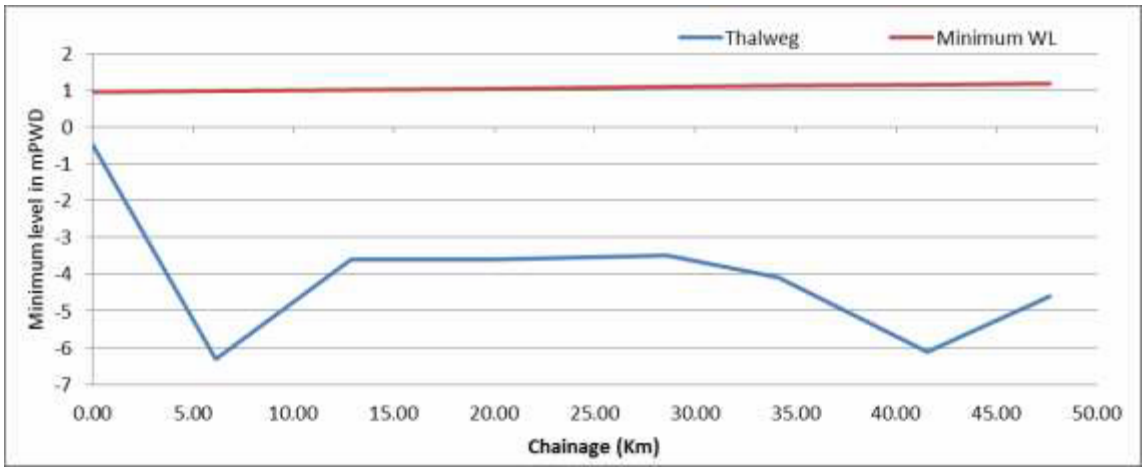


Figure 6.15: Long profile of the Shitalakhya River from Lakhpur to Demra

Groundwater Uses

410. 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

411. 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.

412. 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)

413. 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.

414. 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 SO_2 is insignificant and pollution of air is negligible.

6.2.7 Climate and Meteorology

415. 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).