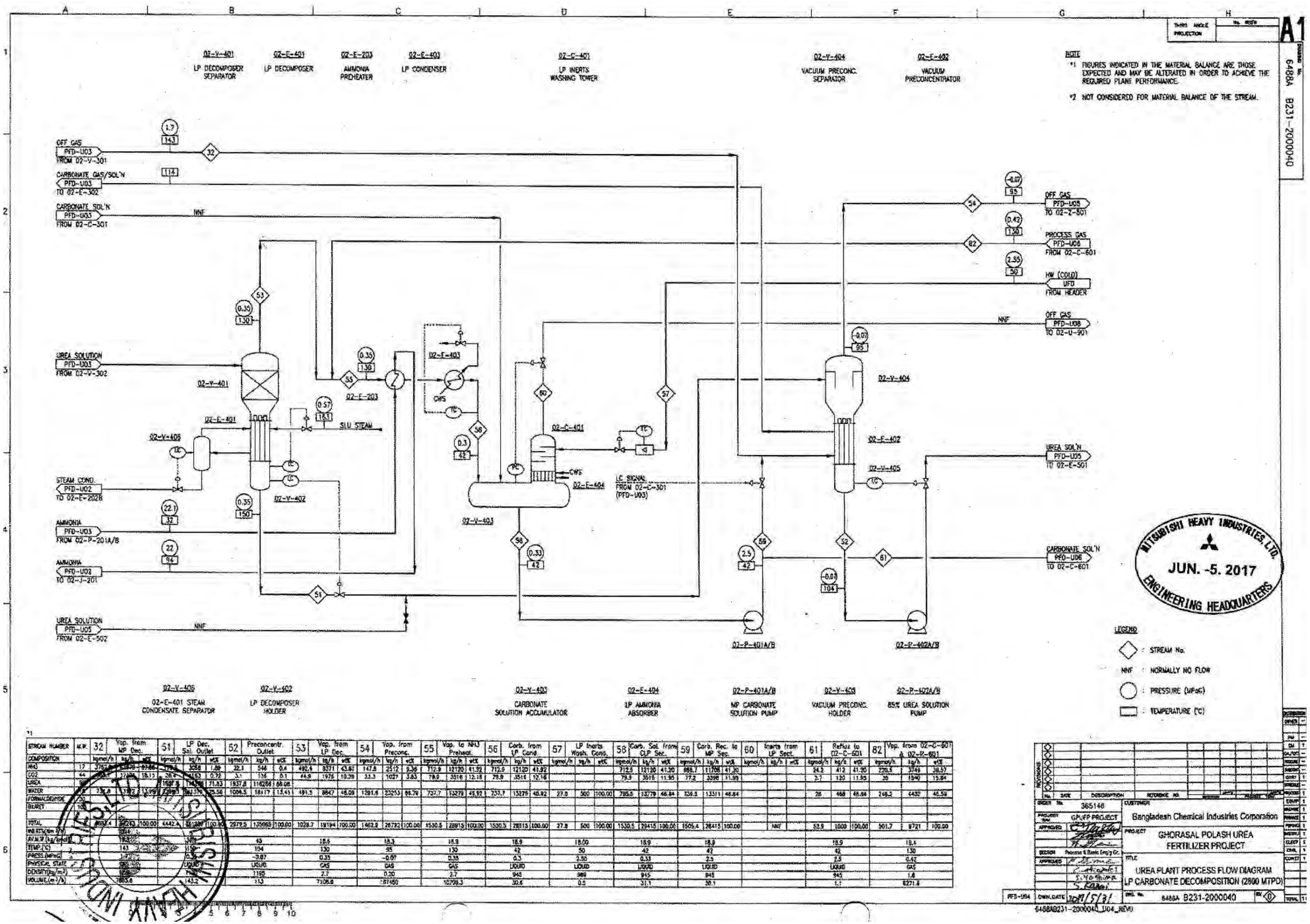
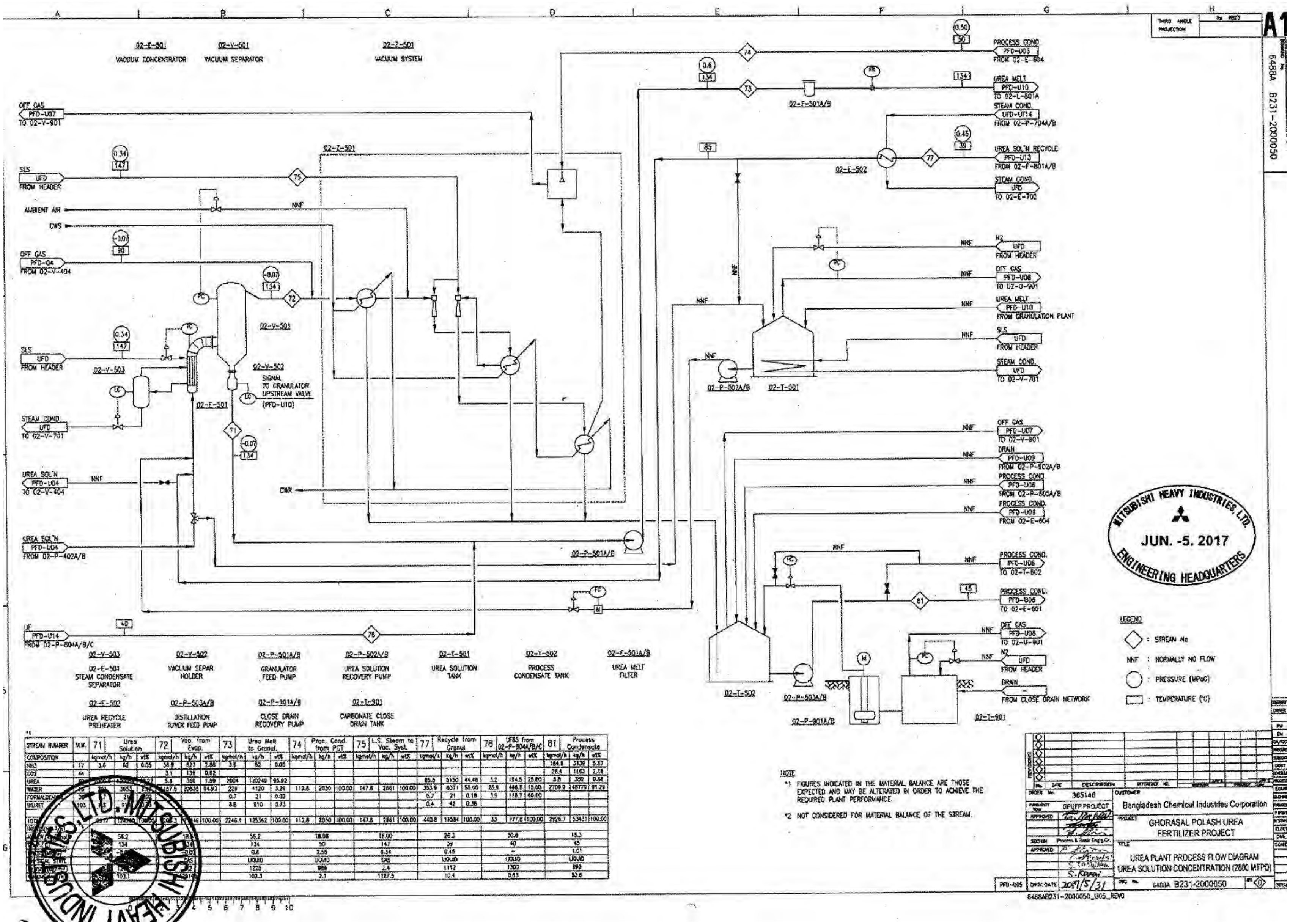

02-V-401
LP DECOMPOSER SEPARATOR
02-E-401
LP DECOMPOSER
02-E-203
AMMONIA PREHEATER
02-E-403
LP CONDENSER
02-C-401
LP INERTS WASHING TOWER
02-V-404
VACUUM PRECONC. SEPARATOR
02-E-402
VACUUM PRECONCENTRATOR
NOTE
*1 FIGURES INDICATED IN THE MATERIAL BALANCE ARE THOSE EXPECTED AND MAY BE ALTERATED IN ORDER TO ACHIEVE THE REQUIRED PLANT PERFORMANCE.
*2 NOT CONSIDERED FOR MATERIAL BALANCE OF THE STREAM.
OFF GAS
PFD-U03
FROM 02-V-301
CARBONATE GAS/SOL'N
PFD-U03
TO 02-E-302
CARBONATE SOL'N
PFD-U03
FROM 02-C-301
UREA SOLUTION
PFD-U03
FROM 02-V-302
STEAM COND.
PFD-U02
TO 02-E-202B
AMMONIA
PFD-U03
FROM 02-P-201A/B
AMMONIA
PFD-U02
TO 02-J-201
UREA SOLUTION
PFD-U05
FROM 02-E-502
NNF
SLU STEAM
CWS
LC SIGNAL
FROM 02-C-301
(PFD-U03)
OFF GAS
PFD-U05
TO 02-Z-501
PROCESS GAS
PFD-U06
FROM 02-C-601
HW (COLD)
UFD
FROM HEADER
OFF GAS
PFD-U08
TO 02-U-901
UREA SOL'N
PFD-U05
TO 02-E-501
CARBONATE SOL'N
PFD-U06
TO 02-C-601
02-P-401A/B
02-P-402A/B
MITSUBISHI HEAVY INDUSTRIES, LTD.
JUN. -5. 2017
ENGINEERING HEADQUARTERS
LEGEND
STREAM No.
NNF : NORMALLY NO FLOW
PRESSURE (MPaG)
TEMPERATURE (°C)
02-V-406
02-E-401 STEAM CONDENSATE SEPARATOR
02-V-402
LP DECOMPOSER HOLDER
02-V-403
CARBONATE SOLUTION ACCUMULATOR
02-E-404
LP AMMONIA ABSORBER
02-P-401A/B
MP CARBONATE SOLUTION PUMP
02-V-405
VACUUM PRECONC. HOLDER
02-P-402A/B
85% UREA SOLUTION PUMP
Bangladesh Chemical Industries Corporation
GHORASAL POLASH UREA FERTILIZER PROJECT
UREA PLANT PROCESS FLOW DIAGRAM
LP CARBONATE DECOMPOSITION (2800 MTPD)
6488A B231-2000040
A1



02-E-501 VACUUM CONCENTRATOR
02-V-501 VACUUM SEPARATOR
02-Z-501 VACUUM SYSTEM
MITSUBISHI HEAVY INDUSTRIES, LTD.
JUN. -5. 2017
ENGINEERING HEADQUARTERS
LEGEND
STREAM No
NNF : NORMALLY NO FLOW
PRESSURE (MPaG)
TEMPERATURE (°C)
Bangladesh Chemical Industries Corporation
GHORASAL POLASH UREA FERTILIZER PROJECT
UREA PLANT PROCESS FLOW DIAGRAM
UREA SOLUTION CONCENTRATION (2800 MTPD)
6488A B231-2000050

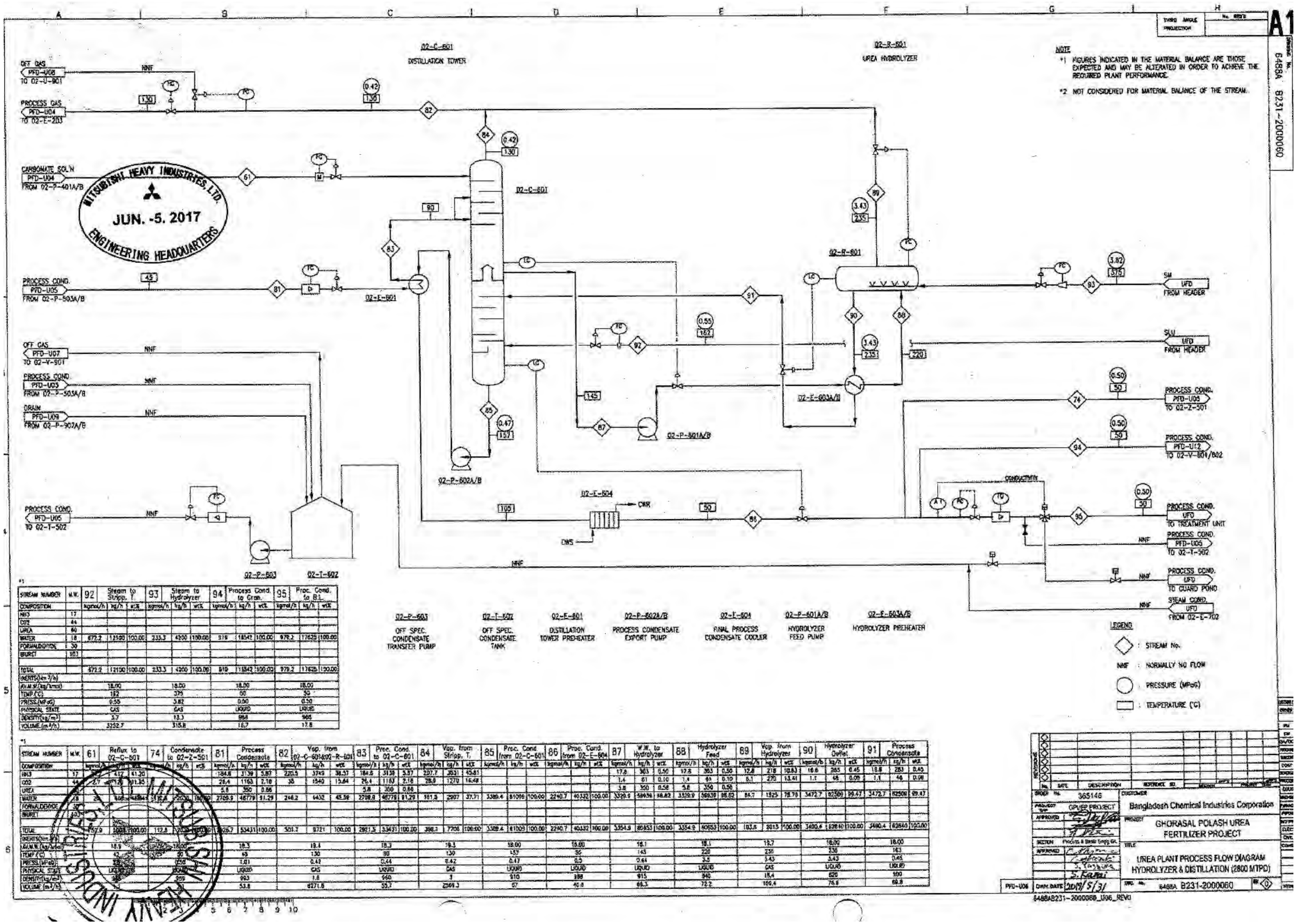


Figure 5.3: Process flow diagram for Urea synthesis

Urea Synthesis and NH_3, CO_2 Recovery at High Pressure

275. Urea is produced by synthesis from liquid ammonia and gaseous carbon dioxide. In the urea reactor, the ammonia and carbon dioxide react to form ammonium carbamate, a portion of which dehydrates to urea and water.

276. The liquid ammonia feed to Urea Plant is filtered through NH3 filters, then enters into NH3 recovery tower, and is collected in the ammonia receiver, it is drawn and pumped to about 2.31 MPa(g) pressure by means of ammonia booster pump. Part of this ammonia is sent to medium pressure absorber, as a reflux, the remaining part enters the high pressure synthesis loop.

277. The carbon dioxide feed drawn to the Urea Plant battery limits, from the CO2 removal unit in Ammonia Plant, at about 27 kPa(g) pressure and 43°C temperature, enters the CO2 compressor, and leaves it at a pressure of about 15.9 MPa(g) and 120°C.

Urea Purification and NH_3, CO_2 Recovery at Medium and Low Pressures

278. Urea purification and relevant overhead gases recovery take place in two stages at decreasing pressure, as follows:

- 1st stage at 1. 72 MPa(g) pressure (MP Recovery)
- 2nd stage at 0.38 MPa(g) pressure (LP Recovery)

279. It is pointed out that the exchangers where Urea purification occurs are called decomposers because in these equipment the residual carbamate decomposition takes place.

Process Condensate Treatment (PCT)

280. This section provides conditions to process the water containing NH_3-CO_2 and urea coming out of the vacuum system, so as to have a process condensate almost free from NH_3-CO_2 urea to be sent to utility unit.

Effluents

281. Every effort has been made in the design of urea melt sections to solve pollution problems. Urea solution sections normally have the following sources of pollution:

- ammonia from inert vents
- ammonia and urea in liquid effluents

282. Ammonia vented with inerts is minimized in Snamprogetti plants since the quantity of air required for passivation, is much less than in other processes. Furthermore water scrubbing is provided for all the vents to recover the ammonia in the inerts.

283. A liquid effluent treatment system (process condensate treatment system) fully integrated in the process is provided to recover ammonia by distillation. In addition a hydrolyzer is provided in order to eliminate completely the urea present in the process condensate.

284. Points of emission for gaseous effluents are: Continuous Urea Flare Stack, collects and burns gases continuously discharged from medium pressure section vent.

285. Discontinuous Urea Flare Stack, collects and burns vapors from high and low pressure section vents and from process condensate· treatment section vent in case of their opening.

286. Furthermore it collects vents from urea solution tank and carbonate close drain tank.

- 1st Vent Stack Separator

287. Collects gases discharged from vacuum section vent, process condensate tank vent, off spec. condensate tank vent and Storage tank vent.

- 2nd Vent Stack Separator

288. Collects gases discharged from process safety valves and rupture disks.

Process Condensate

289. The final contents of ammonia and urea in the treated condensate are such that it can be reused as boiler feed water after treatments in polishing unit.

Open Drain System

290. This system is designed for the collection of the liquid effluents accumulated from the Urea Synthesis and Granulation Plant and distribution to th.Process Condensate Treatment (PCT) System.

291. The chemical contaminated water which is mainly contaminated with ammonia and carbonate is collected from the following Urea Melt and Granulation Plant drain lines.

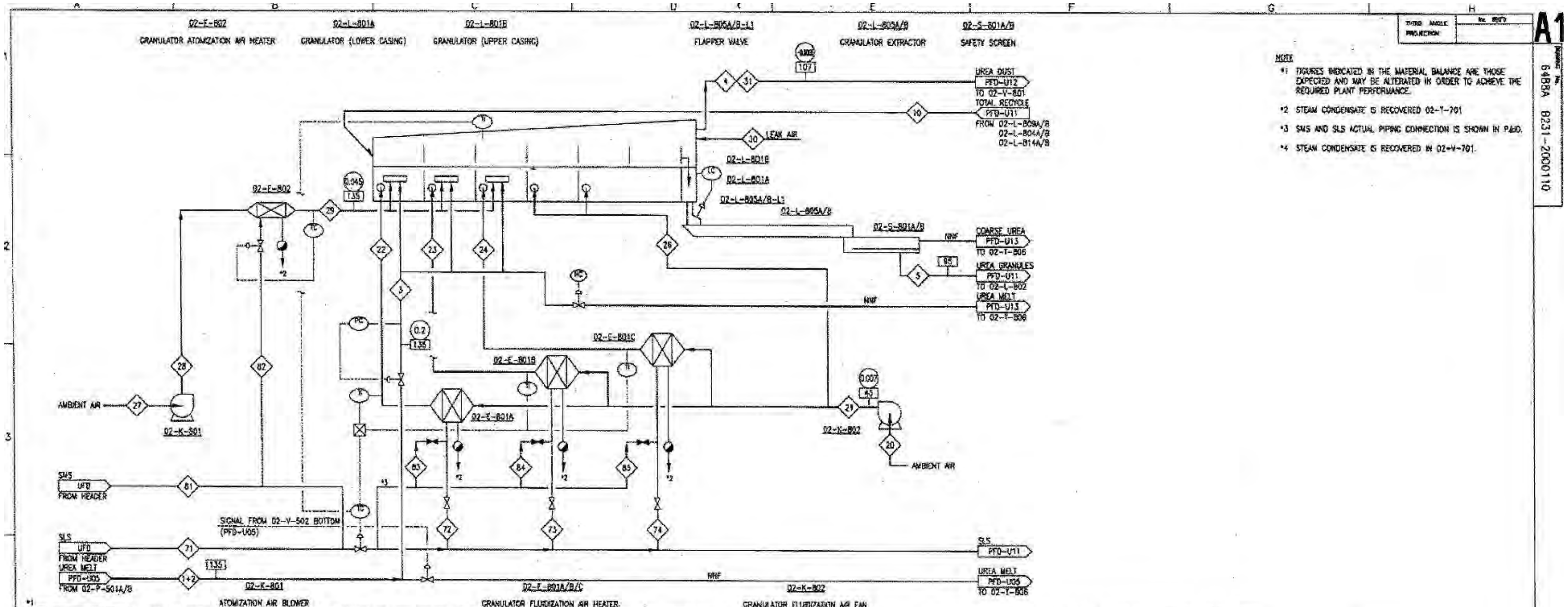
Granulation Urea Process

292. Feedstock is urea solution at a concentration of 97 % wt. and a temperature of 130 - 136°C. Formaldehyde solution is added to the urea solution. The total rate of addition is between 4.0 and 5.5 kg formaldehyde per ton of end product. The formaldehyde addition guarantees a free flowing product without further treatment. Standard formaldehyde solution may be used or, when locally available, liquid urea/formaldehyde pre-condensate is favored. This latter product of higher formaldehyde concentration can be stored for several months in steel tanks without degradation or polymerization, and gives outstanding results in a granulation plant.

293. The flow diagram is based on the addition of UF-85 liquid urea/formaldehyde pre-condensate. The process flow diagram of Granular Urea Plant is shown in Figure 5.4.

294. The used ambient air contains entrained urea dust and the traces of ammonia which is washed in the granulator dust scrubber. The cleaned air is then discharged to atmosphere by granulator scrubber exhaust fan through a stack.

295. Urea dust entrained with air in the granulator dust scrubber amounts for the whole plant to 3.5 % of plant production and is recovered as a 45 % solution which is recycled later on, to the urea plant concentration section.



*1

STREAM NUMBER	M.W.	1	UREA SOL. FROM UREA MELT PLANT		2	UF85 FROM 02-P-501A/B		3	UREA SOL. TO 02-L-801A		4	UREA DUST TO 02-V-801		5	UREA GRAN. TO 02-L-801B	
COMPOSITION		kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%
UREA	60	2003.0	120178.7	96.07	1.8	97.2	25.00	2004.6	120276.0	95.86	67.0	4022.1	98.50	2892.1	173524.1	98.50
FORMALDEHYDE	30	8.3	250.2	0.20	7.8	233.3	60.00	16.1	483.5	0.39	0.5	10.3	0.40	23.5	704.7	0.40
WATER	18	204.3	3677.8	2.94	3.2	58.3	15.00	207.6	3736.1	2.98	0.7	12.3	0.30	29.4	528.5	0.30
BIURET	103	8.9	913.2	0.73				8.9	913.2	0.73	0.3	32.7	0.80	13.7	1409.3	0.80
AMMONIA	17	3.7	62.5	0.05				3.7	62.5	0.05	0.01	0.2	0.005	0.5	8.8	0.005
DRY AIR	29															
MOISTURE	18															
TOTAL		2228.2	[illegible]	100.00	12.6	388.9	100.00	2240.8	125471.4	100.00	68.6	4083.3	100.00	2959.1	[illegible]	100.00
TEMP.(°C)			135			135			135			107			95	
PRESS.(MPaG)			-			-			0.20			-			-	
PHYSICAL STATE			LIQUID			LIQUID			LIQUID			SOLID			SOLID	
DENSITY(kg/m³)			-			1350			1210			-			-	
VOLUME.(m³/h)			-			0.29			103.70			-			-	

STREAM NUMBER	10	TOTAL RECYCLE TO 02-L-801B		20	FLUID. AIR TO 02-K-802		21	FLUID. AIR FROM 02-K-802		22,23,24	FLUID. AIR TO 02-L-801A		26	FLUID. AIR TO 02-L-801A		27	ATOMIZ. AIR TO 02-K-801		28	ATOMIZ. AIR FROM 02-L-801A	
COMPOSITION	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%
UREA	957.6	57458.3	98.50																		
FORMALDEHYDE	7.8	233.3	0.40																		
WATER	9.7	175.0	0.30																		
BIURET	4.5	466.7	0.80																		
AMMONIA	0.17	2.9	0.005																		
DRY AIR				14299.2	414676	96.69	14299.2	414676	96.69	2949.2	85527	96.69	5451.6	158095	96.69	2549.2	73927	96.69	2549.2	73927	96.69
MOISTURE				787.9	14182	3.31	787.9	14182	3.31	162.5	2925	3.31	300.4	5407	3.31	140.5	2528	3.31	140.5	2528	3.31
TOTAL	979.8	58333.3	100.00	15087.0	428858	100.00	15087.0	428858	100.00	3111.7	88452	100.00	15087.0	163502	100.00	2689.7	76455	100.00	2689.7	76455	100.00
TEMP.(°C)		65			36			45			45			45			36			77	
PRESS.(MPaG)		-			-			0.007			0.007			0.007			0.00			0.045	
PHYSICAL STATE		SOLID			GAS			GAS			GAS			GAS			GAS			GAS	
DENSITY(kg/m³)		-			-			-			-			-			-			-	
VOLUME.(m³/h)		-			-			-			-			-			-			-	

*1

STREAM NUMBER	M.W.	29	ATOMIZ. AIR TO 02-L-801A		30	LEAK AIR TO 02-L-801B		31	EXHAUST AIR TO 02-V-801	
COMPOSITION		kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%
UREA	60									
FORMALDEHYDE	30									
WATER	18									
BIURET	103									
AMMONIA	17									
DRY AIR	29	2549.2	7392	96.69	715.0	20734	96.69	17563.4	301338	96.76
MOISTURE	18	140.5	2528	3.31	39.4	709	3.31	947.4	17054	3.24
TOTAL		2689.7	[illegible]	100.00	754.4	21443	100.00	18510.8	318391	100.00
TEMP.(°C)			[illegible]			36			107	
PRESS.(MPaG)			0.045			0.00			-0.0005	
PHYSICAL STATE			GAS			GAS			GAS	
DENSITY(kg/m³)			-			-			-	
VOLUME.(m³/h)			-			-			-	

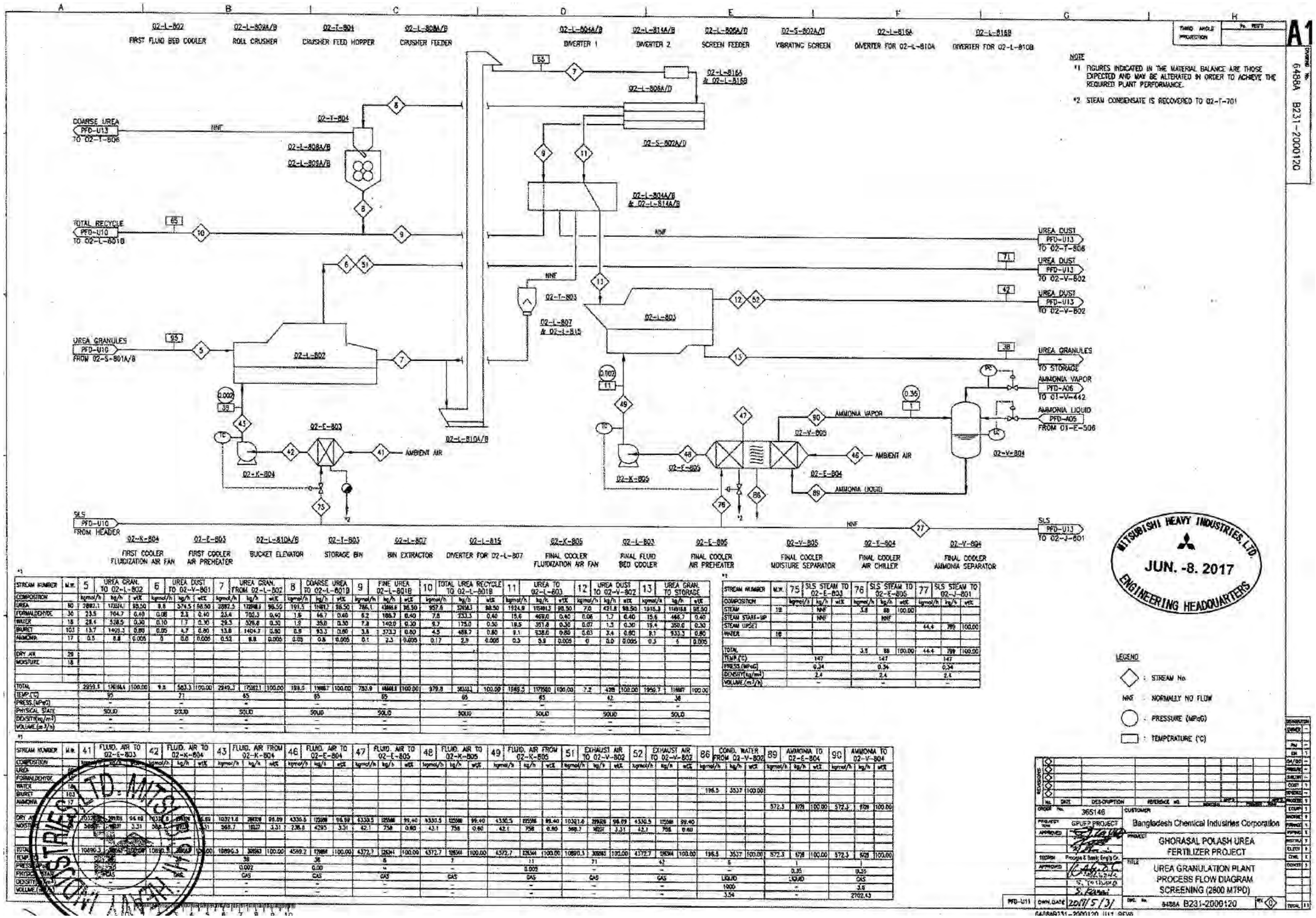
*1

STREAM NUMBER	M.W.	71	SLS STEAM		72,73,74	SLS STEAM TO 02-E-801A/B/C		83,84,85	SMS STEAM TO 02-E-801A/B/C		81	SMS STEAM		82	SMS STEAM TO 02-E-802	
COMPOSITION		kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%	kgmol/h	kg/h	wt%
STEAM	18	3.8	68	100.00		NNF			NNF		126.4	2276	100.00	126.4	2276	100.00
STEAM START-UP						NNF		121.8	2193	100.00	640.5	11528	100.00	47.4	853	100.00
STEAM UPSET																
WATER	18															
TOTAL		3.8	68	100.00				121.8	2193	100.00						
TEMP.(°C)			147			147			219			219			219	
PRESS.(MPaG)			0.34			0.34			2.17			2.17			2.17	
DENSITY(kg/m³)			2.4			2.4			11.4			11.4			11.4	
VOLUME.(m³/h)			28.48			-			-			-			-	

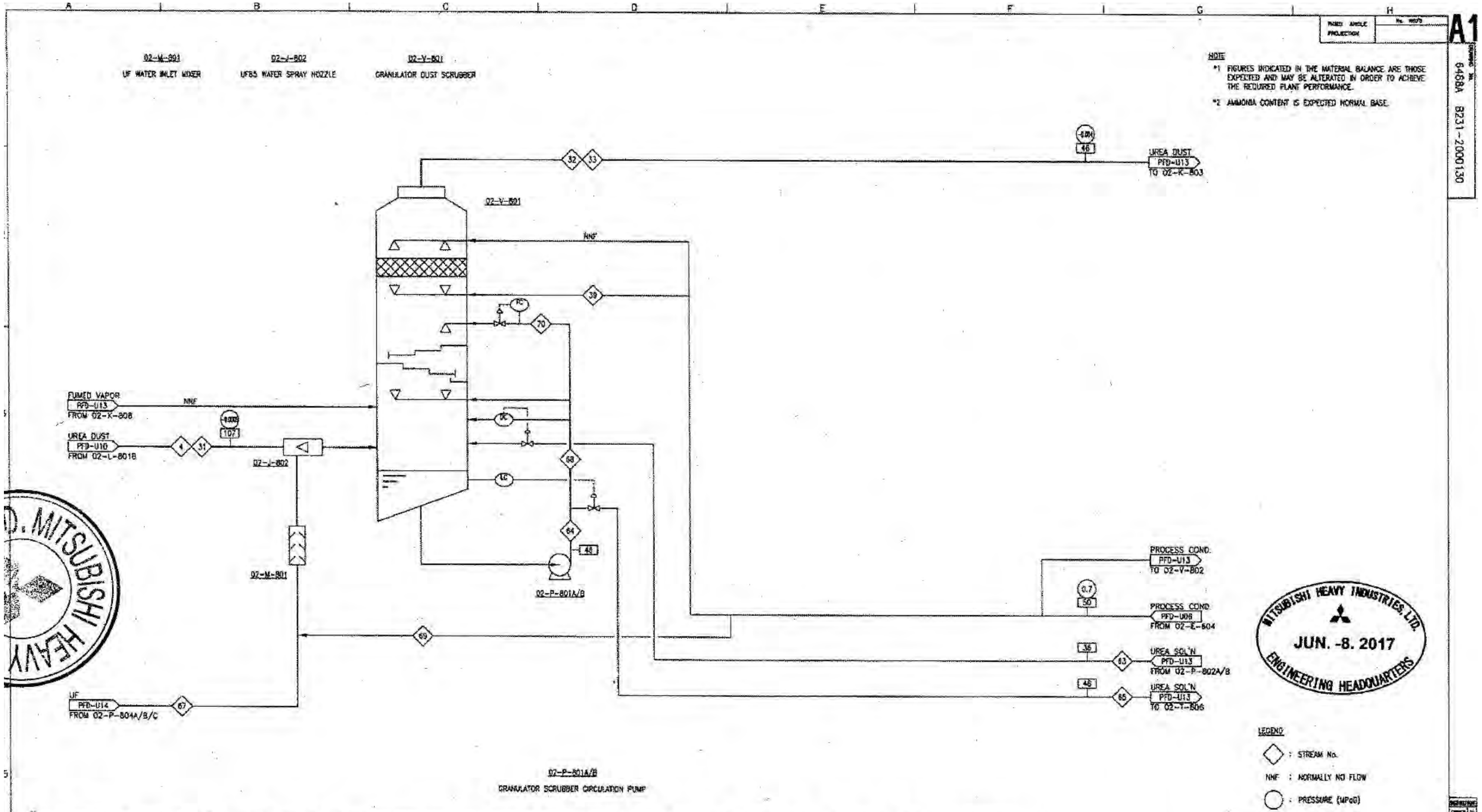
MITSUBISHI HEAVY INDUSTRIES, LTD.
JUN. -8. 2017
ENGINEERING HEADQUARTERS

LEGEND
◇ : STREAM No.
NNF : NORMALLY NO FLOW
○ : PRESSURE (MPaG)
▭ : TEMPERATURE (°C)

CUSTOMER: Bangladesh Chemical Industries Corporation
PROJECT: GHORASAL POLASH UREA FERTILIZER PROJECT
TITLE: UREA GRANULATION PLANT PROCESS FLOW DIAGRAM GRANULATION (2800 MTPD)
ORDER No. 365146
DWG. No. 6488A B231-2000110
DWG. DATE 2017/5/31
6488AB231-2000110_U10_REV0



A1
COARSE UREA
TOTAL RECYCLE
UREA GRANULES
UREA DUST
AMMONIA VAPOR
AMMONIA LIQUID
AMBIENT AIR
FIRST FLUID BED COOLER
ROLL CRUSHER
CRUSHER FEED HOPPER
CRUSHER FEEDER
DIVERTER 1
DIVERTER 2
SCREEN FEEDER
VIBRATING SCREEN
BUCKET ELEVATOR
STORAGE BIN
BIN EXTRACTOR
FINAL FLUID BED COOLER
MITSUBISHI HEAVY INDUSTRIES, LTD.
JUN. -8. 2017
ENGINEERING HEADQUARTERS
LEGEND
STREAM No.
NORMALLY NO FLOW
PRESSURE (MPaG)
TEMPERATURE (°C)
Bangladesh Chemical Industries Corporation
GHORASAL POLASH UREA FERTILIZER PROJECT
UREA GRANULATION PLANT
PROCESS FLOW DIAGRAM
SCREENING (2800 MTPD)
6488A B231-2000120



02-P-801A/B

GRANULATOR SCRUBBER CIRCULATION PUMP

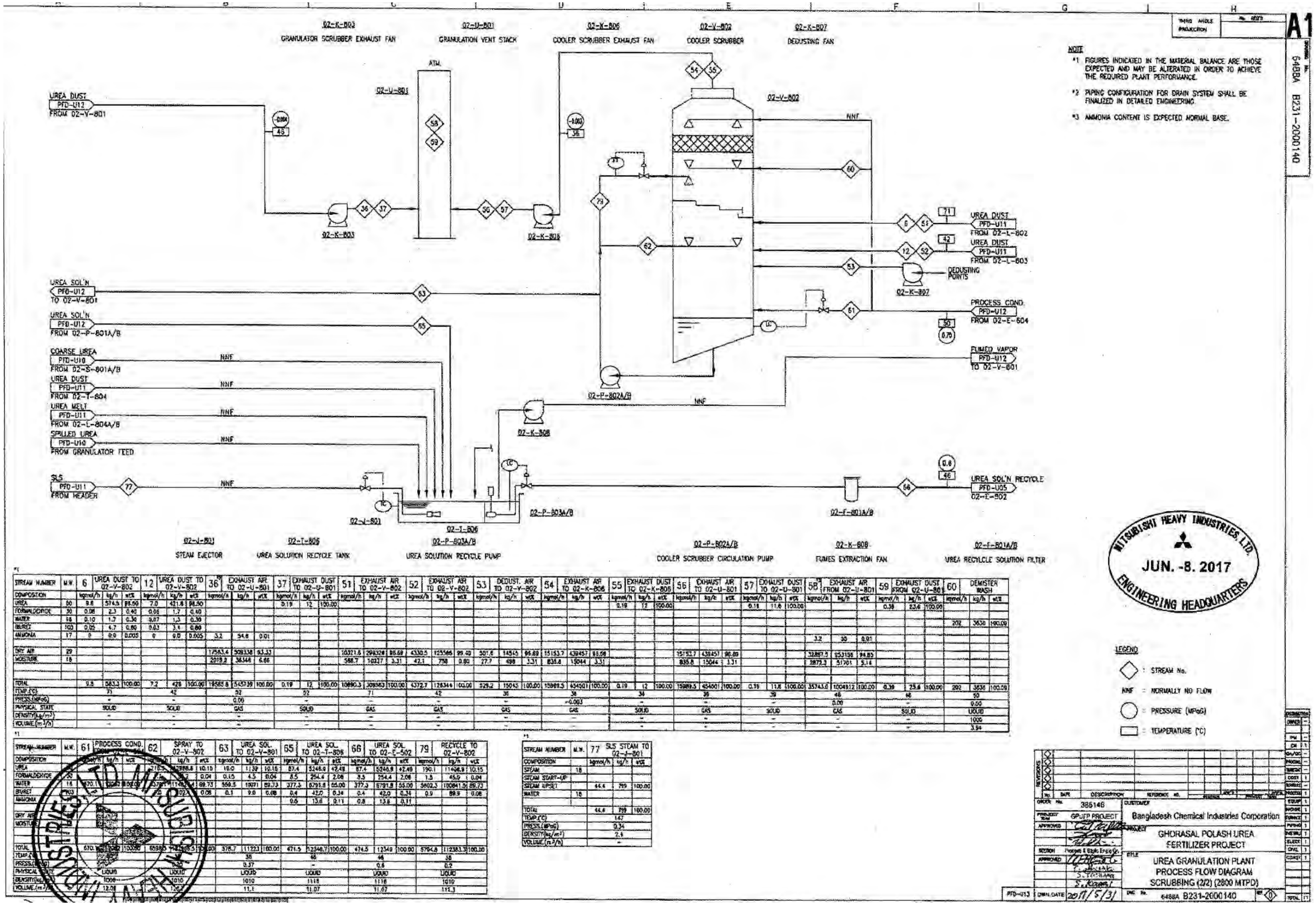
*1

STREAM NUMBER	M.W.	4 UREA DUST TO 02-V-801 kgmol/h	kg/h	wt%	31 EXHAUST AIR TO 02-V-801 kgmol/h	kg/h	wt%	32 EXHAUST AIR TO 02-K-803 kgmol/h	kg/h	wt%	33 EXHAUST DUST TO 02-K-803 kgmol/h	kg/h	wt%
UREA	60	67.0	4022.1	98.50							0.19	12	100.00
FORMALDEHYDE	30	0.5	16.2	0.40									
WATER	18	0.7	12.3	0.30									
BIURET	103	0.3	32.7	0.80									
AMMONIA	17	0.01	0.2	0.005				3.2	54.6	0.01			
DRY AIR	29				17563.4	509338	97.76	17563.4	509338	93.33			
MOISTURE	18				347.4	1764	3.24	2019.2	36346	6.66			
TOTAL		68.6	4083.3	100.00	18610.8	510808	100.00	19585.8	545739	100.00	0.19	12	100.00
TEMP.(°C)		107			107			46			45		
PRESS.(MPaG)		-			-0.0005			-0.004			-		
PHYSICAL STATE		SOLID			GAS			GAS			SOLID		
DENSITY(kg/m³)		-			-			-			-		
VOLUME (m³/h)		-			-			-			-		

STREAM NUMBER	39 PROCESS COND. TO 02-V-801 kgmol/h	kg/h	wt%	63 UREA SOL. TO 02-V-801 kgmol/h	kg/h	wt%	64 BOTTOM FLOW FROM 02-V-801 kgmol/h	kg/h	wt%	65 UREA SOL. TO 02-T-806 kgmol/h	kg/h	wt%
UREA				19.0	1138	10.15	1931.3	115879.5	42.49	87.4	5246.8	42.49
FORMALDEHYDE				0.5	4.0	0.04	187.3	5618.1	2.06	8.5	254.4	2.06
WATER	402.4	7244	100.00	559.5	10071	89.73	8333.2	149997.0	55.00	377.3	6791.6	55.00
BIURET				0.1	9.0	0.08	9.0	927.3	0.34	0.4	42.0	0.34
AMMONIA							17.6	300.0	0.11	0.8	13.8	0.11
DRY AIR												
MOISTURE												
TOTAL	402.4	7244	100.00	579.7	11223	100.00	10478.4	272721.8	100.00	474.5	12348.7	100.00
TEMP.(°C)	30			30			46			46		
PRESS.(MPaG)	0.70			0.37			0.20			-		
PHYSICAL STATE	LIQUID			LIQUID			LIQUID			LIQUID		
DENSITY(kg/m³)	1000			1010			1116			1116		
VOLUME (m³/h)	7.24			11.11			244.37			11.07		

STREAM NUMBER	67 UF85 TO 02-M-801 kgmol/h	kg/h	wt%	68 TOTAL RECYCLE kgmol/h	kg/h	wt%	69 PROCESS COND. TO 02-M-801 kgmol/h	kg/h	wt%	70 RECYCLE TO 02-V-801 kgmol/h	kg/h	wt%
UREA	1.6	97.2	25.00	1843.9	110632.6	42.49				862.2	51729.7	42.49
FORMALDEHYDE	7.8	233.3	60.00	178.8	5363.7	2.06				83.8	2505.0	2.06
WATER	3.2	58.3	15.00	7950.6	143205.2	55.00	138.7	2496.6	100.00	3720	66960.0	55.00
BIURET				8.6	885.3	0.34				4.0	413.9	0.34
AMMONIA				16.8	286.4	0.11				7.9	133.9	0.11
DRY AIR												
MOISTURE												
TOTAL	12.6	388.8	100.00	10004.6	260373.2	100.00	138.7	2496.6	100.00	4677.7	121745.5	100.00
TEMP.(°C)	38			46			30			46		
PRESS.(MPaG)	-			0.20			0.70			0.20		
PHYSICAL STATE	LIQUID			LIQUID			LIQUID			LIQUID		
DENSITY(kg/m³)	1250			1116			1000			1116		
VOLUME (m³/h)	0.29			233.3			2.50			109.1		

365146
GPUFP PROJECT
Bangladesh Chemical Industries Corporation
GHORASAL POLASH UREA FERTILIZER PROJECT
UREA GRANULATION PLANT PROCESS FLOW DIAGRAM SCRUBBING (1/2) (2800 MTPD)
PFD-U12
2017/5/31
6468A B231-2000130
6468AB231-2000130_U12_REV0



02-K-803 GRANULATOR SCRUBBER EXHAUST FAN
02-U-801 GRANULATION VENT STACK
02-K-806 COOLER SCRUBBER EXHAUST FAN
02-V-802 COOLER SCRUBBER
02-K-807 DEDUSTING FAN
UREA DUST PFD-U12 FROM 02-V-801
UREA SOL'N PFD-U12 TO 02-V-801
UREA SOL'N PFD-U12 FROM 02-P-801A/B
COARSE UREA PFD-U10 FROM 02-S-801A/B
UREA DUST PFD-U11 FROM 02-T-804
UREA MELT PFD-U11 FROM 02-L-804A/B
SPILLED UREA PFD-U10 FROM GRANULATOR FEED
SLS PFD-U11 FROM HEADER
UREA DUST PFD-U11 FROM 02-L-802
UREA DUST PFD-U11 FROM 02-L-803
DEDUSTING POINTS
PROCESS COND. PFD-U12 FROM 02-E-604
FUMED VAPOR PFD-U12 TO 02-V-801
UREA SOL'N RECYCLE PFD-U05 02-E-502
02-J-801 STEAM EJECTOR
02-T-806 UREA SOLUTION RECYCLE TANK
02-P-803A/B UREA SOLUTION RECYCLE PUMP
02-P-802A/B COOLER SCRUBBER CIRCULATION PUMP
02-K-808 FUMES EXTRACTION FAN
02-F-801A/B UREA RECYCLE SOLUTION FILTER
NOTE
*1 FIGURES INDICATED IN THE MATERIAL BALANCE ARE THOSE EXPECTED AND MAY BE ALTERATED IN ORDER TO ACHIEVE THE REQUIRED PLANT PERFORMANCE.
*2 PIPING CONFIGURATION FOR DRAIN SYSTEM SHALL BE FINALIZED IN DETAILED ENGINEERING.
*3 AMMONIA CONTENT IS EXPECTED NORMAL BASE.
MITSUBISHI HEAVY INDUSTRIES, LTD.
JUN. -8. 2017
ENGINEERING HEADQUARTERS
LEGEND
STREAM No.
NNF = NORMALLY NO FLOW
PRESSURE (MPaG)
TEMPERATURE (°C)
Bangladesh Chemical Industries Corporation
GHORASAL POLASH UREA FERTILIZER PROJECT
UREA GRANULATION PLANT PROCESS FLOW DIAGRAM SCRUBBING (2/2) (2800 MTPD)
6488A B231-2000140
A1

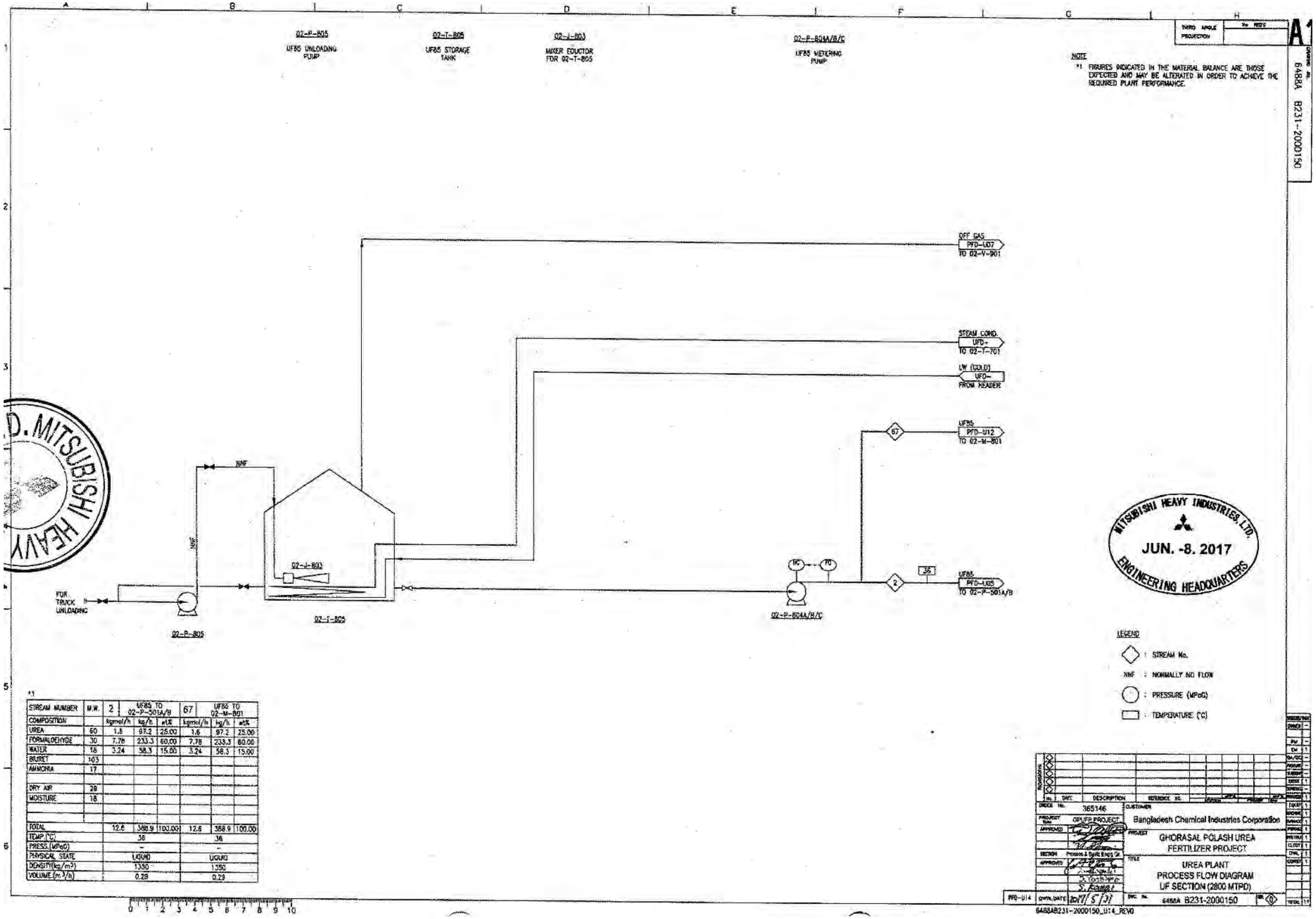


Figure 5.4: Process flow diagram of Granular Urea Plant

Dust Emission and Recovery

296. There are three main locations where urea dust laden air originates from:

- -Granulator,
- -First fluid bed cooler and
- -Final fluid bed cooler.

297. In addition there are various dedusting points i.e. top of the bucket elevators, roll crushers, vibrating screens, that merge into the duct to the dedusting fan.

Ammonia Emission

298. The ammonia present in the urea melt coming from the urea solution plant is stripped out in the granulator and. ends up in the granulator exhaust air stream. The ammonia abatement system located at the granulator will reduce the ammonia content in the air exhaust air stream before sending to Granulator Dust Scrubber.

CO_2 Recovery Process

- Integration of CO_2 recovery facility

299. The CO_2 recovery plant is designed to recover CO_2 from the flue gas of Natural gas reformer. The flue gas is extracted from the stack and brought to the CO_2 recovery plant by the Flue gas blower. The flue gas is emitted directly to the atmosphere through the stack in case of Flue gas blower failure.

- CO_2 recovery plant

300. The CO_2 recovery plant consists of three main sections; (i) Flue gas quenching section, (ii) CO_2 absorption section, and (iii) Solvent regeneration section. The following block flow diagram shows the plant configuration in Figure 5.5.

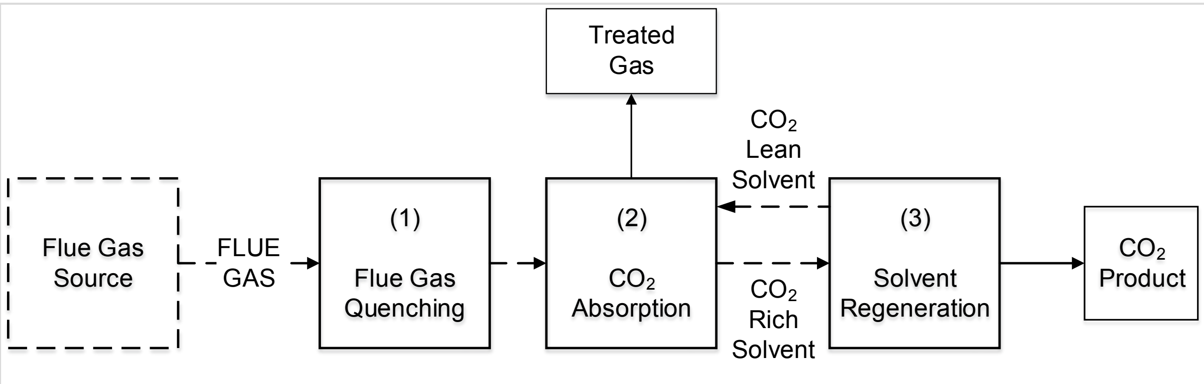


Figure 5.5: Block Flow Diagram of the CO_2 recovery plant

5.3 Description of Major Components

5.3.1 Land Requirement

301. The area of the proposed project site is about 110 acres including the required land area for the construction of the new RMS. The site is partially fallow land on the eastern side of the existing PUFFL and particularly to the Compressor House having bushes, trees, civil structures (buildings) and tin shed warehouses exist. Adequate land is available within the

property line of PUFFL and a small portion of UFFL along with 28 acres of lagoon and no land acquisition will be required for the proposed new fertilizer factory.

5.3.2 Project Layout Including Site Drainage

302. The detailed layout plan showing all structures, road network, drainage network, different pollution abatement measures, waste water and effluent treatment facilities shall be developed by the EPC contractor before construction. The EPC contractor shall be appointed after receiving approval of the EIA report from DoE. BCIC shall submit the final layout plan to DoE for their review and comments considering availability of land, landscape, ground features, elevation, environmental aspects and social concerns recommended by the EIA study. However, a preliminary and detail layout plan of the proposed GPUFP project is presented in Figure 5.6 and drainage general plan is presented in Figure 5.7. The EPC contractor will need to show waste storage and sorting areas as well as a secured disposal location on the layout plan. Given the sensitivity of the demolition activity, it is recommended that the EPC Contractor is certified on OHSAS 18000. The Environmental Management Plan (EMP) and the Emergency Preparedness Plan in this report provides more details in this context.

303. There is an existing drainage network in PUFFL for storm water runoff. Runoff is collected through open drains and stored in a common basin for sedimentation. The overflow is then connected with another drain to finally discharge to the condenser cooling water discharge channel for ultimate disposal to the Shitalakhya River.

304. The run-off drainage network of PUFFL requires improvement with the construction of the proposed Project as new equipment will be installed and existing structures will be demolished. Segregation of storm water run-off and cooling water discharge may be required to avoid possible contamination at the disposal site close to the jetty area. Moreover, it is recommended to avoid demolition work during the monsoon season.

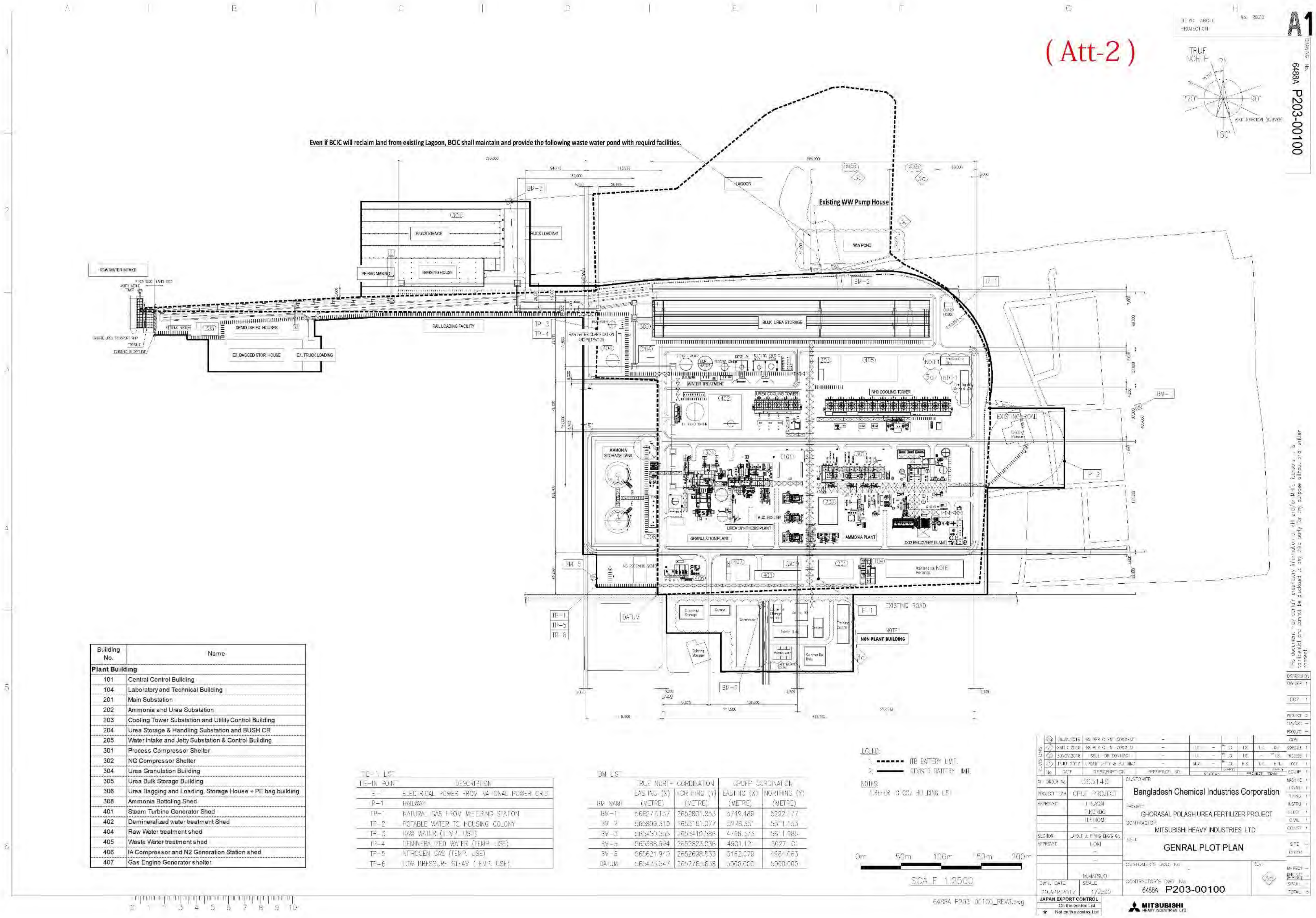
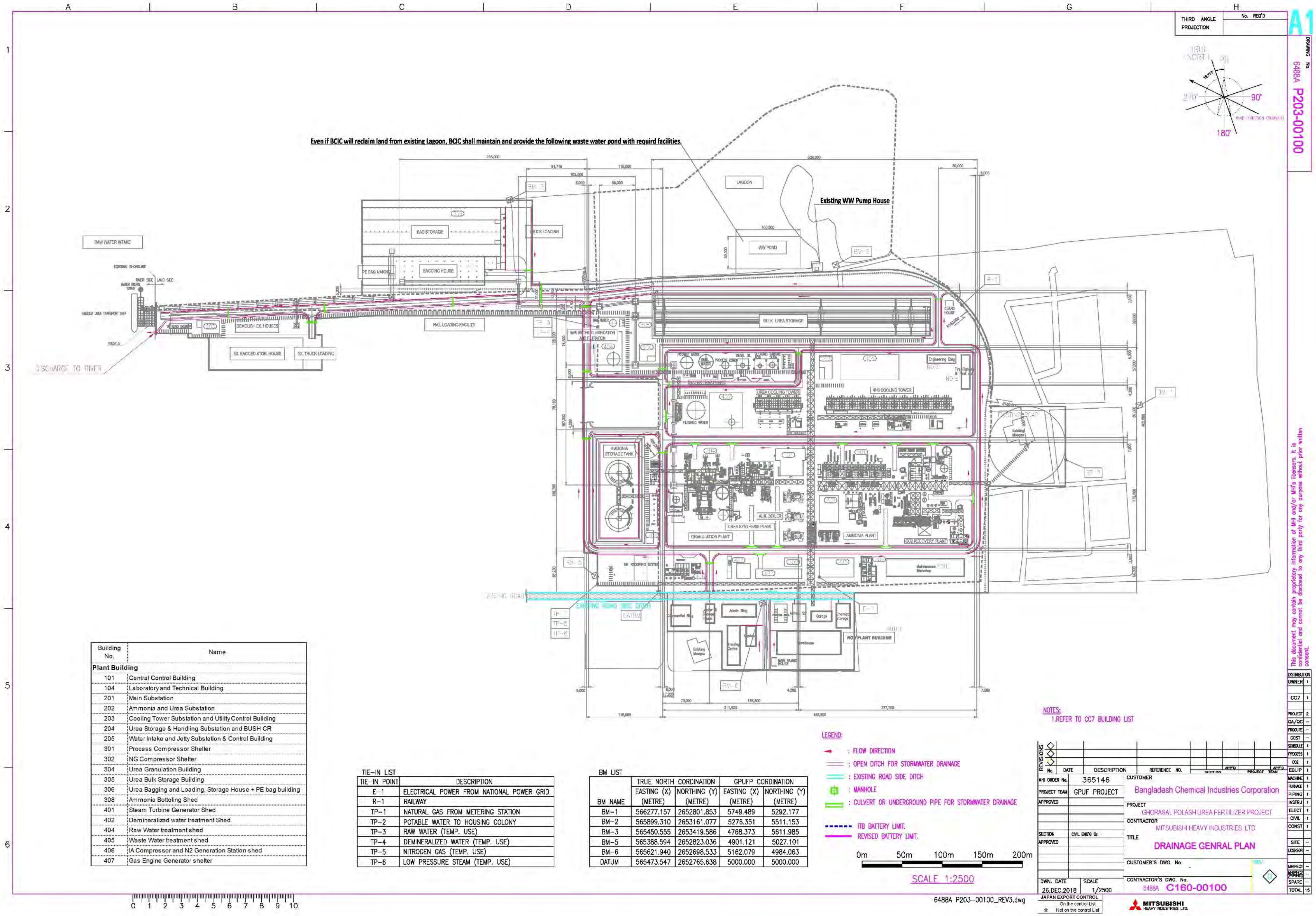


Figure 5.6: Detail layout of the GPUFP



Building No.	Name
Plant Building	
101	Central Control Building
104	Laboratory and Technical Building
201	Main Substation
202	Ammonia and Urea Substation
203	Cooling Tower Substation and Utility Control Building
204	Urea Storage & Handling Substation and BUSH CR
205	Water Intake and Jetty Substation & Control Building
301	Process Compressor Shelter
302	NG Compressor Shelter
304	Urea Granulation Building
305	Urea Bulk Storage Building
306	Urea Bagging and Loading, Storage House + PE bag building
308	Ammonia Bottoling Shed
401	Steam Turbine Generator Shed
402	Demineralized water treatment Shed
404	Raw Water treatment shed
405	Waste Water treatment shed
406	IA Compressor and N2 Generation Station shed
407	Gas Engine Generator shelter

TIE-IN LIST

TIE-IN POINT	DESCRIPTION
E-1	ELECTRICAL POWER FROM NATIONAL POWER GRID
R-1	RAILWAY
TP-1	NATURAL GAS FROM METERING STATION
TP-2	POTABLE WATER TO HOUSING COLONY
TP-3	RAW WATER (TEMP. USE)
TP-4	DEMINERALIZED WATER (TEMP. USE)
TP-5	NITROGEN GAS (TEMP. USE)
TP-6	LOW PRESSURE STEAM (TEMP. USE)

BM LIST

BM NAME	TRUE NORTH CORDINATION EASTING (X) (METRE)	TRUE NORTH CORDINATION NORTHING (Y) (METRE)	GPUFP CORDINATION EASTING (X) (METRE)	GPUFP CORDINATION NORTHING (Y) (METRE)
BM-1	566277.157	2652801.853	5749.489	5292.177
BM-2	565899.310	2653161.077	5276.351	5511.153
BM-3	565450.555	2653419.586	4768.373	5611.985
BM-5	565388.594	2652823.036	4901.121	5027.101
BM-6	565621.940	2652698.533	5162.079	4984.063
DATUM	565473.547	2652765.638	5000.000	5000.000

Figure 5.7: Drainage general plan of the GPUFP

5.3.3 Plant Components of the Layout Plan

305. The major components of the proposed Plant layout are listed in Table 5.2.

Table 5.2: Major components of the layout plan

Code No.	Components	Code No.	Components
101	Central Control Building	305	Urea Bulk Storage Building
104	Laboratory and Technical Building	306	Urea Bagging and Loading, Storage House + PE Bag BuildingAmmonia Plant
201	Main Substation	308	Ammonia Bottling Shed
202	Ammonia and Urea Substation	401	Steam Turbine Generator Shed
203	Cooling Tower Substation and Utility Control Building	402	Demineralized Water Treatment Shed
204	Urea Storage and Handling Substation and BUSH CR	404	Raw Water Treatment Shed
205	Water Intake and Jetty Substation and Control Building	405	Waste Water Treatment Shed
301	Process Compressor Shelter	406	IA Compressor and N_2 Generation Station
302	NG Compressor Shelter	407	Gas Engine Gebnerator Shelter
304	Urea Granulation Plant	--	Drainage System

306. Drainage of storm water and effluent generated from the condenser cooling will follow the existing drainage system of the GPUFP. The new drainage network to be built for the proposed Plant will be connected with the existing drainage network.

5.4 Utility and Offsite Systems

5.4.1 Water Requirements

307. At present, approximately 0.583 m^3/s (2,100 t/h) 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 m^3/s (2,040 t/h) (Design value) for the proposed Project; after storage tank it would be about 0.322 m^3/s (1159 m^3/h); and after clarified water tank it would be about 0.283 m^3/s (1,020 t/h). The source of water for all cooling, steam generation and other purposes including potable water and losses would be surface water from the Shitalakhya River at an amount of about 1,020 t/h. A utility flow diagram of waste water treatment system is presented in Figure 5.8 for the new construction of the Project. Specific relative consumption of water for the GPUFP (production: 2,800 TPD) will be significantly low compared to the urea production from the existing facilities (UFFL and PUFFL altogether production: 900 TPD) due to adoption of modern and efficient technology. There are a number of small-medium industries along the left bank of the Shitalakhya River. In the 10 km study area, industries that abstract water from the river are Desh-Bandu Sugar Mills, Ghazi Textile and Ghorasal Power Station. The following Table 5.3 shows the supply and distribution of water.

Table 5.3: Breakup of water supply and distribution

Sl. No.	Items	Quantity of Water (m^3/s)
A.	**Supply**	
A1	*Raw Water Withdrawal from Shitalakhya River*	0.5667
A2	*After Storage Tank*	0.3219
A3	***After Clarified Water Tank***	***0.2833***
B.	**Distribution**	
B1.	**Makeup Water**	**0.2458**
	(i) Cooling tower evaporation loss	0.1756
	(ii) Drift loss	0.0125
	(iii) Blow down loss	0.0444
	Sub-Total (Total Water Loss in Cooling Tower)=	***0.2325***
B2.	**Other Losses as Waste Water**	
	(i) Cooling tower back wash	0.0133
	(ii) Loss from potable water	0.0083
	(iii) Loss from Demi. Unit	0.0044
	(iv) Loss as service water	0.0042
	(v) Oily contaminated water	0.0039
	(vi) Non-Oily waste water	0.0031
	(vii) CO_2 recovery plant	0.0022
	(viii) Loss from Caustic soda, Sulfuric acid, coagulation and Polymer injection system	0.0114
	Sub-Total (Other Losses as Waste Water)=	***0.0508***
	Total Distribution (B=B1+B2)	**0.2833**

Source: Utility flow diagram for waste water treatment system

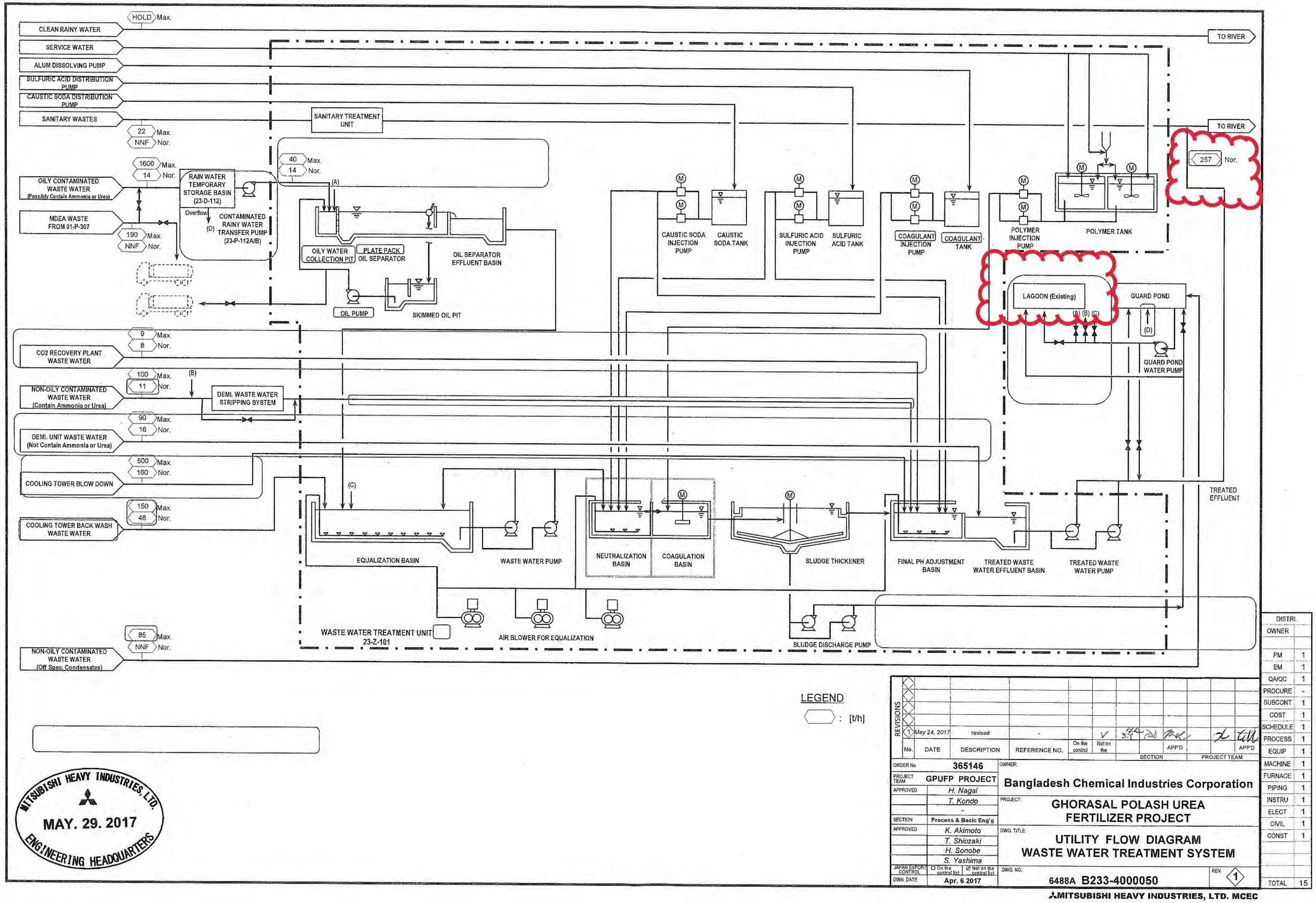


Figure 5.8: Utility flow diagram for waste water treatment system

5.4.2 Cooling Water System

308. The Project has two cooling water systems which are separated into normal and essential. Essential cooling water system is connected to essential cooling water pump.

Cooling Tower

309. The Plant will have two cooling towers namely Urea cooling tower and ammonia and utility cooling tower. Cooling towers are mechanical heat rejection device to remove process heat and cool the working fluid to near the ambient air temperature. The cooling tower is counter flow type.

Chemical Injection

310. In order to maintain the required quality of cooling water, the following chemicals are added separately to each basin of cooling tower:

- Sodium Hypochlorite for Biocide Agent
- Sulphuric Acid for pH control
- Corrosion inhibitor
- Scale inhibitor
- Microbiological Control Agent (if required)

Make Up Water and Blow Down

311. During continuous operation of cooling tower, circulated water from the cooling tower system is lost by way of evaporation and drifts which ultimately cause an increasing salinity in the system. Therefore, to maintain the limit of salinity, a small quantity of water is continuously drained-off from the discharge header of the circulating water pumps as blow down to waste water system by manual. Accordingly, all these losses from the system are made up by continuous feed of raw water to the basin under level control. About 0.102 m^3/s (885 t/h) of surface water will be used as cooling water make-up for two cooling towers with a total of 45,840 m3 water as one time cooling tower filling water.

Side Filtration

312. Normally, around 2% of the circulating water will be filtered from the discharge header of circulating pumps and circulated back to the basin to remove the suspended solids and control the limit of total suspended solids in circulating water.

Circulation

313. Ammonia, Utility and Offsite unit circulation is established by two steam turbine driven pumps and two motor driven pumps. One motor driven pump shall be kept as stand-by for auto-start. Urea unit has two motor driven circulating pumps, out of which one shall be kept as stand-by for auto-start.

Priority Supply

314. Considering the need of uninterrupted supply of cooling water for some critical equipment/ exchangers, a separate priority header, which is called essential cooling water line. This essential cooling water header (ECW) feeds to following 'equipment mainly:

315. For Ammonia Plant

- Blow Down Cooler
- Critical Oil Coolers

316. For Urea Plant

- Seal Water Coolers
- Flushing Condensate Cooler
- Critical Oil Coolers

317. For Utility and Offsite Facilities

- Auxiliary Boiler Blow Down Cooler
- Ammonia Storage Refrigeration Unit
- Instrument Air Compressor
- Critical Oil Coolers

a) System Performance

- Ammonia, Utility and Offsite Cooling Water System
  - Circulation Capacity: Design 42,000 t/h; Normal 34,802 t/h
  - Temperature: Supply Max. 33°C; Return Max. 43°C
- Urea Cooling Water System
  - Circulation Capacity: Design 9,500 t/h; Normal 7,592 t/h
  - Temperature: Supply Max. 33°C; Return Max. 43°C

b) Equipment Performance

- For Ammonia. Utility and Offsite Cooling Water System
  - Cooling Tower: One set with counter flow type
  - Cooling Water Circulation Pump: 3 running+1 stand-by with rated capacity of 14, 100 m3/h each·
- For Essential Cooling Water System
  - Essential Cooling Water Circulation Pump: 1 running+1 stand-by with rated capacity of 2,900 m3/h each
- For Urea Cooling Water System
  - Cooling Tower: One set with counter flow type
  - Cooling Water Circulation Pump: 1 running+1 stand-by with rated capacity of 9,700 m3/h each·

5.4.3 Raw Water Treatment System

Raw Water System

318. Raw Water Intake facilities are located on the left bank of the Shitalakhya River. The raw water is pumped to settling basins located in the Jetty area and transferred to the Raw Water Storage Tank through the pipeline of about 1.1 km long.

319. Raw water will be received in Intake Section from the Shitalakhya river at an amount of about 0.567 m^3/s (2040 t/h) and stored in Raw Water storage Tank (Figure 5.9). Raw water from Storage Tank will be transferred to Raw Water Clarification and Filtration Unit at an

amount of about 0.322 m^3/s (1159 t/h). After clarified the net consumable water will be about 0.283 m^3/s. Raw Water Clarification and Filtration Unit shall be capable of producing filtered water for Fire Water; Cooling Water Make-up, Potable Water, Service Water and Demineralized Water Unit Feed. Raw Water Clarification and Filtration Unit consists of the clarifier and sand filter.

320. Large suspended solids are settled by gravity on the bottom of the basin, and it is removed by the scraper and sent back to the river by mud removal pump.

321. Raw water is fed to the clarifier where the suspended solids are settled. Chemical injection units are provided for sedimentation of suspended solids. Sludge from the clarifier is sent back to the Shitalakhya River with due treatment and meeting the applicable DoE's standard.

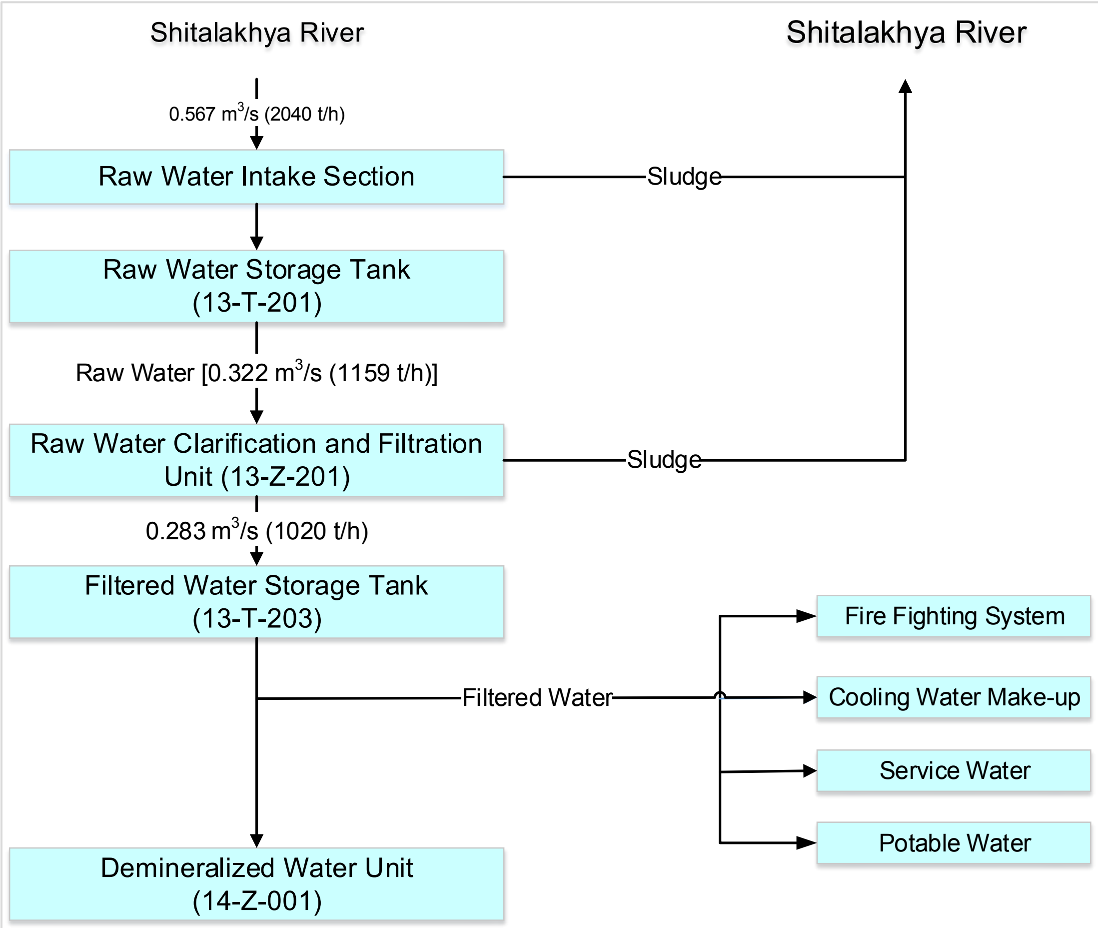


Figure 5.9: Block diagram of water intake and distribution

Potable and Service Water System

322. Filtered water from Raw Water Clarification and Filtration Unit is applied for potable water and service water. The system shall consist of Chlorination Unit for Potable Water at an amount of about 0.0417 m^3/s (150 t/h). The system shall consist of Service Water Treatment Unit with the capacity of at least 0.0083 m^3/s (30 t/h).

Demineralized Water and Condensate Treatment

323. The Demineralized Water Unit consists of the Reverse Osmosis (RO) system and ion exchanger. Filtered water in filter water storage tank is fed to the Reverse Osmosis (RO) system and ion exchangers in the Demineralized Water Unit for demineralization. The Condensate Treatment Unit consists of the ion exchangers. The sources of condensate are: (i) Stripped process condensate from the Ammonia Plant; and (ii) Stripped process condensate from the Urea Plant. The source of demi water is filtered water from Raw Water Clarification and Filtration Unit.

324. Effluent from the neutralization pit for Demineralized Water Unit is transferred by neutralization pump and fed to the Waste Water Treatment System (WWTS) at an amount of at least 0.0569 m^3/s [205 t/h (outlet)].

325. The regeneration stage of the ion exchangers receives chemicals from the sulphuric acid and caustic soda distribution system and injects chemical at the regeneration.

326. Spent regenerant, blowdown and waste water from the Condensate Treatment Unit are discharged into the neutralization pit for the Condensate Treatment Unit lined with chemical resistant material. Air for the polishing unit and neutralization pit is supplied by the mixing air blower for Condensate Treatment Unit.

327. Effluent from the neutralization pit for Condensate Treatment Unit is transferred by neutralization pump and fed to the Waste Water Treatment System (WWTS) at an amount of 0.0375 m^3/s [135 t/h (Inlet)]. The following block diagram in Figure 5.10 shows the process condensate and filtered water.

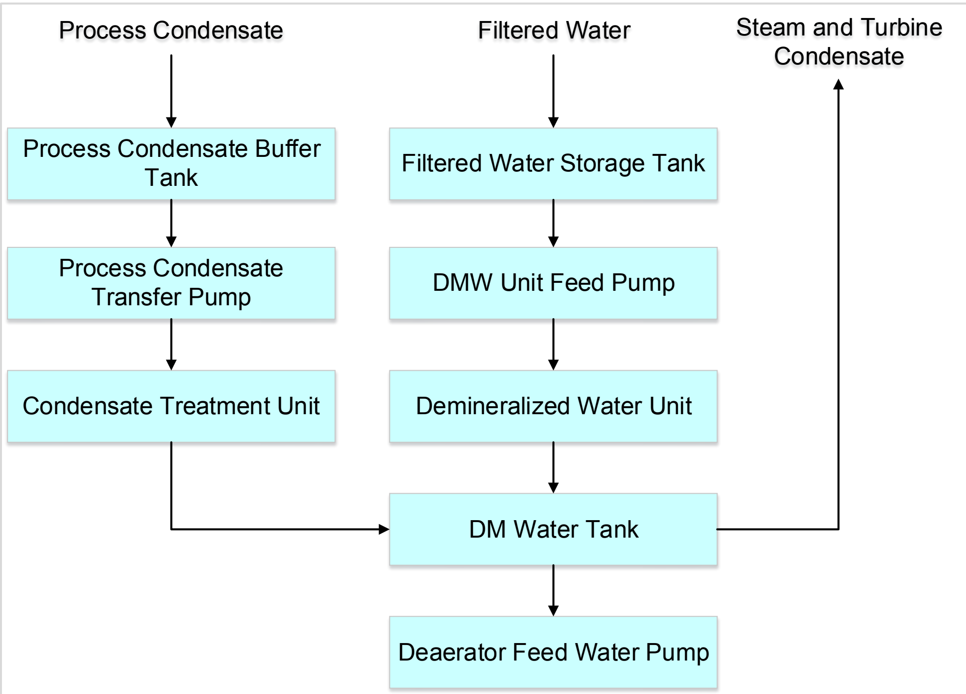


Figure 5.10: Block diagram of process condensate and filtered water

Boiler Feed Water System

328. The chosen boiler water treatment program will be All Volatile Treatment (AVT) using volatile oxygen scavenger (Hydrazine) and neutralizing amine (Ammonia).

Steam Generation System

329. The Steam Turbine Generator is condensing type. In normal operation, all steam generated in the Ammonia Plant, and Auxiliary Boiler is self-balanced without any venting. Auxiliary Boiler has a remote automatic control, combustion safeguards with flame detection and sampling and analyzer system for supervising the steam and boiler water quality and flue gas components.

5.4.4 Electric Power Generation System

330. The Project has provisioned captive power for day-to-day use. For this, two units of Steam Turbine Generator (STG) of 32 MW each and One unit of Gas Engine Generator (GEG) of 9 MW capacity. The STG will supply power to the entire plant while GEG will supply power for start-up of Auxiliary Boiler and Steam Turbine Generator.

5.4.5 Natural Gas and Fuel Gas System

331. Natural gas is used for the process feed and fuel for GPUFP Project. Natural gas is supplied through the incoming line from the battery limit of the plant. The pressure ranges from 0.69-0.98 MPaG. Natural Gas has two functions, e.g., process natural gas and fuel natural gas. The natural gas is distributed as process gas and fuel gas to the users of the followings:

- Process natural gas
  - to Primary Reformer of Ammonia Plant.
- Fuel gas (0.505 MPaG)
  - to Primary Reformer of Ammonia Plant
  - to Start-up Heater of Ammonia Plant
  - to Auxiliary Boiler
  - to Gas Engine Generator
  - to Laboratory
  - to Canteen
  - to Building.
  - to Main Flare Stack
  - to Ammonia Storage Flare Stack
  - to Continuous Urea Flare
  - to Discontinuous Urea Flare.

332. During the normal operation, quantity of blow-out gases is zero or very small. In case of upset conditions and/ or start-up and shut down operations of the facilities, large quantity of blow-out gases is vented. It is sent to Vent Stack located in Ammonia Plant and vented to atmosphere without burning.

5.4.6 Nitrogen Gas System

333. Nitrogen gas will be used as inert gas for each facility, as purge gas of the flare system and as separation gas for the dry gas seal system of compressors at plant normal operation, and nitrogen gas will be also used for N_2 purging to whole plant during start-up and shut-down period. Gaseous and liquid nitrogen will be produced by cryogenic separation of air.

5.4.7 Fuel Oil System

334. The Project has two fuel oil systems. One is diesel oil system, the other is petrol oil system. Diesel oil is received to Diesel oil storage tank via diesel oil unloading pump and distributed as fuel by transfer pump and diesel oil filling station for vehicles. Petrol oil is also received to petrol oil storage tank via petrol oil unloading pump and supplied by petrol oil filling station for vehicles.

Received diesel oil is transferred by pump to the following users:

- Emergency Diesel Generator
- Diesel Oil Driven Fire Water Pump
- Local consumption for vehicle.

5.4.8 Waste Water Treatment System

This system is designed to collect and treat chemical waste water including drained MDEA solution, oily waste water, non-oily contaminated waste water, demineralized water unit waste water, cooling tower waste water and CO_2 recovery plant waste water in the Plant. The treated waste water is discharged to the Shitalakhya River.

a) Rainy water drainage system: The clean rainy water including fire water and clean water in the plant will be directly delivered to the Shitalakhya River. The rainy water contaminated with oil in diked area is collected into the sump pit and sent to Rain Water Temporary Storage Basin, by area sump pump. Holding time of rainy water is approx. 30 minutes and in case of overflow from Rain Water Temporary Storage Basin, the rainy water is delivered to the Guard Pond.
b) Chemical sewer system: Chemical contaminated waste water containing large suspended solids such as the cooling tower back wash waste water (no oil contamination) is sent to the equalization basin. Effluent from the oil separation unit is also fed to the equalization basin. Other chemical contaminated waste water containing small suspended solids such as the cooling tower blow down and CO_2 recovery plant waste water, etc. (no oil contamination) is sent to the final pH adjustment basin. Waste water in the equalization basin is fed to the neutralization basin for coagulation and sedimentation treatment.
c) Oily water sewer system: The area handling oil is diked. The spilled oil and oil contaminated waste water in the diked area are collected into the sump pit. Water in the sump pit' is delivered to the ‘oily water collection pit’ through the rain water temporary storage basin. At the beginning of rain, the diked area may be potentially contaminated with oil. These oily water is also sent to oily water system through sump pit. Water in the oily water collection pit passes through the plate pack oil separator and oil is separated by the rotatable slotted pipe skimmer.
d) Oil separated water flows into the oil separator effluent basin and separated oil is drained off into the skimmed oil pit. Oil in the skimmed oil pit is loaded to a tank lorry for disposal by oil pump. Oil separated water in the oil separator effluent basin overflows into the equalization basin.
e) MDEA waste solution collection and disposal: The drained solution is recovered into the solution preparation tank and sent to the solution storage tank by the solution transfer pump. The rainy water in the paved area and diked area in a MDEA CO_2 removal section can be contaminated with a MDEA solution. The rainy water is

collected in MDEA collection sump pit and is delivered to Oily water sewer system or Guard pond or lorry.

f) Key Stage (KS1) waste solution collection and disposal: The rainy water in the paved area and diked area in CO_2 Recovery Plant can be contaminated with KS1 solution. The rainy water is collected in KS1 collection sump pit and is delivered to Oily water sewer system or Guard pond or lorry.
g) Urea waste solution collection and disposal: The rainy water in the paved area and diked area in Urea Plant can be contaminated with urea. The rainy water is collected in sump pit and can be recovered in process or transferred to Oily Water sewer system or Guard pond.
h) Coagulation and Sedimentation treatment system: The neutralized waste water in the coagulation basin overflows to the sludge thickener. Chemical injection units are provided for sedimentation of suspended solids. Sludge from the sludge thickener will be delivered to the guard pond.
i) pH adjustment system: Waste water in sludge thickener and chemical contaminated waste water containing small suspended solids such as the cooling tower blow down and CO_2 recovery plant waste water, etc. (no oil contamination) are fed to the final pH adjustment basin, where the waste water is neutralized according to the Bangladesh regulation. Sulphuric acid or caustic soda is injected for neutralization. The pH adjusted water overflows into the treated waste water effluent basin. Treated waste water is delivered by the treated waste water pump to the followings according to the water quality of the followings:
    - Shitalakhya River
    - Equalization basin for retreatment via guard pond
    - Guard Pond.
j) Guard Pond: The Guard Pond is the ultimate protection against the off spec. effluent disposal. In case that waste water from Waste Water Treatment system is off-spec, discharge of waste water will be diverted to the Guard Pond. In case that waste water from sump pits in a MDEA CO_2 removal section, CO_2 recovery plant, Urea Plant is contaminated with MDEA/KS1/urea, discharge of waste water can be diverted to the Guard Pond. In case that rainy water overflowed from Rain Water Temporary Storage Basin is delivered to the Guard Pond as non-contaminated waste water will be transferred to the river.
k) Waste Water Stripping System: The regeneration waste water from the Condensate Treatment Unit is treated by this system. The ammoniacal content in the waste water is reduced to less than 10 mg/l as NH_3 by steam stripping. After reduction of ammoniacal content, the treated waste water is sent to the final pH adjustment basin in waste water treatment system.
l) Sanitary Waste Water: Sanitary water from each plant and non-plant building is treated by septic tanks. Sanitary waste water from each septic tank is sent to the collection pit and discharged to the Shitalakhya River through the chlorination unit in Waste Water Treatment system as per Bangladesh regulation.

5.4.9 Fire Fighting Unit

335. 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.

336. 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.

5.4.10 Ammonia Storage and Handling System

337. 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.

5.4.11 Bulk Urea Storage and Handling System

338. 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.

339. 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.

340. 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.

341. 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 5.11.

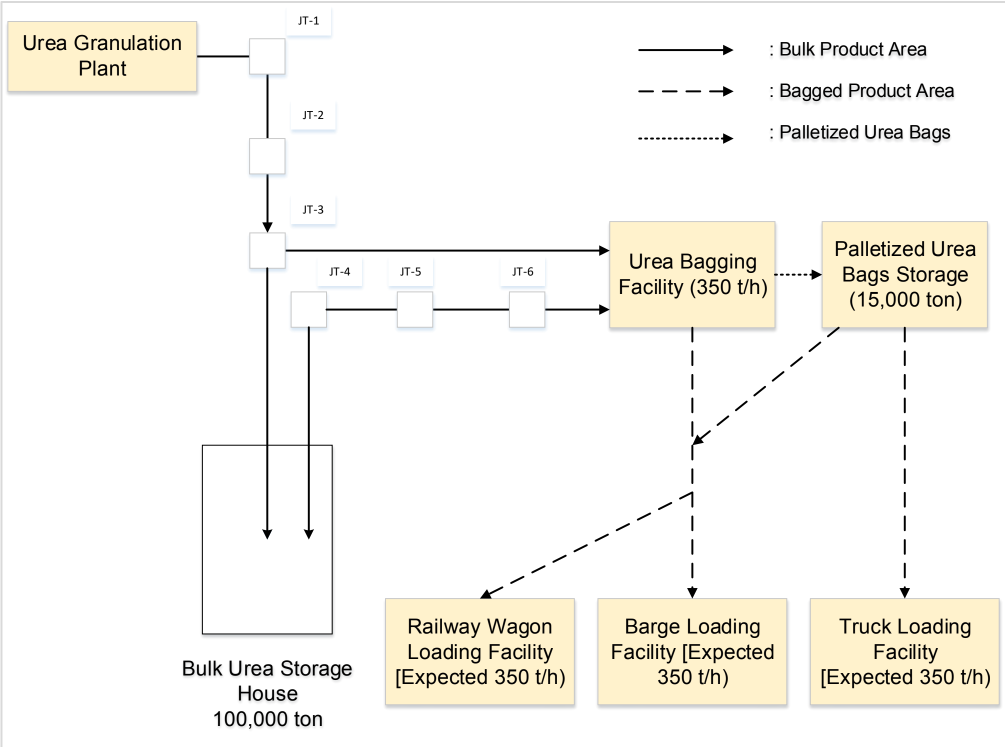


Figure 5.11: Base Flow Scheme of Bulk Urea Handling System

5.4.12 Jetty Equipment

342. Jetty equipment is located on the left bank on Shitalakhya River. The bagged urea product, can be transferred to the jetty area by conveyors and manually loaded into river going barges by using Burge Loading facilities. Barge Loading facilities contain two units having capacity of 175 ton per hour each which is considered as expected capacity since manual operation is required for loading.

5.4.13 Fuel Requirement and Performance

343. 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 5.1) 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).

344. 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

345. 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

346. 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

347. 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 Hazardous Waste

348. About 15 tons of asbestos tin sheet material will be removed from the demarcation area. This material will be temporarily stored in the laydown area or take away from the site with due auction process.

5.6.2 Solid Non-Hazardous Waste

349. Wastes generated during the construction phase (including demolition) of the project include civil structures and associated materials, construction debris and 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 and the remaining waste will be collected by the Ghorasal Municipality for final disposal to designated landfill sites.

5.6.3 Sanitary Sewage Handling

350. 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.

351. 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.

352. 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.

353. 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.

5.6.4 Air Emissions

354. 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. During the operation phase, air 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.

355. 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

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

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.

356. 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).

357. 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.

358. 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.

359. **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.

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

361. **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

5.6.5 Atmospheric Emissions

362. 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:

Table 5.4: 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	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

5.7 Construction

363. 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

364. 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

[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"*

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

365. The estimated number of workers required during (i) Demolition; (ii) Site Preparation; (iii) Construction and (ii) Operation 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

366. 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

367. 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

368. 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)

369. 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 agro-ecological zones in the study area is shown in the **Figure 6.1**.

Land Use and Land Cover

370. 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

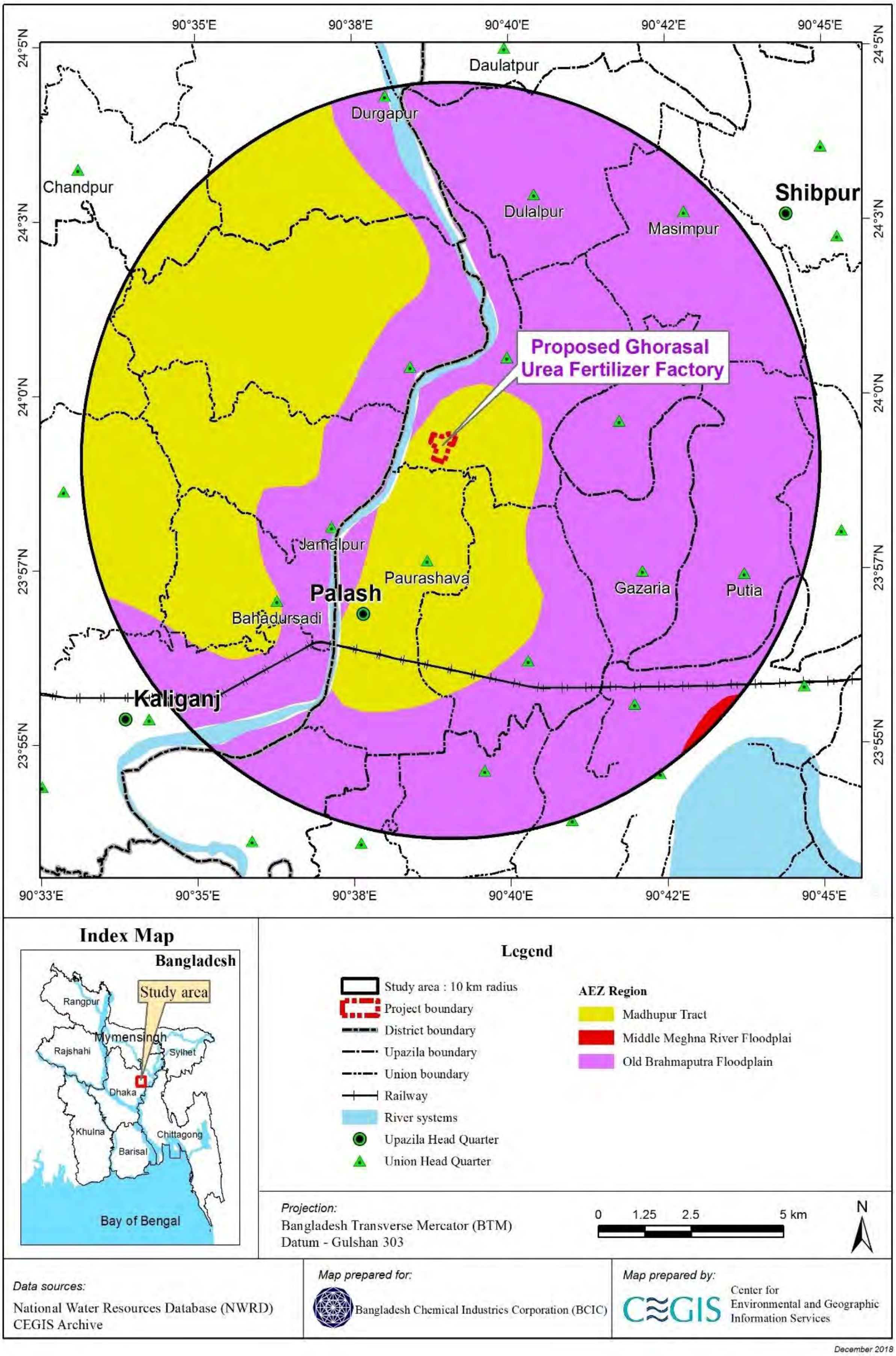


Figure 6.1: AEZ of the study area

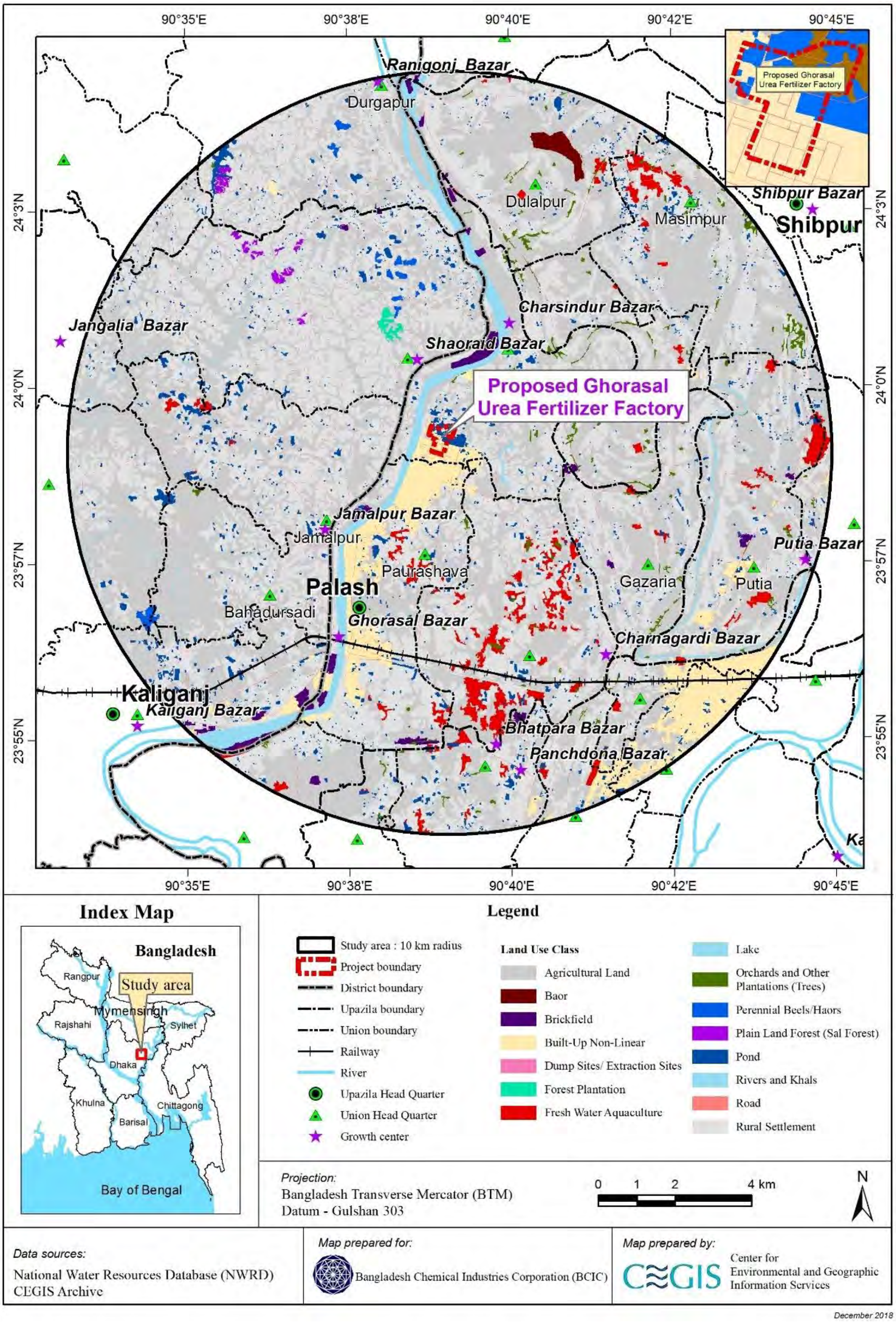


Figure 6.2: Land use map of the study area

Soil Texture

371. 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

372. 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

373. 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

374. 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.

375. 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

376. 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

377. 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.

378. 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.

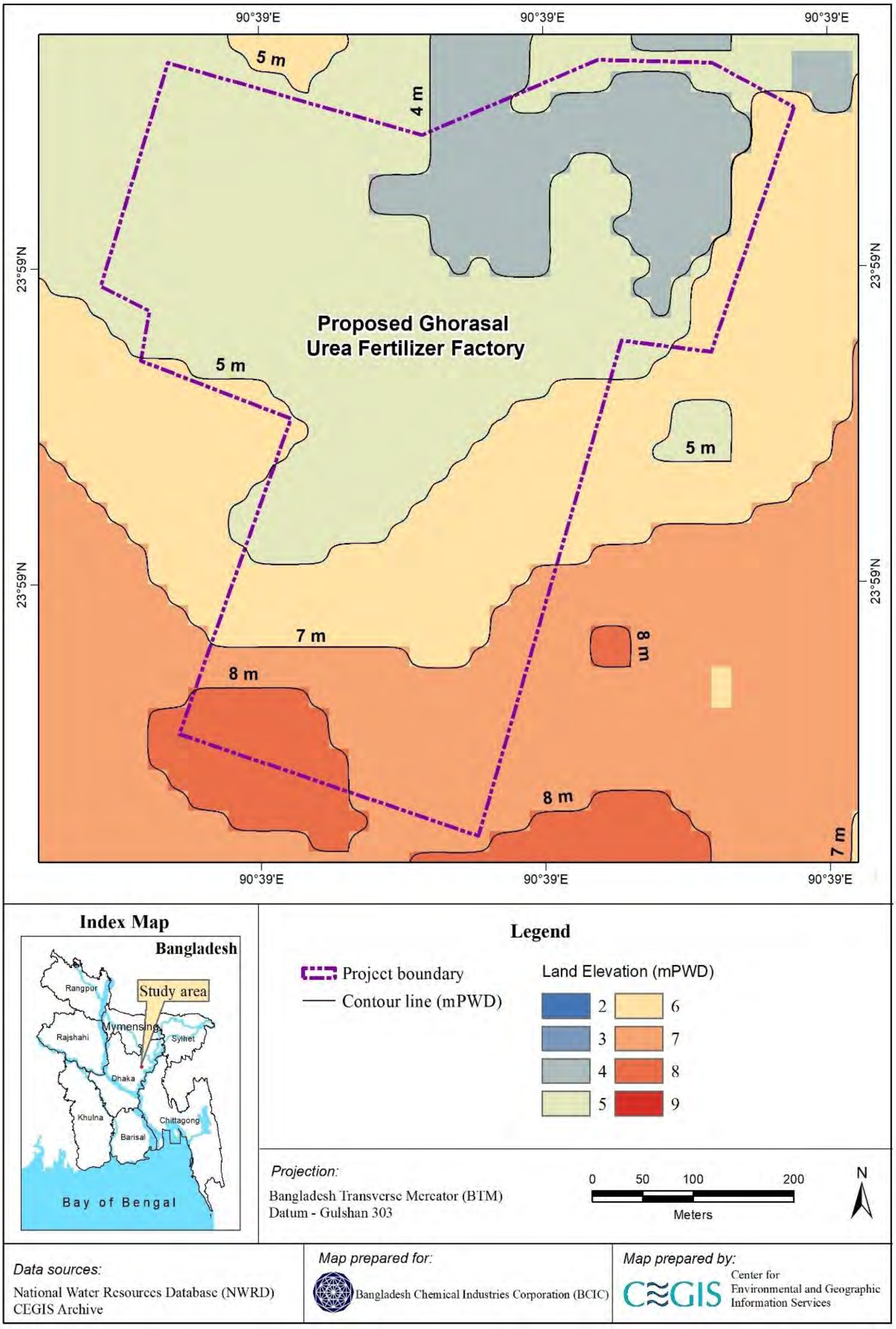


Figure 6.3: Topographic map of the proposed Project Site

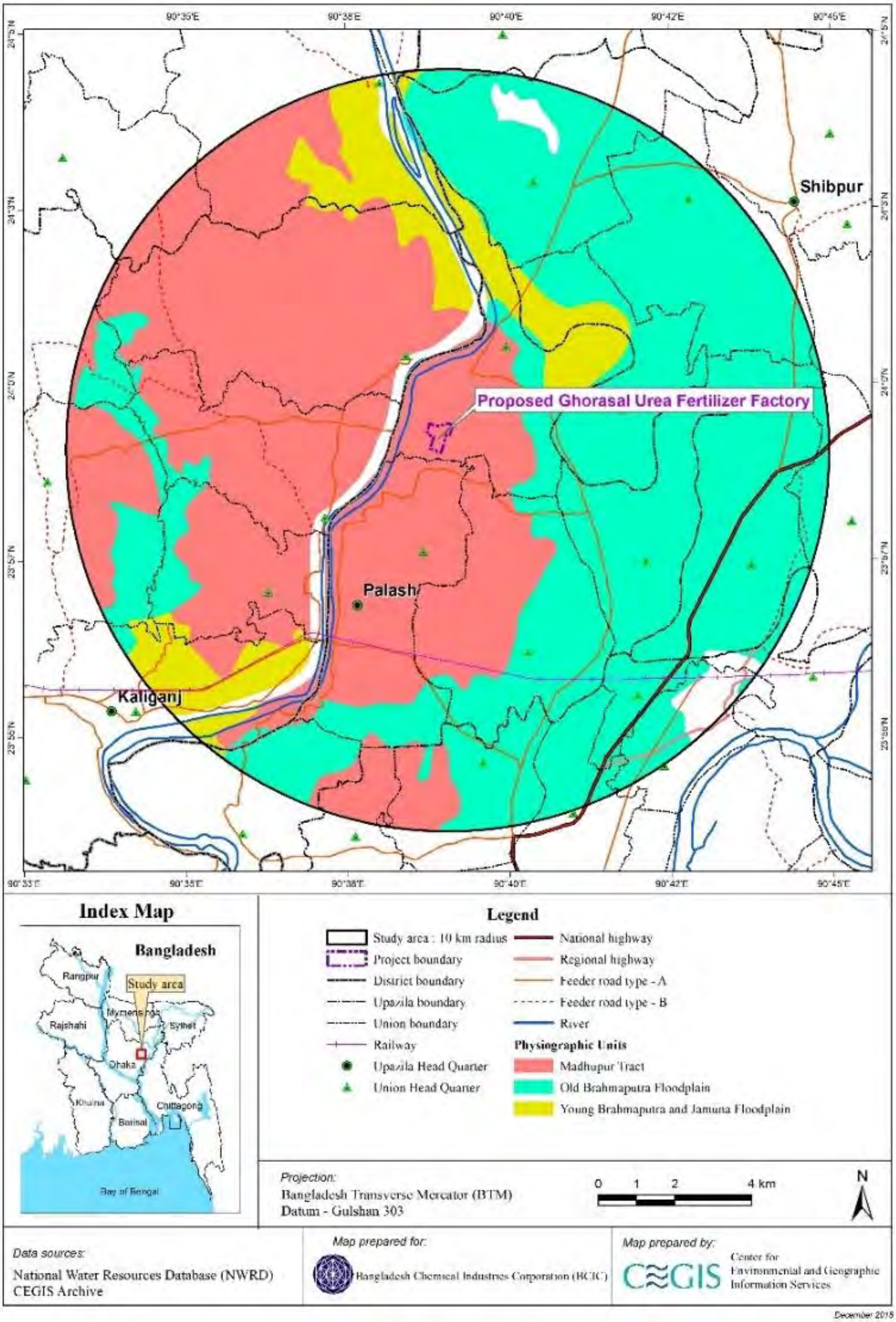


Figure 6.4: Physiographic map of the proposed Project Site

Surface Geology

379. The proposed Project site is situated on the Madhupur Tract (See Map attached). 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.

380. 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 6.5).

Figure 6.5: General Geological map of Bangladesh showing study area

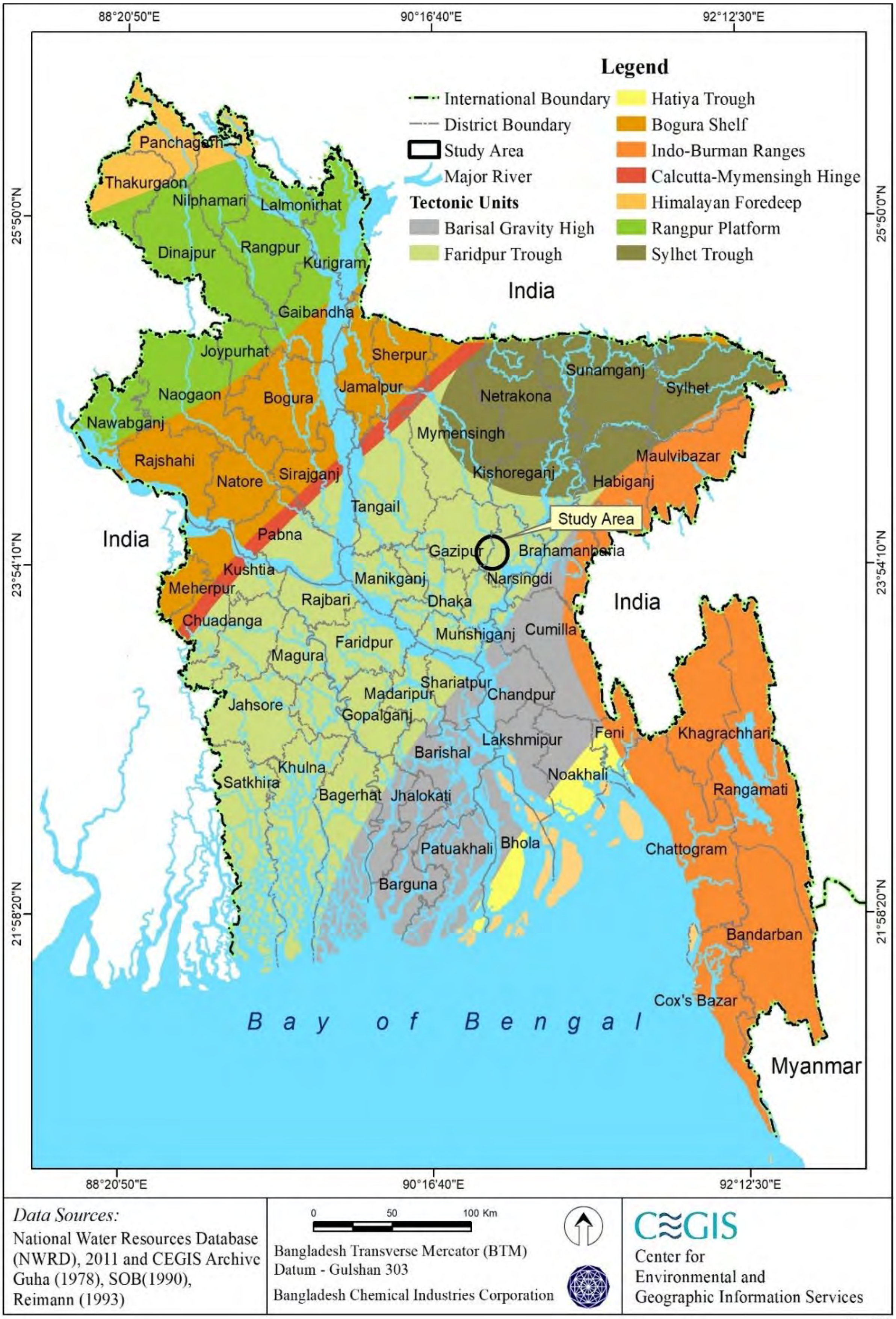


Figure 6.6: Generalized tectonic map of Bangladesh showing study area

6.2.4 Seismicity

381. 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).

382. 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

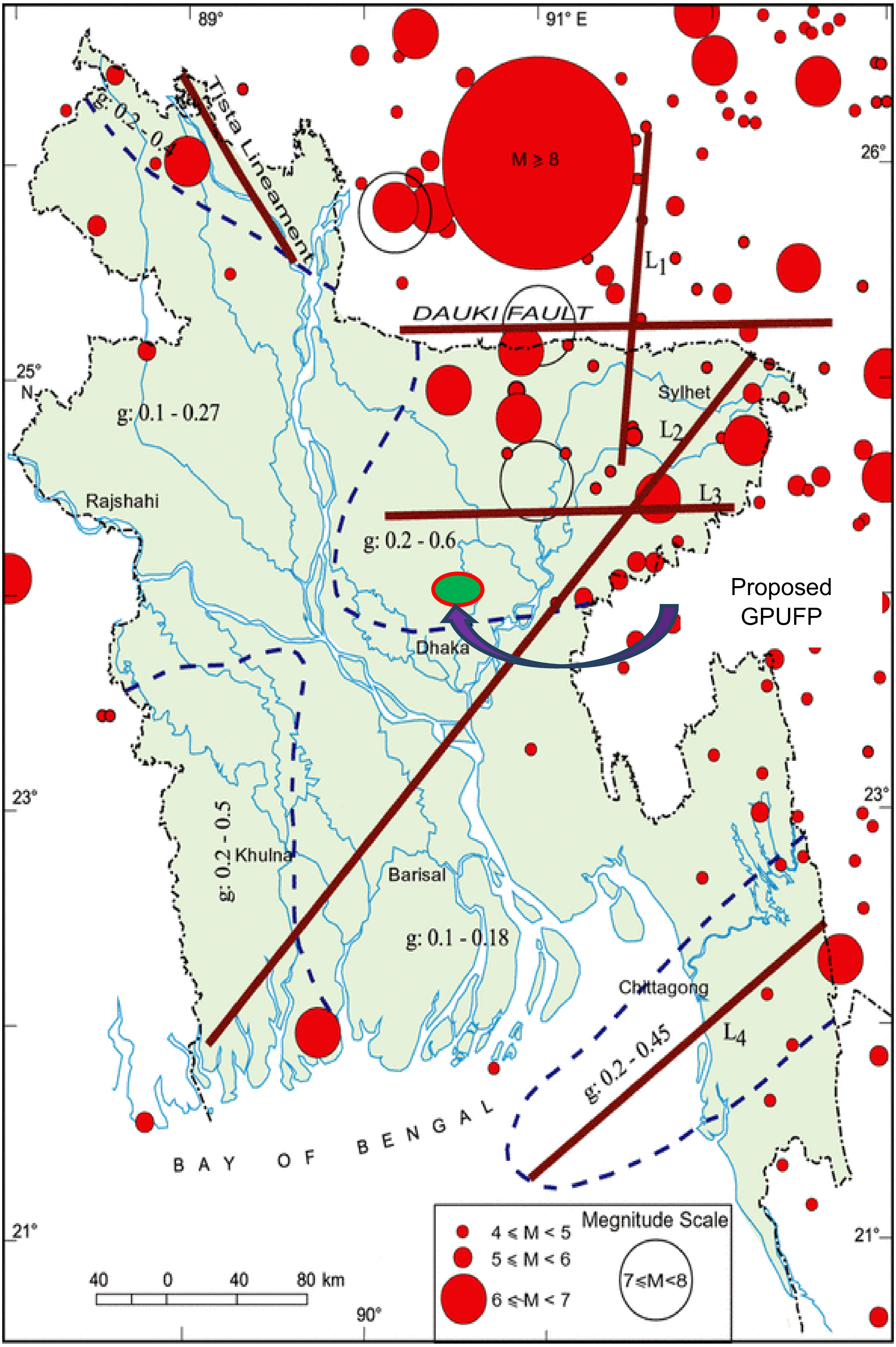


Figure 6.8: Seismic intensity map of Bangladesh showing project site

383. 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	-

384. 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

385. 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	DataSources	Methodology
SurfaceWaterhydrology		
Dryand wet seasonwaterlevel	BWDB	Mean monthlywaterleveldatahas beencollectedfromBWDBdatabase
Drainagesystem	CEGIS	Data has been gathered through image analysis and physical observation
Groundwaterhydrology		
Watertable	BMDand fieldinvestigation	Data has been collected from secondary sources and from different locations of the studyarea.

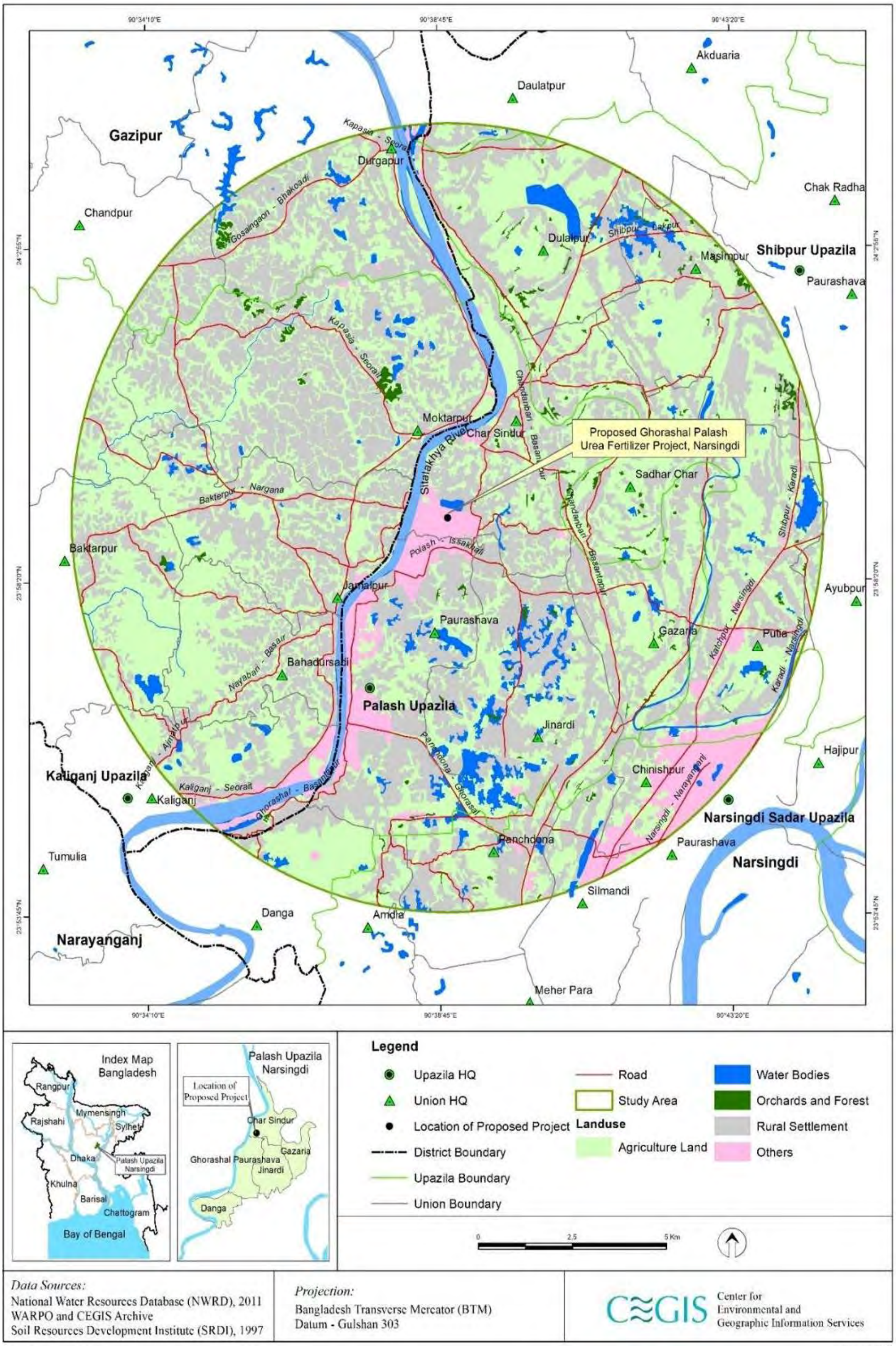
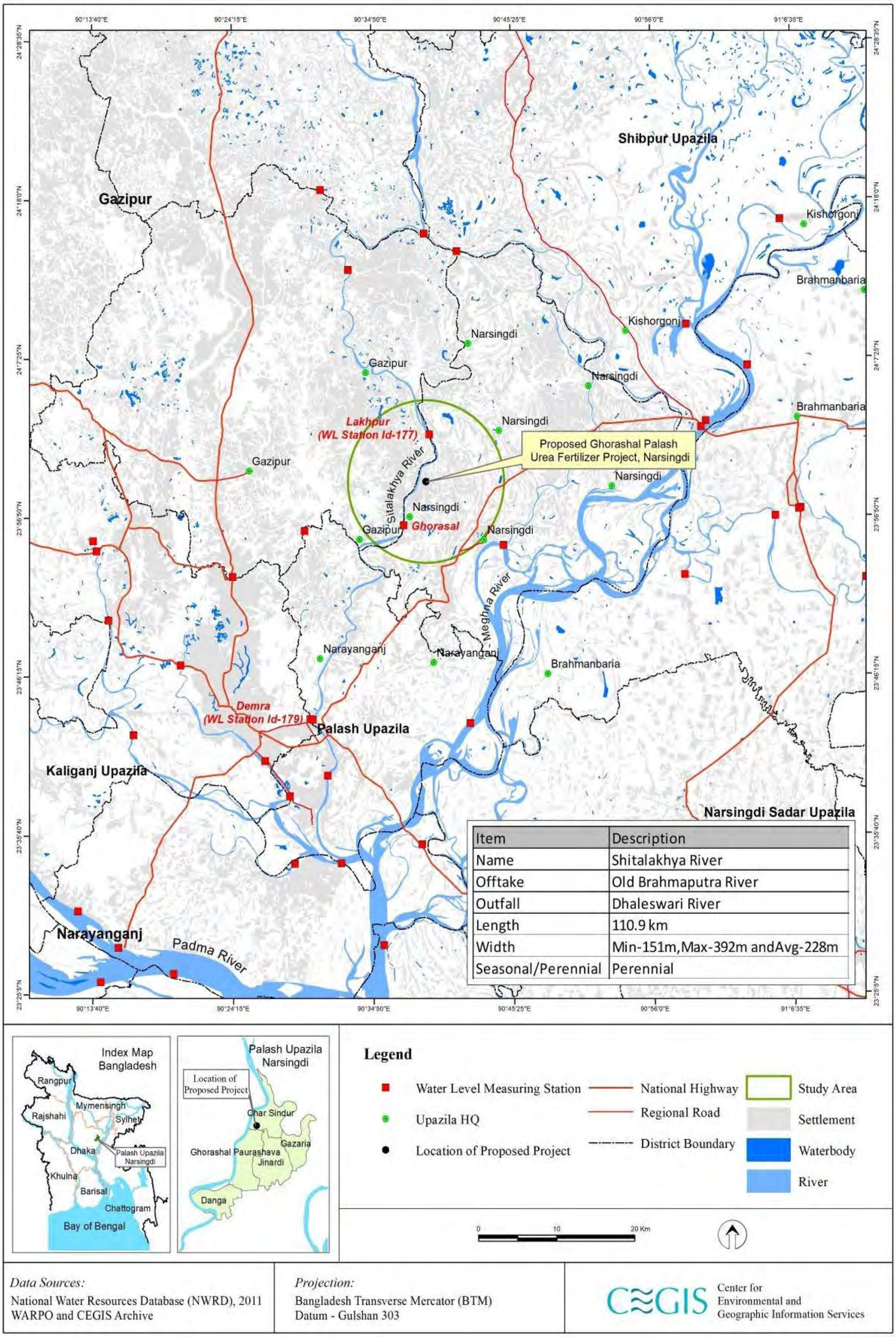


Figure 6.9: Water resources system



Item	Description
Name	Shitalakhya River
Offtake	Old Brahmaputra River
Outfall	Dhaleswari River
Length	110.9 km
Width	Min-151m, Max-392m and Avg-228m
Seasonal/Perennial	Perennial

Figure 6.10: Water level measuring station of BWDB

Surface Water Resources

386. 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.

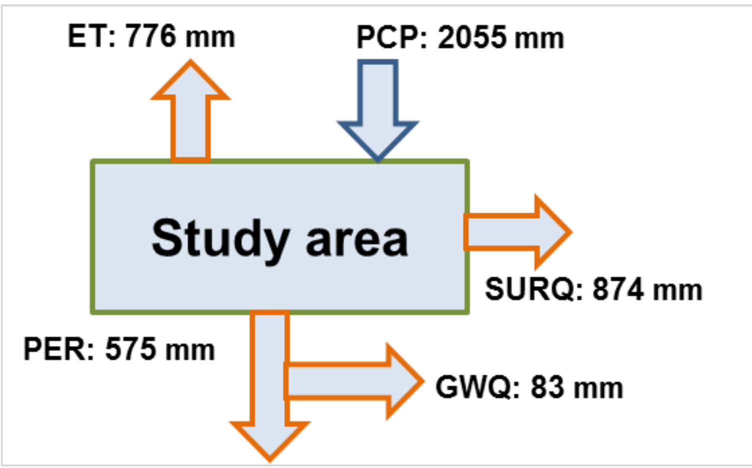
Surface Water System

387. 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.

388. 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)

389. 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**.



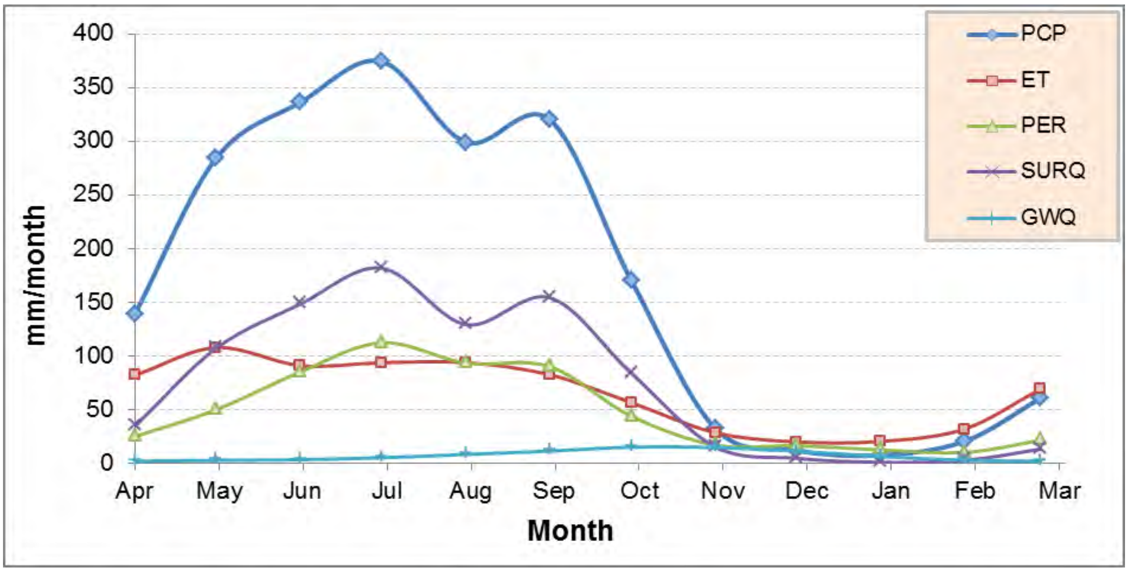


Figure 6.11: Water balance of the study area (a) annual and (b) monthly for the period 1981-2017

390. 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.

391. 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

392. 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 LakhpurStation 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.

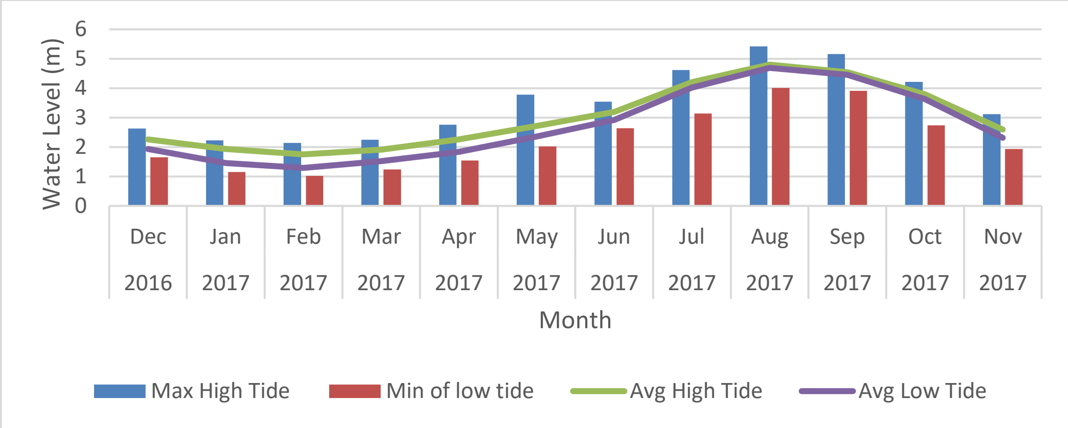


Figure 6.12: Water level at Demra station in 2017

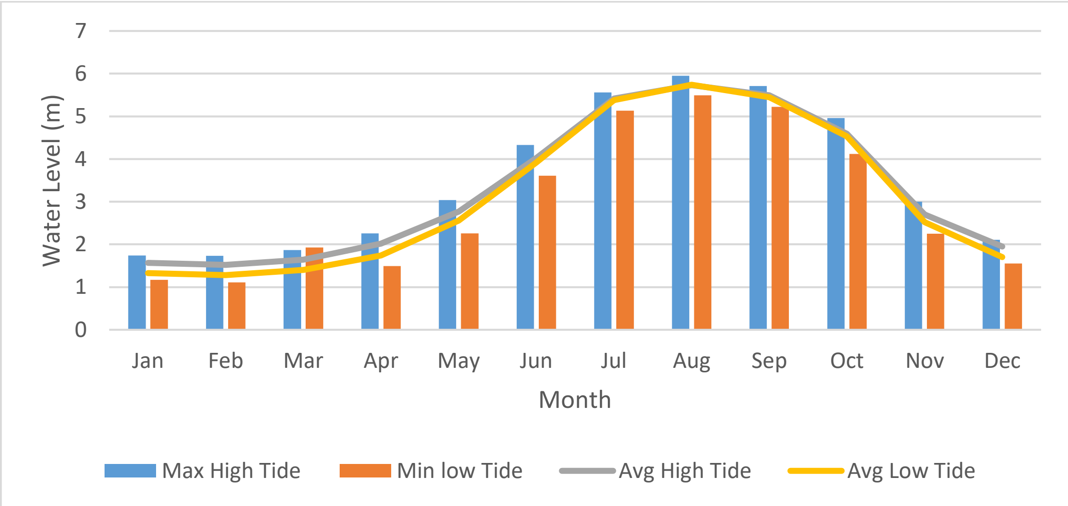


Figure 6.13: Water level at Lakhpur station in 2017

Discharge analysis

a) Average Seasonal Flow (1981-2017)

393. 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.