THE STATE GOVERNMENT OF UTTAR PRADESH
THE REPUBLIC OF INDIA

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA

DRAFT FINAL REPORT

June 2017

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

NJS CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.

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CR(3)
17 - 033

1 USD = 116.0 Yen
1 INR = 1.71 Yen
(As of December 2016)

Photo-1 :

Note)
25-Sep-2015
at Bagwanpur STP (Varanasi)

Photo-2 :

Note)
26-Sep-15
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Photo-3 :

Note)
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Note)
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Note) 30-Sep-2015 Varanasi-3 Near Assi Nala	Note) 30-Sep-2015 Varanasi-4 Roadside Garbage
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ABBREVIATIONS

ADP	Area Development Plan
ASP	Activated Sludge Process
BGL	Below Ground Level
BHP	Break Horse Power
BHU	Banaras Hindu University
BOD	Biochemical Oxygen Demand
CCTV	Closed Circuit Television
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CI	Cast Iron
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health Environmental Engineering Organization
CSP	City Sanitation Plan
CTC	Community Toilet Complex
CW	Civil Works
CWC	Central Water Commission
DA	Drainage Area
DBO	Design, Build & Operate
DG	Diesel Generator
DI	Ductile Iron
DM	District Magistrate
DO	Dissolved Oxygen
DPR	Detailed Project Report
D/S	Downstream
EIRR	Economical Internal Rate of Return
EM	Electrical and Mechanical Works
FAB	Fluidized Aerated Bed
FIRR	Financial Internal Rate of Return
FS	Feasibility Study
FSA	Future Sewered Area
GAP	Ganga Action Plan
GIS	Geology Investigation Survey - Geographical Information System
GL	Ground Level
GoI	Government of India
GRP / DI	Glass Reinforced Plastic / Ductile Iron
HDPE	High Density Polyethylene
HP	Horse Power
HRD	Human Resource Development
HUDCO	Housing and Urban Development Corporation Ltd.
I&D	Interception and Diversion

ID&T	Interception Diversion and Treatment
IPS	Intermediate Pumping Station
IWBC	Integrated Wood Based Crematoria
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LCC	Life Cycle Cost
LCS	Low Cost Sanitation
lpcd	Litre Per Capita Per Day
lps	Litre Per Second
LPS	Lift Pumping Station
MDR	Major District Road
MH	Manhole
MIS	Management Information System
MLD	Million Liters Per Day
MNRE	Ministry of New and Renewable Energy Sources, Govt. of India
MoA	Memorandum of Agreement
MoEF	Ministry of Environment and Forests , Govt. of India
MoUD	Ministry of Urban Development , Govt. of India
MoWR, RD&GR	Ministry of Water Resources, River Development & Ganga Rejuvenation
MPS	Main Pumping Station
MSW	Municipal Solid Waste
NGRBA	National Ganga River Basin Authority
NH	National Highway
NHAI	National Highway Authority of India
NIT	Notice Inviting Tender
NMCG	National Mission for Clean Ganga
NP	Nagal Panchayat
NPP	Nagal Palika Parishad
NRCD	National River Conservation Directorate
NRCP	National River Conservation Plan
ODA	Official Development Assistance
ODR	Other District Road
O&M	Operation and Maintenance
PERT / CPM	Programmed Evaluation Review Technique/ Critical Path Method
PHED	Public Health Engineering Department
PIU	Project Implementation Unit
PMU	Project Management Unit
PS	Pumping Station
PSC	Prestressed Concrete
PWD	Public Works Department
RAP	Resettlement Action Plan
RCC	Reinforced Cement Concrete
RTS	Relief Trunk Sewer

SBR	Sequential Batch Reactor
SCADA	Supervisory Control And Data Acquisition
SFRC	Steel Fiber Reinforced Concrete
SH	State Highway
SOR	Schedule of Rates
SPCB	State Pollution Control Board
SPMG	State Project Management Group
SPMU	State Project Management Unit
SPS	Sewage Pumping Station
SS	Suspended Solids
STP	Sewage Treatment Plant
SWM	Solid Waste Management
SWM	Sewerage Water Management
TF	Trickling Filter
TPI	Third Party Inspection
TSS	Total Suspended Solids
UASB	Up flow Anaerobic Sludge Blanket
UFW	Unaccounted for Water
UIDSSMT	Urban Infrastructure Development Scheme for small and Medium Towns
ULBs	Urban Local Bodies
UPJN	Uttar Pradesh Jal Nigam
U/S	Upstream
VNN	Varanasi Nagar Nigam
VR	Village Road

1 Introduction

1.1 Background

In India, discharging untreated sewage has caused water pollution in the public waterbody, subsoil and groundwater. The Government of India (hereinafter referred to as "GoI") decided to provide sewerage/sanitation facilities for the urban population in its 12th National Five Year Development Plan (from April 2012 to March 2017).

Under the above situation, "Ganga Rejuvenation project" was proposed in January 2014 by the Government of India utilizing Japanese Government yen credit loan. The project shall be executed by local government under administration by National Mission for Clean Ganga (NMCG).

It is the policy for the project that phase 1 of the project will be implemented to deal with the out of bounds of on-going Japanese Government yen credit loan as "Ganga Action Plan Project (Varanasi)" in Varanasi City (L/A signed off on 31st March, 2005) and surrounding five (5) cities. In the phase 2 of the project, assistance for additional cities in the Ganges river basin area shall be expanded.

This project shall be implemented to complete required studies for the items of appraisal such as objectives of the project, outline, cost estimates, implementation structure, operation and maintenance, and consideration to social and environment

1.2 Objective of the Preparatory Survey

1) General Description of the Project

a) New construction and augmentation of sewerage in Varanasi and surrounding five cities

b) Consulting Service for five cities

2) Relevant Authorities, Executing Agencies, Coordinating Mechanisms

c) Responsible Ministry: Ministry of Water Resources, River Development &Ganga Rejuvenation

d) Coordinating/implementing agency: National Mission for Clean Ganga (NMCG)

e) Executing Agency of the project: Uttar Pradesh Jal Nigam (UPJN)

3) Scope of works

f) Complete required studies for the items of appraisal Collect information to assist selection of other candidate cities in the Ganges river basin area from 118 cities in the river basin.

g) Implement a seminar regarding collaboration of Kyoto city and Varanasi city.

h) Conduct study for the Concept of the Varanasi Convention Centre

1.3 KYOTO-VARANASI Seminar

The seminar and preceding workshop were successfully held in Varanasi City on 16th and 17th November 2015.

2 Natural Condition Survey

The Natural condition survey is composed of 1) Topographical survey, 2) Geotechnical survey and 3) Water Quality survey. They were conducted to collect/confirm the latest information regarding the subject area for the project. Refer to Appendices for the details of the surveys.

3 Existing Water Supply and Ongoing/Planned Water Supply Project

In the State of Uttar Pradesh (UP), UP Jal Nigam (UPJN) is responsible for planning and design, construction/implementation of water supply facilities and the Varanasi Municipal Corporation (VMC) is responsible for provision of basic services such as water supply, sewerage and storm water drainage and undertakes their operation and maintenance through the Jal Kal Department (Jal Kal). The District Urban Development Authority (DUDA) is involved in housing development in the slum area.

The Varanasi water supply is managed by the Jal Kal Department under the Varanasi Municipal Corporation. At present, Varanasi water supply takes surface water from the Ganga River and ground water through tube wells.

4 Existing Storm Water Drainage System

General Drainage Condition in Varanasi City, Mirzapur, Chunar, Ramnagar, Saidpur and Ghazipur was confirmed by references and field surveys. Generally, maintenance has not been done for the drainages and status of flow was poor with a lot of solid wastes and garbage inside the drainages.

Water quality observed in the drainages was almost raw sewage since sewerages has not been constructed other than a part of VNN and Mirzapur.

NMCG is going to apply Interception and Diversion with Treatment (ID/T) in light of prompt construction of sewerages and lower construction cost for municipalities with population below 1 lakh. Since the system does not include construction of sewer network, the drainages will be left as existing in this case and sewage will flow down in the open channels up to diversion point to flow into interceptors.

Keeping sanitary condition and removal of wastes along the open channels must be carefully taken care of even after the construction of ID/T to avoid clogging of the intercepters.

5 Existing Sewerage Facilities and On-going Sewerage Projects

Sewage Collection and Pumping System was surveyed by interview to ULB as well as study of references and field survey in Varanasi City, Mirzapur City, Chunar City, Ramnagar City Saidpur City and

Ghazipur City. Ongoing Project for Sewers and Pumping Stations was also surveyed.

Existing sewage treatment plants in Varanasi and Mirzapur were surveyed as well. Dinapur STP and Bhagwanpur STP in VNN and Mirzapur STP and Vindhyachal STP in Mirzapur. Condition of Operation and maintenance was also confirmed for the understanding of current status and issues.

6 Water Pollution of the River Ganga and its Tributaries

Outline of river basin and cities/towns along the river was clarified and reconfirmed by the references as follows:

a. Total length: 2525 km including the sharing length between UP & Bihar (110 km)
b. Catchment area Ganga Basin 861,404 km2 (26.4%) of India
c. Average annual discharge 493,400 million cubic meter
d. Main tributaries: Kali, Yamuna, Ramganga, Gomti, Ghaghara, Gandak,
e. Damodar, Kosi & Kali-East
f. Main sub-tributaries Chambal, Sindh, Betwa, Ken, Tons (beyond Five
g. States), Sone & Kasia-Haldi
h. Major cities located on the bank:

Uttarakhand	Srinagar, Rishikesh, Haridwar, Roorkee
Uttar Pradesh	Bijnor, Narora, Kanauj, Kanpur, Allahabad, Varanasi and Mirzapur
Bihar	Patna, Bhagalpur
West Bengal	Bahrampur, Serampore, Hawarah and Kolkata (in)

Source: CPCB, "Pollution Assessment: River Ganga", July 2013

Table 6.1 Total Population within the River Ganga Basin (2011)

State / UT	Persons	Density (persons per km^2)	Urban Population
Uttarakhand	10,116,752	190	30,91,169 (30.55%)
Uttar Pradesh	199,581,477	828	4,44,70,455 (22.28%)
Bihar	103,804,637	1,102	1,17,29,609 (11.30%)
Jharkhand	1,150,038	720	79,29,292 (7.30%)
West Bengal	91,347,736	1,029	2,91,34,060 (31.89%)
Total	437,816,840		96,354,585 (22%)

Source: CPCB, "Pollution Assessment: River Ganga", July 2013

i. Target water quality of the River Ganga

pH:	6.5 – 7.5
DO:	5 mg/L or more
BOD:	3 mg/l or less
Total Coliforms:	500 MPN/100mL ("Desirable") or less
	5,000 MPN/100mL ("Most Permissible") or less

j. Water Balance and Discharge1

Rainfall, subsurface flows and snow melt from glaciers are the main sources of water in River Ganga. Surface water resources of Ganga have been assessed at 525 billion cubic meter (BCM).

k. Water Quality in the River Ganges

Yearly BOD variation along the River Ganges is shown in the figure below. BOD concentration decrease at the Varanasi point is shown. GAP I project in Varanasi is considered to contribute the result. .

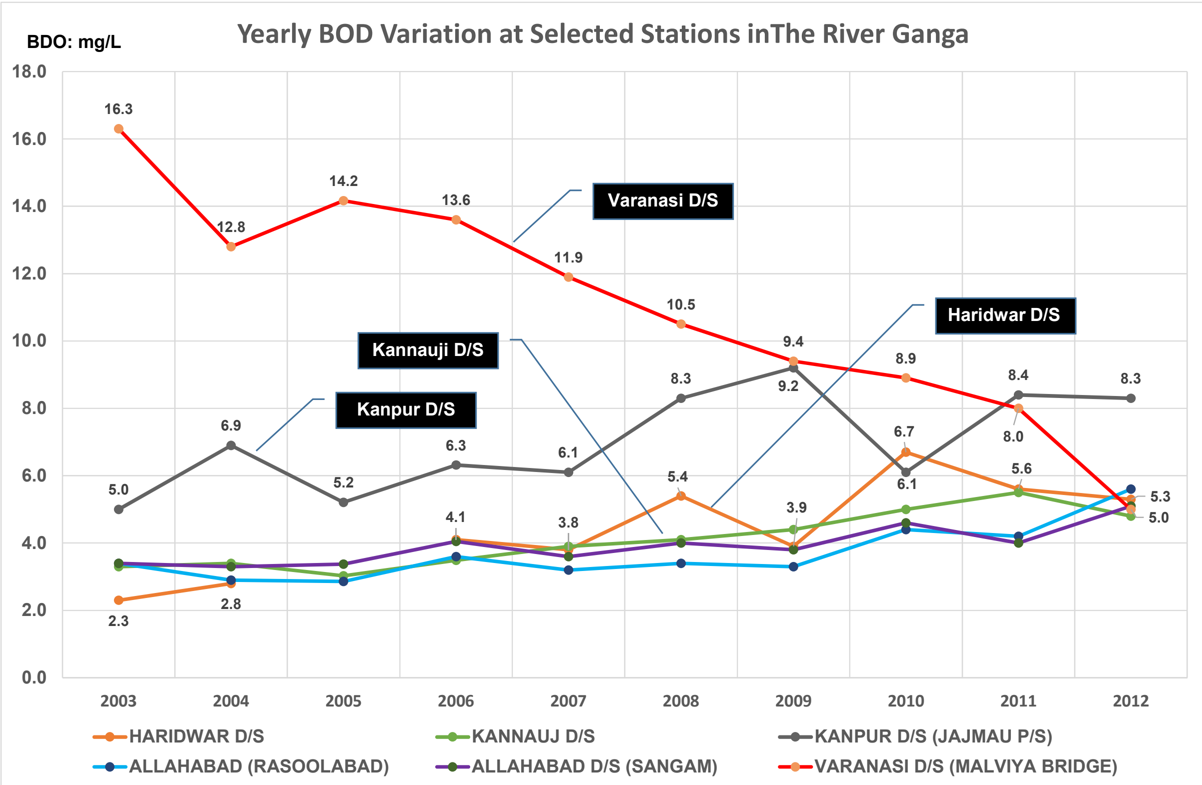


Figure 6.1 Yearly BOD$_5$ Variation at selected Stations in The River Ganga

7 Projection of Sewage Flow by Design Year

Projected Sewage Flow by Design Year after examination of DPR is shown below:

[1] *National River Conservation Directorate, Ministry of Environment and Forests, "Status Paper on River Ganga", August 2009*

Table 7.1 Sewage Treatment Plant Capacity

City	Year	Projected Population		Water Supply Unit [lpcd]	Inter-ception Factor	Infiltration Water Factor	Peak Factor	Average Sewage Volume [MLD]	Maximum Sewage Volume [MLD]
		Projected	Say (Round Up)						
		-	A*****	B	C	D	E	Q1****,*****	Q2*****
Chunar	2020	48,000	48,000	135	0.8	0.10	2.50	5.7	14
	2030	55,000	55,000	135	0.8	0.10	2.50	6.5	16
	2035	63,000	63,000	135	0.8	0.10	2.50	7.5	19
	2050	80,000	80,000	135	0.8	0.10	2.50	9.5	24
Ramnagar	2020	59,845	60,000	135	0.8	0.10	2.25	7.1	16
	2030	72,049	73,000	135	0.8	0.10	2.25	8.7	20
	2035	81,021	82,000	135	0.8	0.10	2.25	9.7	22
	2040	88,176	89,000	135	0.8	0.10	2.25	10.6	24
	2050	109,692	110,000	135	0.8	0.10	2.25	13.1	29
Mirzapur	2020	268,333							
	2030	301,667							
	2035	321,950							
	2050	394,557							
(Mirzapur Zone)*	2020	251,262	252,000	135	0.8	0.10	2.25	30	68
	2030	268,710	269,000	135	0.8	0.10	2.25	32	72
	2035	287,863	288,000	135	0.8	0.10	2.25	34	77
	2050	347,938	348,000	135	0.8	0.10	2.25	41	92
(Vindhyachal Zone)*	2020	35,025	36,000	135	0.8	0.10	2.50	4.3	11
	2030	53,823	54,000	135	0.8	0.10	2.50	6.4	16
	2035	58,823	59,000	135	0.8	0.10	2.50	7.0	18
	2050	75,686	76,000	135	0.8	0.10	2.50	9.0	23
Varanasi	2020	1,729,882							
	2035	2,361,749							
	2050	3,224,416							
(District I)**	2020	479,318	480,000	150	0.8	0.25	2.00	72	144
	2035	557,700	558,000	150	0.8	0.20	2.00	80	160
	2050	653,275	654,000	150	0.8	0.15	2.00	90	180
(District II)*,**,***	2020	961,702	962,000	150	0.8	0.25	2.00	144	288
	2035	1,447,629	1,448,000	150	0.8	0.20	2.00	209	418
	2050	2,149,720	2,150,000	150	0.8	0.15	2.00	297	594
(District III)*,**	2020	182,613	183,000	150	0.8	0.25	2.00	27	54
	2035	286,273	287,000	150	0.8	0.20	2.00	41	82
	2050	379,646	380,000	150	0.8	0.15	2.00	52	104
(District IV)*,**	2020	207,891	208,000	150	0.8	0.25	2.00	31	62
	2035	362,736	363,000	150	0.8	0.20	2.00	52	104
	2050	417,837	418,000	150	0.8	0.15	2.00	58	116
Ghazipur	2015	128,768	129,000	135	0.8	0.10	2.25	15	34
	2030	162,511	163,000	135	0.8	0.10	2.25	19	43
	2045	205,094	206,000	135	0.8	0.10	2.25	24	54
Saidpur									

*Including Future Service Area (FSA).
**STP capacity in Varanasi is determined separately.
***Including Non Sewerage Area (NSA).
****Adopted for STP Calculation except for STPs in Varanasi.
*****Original setteings in this report.

City	STP	Existing STP (Capacity[MLD])	Year	Average Sewage Volume [MLD]	Comrehensive		Interception Diversion	
				Q1*	Sewage Volume at DPR [MLD]	Sewage Volume for STP Planning at DPR [MLD]	Sewage Volume at DPR {MLD]	Sewage Volume for STP Planning at DPR [MLD]
Chunar	Chunar		2020	5.7	5.68	-	5.68	-
			2030	6.5	6.51	6.5	6.51	6.5
			2035	7.5	7.46	-	7.46	-
			2050	9.5	9.48	-	9.48	-
Ramnagar	Ramnagar		2020	7.1	7.6	-	7.11	-
			2030	8.7	-	-	-	-
			2035	9.7	10.36	-	10.00	10
			2040	10.6	-	-	-	-
			2050	13.1	14.06	13to14	13.00	-
Mirzapur	Mirzapur	O (14)	2020	30	30	-	30	-
			2030	32	32	32	32	32
			2035	34	34	-	34	-
			2050	41	41	-	41	-
	Vindhyachal	O (4)	2020	4.3	4	-	4	-
			2030	6.4	6	6	6	6
			2035	7.0	7	-	7	-
			2050	9.0	9	-	9	-
Varanasi	Dinapur	O (80)	2025	-	-	140		
	Bhagwanpur	O (8to9.8)	2025	-	-	9.8		
	Ramna		2035	-	-	50		
Ghazipur	Ghazipur		2015	15	15.44	15		
			2025	-	17.88	18		
			2030	19	19.60	18		
			2045	24	24.36	18		
Saidpur	Saidpur							

*Original setteings in this report.

8 Scope of Work for the Project

Scope of work was examined based on DPR review. Review of drawings and calculation sheet which were submitted was made and issues were found out.

9 Preliminary Design of Sewerage Facilities

9.1 Sewers

Table 9.1 shows the category of development method for each target city.

Table 9.1 Category of Development Method for Target Cities

City	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar	Saidpur
District	Varanasi	Mirzapur	Ghazipur	Varanasi	Mirzapur	Ghazipur
Population (Census2011)	1,435,113	234,170	121,020	49,087	37,227	24,338
Scale of City	More than 1 million	More than 1 lakh	More than 1 lakh	Less than 1 lakh	Less than 1 lakh	Less than 1 lakh
Development Method	Comp.	ID&T Sewer	ID&T Sewer	ID&T	ID&T	ID&T

Source: JICA Survey Team

Although Mirzapur and Ghazipur have population of more than 1 lakh, ID&T method was directed by NMCG.. Plans and profiles of sewers of each municipalities were reviewed and revisions were recommended as required.

9.2. Pumping Stations

(1) Varanasi City District-I

No pumping station is proposed for Varanasi City District-I.

(2) Varanasi City District-II

No pumping station is proposed for Varanasi City District-II.

(3) Varanasi City District-III

Table 9.2 Proposed Dimension for LPS near Sarai Nandan in Varanasi District-III

No.	LPS (New)													
	Location	Flow (MLD)		Pumps								Rising Main		
		2035	2050	Total	Duty	Standby	Capacity (m3/hr)	Total Capacity (Duty) (m3/hr)	Total Capacity (Duty) (MLD)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	near Sarai Nandan (MH No. 1295)	3.92	6.45	6	4	2	100	400	9.6	15	10	DI	200	30

Source: DPR Varanasi District-III

(4) Ramnagar City

A master pumping station (MPS) was proposed by UPJN in DPR Ramnagar ID&T as the design period is shown in **Table 9.3** and the general specification is shown in **Table 9.4**

Table 9.3 Design Period for MPS at Ram Bagh Drain, Mallahi in Ramnagar City

No.	Item	Design Period
1	Civil Structure (Wet Well, Screen Chamber etc.)	30 years (2050)
2	E&M (Pumps etc.)	15 years (2035)

Source: DPR Ramnagar ID&T

Table 9.4 General Specification of Proposed Pumping Stations in Ramnagar City (ID&T)

No.	PS	Location	PS Capacity (MLD)		Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
			Average	Peak			Nos.	Duty	Standby						
1	MPS	Ram Bagh Nala, Mallahi	**13**	29.25	Peak	Submersible non clog	3	2	1	7.84	55	180	DI-K9	400	2,700
					Non-peak	Submersible non clog	2	1	1	3.94	55	100			

Source: JICA Survey Team confirmed from DPR Ramnagar ID&T

(5) Mirzapur City

1) Phase-I: ID&T Work

a) IPS

Two existing IPS will be rehabilitated and three new IPS will be constructed as shown in following tables

Table 9.5 General Specification of Rehabilitated IPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**
Vindhyachal														
2	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**

Table 9.6 General Specification of New IPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal													
3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	50	2	1	1	12	50	1.2			

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed.

Table 9.7 General Specification of Rehabilitated MPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity (Duty)		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	MPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal														
2	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100
											Proposed	**DI-K9**	**300**	**30**

Table 9.8 General Specification of New MPS in Mirzapur City (ID&T)

No.	Proposed													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (m3/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	600	30

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

2) Phase-II: Sewer Network

Table 9.9 General Specification of New IPS in Mirzapur City (Sewer Network)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos. Total	Duty	Standby	Head (m)	Total Capacity (cum/hr)	(MLD)	Material	Dia. (mm)	Length (m)
Mirzapur													
1	IPS-7-> IPS-9	district jail Mirzapur	Peak	280	3	2	1	13	13	13	DI-K9	300	36
			Non-peak	150	2	1	1	13	13	13			
2	IPS-8-> IPS-10	lalah ghat	Peak	160	3	2	1	21	21	21	DI-K9	200	356
			Non-peak	65	2	1	1	17	17	17			

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

(6) Chunar City

IPS-1 and MPS were proposed in DPR Chunar ID&T as listed in the following table.

Table 9.10 General Specification of Proposed Pumping Stations in Chunar City (ID&T)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Tambal Ganj	Peak	Submersible	3	2	1	105	23	DI-K9	200	2,130
			Non-peak	Submersible	2	1	1	45	19			
					5	3	2					
2	MPS	Near STP	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar ID&T

9.3 Sewage Treatment Plants

The transition in recent years of effluent quality regulation is shown in the following. In 2016, there has been a movement of further tightening of regulations. Review work was done by the CPCB Standard which was notified to UP on 27th April 2016.

Table 9.11 History of Effluent Standards from STP in India

Water Quality Item		NGRBA Guidelines (2010)	CPHEEO Manual (2013)	CPCB New Standards (27^{th} April 2016)
		Effluent Standards for discharge into water bodies	Recommended Guidelines for Treated Sewage	Parameters Limit Not Authorized
pH	-	5.5-9.0	-	6.5-9.0
BOD_5	mg/l	20	Less than 10	Not more than 10
COD	mg/l	-	-	Not more than 50
TSS	mg/l	30	Less than 10	Not more than 10
NH_4-N	mg/l	-	-	Not more than 5
T-N	mg/l	-	Less than 10	Not more than 10
T-P	mg/l	-	Less than 2	Less than 2
Faecal Coliforms	MPN/100mL	Desirable– 1,000 Permissible– 10,000	Less than 230	Less than 230

Source: JICA Survey Team

Process selection was reviewed according to the new regulation and detailed recommendations were sent to UPJN for revision.

Table 9.12 Process selection for each STP

Item	Process incapable of Nitrogen removal				Process for Nitrogen removal					
Name	Sequencing Batch Reactor	Activated Sludge Process	Oxidation Ditch Process	Anaerobic Aerobic Process	Advanced Oxidation Ditch Process	Sequencing Batch Reactor	Circulation Type Nitrification Denitrification Process	Moving Bed Biofilm Reactor	Anaerobic Anoxic Aerobic Process	Membrane Bioreactor
	SBR	ASP	OD	AO	Advanced OD	Advanced type SBR	CND	MBBR	A2O	MBR
DPR		Bhagwanpur (Existing)				Chunar	Ramnagar	Dinapur		
						Vindhyachal (Extension)	Ramna			
						Mirzapur (Extension)				
						Ghazipur				
Nitrogen removal	N/A	N/A	N/A	N/A	5	5	5	5	5	5
Treated Water Quality	3	3	3	3	4	4	4	4	4	5
Lot for Treatment Process	3	3	2	3	3	3	3	3	3	3
CAPEX	3	3	3	3	3	3	3	3	2	2
Easiness of Maintenance	3	3	4	3	3	3	3	4	2	2
OPEX	3	3	3	3	4	3	3	3	3	3
Past Record in India	4	3	2	1	1	4	4	2	1	1
Total	(19)	(18)	(17)	(16)	23	25	25	24	20	21
Adoption	N/A	N/A	N/A	N/A	Better	Best	Best	Better	Fair	Fair

Legend 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A (Not Applicable)

(1) Construction schedule

There is no description of the specific construction process in the DPRs. Defining operation start and confirming excess capacity of the process against sewage inflow should be clarified as well. From the figures below it is understood that augmentation of the plants before 2030 is required. Additional lot for the augmentation and budget must be prepared before 2025.

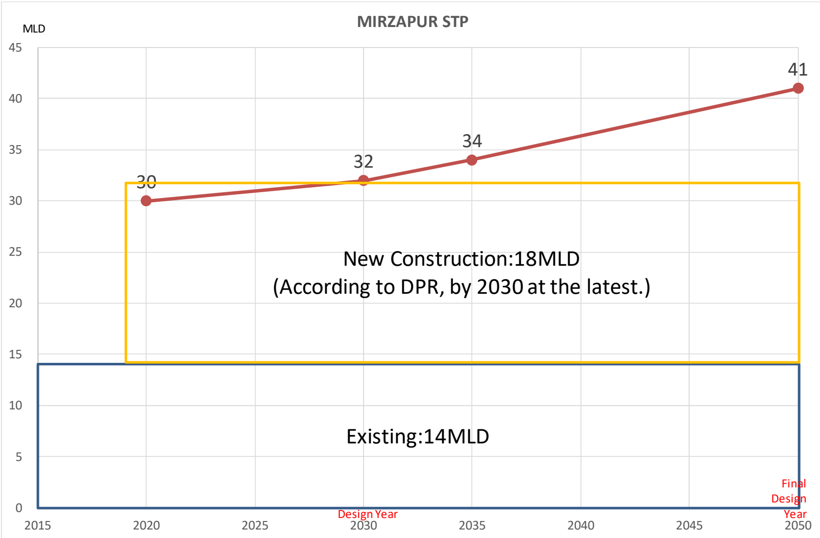


Figure 9.1 Construction plan of Mirzapur STP based on DPR

Source: JICA Survey Team

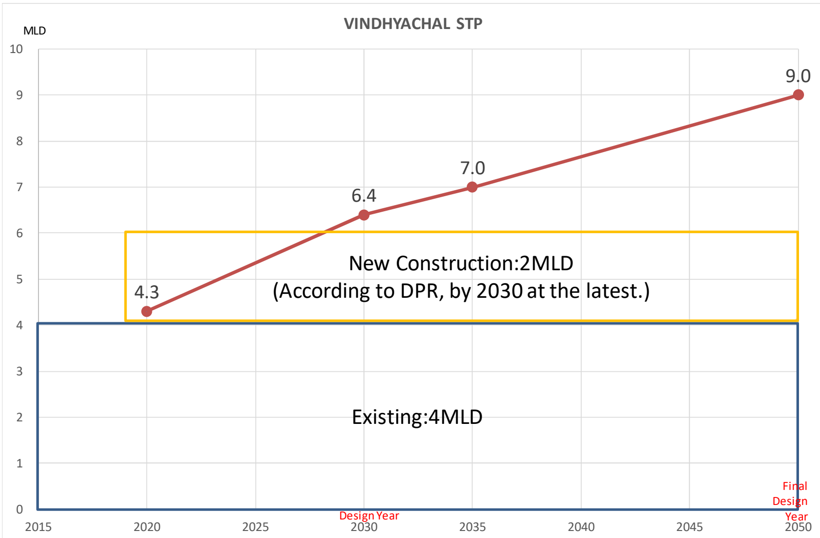


Figure 9.2 Construction plan of Vindhyachal STP based on DPR

Source: JICA Survey Team

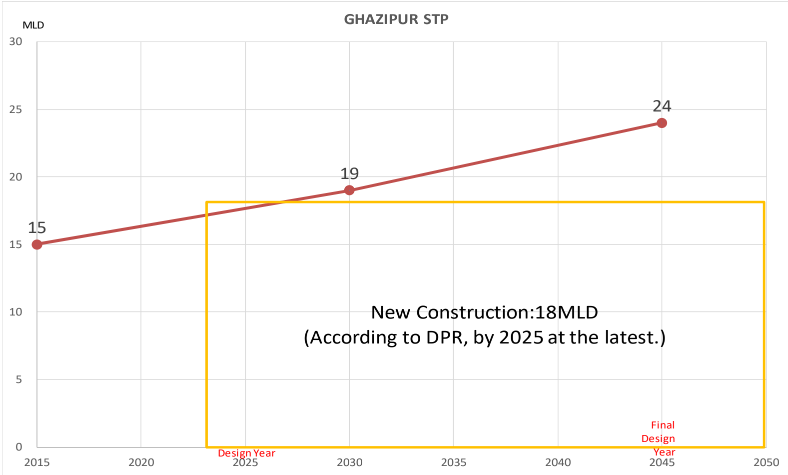


Figure 9.3 Construction plan of Ghazipur STP based on DPR

Source: JICA Survey Team

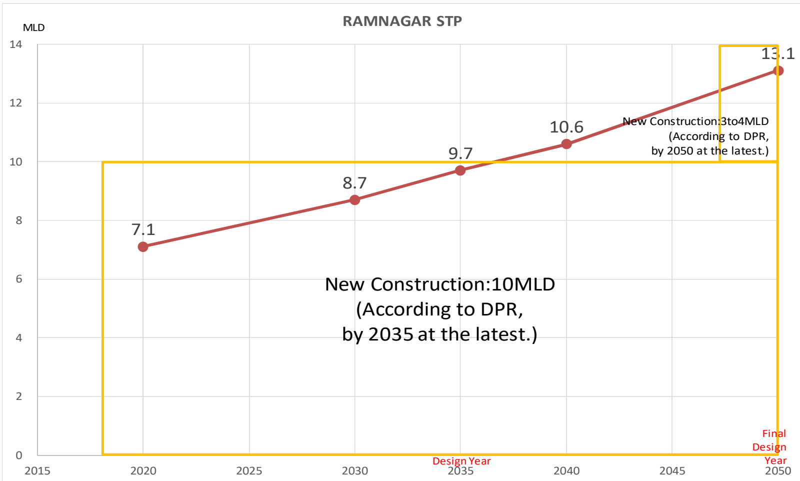


Figure 9.4 Construction plan of Ramnagar STP based on DPR

Source: JICA Survey Team

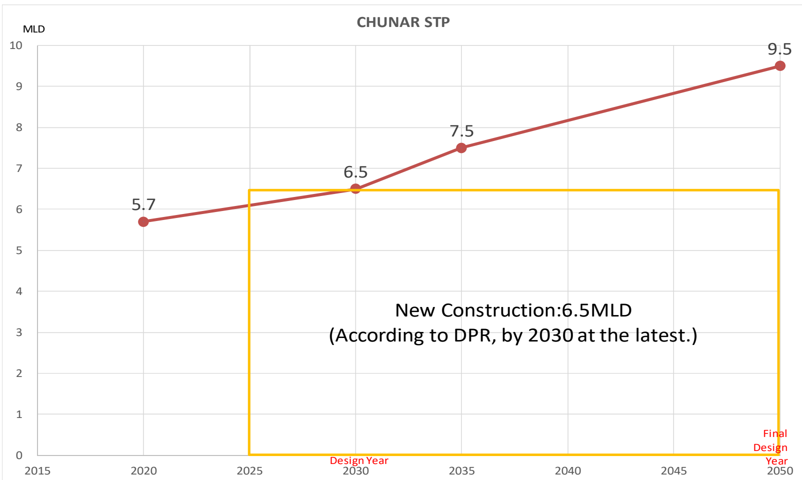


Figure 9.5 Construction plan of Chunar STP based on DPR

Source: JICA Survey Team

10 Operation and Maintenance of Sewerage Facilities

List of Assets for O&M at the End of the Project is shown in the table below:

Table 10.1 List of Existing Sewerage Assets in Project Area

Town	Sewerage Network Assets	Sewage Treatment Plant Assets
Chunar	There is no sewerage system. Some houses have own septic tanks whereas most of the houses discharge directly to Nalas that flow into the Ganga.	None
Mirzapur	Has existing sewerage network that is determined to be mostly functional except for a sewer of 4.5km length. There are 4 sewage pump stations	2 STPs: 4mld at Vindhyachal on WSP technology and 14mld at Mirzapur on UASB technology
Saidpur	no existing sewerage	None
Ghazipur	no existing sewerage	None
Varanasi Dist I	Almost 80% sewerage coverage	3 STPs: Dinapur STP 80mld, activated sludge process with roughing filter; BHU/Bhagwanpur STP 8mld, activated sludge with surface aeration; DLW STP 12mld
Varanasi Dist II	Partial sewerage system	Sewage from Dist II is treated at Dinapur STP in Dist I
Varanasi Dist III	Partial sewerage system; BHU area fully sewered with sewage flow to BHU/Bhagwanpur STP	2 STPs: Bhagwanpur STPs of 1.8mld and 8mld capacity
Varanasi Dist IV	No sewerage system, the area is outside municipal limits	None
Ramnagar	35km of sewerage existing in Ramnagar area but there is no clear network of these sewer lines as many interconnections have not been constructed. There is no sewerage network in Padao area. Only few houses have septic tanks.	None
Total	Partial sewerage network in the Project Area with several sewage pumping stations	7 STPs of capacities ranging from 1.8mld to 80mld with various aerobic and anaerobic processes

Source: Discussion with GAP II Team

Table 10.2 List of Sewerage Assets Being Created under GAP II in Varanasi

Town	Sewerage Network	Sewage Treatment Plant
Varanasi Dist I	Rehabilitation of existing old trunk sewer; Rehabilitation of Konia MPS; Rehabilitation of Ghat pumping stations; Sarai IPS (new); Narokar pumping station (new)	Construction of new 140mld STP to treat sewage from Dist II, STP with ASP process and digestion and power generation
Varanasi Dist II	Relief trunk sewer (new); Chauka Ghat pump station (new); Varuna River interceptor sewer (new); Phulwaria pumping station (new)	None
Varanasi Dist III	Assi nalla interceptor sewer (new); Nagwa pumping station (constructed but not yet commissioned)	Ramana STP of 50mld capacity (new) being constructed under another scheme and not under GAP II; Rehab of Bhagwanpur STP of 9.8mld capacity
Varanasi Dist IV	None as not in municipal area	None as not in municipal area
Total	Extensive sewerage network in Varanasi with rehabilitation of existing pump stations and several new pump stations	2 new STPs of 50mld and 140mld capacity

Source: Discussion with GAP II Team

Table 10.3 List of Sewerage Assets Proposed in the Project Area

Town	Sewerage Network Assets	Sewage Treatment Plant Assets
Chunar	60.7km of sewerage network including mains, sub-mains and lateral sewers with sewer diameters from 200mm to 700mm dia Flushing mobile van to flush the sewers as velocities will be low	6.5 mld on WSP (waste stabilization ponds) technology followed by disinfection
Mirzapur	245.4km of sewerage network including mains, sub-mains and lateral sewers with sewer diameters from 200mm to 1000mm dia Replacement of non-functional sewer length of 4.5km	Upgrade the Vindhyachal STP to 6mld capacity with disinfection; Construct a new STP of 18mld capacity with SBR technology in Mirzapur; Upgradation of the existing 14mld STP with MBBR addition

Saidpur	DPR not yet available. Dropped from the project	Land is not available, dropped from the project.
Ghazipur	DPR for ID/T is not yet available. Comprehensive plan is available.	Ditto
Varanasi Dist I	Almost 80% sewerage coverage	Rehab of existing Dinapur 80mld STP
Varanasi Dist II	Secondary and branch sewers being designed to achieve 100% coverage	Sewage flow to be treated at new 140mld STP at Dinapur located in Dist I
Varanasi Dist III	Secondary sewers and branch sewers with final outlet to Ramna STP through Nagwa Pump station	Ramana STP (being designed by UPJN under another project)
Varanasi Dist IV	DPR not yet available. Out of scope	DPR not yet available. Out of scope
Ramnagar	Sewage pump station at Ramnagar of 20.7 mld peak capacity Sewage pump station at Padao of 3mld peak capacity Main pump station at Kodopur of 32mld peak capacity	1 STP at Ramnagar of 14mld capacity with Activated Sludge based MLE Process
Total	Complete sewerage network in the Project Area with several sewage pumping stations	3 new STPs of 6.5mld, 18mld and 14mld capacities

Source: DPRs given to the Preparatory Survey Team

Table 10.5 Estimated O&M Cost of Proposed Sewerage Works (INR Lacs)

Town	Sewerage Network Construction Cost	Sewage Treatment Plant Construction Cost	Sewage Pump Stations Construction Cost	Sewerage O&M Cost for 5 years
Chunar	8163.01	638.70	1132.54	905.16
Mirzapur	21455.25	3683.41	2078.80	2958.28
Saidpur	N/A	N/A	N/A	N/A
Ghazipur	9941.70	3664.49	1479.85	2803.27
Varanasi Dist I	28027.29	No STP in DPR	No PS in DPR	948.84
Varanasi Dist II	42050.79	6703.39	No PS in DPR	6765.58
Varanasi Dist III	15045.98	10301.90	No PS in DPR	3754.60
Ramnagar	8860.92	2233.62	1477.32	5554.67

11 Environmental and Social Considerations

11.1 Biological Environment

(1) Flora

The plains of Uttar Pradesh have been very rich in natural vegetation which has, however, diminished due to wide-ranging needs of the people. The project sites are public roads, vacant lands or facility areas of sewerage systems where some shrubs or scrubs are growing.

(2) Fauna

For fauna, animal depends on forest not only of food but also for habitat. The diversity of fauna living in water and terrestrial environment in the air are found in the StateSocio-Economic Environment

11.2 Legal Framework of the Government of India

The Government of India has laid various policy guidelines, acts and regulations pertaining to the environment. The Environment (Protection) Act, 1986 is the umbrella legislation for the protection of environment. As per this Act, the responsibility to administer the legislation has been jointly entrusted to the Ministry of Environment and Forests (MoEF) and the Central Pollution Control Board (CPCB)/State Pollution Control Boards (SPCBs).

11.3 Estimation of Potential Impacts and Assessment

The potential adverse impact by the proposed projects is shown in **Table 11.5.2**.

11.4 Assessment Results of Environmental and Social Impacts at Initial Scoping and IEE

The assessment result toward potential adverse impacts for the initial scoping and IEE is shown in **Table 11.6.1**.

11.5 Recommended Mitigation Measures toward Potential Adverse Impacts

The recommended mitigation measures toward the potential adverse impact are shown in **Table 11.7.1**..

11.6 Environmental Monitoring Plan

The environmental monitoring plan at each project phase is shown in **Table 11.8.1**.

11.7 Land Acquisition and Resettlement

(1) Necessity of Land Acquisition and Resettlement

The necessity of land acquisition for the project sites is shown in **Table 11.9.1** as interim results. For the project sites of pumping stations and Ramnagar STP, land acquisition will be necessary. There will be no resettlement for these sites because of no inhabitation at these sites. However, since the components of the proposed projects and the selection of sewage collection method for either ID & T or the Comprehensive method (sewer networks) have not been approved by NMCG, the process of the land acquisition and their relevant surveys cannot be initiated. In addition, the sewage collection system for Mirzapur,Ghazipur, Ramnagar and Chunar cities.

(2) Scope of Impact of Land Acquisition and Resettlement

Since the components of the proposed projects have not been approved by NMCG, the process of the land acquisition and their relevant surveys cannot be initiated. Therefore, the baseline data on the PAPs (Project Affected Persons) and PAHs (Project Affected Households) to identify the scope of the impact by the land acquisition cannot be obtained.

12 Financial and Economic Consideration and SPV

The total cost of the proposed in **Table 17.7.1** is about Rs.21,653 million (JY37,026 million). From economic analysis standpoint, EIRR is determined as 8.3%, which is slightly lower than hurdle rate of 10%. And net economic present value of the program is -3,537 JPY under 10% discount rate. Thus, the program is also not economically feasible under updated final construction cost estimation.

From financial evaluation standpoint, FIRR cannot be determined because both total cash flow and net present value of the program less than zero, and thus, the program is not financially feasible under updated project cost estimation.

Financial IRR is not computed since the NPV itself is negative in this project. However, in this type of the project for development and improvement of public utility or social infrastructure so called as “public works”, it may not be adequate to analyse cost recovering ability only by financial benefit. Generally sewerage projects cannot recover all O&M costs as well as initial capital outlay.

SPV Financial Modeling

HAM-PPP (Hybrid Annuity model) is different from current EPC model in the legal matters and various conditions in the agreement or the contracts. Similarly, HAM-PPP will show a different cash flow model or financial model.

13 Organization of implementing agency

13.1 The Project Implementation Unit (PIU) Structure

UPJN shall organize the Project Implementation Unit (PIU) in the UPJN Varanasi Zone office, set up as an independent office under the Office of the General Manager, UPJN Ganga Pollution Prevention Unit (UPJN-GPPU). The UPJN-GPPU implements centrally and state funded pollution prevention projects for the River Ganga.

13.2 Organization Structure of PIU

The proposed organization structure and staffing of PIU considers the application of organisational principles to ensure efficient and effective accomplishment of the Project objectives as delegated to it by the NMCG / SPMG and the particular SPV, together with organisational factors and practices existing in UPJN-GPPU.

The engagement of the PIU staff will be governed by the Service Regulations of UPJN.

13.3 SPV Proposed Organization, Roles and Responsibilities

The Special Purpose Vehicle (SPV) for Hybrid Annuity-based Mode of Public Private Partnership (HAM-PPP) will be set up and institutionalized for project execution of sewage treatment infrastructure under Namami Gange for each ULB covered under this. The Institutional Arrangement, recently released by NMCG for all projects under the Namami Gange, is shown in エラー! 参照元が見つかりません。

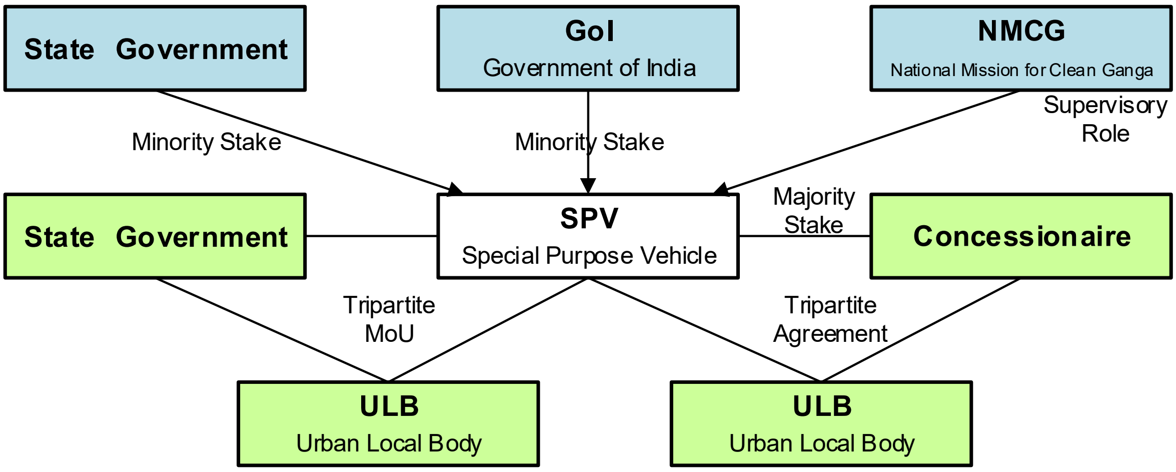
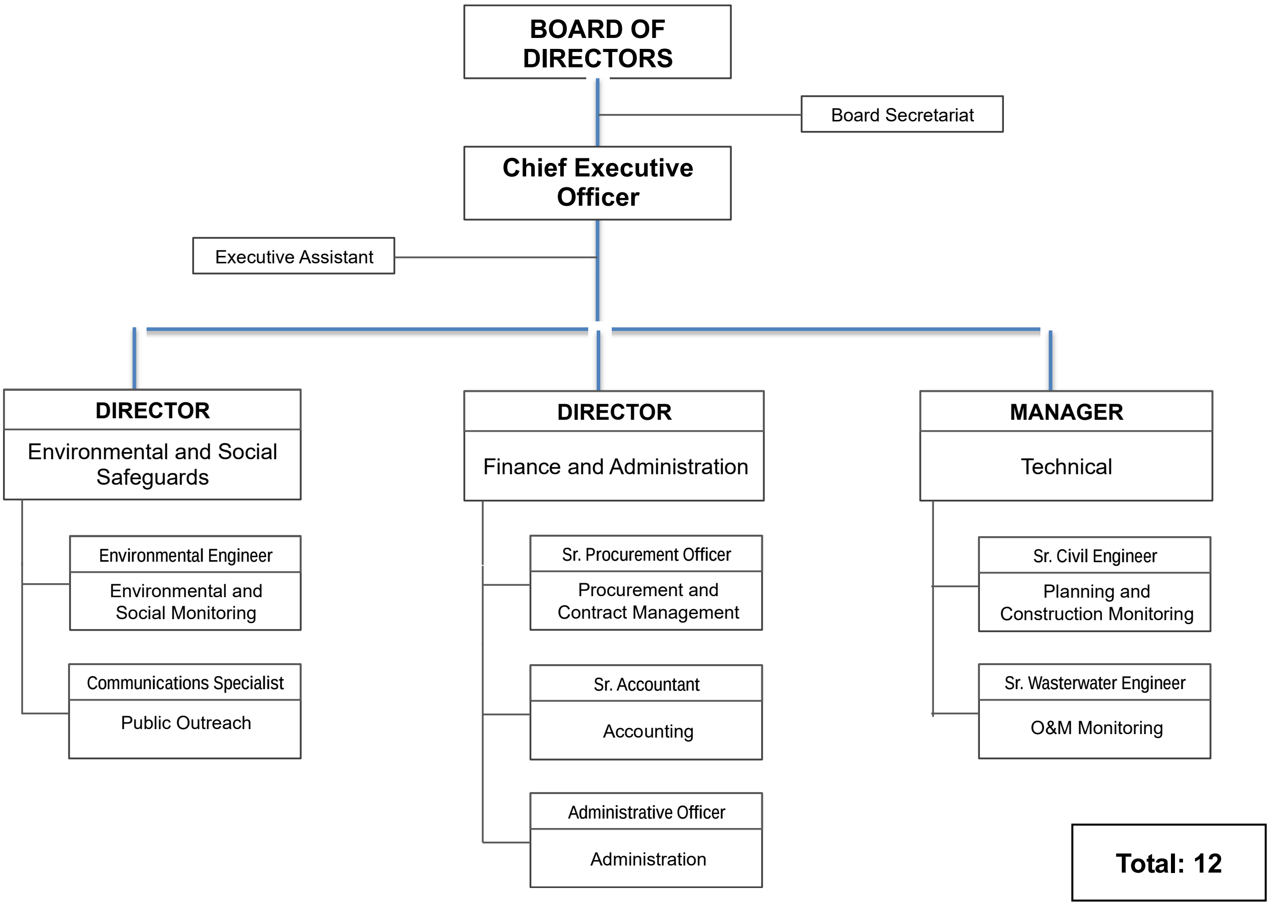


Figure 13.1 Institutional Arrangements for SPV

13.4 Roles and Responsibilities of SPV

In addition, the SPV will undertake activities in seven areas of project identification and development; implementation arrangement and pre-procurement; procurement; approval and contract awarding; contract management; project implementation and project operation.



JICA Survey Team, March 2016.

Figure 13.2 Typical Organization Structure of ULB-Level SPV

a. Project Management Consultants

The Project Management Consultants (PMC) shall be engaged by the SPMG for the primary purpose of undertaking the detailed design of the specific projects(s), as well as ensuring proper, efficient and effective implementation of the projects identified in the project preparation stage.

b. Streamlining the Decision-Making Process

Decision making for procurement should both be strengthened and streamlined with the procuring agencies – SPMG for consulting services, and SPVs for the HAM-PPP Contractor-Concessionaire, focusing not only on downstream activities such as tender conditions, bid documents, eligibility criteria, bid evaluation, contract awarding etc.; but also on upstream activities like determination of technology, conceptual design, specification, "vendor" base identification, as well as post-tendering procedures such as contract management, payment, and monitoring after the award of a contract. This can be done.

13.5 Considerations on Procurement Process of SPV

The Planning Commission, through its Secretariat for PPP & Infrastructure, has issued the third revision of the “Model Request for Qualification (RFQ) Document” in 2014. This incorporates the results of experiences in implementing the first set of guidelines, as well as includes best practices after the said document was issued in 2007. It is the expected that Ministries and autonomous bodies of the Central Government will follow these Guidelines, and that the State Government are to adopt the same to enhance the possibilities of fair, transparent and competitive selection of bidders for delivery of successful PPP projects in infrastructure.[2]

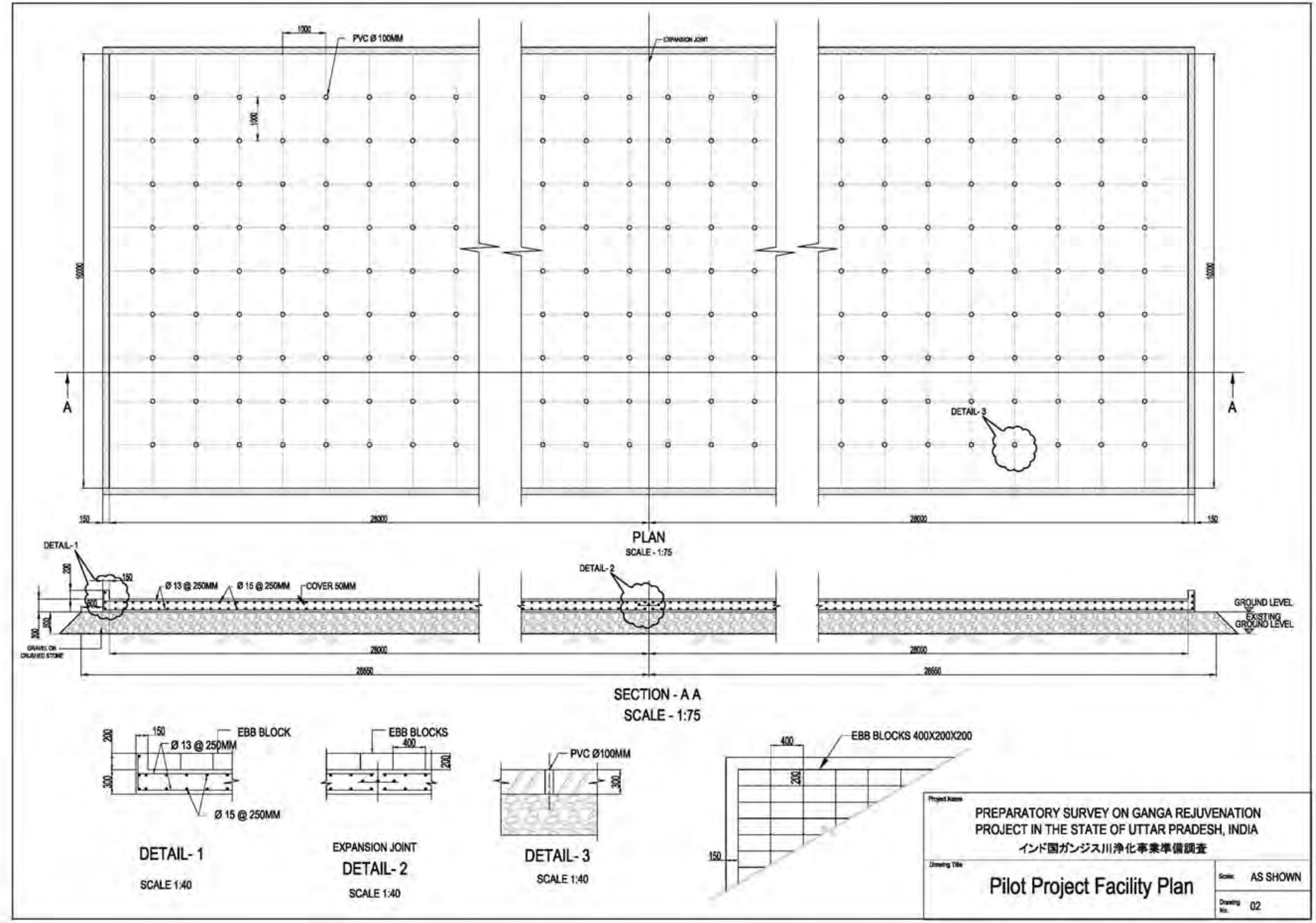
The guidelines are also expected to be followed by the SPV. The guide’s framework is not only broad and generic, which makes it easy to adopt; but is also flexible enough to make it project-specific.

14 Pilot Project

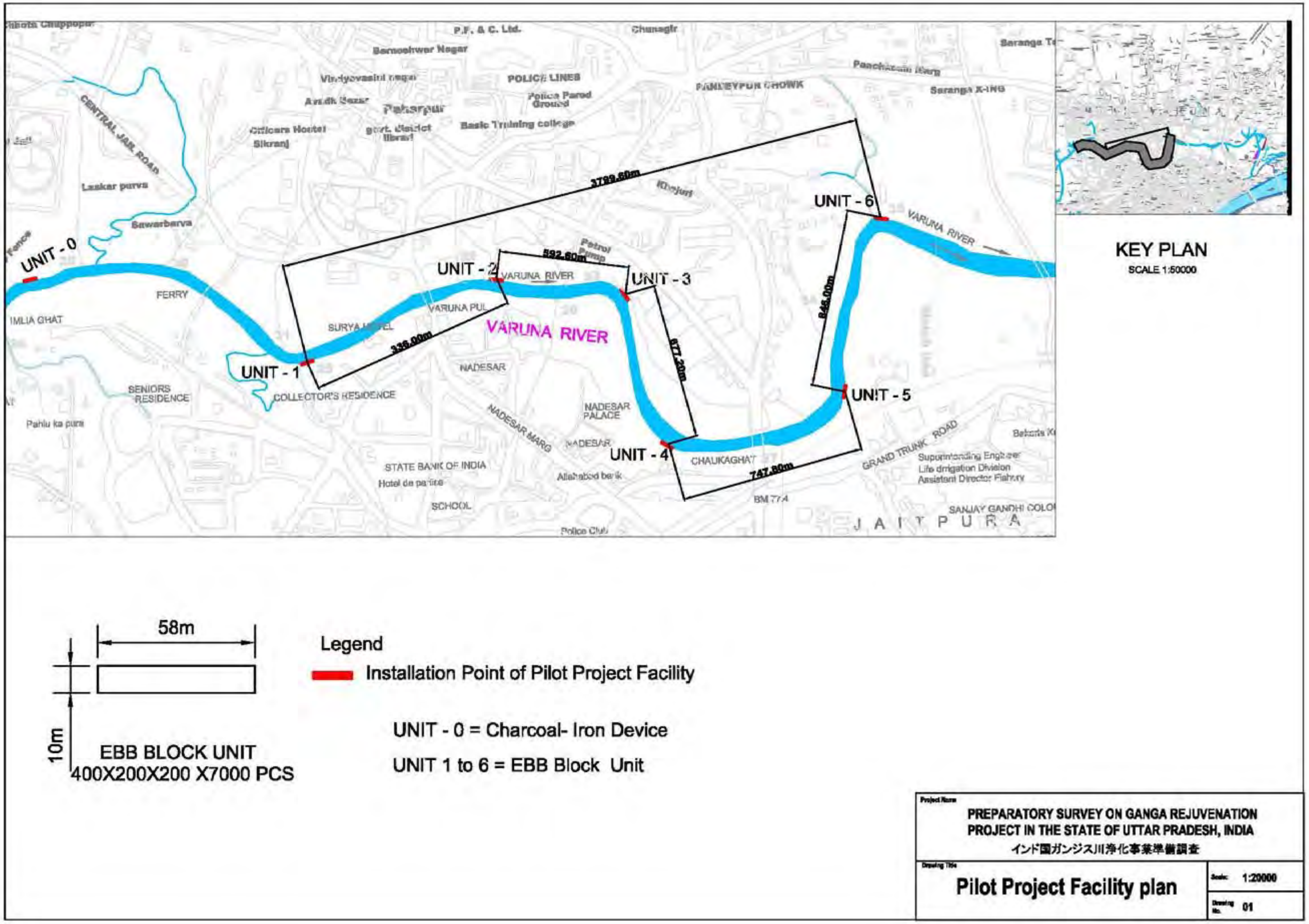
Treatment of the entire flow for all the season is impossible in terms of flowrate and water level variation. During the rainy season, Ghats are submerged under water with any facility on the bottom of the river or along the river side to be submerged in the deep water and no maintenance work will be possible in the rainy season. After the rainy season, large amount of sediment will be left on the structures of the Ghats and floors. Varuna river was selected and proposed for the Pilot Project.

From the stand point of maintenance and operation, EBB and Iron and Charcoal method were proposed for the Pilot Project. EBB unit was taken as possible process with less maintenance work and less operation cost in the CPHEEO.

[2] Planning Commission. “PPP Request for Qualification: Model RFQ Document”, 2014.


PVC Ø 100MM
EXPANSION JOINT
DETAIL- 3
A
PLAN
SCALE - 1:75
DETAIL- 1
DETAIL- 2
Ø 13 @ 250MM
Ø 15 @ 250MM
COVER 50MM
GROUND LEVEL
EXISTING GROUND LEVEL
GRAVEL OR CRUSHED STONE
SECTION - A A
SCALE - 1:75
EBB BLOCK
EBB BLOCKS
PVC Ø100MM
EBB BLOCKS 400X200X200
DETAIL- 1
SCALE 1:40
EXPANSION JOINT
DETAIL- 2
SCALE 1:40
DETAIL- 3
SCALE 1:40
Project Name
PREPARATORY SURVEY ON GANGA REJUVENATION
PROJECT IN THE STATE OF UTTAR PRADESH, INDIA
インド国ガンジス川浄化事業準備調査
Drawing Title
Pilot Project Facility Plan
Scale: AS SHOWN
Drawing No. 02

a. Location of Units Installed in the Varuna River



15 Varanasi Convention Centre (VCC)

Objectives: The proposed building aims to address the requirement for a convention centre which will facilitate for hosting conventions on a grand scale.

(1) Layout Plan

(2) Implementation Program

(3) Exhibit of River Purification Facility>

(4) Design Proposal>

Design Concept based on the motif of culture, history, heritage, industry, tourism and regional characteristic shall be established to fit to the natural condition and surrounding environment. Ornate appearance will be avoided and in this context, façade of Mughal style is recommended to express the heritage and history of Varanasi.

16 ACTION PLAN

For the action plans for institutional improvement, the following nine subjects are given to be discussed:

1) Self-reliant Management of Sewerage Works
2) Preparation of Annual Business Plan up to Project Completion
3) Development of Asset Ledger
4) Improvement of Information Management System
5) Streamlining of Sewage Tariff and Improvement of a Collection System
6) Mandatory House Connection to a Sewerage Network
7) Preparation of Financial Statements
8) Improvement of Customer Service
9) Improvement of Human Resource Development and Management

17 Construction Cost and Implementation Plan

17.1 Outline of the Projects and Components

Table 17.1 the planned construction commencement and construction period of project

<table>
<tr><th>City Name</th><th>Type of Report</th><th>Commencement year</th><th>Construction duration (month)</th></tr>
<tr><td>Dinapur & Bhagwanpur</td><td>Comprehensive</td><td>-</td><td>20.5</td></tr>
<tr><td>Ramna</td><td>Comprehensive</td><td>2015-2016</td><td>32.0</td></tr>
<tr><td>Mirzapur</td><td>comprehensive</td><td>2016-2017</td><td>36.0</td></tr>
<tr><td>Mirzapur</td><td>I&D-part 1</td><td rowspan="3">2016-2019</td><td rowspan="3">36.0</td></tr>
<tr><td>Mirzapur</td><td>I&D-part 2 A-1</td></tr>
<tr><td>Mirzapur</td><td>I&D-part 2 A-2</td></tr>
<tr><td>Chunar</td><td>Comprehensive</td><td>2016-2017</td><td>36.0</td></tr>
</table>

Chunar	I&D	2016-2017	36.0
Ghazipur	Comprehensive	2015/May	27.0
Varanasi District III	Comprehensive	-	30.0
Ram Nagar	Comprehensive	2016/Jan	30.0
Ram Nagar	I&D	2015/Dec	22.0

Note: The symbol (-) means DPR does not mention specific year.

Table 17.2 shows the scope of work for the Project.

Table 17.2 Project Components for Ganga Rejuvenation Project in Uttar Pradesh

Category	Component	Remarks
A. Sewer	1.Construction of Main/Sub-main and Branch sewers in Varanasi District-1	220km
	2.Construction of Main/Sub-main and Branch sewers in Varanasi District-2	276 Km
	3.Construction of Main/Sub-main and Branch sewers in Varanasi District-3	128 Km
	4. Construction of Rising Main and sewer diversion in Ramnagar	3km
	5. Construction of Main Sewers and interceptor in Chunar	4.3km and 16 locations
B. Sewage Treatment Plant (STP) and Pump Station (PS)	6. Construction of STP, IPS and MPS in Chunar	Treatment capacity:6.5 MLD
	7. Construction of STP and SPS in Mirzapur	Treatment capacity: 18 MLD
	8. Construction of STP and SPS in Ramnagar	Treatment capacity: 13 MLD
	9. Construction of STP in Ramnar	Treatment capacity: 50 MLD
	10. Rehabilitation of Dinapur STP	Treatment capacity: 8 MLD
	11. Rehabilitation of Baganpur STP	Treatment capacity: 80 MLD
C. Environmental management	12. Environmental Monitoring Plan (EMoP)	
D. Consulting Services	a. Detailed Design, Bidding and construction for Sewers b. Design Built: Basic Design, Bidding and Construction Supervision for IPS and STPs, Strengthening in Public awareness/participation and institutional capacity, and facilitation of implementation of Environmental Management Plan (EMP)	(1) Sewers: Detailed design, assistance for Bidding and construction supervision (2) IPSs & STPs,: Basic Design, assistance for Bidding and Construction Supervision (3) Public Part., Institution-

		al Capacity & Environment: Supervise Contractors

Note: Sewer Numbers in item "A is refereed to those in sewerage DPR

17.2 Packaging for Project Component

Based on the contents of the work, project packages by component are divided as follows;

(1) Package 1: Construction of Main/Sub-main and Branch sewers in Varanasi District-1
(2) Package 2: Construction of Main/Sub-main and Branch sewers in Varanasi District-2
(3) Package 3: Construction of Main/Sub-main and Branch sewers in Varanasi District-3
(4) Package 4: Construction of STP, SPS, rising main and sewer diversion in Ramnagar
(5) Package 5: Construction of STP in Ramna
(6) Package 6: Construction of STP, IPS, MPS and Main Sewers and interceptor in Chunar
(7) Package 7: Construction of STP and SPS in Mirzapur
(8) Package 8: Rehabilitation of Dinapur STP and Bhagwanpur STP
(9) Package 9: River Purification
(10) Package 10: Construction of community toilet
(11) Package 11: Strengthening in public awareness/participation and institutional capacity and facilitation of implementation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP)
(12) Package 12: Capacity development for UPJN (institutional development)
(13) Package 13: MIS
(14) Package 14: Consulting Services

17.3 Procurement Method for the Implementation of the Project

(1) Contract method for the construction of sewerage system

However, for the construction/rehabilitation work for STPs and IPSs, design-Built method is recommended following current practices in the similar projects in India. While for the construction of sewers, Design-Bid-Construction method shall be adopted, since this work needs to adjust/arrange right of way for pipe laying and house connections with beneficiaries.

(2) Possibility of adopting Local Bidding

In conclusion, ICB is applied for all packages in the view of securing the quality assurance and time management for constructing the facilities. On the other hand, supporting components of the Project for Capacity Development for UPJN in application of GIS and MIS, and Strengthening in Public awareness/participation and institutional capacity, and facilitation of implementation of Environmental Management Plan, LCB is also recommended instead of applying ICB.

18 Measures for Climate Change

(1) Scenario and fundamentals

Simulated climate outputs from PRECIS regional climate model for present (1961-1990, BL) near term (2021-2050, MC) and long term (2071-2098, EC) for A1B IPCC SRES socio-economic scenario has been used. Q14 QUMP ensemble has been used for the simulation. Global Circulation Models (GCM) is applied. The projected climate change in 2030 (average of 2021-2050) and in 2080 (average of 2071-2098) over Uttar Pradesh using IPCC SRES A1B scenario were studied. Climate change poses uncertainties to the supply and management of water in the State.

(2) Measures for Climate Change in the Proposed Project

The influence for climate change in the sewerage project is roughly classified into the following four categories: 1) Emission through energy consumption of power, fuel, etc., 2) Emission from treatment processes accompanied with the operation of treatment facilities, 3) Emission accompanied with the consumption of clean water, industrial water, chemicals and 4) Reduction of emission amount through the utilization of sewerage resources

(3) Promotion of sewerage development and sewage treatment

The implementation of sewerage projects itself is one of important measures against climate change.

(4) Utilisation of Treated Sewage and sludge

The central government has also encouraged the reuse of treated sewage for industrial purpose. Sewage sludge generated in the process of sewage treatment is used for power generation by digestion gas and as manure for agricultural use in the address utilizing the sewage value as a resource.

19 SELECTION OF TARGET AREAS FOR PHASE-II PROJECT

The additional STP capacity requirement for the year of 2030 is biggest as 413.6 MLD in Kolkata, followed by Kanpur (203.5 MLD), Patna (135.4 MLD), Howrah (133.3 MLD) and Moradabad (83.0 MLD), respectively. However the Ganga Action Plan aims to achieve BOD concentration of less than 3 mg/l for bathing purpose in the holly Ganga in the earliest time. Therefore, the priority should be given to the compliance status of primary water quality criteria set for the Ganga in selecting the target area for the Phase-II Project.

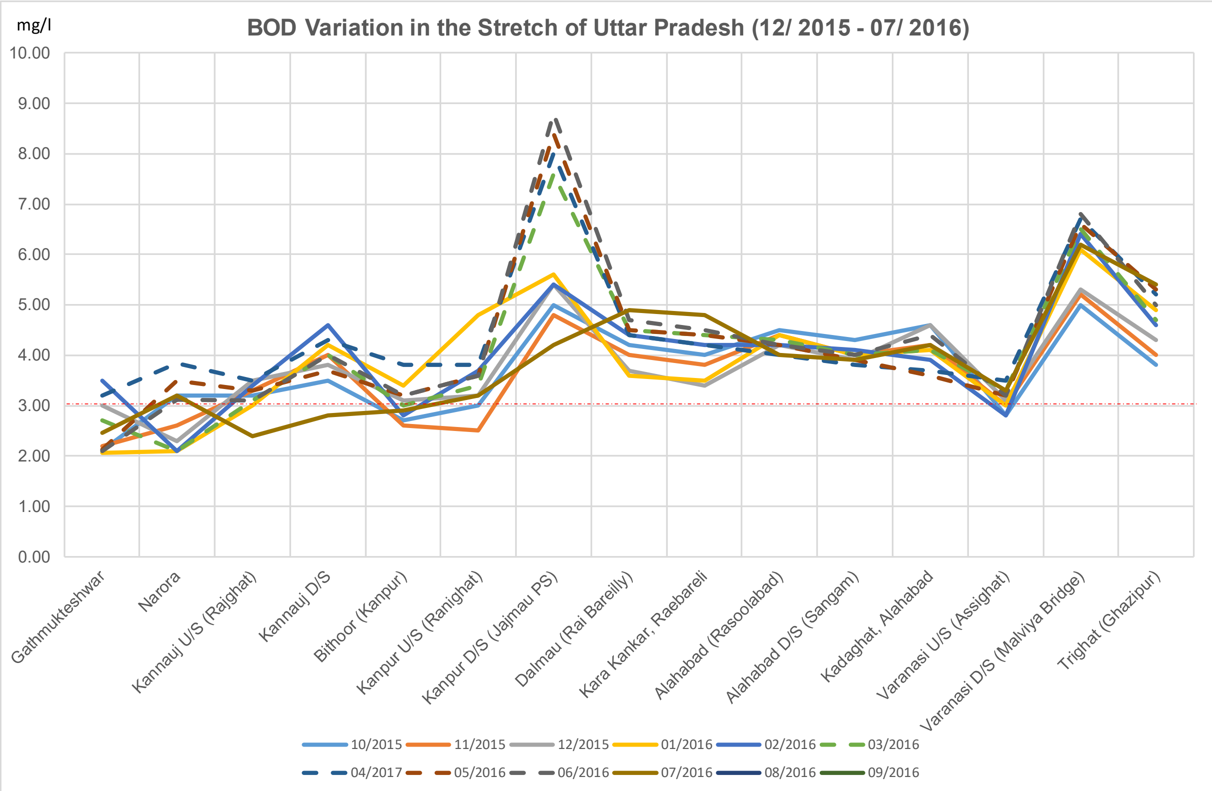


Figure 19.1 BOD Variation along the Stretch of Uttar Pradesh (12/2015-07/2016)

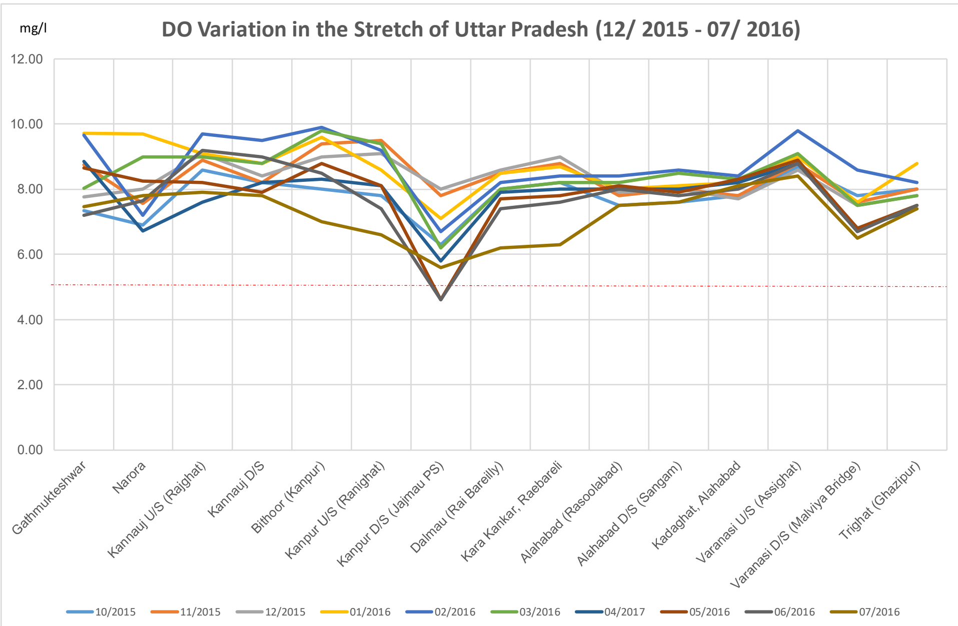


Figure 19.2 DO Variation along the Stretch of Uttar Pradesh (12/2015-07/2016

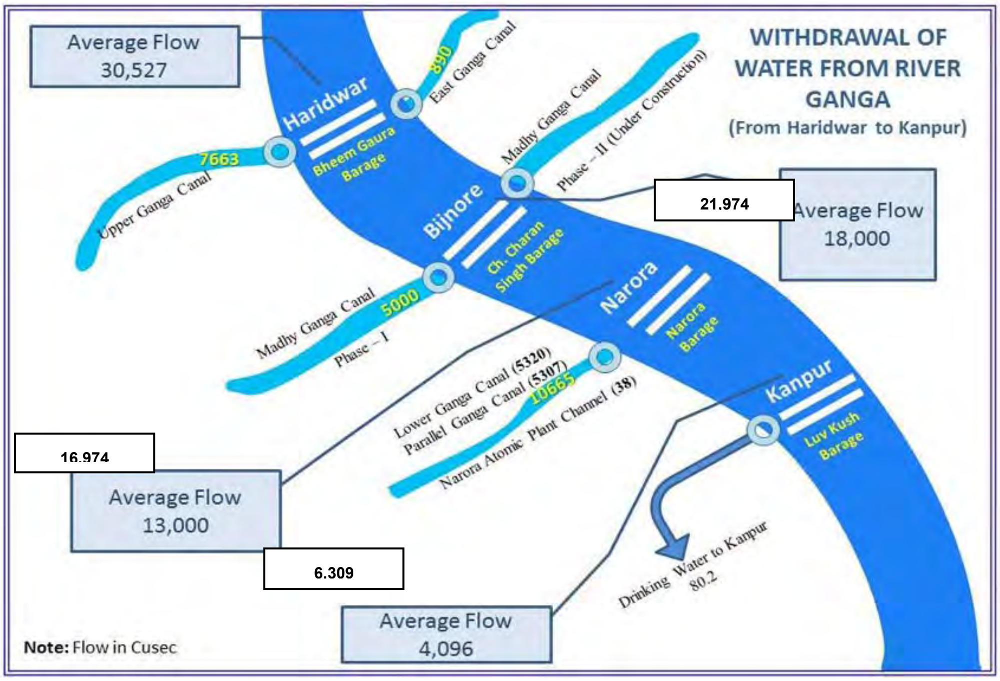


Figure 19.3 Withdrawal of Water from River Ganga from Haridwar to Kanpur

From the situation mentioned above, Kanpur is recommended as the target area for the Phase-II Project together with Unnao (additional STP capacity requirement: 50.1 MLD) and Gangaghat (16.2 MLD). Unnao and Gangaghat are located on the opposite side of the River Ganga from Kanpur. Moradabad is secondly proposed as the target area.

20 Risk Control

The possible risks involved in the project implementation is summarized in **Table 20.1**.

Table 20.1 Possible Risks Involved in the project Implementation.

Potential Project Risks	Assessment
Project Risk	
Increase of STP effluent discharge not conforming to the new effluent standards The wastewater generated in District-I and District-II of Varanasi will flow into the existing 80 MLD Dinapur STP and the 140 MLD Dinapur STP under construction, respectively. A part of wastewater generated in District-I is diverted to District-II. The DPR for upgrading and rehabilitation of the Dinapur and Bhagwanpur STPs was once revised so as to meet the new effluent standards in accordance with the instruction of NMCG, but NMCG/UPJN has decided to maintain the oper-	**Probability: High** **Impact: Small** **Analysis of Probability and Impact:** Since the continuation of present operation at Dinapur and Bhagwpur STPs is the matter decided by NMCG/UPJN who is the implementation/execution agency, it is unavoidable to discharge the treated sewage not conforming to the new effluent standards. The continuation period is unknown at this moment **Mitigation Measures:**

ation of the 80 MLD Dinapur STP as it is with no modification. Therefore, the development of District-I sewer network will increase the discharge of STP effluent in no conformity with the new effluent standards. When the existing 80 MLD Dinapur STP will be reconstructed to meet the new effluent standards is unknown at this moment. While the 140 MLD Dinapur STP is under construction as JICA-assisted GAP-II Project, which adopts the activated sludge process as the treatment process in conformity with the old effluent standards, or BOD/TSS: 20/30. Accordingly likewise District-1, the development of District-II sewer network will increase the discharge of STP effluent in no conformity with the new effluent standards.	Adoption of treatment process proposed by the JICA survey team, if the reason for the continuation of present operation at Dinapur STP is attributed to its high construction cost proposed by UPJN. The continuation of present operation with no modification at Dinapur STP is decided by NMCG/UPJN but its reason is unknown. The revised DPR by UPJN to meet the new effluent standards is based on the idea to demolish the existing STPs fully and re-construct them in the present premises due to the constraint of land availability. If the decision is based on the such construction cost, the proposal of the JICA survey team will be worthy to be considered, Its proposal is based on the idea to make use of existing treatment facilities as long as possible, since they were constructed 23 years ago in 1994 and has not yet reached to their service life and are still usable. **Action during the Implementation: None** **Contingency Plan (If Applicable): None**
Executing Agency Risk	
Timing gap of construction completion under the different project implementation structure for sewer network and SPS/STP The wastewater of District-III will flow into the 50 MLD Ramna STP to be implemented under the HAM-PPP Model but the District-III sewer network development will be done under the conventional EPC model. The construction schedule for the Ramna STP is already open in its bidding documents and, if the schedule will be in progress as expected, the Ramna STP will be completed by June 30, 2019 including 63 days for contractual processing and two-year construction period starting from the bid opening on April 29, 2017. On the other hand, since the schedule of the loan agreement for District-III has been not yet fixed, the Ramna STP will be completed preceding the commissioning of the District-III sewer network, which will lead to the idle time of the Ramna STP.	**Probability: High** **Impact: Small** **Analysis of Probability and impact** **Mitigation Measures:** According to the JICA-assisted Master Plan, when the Ramna STP will be completed, the existing Bhagwanpur STP will be de-commissioned and the wastewater that flows into the Bhagwanpur STP will be led to the Ramna STP. Therefore, if the trunk sewer to convey the wastewater from the Bhagwanpur STP to the Ramna STP will be installed in the early time during the District-III sewer network development work, the idle time of the Ramna STP will be avoided and the period that the Bhagwanpur STP discharge the effluent not conforming to the new effluent standards will be shortened. **Action during the Implementation:** Keep close communication between both EPC and HAM-PPP projects so as to adjust the construction schedules **Contingency Plan (If Applicable): None**
Executing Agency Risk	
Whether tendering for Ramana STP is completed suc-	**Probability: Middle**

cessfully or not may affect on subsequent HAM-PPP projects The Ramana STP is the first project that the HAM-PPP Model is applied to the Ganga Projects. Whether the procedure up to the contract signing will be in progress as scheduled in the bid documents is unknown and there is even the risk of delay. When the bidder will attend the contract negotiation with any alternatives or requests on the application conditions of the HAM-PPP model shown in the bid documents, since such results will become the previous instance for other projects, NMCG/UPJN will carefully correspond to thrush out the conditions that the concessionaire will be acceptable which will result in taking a time. The sewerage projects in Mirzapur, Chunar and Ghazipur that the HAM-PPP Model will be expectedly applied to will be affected by the movement of contract negotiation on the Ramana STP project.	**Impact: Small** **Analysis of Probability and impact:** If the Ramana STP project under HAM-PPP will not be successfully negotiated, other projects that HAM-PPP will be applied to subsequently will be affected **Mitigation measures: None** **Action during the Implementation:** Watch the bid for the Ramna STP under the HAM-PPP Model closed on April 29, 2017 and the subsequent contract negotiation **Contingency Plan (If Applicable):** Dialogue to develop the model at policy level.
Executing Agency Risk	
Land acquisition for the Ramnagar STP According to the letter (draft) from Executive Office, Municipal Council Office, Ramnagar addressed to General Manager, Ganga Pollution Prevention Unit, UPJN, the landowner for the Ramnagar STP site mentioned The JICA survey team also submitted the letter to the State Government of Uttar Pradesh to get the budgetary allocation and proceed the land acquisition of the particular site as early as possible but could not get the information that the land acquisition had been completed during the field survey in Varanasi. Therefore, it is necessary to confirm the situation of STP site land acquisition in the course of project formation。	**Probability: Low** **Impact: Big** **Analysis of Probability and impact:** On the delay in land acquisition, "Ganga Rejuvenation Committee of Estimate (2016-17)" on May 11, 2016" under MoWRRD&GR describes below. "In written reply to a query as to why only 25 out of 80 projects and 600 kms out of 3315 Kms network of sewer lines were built, the M/oWR,RD&GR stated that "The delay in the construction of STPs is mainly due to delay in land Acquisition and dispute over land. Laying of sewer network in densely populated towns is delayed, mainly due to narrow streets and issues in road cutting. Despite such constraints, 25 out of 80 projects and 600 kms out of 3315 Kms network of sewer lines were built''. Therefore, the land acquisition issue is common in India. If the land acquisition for the STP site will not be completed by the conclusion of L/A, the impact will be big. **Mitigation measures: None** **Action during the Implementation:**

<table>
<tr><td></td><td>Monitor the status of land acquisition for the Ramnagar STP site
Contingency Plan (If Applicable): None
Confirm the completion of land acquisition for the Ramnagar STP site before the agreement on the scope (design site) for the project.
.</td></tr>
<tr><td>Stakeholder Risk</td><td></td></tr>
<tr><td>Sewerage development by the comprehensive or ID&T system
MoUD promotes the comprehensive (or comprehensive) sewerage system for the cities with a population of more than 100,000 (1 lark), while NMCG adopts the Interception, Diversion and Treatment sewerage system (ID&T system) with the priority to solve the water pollution issues. Mirzapur has submitted both DPRs for the comprehensive and ID&T systems, but Ghazipur has submitted only the DPR for the comprehensive system and not submitted the DPR for the ID&T system in spite of the request of the JICA survey team during the field survey. Both cities have once shown the movement to submit the application to AMRUT which provides the fund for the development of a comprehensive system. This issue will smolder in the future and may cause the delay of project implementation.
In case that the project will be implemented under the HAM-PPP model, since the sewer cost is very small in the ID&T system, it will be included in the HAM-PPP cost, but it will be too big in the comprehensive system resulting in an increase of the concessionaire's burden. For example, in Mirzapur, the net construction cost is sewer : SPS/STP=21,455:5,762 (unit: Rs. Lacs) for the comprehensive system and 1,478:5,651 for the ID&T system. The total cost of the comprehensive system is 3.8 folds of that of the ID/T system. There is a big gap in the rate of the sewer cost to the STP cost, or 372% for the comprehensive system and 26% in the ID/T system.</td><td>Probability: Middle
Impact: Small
Analysis of Probability and impact:
Since Ghazipur could not submit the ID&T DPR to the JICA survey team, it has somewhat high possibility that the comprehensive plan sewerage system will be adopted.
The project cost of a sewer network for Ghazipur is not so big.
Mitigation measures:
Action during the Implementation:
Watch the scope of work for Mirzapur and Ghazipur HAM-PPP projects.
Contingency Plan (If Applicable): None</td></tr>
<tr><td>Overall Risk Rating</td><td>Probability: Middle
Impact: Low</td></tr>
<tr><td colspan="2">The role of UPJN who will be involved in both EPC and HAM-PPP projects is very important to adjust two project implementation schedule for sewer networks and STP/SPS. UPJN is also concerned with land acquisition and the decision on sewerage development method for the comprehensive or ID&T system.</td></tr>
</table>

21 Operation and Effect Indicators

The operation and effect indicators are set for the year of 2022 two years later after its completion.

(1) Operation Indicators

1) Served population by Sewage Treatment

Although there is no actual data on the increase rate of a number of connections, referring to the actual data in Kyoto, Japan of which the population size is almost same, the increase rate is set at 4.0% per annum, the served population is estimated as 962,000 persons in the year of 2022.

2) Amount of Sewage Treatment

Assuming the per capita water supply at 150 lpcd, the conversion factor to sewage at 0.80 and the groundwater infiltration rate as 25% for a mega city like Varanasi, the amount of sewage treatment in 2022 is calculated as 144.3 MLD.

(2) Effect Indicators

1) Coverage Ratio by Sewerage

Growth rate of household connections is assumed at 4% per annum for the first two years and the coverage ratio by sewerage is calculated at 84.5% In the year of 2022.

2) Water Quality Improvement Effect in the Receiving Water Bodies

The river discharge (30,358.7 MLD) is big enough in comparison with the sewage flow (144,3 MLD) with only 0.5% of the river discharge. It will be difficult to show the improvement effect numerically.

22 SAFETY MEASURES

The safety control in the construction works is mainly regulated by the following two acts:

- The Factories Act, 1948
- The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996

Shown below are studied and described:

(1) Laws, Regulations, etc. Concerning Safety and Health

(2) Submission of Documents Concerning Safety and Health to the Administrative Office

(3) Obligation When Worker's Accidents or Accidents Occurs

(4) Compensation, etc. to Sufferers when Worker's Accident or Accident Occurs

(5) Safety Control Structure for Offices/Establishments

(6) Expenses for Safety

(7) Administrative Measures, Social Sanction, etc. by Worker's Accident or Accident Occurrence

CHAPTER 1 Introduction

1.1 Background

In India, discharging untreated sewage has caused water pollution in the public waterbody, subsoil and groundwater. Increasing water use by the growing population and for economic development has raised the sewage volume and discharge into public water body. At present (as of year 2009), however, only about 30% of the nation's generated sewage is treated by the existing sewage treatment plants. Under these conditions, people are exposed to unsanitary and inconvenient living conditions. On the other hand, the sewerage services are insufficient due to lacking of efficient management both in technical and financial aspects including operation and maintenance of sewerage facilities that need to be improved.

The Government of India (hereinafter referred to as “GoI”) decided to provide sewerage/sanitation facilities for the urban population in its 12th National Five Year Development Plan (from April 2012 to March 2017).

Varanasi city in Ganges river basin is the greatest sacred city of the Hindu. 300,000 people per day visit the city for taking ritual bathing or sightseeing. The Prime Minister Modi who was elected May 2015 committed to purify the Ganges allotting the budget of 40 billion JPY in budget plan in 2015 which was 40% over the previous fiscal year. GoI set a target that untreated sewage will never be discharged to Ganges River after 2020 in “Clean Ganga Mission” in 2010.

River Ganges is worshipped as the holiest river in India. The catchment area is 861,404 km2, that is one fourth of total land area with 43% of the total population in the river basin. Although Central Pollution Control authority set the target water quality for taking ritual bath as 3mg/l of BOD5, it was 3.7 times higher than the regulation and that of faecal coliform was 440 times bigger. Health and sanitary condition of the residents along the Ganges River who are using Ganges River for ritual bathing and daily life water has been threatened.

Under the above situation, “Ganga Rejuvenation project” was proposed in January 2014 by the Government of India utilizing Japanese Government yen credit loan. The project shall be implemented in collective manner over multiple states for purification of the Ganga River, which is executed by local government under administration by National Mission for Clean Ganga (NMCG). In this connection, a number of local governments have been preparing Detailed Project Report (DPR) according to the guideline of GoI.

It is the policy for the project that phase 1 of the project will be implemented to deal with the out of bounds of on-going Japanese Government yen credit loan as “Ganga Action Plan Project (Varanasi)” in Varanasi City (L/A signed off on 31st March, 2005) and surrounding five (5) cities. In the phase 2 of the project, assistance for additional cities in the Ganges river basin area shall be expanded.

Other donors also have commenced the assistance and/or study of assistance for purification of the Ganges River, like “The National Ganga River Basin Project” with 1 billion USD by World Bank, starting June 2011. Such areal role-sharing and collaboration will be conducted in the broad catchment area of Ganges among the donors. “Data collection survey for the improvement of environment in Varanasi” was implemented in June 2015 to seek for possible technical assistance project in collaboration with “Ganga Rejuvenation Project” in consideration of significance of culture and politics of Varanasi city and urgency of the issue of the Ganges purification. Above said project proposes to aim for comprehensive capacity development of the Varanasi local government including development of financial capacity through counter measures for NRW issue as well as improvement of sanitary condition of the city.

This Preparatory survey shall be implemented to complete required studies for the items of appraisal such as objectives of the project, outline, cost estimates, implementation structure, operation and maintenance, and environmental and social consideration.

After a series of discussions on the framework of the Preparatory Survey between Japanese and Indian sides, M/M (Minutes of Meetings) was exchanged in June 2015.

1.2 Objective of the Preparatory Survey

The objectives of the Project is to improve the water quality in Ganges River in the process improve hygienic condition in the river basin by augmenting sewage collection systems and sewage treatment facilities in the State of Uttar Pradesh and city of Varanasi and surrounding five (6) cities of Chunar, Mirzapur, Saidpur, Ghazipur, Mugahalsarai[1] and Ramnagar as well as capacity development of urban local bodies and to take other measures required for pollution abatement of river and for improved hygienic condition in the cities, thereby improving the sanitation and living conditions of people. It also includes taking other measures required for pollution abatement of the rivers and thereby improving the sanitation and living conditions of people who reside in the said area and in the watershed of the downstream area.

[1] Mugahalsarai was excluded from the scope of the survey in October, 2015 because it was found out that there was no prospect on the submission of DPR.

1) General Description of the Project
   a) New construction and augmentation of sewerage in Varanasi and surrounding five cities
   b) Consulting Service for five cities of Chunar, Mirzapur, Saidpur, Ghazipur, Mugahalsarai and Ramnagar for Detailed Design, bidding support, supervision of construction work, capacity building of relevant organizations, and supporting public awareness activities including conducting campaigns on open defecation elimination, improved solid waste management, making the cities more hygienic by citizen's participation.

2) Relevant Authorities, Executing Agencies, Coordinating Mechanisms
   a) Responsible Ministry: Ministry of Water Resources, River Development &Ganga Rejuvenation
   b) Coordinating/implementing agency: National Mission for Clean Ganga (NMCG)
   c) Executing Agency of the project: Uttar Pradesh Jal Nigam (UPJN)

3) Scope of works
   a) Complete required studies for the items of appraisal such as objectives of the project, outline, cost estimates, implementation structure, operation and maintenance, and consideration to social and environment.
   b) Collect information to assist selection of other candidate cities in the Ganges river basin area from 118 cities in the river basin.
   c) Implement a seminar regarding collaboration of Kyoto city and Varanasi city.
   d) Adaption of Hybrid Annuity based PPP model for sewerage system in the subject projects

Following Scopes were added in May 2016 as follows:
   e) Adaption of New Effluent water quality standard for subject projects
   f) Adaption of Hybrid Annuity based PPP model for sewerage system in the subject projects
   g) Confirmation of Concept for the VARANASI CONVENTION CENTER

Figure 1.2.1 Varanasi City and Surrounding Five Cities

1.3 Status of the DPRs as of January 2017 and Course of Discussion in the survey period

(1) Collected DPRs and Composition

Survey Team collected 12 DPRs for the original proposed scope of work as of January 2017 as follows:

1. Varanasi District 1 for Sewer Network
2. Varanasi District 2 for Sewer Network
3. Varanasi District 3 for Sewer Network
4. Bhagwanpur & Dinapur STPs Rehabilitation
5. Ramna STP
6. Ramnagar Interception Diversion and Sewage Treatment (herein after ,ID/T)
7. Mirzapur ID&T
8. Mirzapur Comprehensive Plan (Sewer Net Work and Sewage Treatment)
9. Chunar Comprehensive Plan
10. Chunar ID&T
11. Ghazipur Comprehensive Plan
12. Saidpur ID&T

These DPRs were re-arranged jurisdiction-wisely in the Table 1.3.1 and 1.3.2 for sewer networks and STPs. NMCG and MOUD can be the possible implementing agencies. It becomes 10 projects for sewer networks and 9 projects for STPs.

(2) Course of Discussion

Two items were added to correspond with major change in Indian policy, which affected the preparation of DPRs by India side and review work by Preparatory Survey Team.

- Adaption of Hybrid Annuity based PPP model for sewerage system in the subject projects
- Adaption of New Effluent water quality standard for subject projects

During the Survey period, the status of each DPR were in floating situation depending on GoI (both central and local governments' policy)

1) NMCG announced that Varanasi and Ramnagar would be the two cities prioritized and implemented exceptionally under EPC scheme in February 2016

2) NMCG announced that all the STPs including Varanasi and Ramnagar would be implemented under HAM-PPP model in the JICA mission in July 2016

3) NMCG announced that Ramna STP was excluded from the scope and implemented by NMCG under HAM-PPP in the JICA mission July 2016.

4) Saidpur was indicated by UPJN to be excluded due to issue of STP lot securing in in the JICA mission July 2016.

5) Resubmission of DPR for New Effluent water quality standard was done only for Bhagwanpur and Dinapur STP by UPJN in September 2016. However, other local governments did not respond to produce new DPRs for New Effluent water quality standard. Survey team independently studied the change of the condition and completed the review works. So, plan of the STPs are not submitted to NMCG and those local government's plans are not sanctioned yet.

6) It was indicated by UPJN that Bhagwanpur and Dinapur STPs would be excluded from the scope of the Project in January 2017.

7) Concrete plan of Hybrid Annuity based PPP model for sewerage system was notified in public in the form of Request for Proposal in January 2017

8) For Chunar and Mirzapur, it has not been decided which would be adopted, comprehensive plan or ID&T plan, although ULBs indicated to prefer comprehensive plans.

9) Ramnagar has an issue for land acquisition of the proposed site lot for a STP and it had not been solved in the project period. Therefore, technical review of it has not been completed.

(3) Latest Status

Under these circumstances, Varanasi District 1 and Varanasi District 2 are left as projects as of January 2017. DPR of Varanasi District 3 was completed in December 2016, and Survey Team finished review work however, sanction of the DPR did not reach to the Team. The scope of "Ganga Rejuvenation Project" is not clear as of May 2017 because NMCG has not responded to the JICA request for official communication to explain about the updated scope of the project and implementation scheme.

Table 1.3.1 Project Scheme of the Sewer Network Projects

Sewer Network										
District	Varanasi				Mirzapur				Ghazipur	
City/Town	Varanasi			Ramnagar	Mirzapur		Chunar		Ghazipur	Saidpur
Sewerage District	District-1	District-2	District-3	-	-		-	-	-	-
Development	comprehensive	comprehensive	comprehensive	ID&T	ID&T	comprehensive	ID&T	comprehensive	comprehensive	ID&T
Central Gov	NMCG	NMCG	NMCG	NMCG	NMCG	MOUD	NMCG	MOUD	MOUD	NMCG
DPR Review	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team
Decision of Sewer Plan	Decided/ sanctioned	Decided/ sanctioned	Not sanctioned yet.	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet
Project Scheme	EPC	EPC	EPC	EPC	HAM	EPC	HAM	EPC	EPC	
Issue	-	-	Pump station lot to be purchased after sanction	-	Plan not decided whether ID&T or Comprehensive		Plan not decided whether ID&T or Comprehensive		Plan not decided whether ID&T or Comprehensive	Dropped

Table 1.3.2 Project Scheme of the STP Projects

STP										
District	Varanasi				Mirzapur				Ghazipur	
City/Town	Varanasi	Varanasi		Ramnagar	Mirzapur		Chunar		Ghazipur	Saidpur
Name of the Facility	Bhagwanpur Dinapur	Ramna STP	-	STP and PS	STP and PS	STP and PS	STP and PS	STP and PS	STP and PS	Land not purchased
Development	HAM	HAM	-	HAM	HAM	comprehensive	HAM	comprehensive	comprehensive	HAM
Central Gov	NMCG	NMCG	-	NMCG	NMCG	MOUD	NMCG	MOUD	MOUD	NMCG
DPR Review	Review done by survey team	Review done by survey team		Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	Review done by survey team	DPR Not submitted Review undone
Decision of STP Plan	To be excluded from rehabilitation work	To be excluded from the scope		Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not sanctioned yet	Not Sanctioned yet	Dropped
Project Scheme	EPC	EPC	-	EPC	HAM	EPC	HAM	EPC	EPC	
Issue	UPJN planned to demolish and reconstruct the existing facility, while Survey Team recommended rehabilitation and upgradation of existing facility	Bidding on going by NMCG as of May 2017		STP Site lot issue, geo-survey needed after sanction	Plan not decided whether ID&T or Comprehensive		Plan not decided whether ID&T or Comprehensive		ID/T not submitted	Dropped by STP Site lot issue

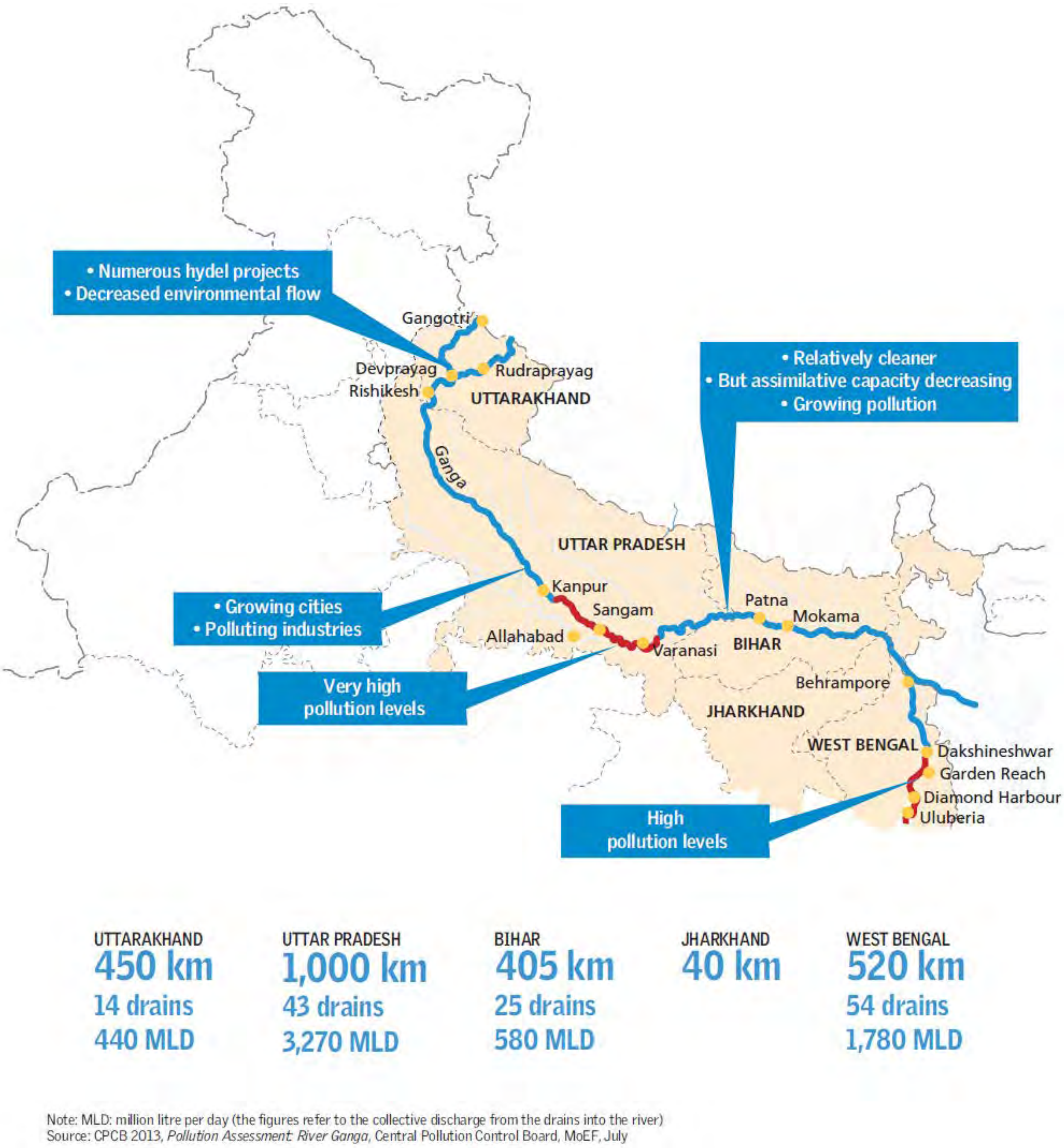
Souce: JICA Survey Team

1.4 Basic information on the survey area

1.4.1 Ganga River

The Ganga basin accounts for a little more than one-fourth (26.3%) of the country's total geographical area and is the biggest river basin in India, covering the entire states of Uttarakhand, Uttar Pradesh (UP), Bihar, Delhi, and parts of Punjab, Haryana, Himachal Pradesh, Rajasthan, Madhya, Pradesh, and West Bengal. The Ganga basin is bound in the north by the Himalayas and in the south by the Vindhyas. The main river stream originates in the northern-most part of Uttarakhand, flows through Uttar Pradesh, Bihar, and West Bengal, and finally drains into the Bay of Bengal. The river traverses a length of 1450 km in Uttarakhand and UP while touching the boundary between UP and Bihar for a stretch of 110 km. It then flows through Bihar, more or less covering a distance of 445 km. The length of the river measured along the Bhagirathi and Hugli rivers during its course in West Bengal is about 520 km. The River Ganga has a large number of tributaries, namely, Kali, Ramganga, Yamuna, Gomti, Ghaghara, Gandak, and Kosi. The River Yamuna, although a tributary of Ganga, is a river in itself. Its major tributaries are Chambal, Sind, Betwa, and Ken. The main plateau tributaries of the Ganga river are Tons, Son, Damodar, and Kangsabati-Haldi. The salient features of the Ganga River are summarized in below table.

Source: GANGA- Water Quality Trend (CPCB, 2009)



Source: GANGA -The River, its pollution and what we can do to clean it (CSE, 2014)

Figure 1.4.1 Outline of Ganga river

Table 1.4.1 Salient Features of Ganga River

Total length	2,525 km
Uttar Pradesh and Uttarakhand	1,450 km
Boundary between Uttar Pradesh and Bihar	110 km
Bihar	445 km
West Bengal	520 km
Geographical area of India	3.28 million sq km
Reported area – river basins	3.05 million sq km
Catchment area – Ganga basin	8,61,404 sq km (26.4%)
Average annual discharge	4,93,400 million cubic metre
Tributaries	Yamuna, Ramganga, Gomti, Ghaghara, Gandak, Kosi and Kali
Main sub tributaries	Chambal, Sindh, Betwa, Ken, Tons, Sone, Damodar and Kangsabati Haldi

Source: GANGA- Water Quality Trend (CPCB, 2009)

Table 1.4.2 Analytical results of point sources for Ganga region

Catch-ment region	Point Source	Flow (MLD)	Parameters					BOD Load (kg/day)
			pH	COD (mg/l)	BOD (mg/l)	TSS (mg/l)	TDS (mg/l)	
Mirzapur	Ghore Saheed drain	86.4	-	110	47.7	118	-	4,121
	Khandwa drain	62.21	-	252	86	199	-	5,350
	Sub-Total	148.61	-	-	-	-	-	9.471
Varanasi	Rajghat drain	16.19	7.28	100	49.9	81.8	454	808
	Nagwa drain	66.45	7.46	156	61.1	106.42	608.4	4,060
	Ramnagar drain	23.65	6.65	144	40.7	110.8	703.6	963
	Varuna drain	304.5	7.31	46.2	12.4	433.8	552.4	3,776
	Shivala Drain	*	7.32	100	49.9	81.8	454	-
	Sub-Total	410.79	-	-	-	-	-	9,607

Source: Pollution Assessment: River Ganga (CPCB, 2013)

Table 1.4.3 Connectivity for sewage treatment plants: UP cities

City	Area of city (ha)	Area with sewerage (ha)	Un-sewered area (ha)	Un-sewered area (%)	Drains
Varanasi	10,058	1,635	8,432	84	23

Source: Presentation made at the meeting of the Executive Committee of the State Ganga river Conservation Authority, Lucknow (UP government 2010)

1.4.2 Varanasi

1) Brief history of the town

Varanasi is one of the world's oldest cities. Varanasi is regarded as one of the seven holy cities of India which can provide Moksha. The earliest known archaeological evidence suggests that settlement around Varanasi in the Ganga valley began in the 11th or 12th century BC. Varanasi grew as an important industrial centre, famous for its muslin and silk fabrics, perfumes, ivory works, and sculpture. Varanasi was also home to Parshva, the 23rd Jain Tirthankara and the earliest Tirthankara accepted Varanasi as a historical city in the 8th century BC. Buddha is believed to have founded Buddhism here around 528 BC when he gave his first sermon, "Turning the Wheel of Law", at / nearby Sarnath. The city's religious importance continued to grow in the 8th century, when Adi Shankara established the worship of Shiva as an official sect of Varanasi.

In ancient times, Varanasi was connected by road starting from Taxila and ending at Pataliputra during the Mauryan Empire. In 1194, the city succumbed to Turkish Muslim rule under Qutb-ud-din Aibak. The city went into decline over some three centuries of Muslim occupation, although new temples were erected in the 13th century after the Afghan invasion. Feroz Shah ordered further destruction of Hindu temples in the Varanasi area in 1376. The Afghan ruler Sikander Lodi continued the suppression of Hinduism in the city and destroyed most of the remaining older temples in 1496. Despite the Muslim rule, Varanasi remained the centre of activity for intellectuals and theologians during the Middle Ages.

In the 16th century, Varanasi experienced a cultural revival under the Muslim Mughal emperor Akbar who invested in the city and built two large temples dedicated to Shiva and Vishnu. The Raja of Poona established the Annapurnamandir and the 200 metres (660 ft) Akbari Bridge was also completed during this period.

2) Geographical Location

Varanasi or Banaras is one of the oldest cities in the world. It is situated on the bank of river Ganga spreading over 1535 km2 area in the state of Uttar Pradesh. It is located between the confluences of river Ganga and Varuna and river Ganga and Assi rivulet. the urban agglomeration is stretched between 82° 56'E – 83° 03'E and 25° 14'N – 25° 23.5'N. The Varanasi city is geographically located at 25° 000' to 25016' N Latitude and 82° 050' to 83° 010' E Longitude. The Ganga River flows from South to North having the world famous Ghats on its left bank.

Neighbourhoods of the city include Adampura, Kotwali, Jaitpura, Dhupchandi, Chaukaghat, Kail Garh, Guru Nanak Nagar, Chaitganj, Naipokhari, Sigra, Maulvibagh, Siddhagiribagh, Bulanala, Chowk, Bangali Tola, Luxa, Khanna, Gopal Vihar, Giri Nagar, Mahmoorganj, Maheshpur, Bhelpura, Shivala, Anandbagh, Nagwar, Dumraon, Gandhinagar, and Gautam Nagar, Lanka Mandu-adih.

3) Climate

Varanasi experiences a humid subtropical climate with large variations between summer and winter temperatures.

Temperatures: The dry summer starts in April and lasts until June, followed by the monsoon season from July to October. The temperature ranges between 22 and 46 degrees C in the summers. Winters in Varanasi see very large diurnal variations, with warm days and downright cold nights. Cold waves from the Himalayan region cause temperatures to dip across the city in the winter from December to February and temperatures below 5 degrees C are not uncommon. The average annual rainfall is 1,110 mm (44 in). Fog is common in the winters, while hot dry winds, called loo, blow in the summers.

Rain Fall: The annual average rainfall in the basin varies between 39 cm to 200 cm, with an average of 110 cm. Eighty percent of the rainfall occurs during the monsoon months i.e. from June to October. Because of large temporal variations in precipitation over the year, there is wide fluctuation in the flow characteristics of the river.

In Varanasi monsoons normally begin from late June. The annual rainfall varies from 680 mm to 1,500 mm with large proportion of its occurring during the months of June to September. The month of October receives about 5 % of rainfall, and only 8 % of the rain occurs in remaining seven months from November to May

4) Topography

Being located in the Indo-Gangetic Plains of North India, the land is very fertile because low level floods in the Ganges continually replenish the soil. General ground level varies from 71m to 80m. The Varanasi city is situated above 80 m height from the sea level. Geologically it is situated in the alluvial Gangetic plains and mixed with clay and fine sand.

Varanasi is well connected by air, rail and road with the major Indian cities like New Delhi, Mumbai, Kolkata, Chennai, Pune, Ahmedabad, Indore etc. It is located on the golden quadrilateral of the National Highway. National Highways NH 2, NH 56 and NH 29 and State Highways SH 87, SH 73, SH 74 and SH 98 passes through the city.

5) Administrative divisions

Varanasi Nagar Nigam and Varanasi Development Authority are responsible for planning, design and construction of infrastructure for the city. Water Supply and Wastewater system is maintained by Varanasi Nagar Nigam through its Jal Kal Vibhag which was formerly known as Varanasi Jal Sansthan. The UP Jal Nigam maintains and operates only the large Sewage Pumping Stations & STPs constructed under the GAP for and on behalf of the Nagar Nigam.

6) Commercial aspects & Industrial activities

Silk weaving is the dominant manufacturing industry in Varanasi. Weaving is typically done within the household, and most weavers are Momin Ansari Muslims. Varanasi is known throughout India for its production of very fine silk and Banarasi saris, brocades with gold and silver thread work, which are often used for weddings and special occasions.

In the metal manufacturing sector, Diesel Locomotive Works is a major employer. Bharat Heavy Electricals Limited, a large power equipment manufacturer, also runs a heavy equipment repair plant. Other major commodities manufactured and traded in Varanasi include hand-knotted Mirzapur carpets, rugs, brassware, copperware, wooden and clay toys, handicrafts, gold jewellery, and musical instruments.

Tourism is Varanasi's second most important industry. Over 3 million domestic and 200,000 foreign tourists visit annually most commonly for religious reasons. Most domestic tourists are from Bihar, West Bengal, Madhya Pradesh, and Uttar Pradesh; most foreign tourists are from Sri Lanka and Japan.

The prominent malls and multiplexes in Varanasi are IP Mall in Sigra, IP Vijaya Mall in Bhelupur, PDR in Luxa and JHV Mall in the Varanasi Cantonment area. The city has several banks, including the State Bank of India, Indian Overseas Bank, Bank of Baroda, Canara Bank, Andhra Bank, Allahabad Bank, and the Central Bank of India.

7) Main Causes of River Pollution

The River Ganga is the holiest river in India. Water quality in the river has deteriorated as a result of direct discharge of domestic and non-point pollution sources such as human open defecation and urination, cattle waste, mass bathing and washing of clothes by dhobis.

Open defecation and urination is a common problem in Varanasi, especially in slum areas. This, besides causing unhygienic living environment to slum dwellers is also a serious nonpoint pollution source of the Ganga River. The wastewater from dhobi ghats, which is not connected to sewers, is also a source of river pollution.

8) Socio-Economic status

Approximately 29% of Varanasi's population is employed. Approximately 40% of those employed work in manufacturing, 26% work in trade and commerce, 19% work in other services, 8% work in transport and communication, 4% work in agriculture, 2% work in construction, and 2% are marginal workers (working for less than half of the year).

Among manufacturing workers, 51% work in spinning and weaving, 15% work in metal, 6% work in printing and publishing, 5% work in electrical machinery, and the rest work in a wide variety of industry sectors. Varanasi's manufacturing industry is not well developed and is dominated by small-scale industries and household production.

Source: District III (Varanasi) DPR

1.4.3 Mirzapur

1) Brief history of the town

Mirzapur is a city in Uttar Pradesh, India, roughly 650 km from both Delhi and Kolkata, 100 km from Allahabad and 60 km from Varanasi. It is known for its carpet and brassware industries. The city is surrounded by several hills and is the headquarters of Mirzapur District and is famous for the holy shrine of Vindhyachal.

On the north and north-east it is bounded by the Varanasi district; on the south bounded by Sonbhadra district; on the north by Sant Ravidas nagar district on the north-west by Allahabad district. The Chanvar fields, considered to be one of the most fertile land tracts in India, are located on Gangetic flood plains of the district. Also, Indian Standard Time is calculated on the basis of 82.5° E longitude, from a clock tower in Mirzapur.

2) Geography and Topography

Mirzapur is located between latitude 23º 52’ to 23º 32’ and longitude 82º 72’ to 83º 33’. It is spread over an area of 2088 ha. It is surrounded by Varanasi and Sant Ravidas Nagar on the north, Allahabad on the west, and towards south east its boundaries are contiguous with district, Sonebhadra and the state of Madhya Pradesh. Land has uneven topography with ground levels varying from 77.2 m up to 91.4 m. and soil strata is Inorganic silt of low plasticity (ML).

3) Climate

Temperature: Town has sub-Tropical climate, temperature varies from 20 degrees C in the winter season to 46 degrees C in summer season. Temperature ranges between 22 degrees C to 46 degrees C during summer season and 20 degrees C to 17 degrees C in winter season.

Rainfall: Average annual rainfall is 1,110 mm (44 in).

4) Ganga River

The Ganges is the most sacred river to Hindus and is also a lifeline to millions of Indians who live along its course and depend on it for their daily needs. It is worshiped as the goddess Ganga in Hinduism.

The Ganga rises in the Garhwal Himalaya from the Gangotri Glacier, some 4,100 meters above the sea level under the name of Bhagirathi. The river flows through the Himalayas till another two streams, the Mandakani and the Alakhnanda join it at Devprayag. It is below this confluence that the river is known as the Ganga. The Ganga Basin which is the largest river basin of the country houses about 40% population of India. The river after traversing a distance of 2,525 km from its source, meets the bay of Bengal at Ganga Sagar in West Bengal. During the course of its journey from the hills to the sea, municipal sewage from large urban centres, effluents from industries and polluting waste from several other non-point sources are discharged into the river resulting in its pollution. The Highest Flood Level (HFL) of river Ganga in Mirzapur Town of Uttar Pradesh is 80.34m recorded during the flood season 2005.

5) Hydrology Ganga River

Rainfall, subsurface flows and snow melt from glaciers are the main sources of water in river Ganga. Surface water resources of Ganga have been assessed at 525 billion cubic meter (BCM). Out of its 17 main tributaries Yamuna, Sone, Ghagra and Kosi contribute over half of the annual water yield of the Ganga. These tributaries meet the Ganga at Allahabad and further downstream.

The river has a problem of low flows between the Haridwar - Allahabad stretch. December to May are the months of lean flow in the Ganga. On an average, each square km of the Ganga basin receives a million cubic meters (MCM) of water as rainfall. 30% of this is lost as evaporation, 20% seeps to the subsurface and the remaining 50% is available as surface runoff. The deep channel of the river bounded by high banks facilitates the passage of ground water as base flow. Annual flooding is the characteristic of all rivers in the Ganga basin. The Ganga rises during the monsoon but the high banks restrict the flood water from spreading. The flood plain is usually 0.5 to 2 km wide. This active flood plain is flooded every year. There are many structures on the Ganga which divert its discharge.

6) Commercial aspects & Industrial activities

The main business in Mirzapur is carpet manufacturing. Manufacturers range from very small to medium sized. Most of the carpets are sold internationally as India has a limited market for carpets. The second main business is of metal pots (brass).

7) Socio-Economic status

Mirzapur is famous for Manufacture of carpets and brass wares which are the main cottage industries of the Town. The living conditions in Mirzapur are generally moderate with intermittent water supply and inadequate sanitary facility.

1.4.4 Ghazipur

1) Brief history of the town

Ghazipur was covered with dense forest in Vedic era and it was a place for Ashrams of Saints during that period. This place is related to the Ramayana period where Maharshi Yamdgni. Aurihar area of Ghazipur district became the main centre for teaching of Lord Buddha. Many stoopas and pillars are the main evidence of that period.

This Place was the main centre in medieval period from Sultanate period to Mughals. In Tughalk period, Zuna Khan, alias Muhammad Tuglak established the Jaunpur as the capital under which the Ghazipur was ruled. In the regime of Zuna Khan, the Saiyyad Massod Ghazi established this town, by defeating he Raja Mandhata, the ancestor of brave King Prithvi Raj Chauhan. In Lodhi Period, the Naseer Khan Nuhani was the Administrator of Ghazipur who changed its conditions. This Area was the main centre during Mughal period. In recent times Ghazipur showed its notable bravery in Kargil victory against Pakistan in 1999.

2) Geographic location of Ghazipur District

Ghazipur district forms the eastern part of the Varanasi Division. It lies to the east and north of the Jaunpur and Varanasi district respectively between the parallels of 25° 19' and 25° 54' north latitude and 83° 4' and 83° 58' east longitude. This location is 67.50 meter above the sea level. The length of district from East to West is 90 Km. and Width from North to South is 64 Km. The River Ganges from one side and Karmnasa from other side divided it from Bihar State. It is bounded on Ballia and Bihar State in east, Jaunpur, Varansi and Azamgarh in west, Mau and Ballia in north and the Chandauli in south. The boundaries are generally conventional though at places they are marked by natural feature.

The Ghazipur garlanded by Ganga, Karmnasa and Gomti, that makes this locality stronger in economic and geographic condition. The total geographic area of this district is 3,384 km^2. Ghazipur is embellished with picturesque geographical environs. This Place is a part of Mid gangetic plain. Total area is approx. 3, 33, 209 Hectare in which 2, 52, 824 Hectare is for Agriculture purpose. Approx. 38 % of soil is cattle field. This district does not contain any forest area.

3) Administrative Units

Ghazipur was constituted a separate district in 1818. originally the district was very big, including not only modern Ballia but also Narwan of Varanasi, Chausa of Buxar (Bihar) and pargana of Sagari, Ghosi, Mau and Muhammdabad in district Azamgarh.The District has five subdivisions viz. Sadar, Saidpur, Zamania, Muhammadabad and Jakhania each also forming a tehsil of same name Tehsil Saidpur constitutes the western subdivision of the district.Tehsil and Subdivision Ghazipur constitutes the central part, tehsil Muhammdabad forms the north eastern subdivision and extends eastward from the border of Ghazipur to boundary of Ballia. Tehsil Zamania forms the south western subdivision, The Jahkhnia subdivision, newly constructed tehsil lies in north western part of district. and 16 blocks. Ghazipur district consist of 193 Nyay Panchayats and 1046 Gram Sabhas. There are Total 2,583 inhabited villages and 781 uninhabited villages in the district. In Urban sector there are 3 Nagar Paika Parishad (Ghazipur, Muhammdabad, Zamania) and 5 Town Areas (Saidpur, Jangipur, Dildarnagar, Sadaat and Bahadurganj).

At Administrative structure, Ghazipur is divided in 5 Tehsils and 16 Developments Blocks, details are as follows:

Tehsil	Development Blocks
1. Ghazipur	1. Ghazipur 2. Karanda 3. Virno 4. Mardah
2. Saidpur	1. Saidpur 2.Deokali 3. Manihari (Partial)
3. Muhammadabad	1. Muhammdabad 2. Bhwarkol 3.Kasimabad 4. Barachawar
4. Zamania	1. Zamania 2. Bhadaura 3. Reotipur
5. Jakhnia	1. Sadat 2. Jakhnia 3. Manihari (Partial)

There are total 23 Police Stations in District Ghazipur. Tehsil Ghazipur consist of 3 Police stations, Saidpur 4, Jakhnia 3, Zamania 2 and Muhammdabad 5, in urban area there are 7 Police Stations. There are total 210 Govt. Offices are serving by consisting of 14638 officials. Total 6811 Teachers in 1830 primary schools, 2755 Teachers in 396 Junior High Schools, 2795 Teacher in higher secondary and 332 Teachers in degree colleges are giving their contributions in districts. There are 55 Class 1 and 391 Class 2 officers are working in district.

Source: District Ghazipur website

1.4.5 Ramnagar

1) Brief history of the town

Ram Nagar has a fort known as Ram Nagar Fort which is still the residence of King of Varanasi. He was known as Kashi Naresh meaning king of Kashi (Ancient name of Varanasi) and is still regarded by old residents of the city of Varanasi. Ram Nagar Fort and its museum are the repository of the history of the kings of Varanasi and since the 18th century has been the home of Kashi Naresh. Even today the Kashi Naresh is deeply revered by the people of Varanasi. He is the religious head and the people of Varanasi consider him the incarnation of Lord Shiva. He is also the chief cultural patron and an essential part of all religious celebrations.

2) Geographical location

The Ram Nagar is situated near the Ganga River on its eastern bank, opposite to the Tulsi Ghat& having 25° 16'22"North latitude, 83° 1'50" East longitude. A pontoon bridge connects Ram Nagar to Varanasi City which is constructed upon a base of floating drums. It is operational between Nov-June every year. Banaras Hindu University is just at 4.1 km away from Ram Nagar via pontoon bridge. Varanasi Junction and Mughal Sarai are the two nearest main railway stations from here.

3) Climate

The weather is mostly humid & land is characterized by subtropical monsoon region making it prone to extremities experiences during change of weather from summer to winter. January is the middle of winter season and therefore weather remains freezing cold till February end. By March, with the arrival of springs, the temperature begins to rise. The city experiences a lot of hot & humid weather In April to June. July to September is monsoon period. Though the rainfall is supposed to bring respite from heat, the weather here becomes even more humid. It starts to cool down from October and hence maximum tourist activity is seen during this period. Variation in temperature is from 44 degrees C to 5 degrees C. The average annual rainfall is about 950 mm.

Climate Condition	
Maximum Temperature	44 degrees C
Minimum Temperature	5 degrees C
Annual Average Rainfall	950 mm
Sub Soil Water Level Depth	8-10 m

4) Topography

The morphological expression of the site is one of the important components which helps for planning and implementation of any project. The topographical conditions in Ram Nagar and its surroundings are more or less plane with low level of local undulations and gentle slopes. The area is covered with alluvial plains of river Ganga. Ram Nagar is located at an altitude of around 80 m above Mean Sea Level having a natural slope towards Ganga River. The terrain of the town is flat, difference between highest & lowest ground point is 2.5 to 4.5 meters. Low-lying areas such as Rampur sanitary ward are subjected to water logging during monsoon due to lack of natural drainage facilities.

5) Demography

As of 2011 India census, Ram Nagar municipal area had a population of 49,087. The average population density of the city is 9,425 persons per sq km. Males and females constitute 54.27% and 46.73% of the total population respectively. Ram Nagar has an average literacy rate of 58%, lower than the national average of 59.5%. The male literacy is 66% whereas the female literacy is 49%. In Ram Nagar, 15% of the population is under 6 years of age. Villages under peri-urban areas also contain sizeable population.

6) Drainage channels

In the Ram Nagar, there is lot of problem of water logging during the rainy seasons because the coverage of storm water drainage network is near about 50% (primarily kutcha) of the city. There is no proper drainage or sewerage network in the city but Nagar Palika Parishad made temporary small arrangements of drains to collect storm water. There are five such drains exist carrying waste water of the city to the River Ganga.

7) Administrative divisions

Urban local bodies (Nagar Palika Parishad) Ram Nagar, Varanasi delivers broad services to its residents like water supply, solid waste management, sewerage, construction, repair and cleaning of street drains and storm water drains, street lighting, roads and parks etc. The local governance is politically administrated by the chairman and 25 municipal councillors elected from 25 municipal wards on the legislative front. The executive officer (E.O) is the highest administrative body of Ram Nagar. The health Department (Swasthya Vibhag) and Engineering Department (Nirman Vibhag) are the two executive bodies responsible for implementation of the solid waste management plan and civil infrastructure in the city respectively. The Health Department takes care of water supply and sewerage management, civil and infrastructural facilities in the city.

8) Commercial and Industrial Activities

The presence of perennial source of water like Ganga is a major lifeline for the agriculture dependent economy. At present, the town is thickly populated & several wholesale and retail trade activities are being practiced like vegetable, cloth, meat, sweets, fruit, cosmetic shops and tea stalls. Also people can be seen near the bank of river for fishing. However, it is not the permanent occupation. Due to less education & illiteracy some are working as auto driver, labours, street hawkers, etc.

The town does not have any major industrial development. Some micro & small enterprises and artisan units are found in the area. Except few tiny and artisan household units, even no medium size industrial units exists in the ULB. Household level small scale manufacturing units like furniture, steel almirah making, etc. and small units of cloth weaving and printing work are also present.

The industrial investment has been extremely insignificant in the town but for last few years it has been seen that inclination towards literacy and education has increased among the citizens. As a result, presently many residents of the city are employed in schools, educational institutes, public service departments, banks, hospitals, private jobs, etc.

9) Commercial and Industrial Activities

One of the famous Universities, Banaras Hindu University is just 4.1 km away from Ram Nagar. There are many primary schools near Ghats such as PAC Primary school, Swami Krishnayan Public School and Indira Gandhi Children School etc. Schools in Ram Nagar are affiliated with the Indian Certificate of Secondary Education (ICSE), the Central Board of Secondary Education (CBSE), or the U.P. Board.

Source: Ramnagar DPR

1.4.6 Chunar

1) Brief history of the town

Chunar located in Mirzapur District of Uttar Pradesh state, India, is an ancient town. Chunar town is situated on the bank of holy River Ganga 33 km away from Mirzapur along NH-7 (between Varanasi & Mirzapur). It is connected to Allahabad, Varanasi, Sonbhadra etc. with rail as well as road link. It is situated on the main Howrah Delhi Northern railway line at a distance of 758km from New Delhi and connected by metalled road to Allahabad and Varanasi, the ancient and pilgrimage city also well known as Kashi or Benaras. The Ganga flows on the north to Chunar town. The town is famous for its historical importance as well as for its pottery work especially clay toys.

2) Geography and topography

Chunar is located at 820 45’ East longitudes and 350 North latitude. It is spread over an area of

8.31sq.Km (831.2 hectare). It is situated at south of the river Ganga. Land has uneven topography with ground levels varying from 71 meters (233 feet) up to 97 meters (318 feet).

3) Climate

Temperature: Town has sub-Tropical climate, temperature varies from 20 degrees C in the winter season to 46 degrees C in summer season. Temperature ranges between 22 degrees C to 46 degrees C during summer season and 20 degrees C to 17 degrees C in winter season.

Rainfall: Average rainfall is 1,110 mm (44 in).

4) Ganga River

The Ganges is the most sacred river to Hindus and is also a lifeline to millions of Indians who live along its course and depend on it for their daily needs. It is worshiped as the goddess Ganga in Hinduism. The Ganga rises in the Garhwal Himalaya from the Gangotri Glacier, some 4100 meters above the sea level under the name of Bhagirathi. The river flows through the Himalayas till another two streams, the Mandakani and the Alakhnanda join it at Devprayag. It is below this confluence that the river is known as Ganga. The Ganga Basin which is the largest river basin of the country houses about 40% population of India. The river after traversing a distance of 2525 kms from its source, meets the bay of Bengal at Ganga Sagar in West Bengal. During the course of its journey from the hills to the sea, municipal sewage from large urban centres, effluents from industries and polluting waste from several other non-point sources are discharged into the river resulting in its pollution.

5) Hydrology Ganga River

Rainfall, subsurface flows and snow melt from glaciers are the main sources of water in river Ganga. Surface water resources of Ganga have been assessed at 525 billion cubic meters (BCM). Out of its 17 main tributaries Yamuna, Sone, Ghagra and Kosi contribute over half of the annual water yield of the Ganga. These tributaries meet the Ganga at Allahabad and further downstream.

The river has a problem of low flows between the Haridwar - Allahabad stretch. December to May is the months of lean flow in the Ganga. On an average, each square km of the Ganga basin receives a million cubic meters (MCM) of water as rainfall. 30% of this is lost as evaporation, 20% seeps to the subsurface and the remaining 50% is available as surface runoff. The deep channel of the river bounded by high banks facilitates the passage of ground water as base flow. Annual flooding is the characteristic of all rivers in the Ganga basin. The Ganga rises during the monsoon but the high banks restrict the flood water from spreading. The flood plain is usually 0.5 to 2 km wide. This active flood plain is flooded every year. There are many structures on the Ganga which divert its discharge.

6) Commercial aspects & industrial activities

Agriculture is primarily dependent on the moderate rainfall occurring between July to September. There is a cement factory in Chunar established by the JAYPEE group and this factory has its own railway line for transporting cement. Chunar is well known for its pottery industries especially clay toys. Various exotic waterfalls and religious worship places attract thousands of tourists and locals.

7) Socio-Economic status

Primary mode of earning livelihood is agriculture and agri-based business. Chunar is well known for its pottery industries especially clay toys. The living conditions in Chunar are generally moderate with intermittent water supply and inadequate sanitary facility.

Source: Chunar DPR

1.4.7 Saidpur

DPR for Saidpur is still under preparation by UPJN, hence any data is not available at present. JICA study team has requested them to provide the DPR immediately.

CHAPTER 2 General Description of the Project Area

<Objectives of the Survey>

The Natural condition survey is composed of 1) Topographical survey, 2) Geotechnical survey and 3) Water Quality survey. They were conducted to collect/confirm the latest information regarding the subject area for the project.

<Result of the Survey>

Weather and climate, topography and geology were studied based on the references. 1) Topographical survey, 2) Geotechnical survey and 3) Water quality survey were studied using outsourcing. Refer to Appendices for the details of the surveys.

Legislative conditions were also confirmed based on references.

2.1 Natural Conditions

2.1.1 Weather and Climate

Varanasi, the biggest city of project area, has a humid subtropical climate, and temperatures vary widely between summer and winter. The summer lasts from early April to October, and the temperatures range from 22 degrees C to more than 45 degrees C.

On the other hand, the winter in Varanasi brings simply pleasant temperature with the average high of 22.5 degrees C. However, the temperatures widely vary hour by hour with warm daytimes and downright cold nights. Cold waves from the Himalayan region cause temperatures to dip across the city in the winter from December to February and temperatures sometimes reach below 5 degrees C.

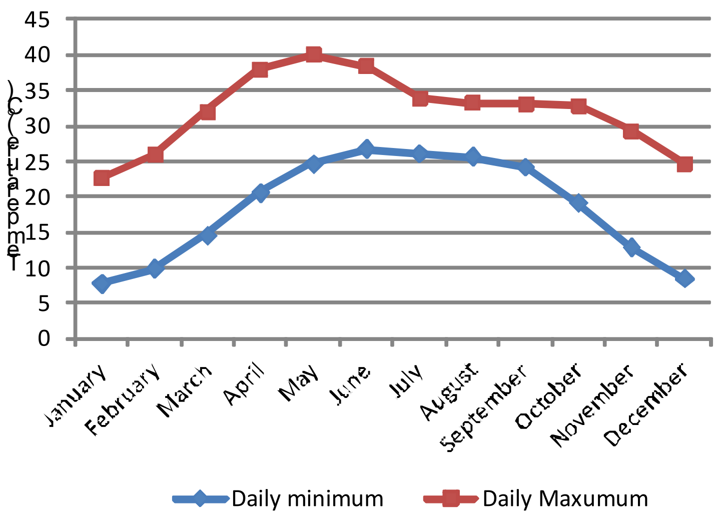


Figure 2.1.1 Mean Temperature in Varanasi (1971-2000)

Source: Indian Meteorological Department

As for the precipitations, Varanasi annually has 990 mm of average rainfall. July and August are the wettest season due to the monsoon. However, the precipitations fluctuate by year. During dry season, the rain is hardly seen.

Table 2.1.1 Precipitation in Varanasi City mm/month

	2009	2010	2011	2012	2013
January	0.6	1.8	5.0	23.0	8.1
February	0.0	17.2	3.5	0.8	68.1
March	0.0	0.0	0.3	13.5	7.3
April	0.9	0.0	14.9	33.1	11.4
May	14.9	36.4	11.6	0.0	0.0
June	4.9	19.9	220.5	33.8	164.7
July	188.2	199.5	165.9	347.9	246.9
August	88.2	237.4	292.7	158.1	274.3
September	111.4	153.7	385.2	128.0	86.7
October	9.3	31.5	0.7	13.6	161.6
November	12.9	7.8	0.0	0.0	0.0
December	2.3	0.0	0.0	0.0	0.0

Source: Indian Meteorological Department

As for Mirzapur and Ghazipur, major cities of target area, temperatures and precipitations there have same features and trend with Varanasi. The precipitations in Mirzapur and Ghazipur are shown in following tables.

Table 2.1.2 Precipitation in Mirzapur City mm/month

	2009	2010	2011	2012	2013
January	No Data	0.0	0.0	12.5	0.0
February	No Data	14.5	0.4	0.0	66.5
March	No Data	0.0	0.0	0.0	9.5
April	No Data	0.0	0.0	18.0	8.5
May	No Data	0.0	0.0	0.0	0.0
June	2.4	0.0	163.3	7.3	197.8
July	170.4	143.7	109.3	285.2	223.5
August	42.9	245.2	317.0	283.8	328.9
September	91.7	240.0	321.3	482.8	64.9
October	37.9	12.0	6.7	2.3	143.7
November	18.5	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0

Source: Indian Meteorological Department

Table 2.1.3 Precipitation in Ghazipur City mm/month

	2009	2010	2011	2012	2013
January	0.0	4.1	0.0	22.7	5.7
February	0.0	19.2	0.0	1.7	51.4
March	0.0	0.0	2.4	13.7	1.4
April	0.0	0.0	0.9	5.8	33.9
May	0.0	26.9	0.0	0.0	0.0
June	9.8	4.5	308.8	76.7	150.2
July	125.3	305.2	202.7	178.7	199.4
August	315.0	291.9	280.9	175.9	251.4
September	164.5	95.9	177.4	199.7	171.6
October	11.8	6.7	0.0	6.0	217.2
November	16.8	0.0	0.0	0.0	0.0
December	0.0	0.0	0.0	0.0	0.0

Source: Indian Meteorological Department

2.1.2 Topography and Geology

1) Topography

The city of Varanasi, Mirzapur, Ghazipur and other target cities are located in the middle Ganga valley of North India, in the Eastern part of the state of Uttar Pradesh, along banks of the river Ganges. The landform of the target areas is fairly flat, and all areas are within the altitude of 0-150 m.

The detailed descriptions of each site are the following:

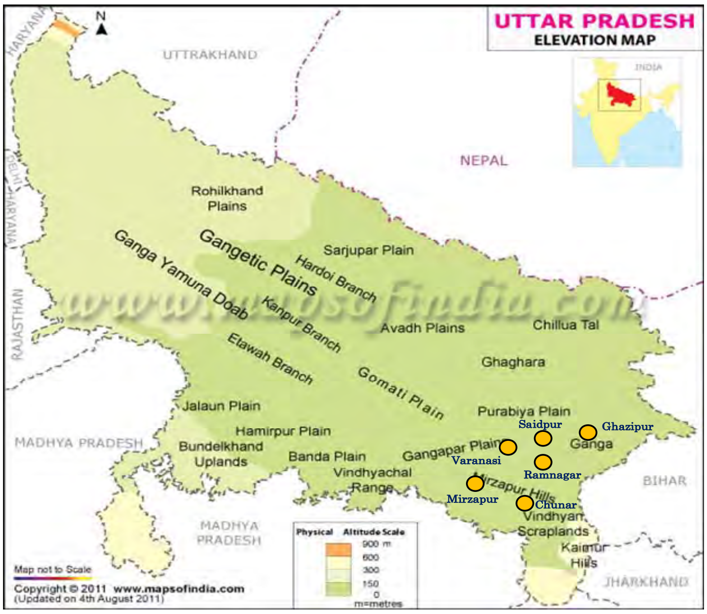


Figure 2.1.2 Topographic Map of the Project Sites

- The Varanasi City is situated above 80 m height from the sea level. Being located in the Indo-Gangetic Plains of North India, the land is very fertile because low level floods in the Ganges continually replenish the soil. General ground level varies from 71m to 80m.
- Mirzapur has uneven topography with ground levels varying from 77.2 m up to 91.4 m. and soil strata is Inorganic silt of low plasticity (ML).
- Ghazipur has topography about 67.50 m above the sea level.
- Ram Nagar is located at an altitude of around 80 m above Mean Sea Level having a natural slope towards Ganga River. The terrain of the town is flat, difference between highest & lowest ground point is 2.5 to 4.5 meters. Low-lying areas such as Rampur sanitary ward are subjected to water logging during monsoon due to lack of natural drainage facilities.
- Chunar is situated at south of the river Ganga. Land has uneven topography with ground levels varying from 71 meters (233 feet) up to 97 meters (318 feet).
- Saidpur has an average elevation of 70 m (229 feet).

2) Geology

The Ganga plain which dominates the landscape and nearly covers three fourth of the geographical area of the State, lies between the rocky Himalayan belt in the north and the southern hilly tract comprised of mainly Pre-Cambrian rocks. Flexing of the Indian lithosphere in response to the compressive forces due to collision, and thrust fold loading produced the Ganga Plain foreland basin.

It is filled with recent alluvial sediments which are at places more than 1,000 m. thick and an amalgam of sand, silt, clay in varying proportions.

As seen in Figure 2.1.3, Varanasi and Ramnagar Districts falls under the Younger Alluvium classification and same with Ghazipur District which also covers Saidpur. For Mirzapur District which includes Chunar, two (2) classifications covered, namely: Mahakoshal Group and Kaimur Group.

Figure 2.1.3 Geologic Map of the Project Sites

Younger Alluvium - Younger alluvium (Qal) is underlying geologic unit. This is an unconsolidated, poor to well graded mass consisting of sand, gravel, and cobbles. Surface soils are well drained, with moderately rapid permeability, slow runoff, and slight erosion hazard.

Mahakoshal Group – This group comprises of volcano-sedimentary rocks. These rocks show an uncomformable relationship with the gneissic complex (Archaen) exposed in the north as well as south. These are undated but have been intruded by syn- to post-tectonic ganites of 1800-1865 Ma age. This age data constrain the upper age limit of the Mahakoshal Group, indicating Palaeproterozoic afe for the Mahakoshal orogeny.

Kaimur Group - The Kaimur Group consists predominantly of sandstones. On the basis of the present study they are classified as subarkose, sublitharenite, and quartz arenite in the Quartz (Q)-Feldspar (F)-Rock fragment (R) triangular diagram.

The soil type that can be found in Varanasi District includes Sandy to Sandy Loam (good for cultivation); Loam to Clay Loam (water logged); and Sodic Soils/Saline (Usar). In Mirzapur District, the soils are Red Lateritic and Sandy Loam which mostly covered with rocks, forest and bushes. For Ghazipur District, the soils are Clay Loam; Sandy Loam, Diara Soil (Silt); and Black Soil (Karail Region). Figure 2.1.4shows the Soil Map of the project sites.

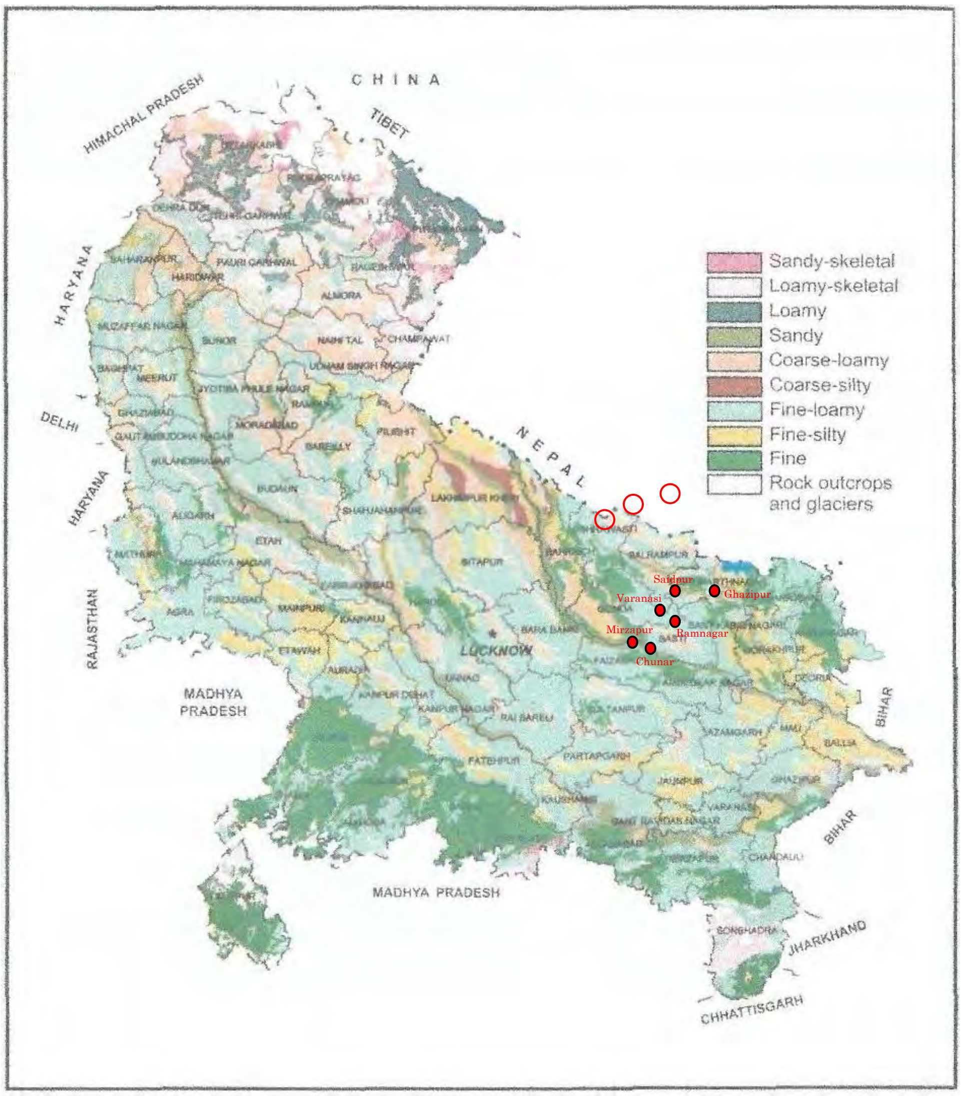


Figure 2.1.4 Soil Map of the Project Site

2.2 Natural Condition Survey

2.2.1 Survey Item

The Natural condition survey is composed of 1) Topographical survey, 2) Geotechnical survey and 3) Water quality survey.

As for Saidpur, the land acqutision of the access road to the STP has not been accomplished due to the budget problems of UPJN, which results in the imcompletion of the preparation of the DPR. Therefore, the topographic survey in Saidpur was cancelled.

2.2.2 Survey location and progress

The survey locations and progress are shown as below:

Table 2.2.1 Survey Location and Item

Location	Survey	Item	Quantity (achieved)
Varanasi (District-I, District-II, District-III)	Topographic and Route Inspection Survey	Topographic Survey	Ramna STP site: 14 ha
		Cross Section Survey	Access road to the STP site: 550 m
		Route Inspection Survey	District-I&II: 57.9 km District-III: 12.6 km
	Geotechnical Survey	Boring, SPT, and laboratory test	Ramna STP site: 2 boring
Chunar	Topographic and Route Inspection Survey	Topographic Survey	Chunar STP site: 9.8 ha
		Cross Section Survey	Access road to the STP site: 550 m
		Route Inspection Survey	Major sewer and rising main: 10.1 km
	Geotechnical Survey	Boring, SPT, and laboratory test	Chunar STP site: 2 boring
Ramnagar	Topographic and Route Inspection Survey	Topographic Survey	Ramnagar STP site: 2.3 ha
		Cross Section Survey	Access road to the STP site: 1100 m
		Route Inspection Survey	Major sewer and rising main: 4.2 km
	Geotechnical Survey	Boring, SPT, and laboratory test	Ramnagar STP site: 2 boring
Mirzapur and Vindyachal	Topographic and Route Inspection Survey	Topographic Survey	Mirzapur STP site: 1.0 ha Vindyachal STP site: 1.6 ha
		Cross Section Survey	Access road to Mirzapur STP site: 450 m Access road to Vindyachal STP site: 250 m
		Route Inspection Survey	Major sewer and rising main: 31.7 km
Saidpur	Topographic and Route Inspection Survey	Topographic Survey	cancelled
		Cross Section Survey	cancelled
		Route Inspection Survey	Major sewer and rising main: 3.6 km
	Geotechnical Survey	Boring, SPT, and laboratory test	cancelled
Ghazipur	Topographic and Route Inspection Survey	Topographic Survey	Ghazipur STP site: 5.5 ha
		Cross Section Survey	Access road to the STP site: 450 m
		Route Inspection Survey	Major sewer and rising main: 22.8 km
	Geotechnical Survey	Boring, SPT, and laboratory test	Ghazipur STP site: 2 borings
Ganga and Major drains	Water Quality Survey	Water Sampling and analysis	1st survey: 25 samples 2nd survey: 29 sample 46 samples to be collected in next survey

Source: JICA Study Team

2.3 Legislative Conditions

This section takes an account of all the relevant policies, laws and legislation and the administrative framework with regards to sewerage projects at national, state and local levels. Different bodies that are currently responsible for sewerage are described along with their roles and jurisdictions.

2.3.1 National Water Policy

The Water (Prevention and Control of Pollution) Act and the Environment Protection Act promulgated in 1974 and 1986, respectively deal with the prevention and control of water pollution. The latter is considered as an umbrella act covering all aspects of the environment, under which the central government can take appropriate measures for;

- Protecting and improving the quality of the environment, and
- Preventing, controlling and abating environmental pollution.

The Pollution Control Board (PCB) was established under this act both at the Central Government called as Central Pollution Control Board (CPCB) and also at the State Government level for each state, known by the name of the State like UPPCB (Uttar Pradesh Pollution Control Board).

2.3.2 Legal framework

The rejuvenation of Ganga-river will need a holistic approach. The Ministry of Environment, Forests and Climate Change has drafted various rules and regulations to control the pollution. The rules applicable in the context of the Project are summarized in Table 2.3.1.

Table 2.3.1 Summary of the relevant Indian rules

Environment Legislation	Salient Features
Forest (Conservation) Act, 1980 - as amended in 1988	The Central Government enacted The Forest (Conservation) Act in 1980 to stop large-scale diversion of forestland for non-forest use. As amended in 1988, the Act requires the approval of the Central Government before a State "de-reserves" a reserved forest, uses forestland for non-forest purposes, assigns forestland to a private person or corporation, or clears forests land for the purpose of reforestation. Such diversion is generally allowed on the advice of an Advisory Committee constituted under the Act. In case of such diversion of forest land, compensatory forestation has been made mandatory.
Wildlife Protection Act	An act to provide for the protection of wild animals, birds and plants and for matters connected therewith. The provisions under this act are: Section 9 of the Act says that no person shall hunt any wild animal specified in Schedule I The act prohibits picking, uprooting, damaging, destroying, acquiring any specified plant from any forest land It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife in a sanctuary. No alteration of the boundaries of a National Park shall be made except on a resolution passed by the Legislature of State. Destruction or damaging of any wildlife property in national Park is prohibited.
Water (Prevention and Control of Pollution) Act, 1974 - as amended in 1978 &1988	The Act vests regulatory authority on the State Pollution Control Boards and empowers them to establish and enforce effluent standards for industries and local authorities discharging effluents. Following are the important provisions under this Act which are to be compiled with: Provide the State Pollution Control Board (SPCB) any information which is sought for preventing or controlling pollution of water regarding the construction, installations, operation or the treatment and disposal system of an industrial establishment Not to discharge, knowingly of any effluent into the stream, sewers or on land of quality which is not conforming to the standards prescribed by SPCB. Furnish information to SPCB and other designated agencies of any accident or unforeseen event, in which effluents not conforming to the prescribed standards are being discharged or likely to be discharged in to a stream or sewer or on land Comply with the directions issued in writing by SPCB, within the specified time. Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for discharge of effluent in to stream or sewers or on land. Responsibilities Obtain "Consent to Establish", prior to taking any steps to establish any industry or any treatment and disposal system which is likely to discharge effluents. Obtain "Consent to Operate", prior to commencing operation of any industry or any treatment and disposal system which is likely to discharge effluents. Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
Water (Prevention and Control of Pollution)	An act to provide for the levy and collection of a cess on water consumed by persons carrying on certain industries and by local authorities to augment resources for PCB.

Cess Act, 1977 including Rules	As per the provision of Section 3, all specified industries under the Water (Prevention and Control of Pollution) Cess Act, 1977 are liable to pay cess in the prescribed rate made under the statute. It is provided under Section 5 that every specified industry or local authority is liable to furnish cess to respective authorities. Also all specified industries and local authorities for the purpose of measuring the quantity of water consumption shall install suitable meters. To encourage capital investment in pollution control, the Act gives a polluter a 70 per cent rebate of the applicable cess upon installing an effluent treatment plant
Air (Prevention and Control of Pollution) Act, 1981 - as amended in 1987	An act providing for prevention, control and abatement of air pollution. Section 21 of the Air Act specifies that no person shall without the consent of the State Board establish or operate any industrial plant in any air pollution control area. It is also provided in the statute that industrial units cannot discharge any pollutants into the air in excess of the standards of the standards prescribed by SPCB. The States are required to prescribe such "Emission Standards" for industry and automobiles after consulting the Central Board and noting its Ambient Air Quality Standards. Furnish information to the SPCB and other designated agencies of any accident or unforeseen event, in which emissions of air pollutants occurred in excess of the prescribed standards or are likely to occur. Comply with the directions issued in writing by the SPCB , within the specified time. Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for emissions Responsibilities Obtain "Consent to Establish", prior to establishing any industrial plant in an air pollution control area, which is likely to emit air pollutants. Obtain "Consent to Operate", prior to commencing operation of any industrial plant which is likely to emit air pollutants in an air pollution control area,. Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
The Environment (Protection) Act, 1986, 2004 (amended)	The Environment (Protection) Act was conceived as an "umbrella legislation" seeking to supplement the existing laws on the control of pollution (the water Act and the Air Act) by enacting a general legislation for environment protection and to fill the gaps in regulation of major environmental hazards. Section 3 (1) of the Act empowers the Centre to " take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution". It also authorizes the government to make rules on any aspect related to environment protection. No industries can discharge any solid, liquid or gaseous substances beyond the permissible limit as laid down by the Central Government on its behalf. Comply with the directions issued in writing by the Central Government within a specified time as mentioned in the order. Furnish information to the prescribed agencies of any accident or unforeseen event, in which environmental pollutants occurred in excess of the prescribed standards are being discharged, of are likely to be discharged in the environment. Responsibilities

	Obtain prior "Environmental Clearance" from MoEF in case of a new project or for modernization/expansion of the existing project and in respect of projects falling under EIA notification
The Hazardous Wastes (Management and Handling) Rules, 1989	These rules aim at providing control for the generation, collection, treatment, transport, import, storage and disposal of hazardous wastes. These Rules provide for effective inventorisation and controlled handling and disposal of hazardous waste. Occupiers responsibility to ensure proper handling and disposal of hazardous waste either by themselves or through the operator of hazardous waste management facility Restriction on handling of hazardous wastes without prior authorization Packaging, labelling and transportation of hazardous waste to be done in the specified manner Occupier generating hazardous wastes, or operator handling facility to submit annual returns in the prescribed format. Occupier or operator handling facilities to report to SPCB in prescribed forms, in case of accident at the hazardous waste handing site or during transportation.
The Municipal Solid Wastes (Management and Handling) Rules, 2000	Every municipal authority will be responsible for the implementation of the provisions under these rules. The municipal authority shall make an application in Form-I for grant of authorization for setting up waste processing and disposal facility from SPCB The municipal authority shall comply with the implementation schedule under Schedule I The municipal authority shall furnish its annual report in Form II on or before 30th June every year Any municipal solid waste shall be managed in accordance to the procedure laid down in Schedule II The waste processing and disposal facilities to be set up by Municipal authority shall meet the specifications and standards specified in Schedule II and IV
Bio-Medical Waste (Management and Handling) Rules, 1998	The occupier of an institution generating bio-medical waste shall take all steps to ensure that such waste is handled without any adverse effect to human health and environment Bio-medical waste shall be treated and disposed of in accordance with Schedule 1 and in compliance with the standards prescribed in Schedule V. The occupier should set up requisite bio-medical waste treatment facilities in accordance with the time frame in Schedule VI Bio-medical waste shall be segregated into containers/bags at the point of generation as per Schedule II prior to its storage, transportation, treatment and disposal. If a container is transported from the premises of the generation point to any waste treatment facility, it will also carry information as in Schedule IV apart from that prescribed in Schedule III Bio-medical waste shall be transported in vehicles as authorized for the purpose by the competent authority No untreated bio-medical waste shall be kept stored beyond 48 hours Occupier/operator shall submit an annual report to the prescribed authority (SPCB) in Form II by 31st Jan every year for the preceding year.
The Land Acquisition	The Act seeks to set out the circumstances and the purposes for which private land can be

Act, 1894	acquired by the Central/ State Government. The procedure under the Act is briefly listed below. Stage I Publication of a preliminary notification by the Government that land in a particular locality is needed or may be needed for a public purpose or for a company Entry of authorised officers on such land for the purpose of survey and ascertaining whether it is suitable for the purpose in view Filing of objections to the acquisition by persons interested and enquiry by Collector Stage II Declaration of intended acquisition by Government Publication of declaration as required by the Act Collector to take order from the Government for acquisition and land to be marked out, measured and planned Stage III Public notice and individual notices to persons interested to file their claims for compensation Enquiry into claims by Collector Award of Collector Reference to court Stage IV Taking of possession of the land by the Collector Payment of compensation

Source: JICA Study Team

2.3.3 Classification of Inland Water Bodies

As of 25th November 2015 only criteria available for classification of water bodies are as per the "Designated Best Use" (DBU) prescribed by Bureau of Indian Standards and Central Pollution Control Board (CPCB) prepared way back in 1981 (refer to Table 2.3.2). According to this concept, out of various purposes for which the water body is used, the one, which requires highest quality of water, is taken as the benchmark and classified as "Designated Best Use". According to these criteria water bodies are divided into five categories as follows:

Class A: Drinking water source without conventional treatment, but with chlorination
Class B: Outdoor bathing
Class C: Drinking water source with conventional treatment
Class D: Propagation of wildlife and fisheries
Class E: Irrigation, industrial cooling and controlled waste disposal

These criteria lay down reference values for pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD_5), coliform, etc.

Table 2.3.2 Classification of Surface Waters based on Designated Best Use

Designated Best Use	Quality Class	Primary Water Quality Criteria	Values
Drinking water source without conventional treatment, but after disinfection	A	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	6 or more
		BOD_5 (20ºC), mg/L	2 or less
		Total coliform (MPN/100 ml)	50 not > 5% 200 not > 20% 50
Outdoor bathing (organized)	B	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	5 or more
		BOD_5 (20ºC), mg/L	3 or less
		Total coliform (MPN/100 ml)	500 not > 5% 2,000 not > 20% 500
Drinking water source after conventional treatment and disinfection	C	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	4 or more
		BOD_5 (20ºC), mg/L	3 or less
		total coliform (MPN/100 ml)	5,000 not > 5% 20,000 not > 20% 5,000
Propagation of wildlife and fisheries	D	PH	6.5 to 8.5
		Dissolved oxygen, mg/L	4 or more
		free ammonia, mg/L	1.2
Irrigation, industrial cooling, and controlled waste disposal	E	PH	6.5 to 8.5
		electrical conductivity, μmho/cm	2250
		sodium adsorption ratio	26
		Boron	2

Source: CPCB

2.3.4 Sewage discharge standards in India

1) National standards

The first environment protection act was introduced in 1986. This act comprises of discharge standards for waste water/ sewage. The discharge standards are given as shown in Table 2.3.3.

Table 2.3.3 General standards for discharge of environmental pollutants

Sr. No	Parameters	Standards			
		Inland surface water	Public sewers (A)	Land for irrigation	Marine coastal areas
1	Colour and Odour	(B)	--	(B)	(B)
2	Suspended solids	100	600	200	(C), (D)
3	Particulate size of suspended solids	(E)	--	--	(F), (G)
4	pH	5.5 to 9.0			
5	Temperature	(H)	--	--	(H)
6	Oil and grease	10	20	10	20
7	Total residual Chlorine	1	--	--	1
8	Ammonical nitrogen (as N), mg/L Max.	50	50	--	50
9	Total Kjeldahl Nitrogen (TKN) (as N)	100	--	--	100
10	Free Ammonia (as NH_3)	5	--	--	5
11	Biochemical Oxygen demand [3 days at 27 degrees C]	30	350	100	100
12	Chemical Oxygen Demand	250	--	--	250
13	Arsenic (as As)	0.2			
14	Mercury (as Hg)	0.01	0.01	--	0.01
15	Lead (as Pb)	0.1	1	--	2
16	Cadmium (as Cd)	2	1	--	2
17	Hexavalent Chromium (as Cr^{6+})	0.1	2	--	1
18	Total Chromium (as Cr.)	2	2	--	2
19	Copper (as Cu)	3	3	--	3
20	Zinc (as Zn)	5	15	--	15
21	Selenium (as Se.)	0.05	0.05	--	0.05
22	Nickel (as Ni)	3	3	--	5
23	Cyanide (as CN)	0.2	2	0.2	0.2
24	Fluoride (as F)	2	15	--	15
25	Dissolved Phosphates (as P)	5	--	--	--
26	Sulphide (as S)	2	--	--	5
27	Phenoile compounds (as C_5H_5OH)	1	5	--	5
28	Radioactive materials:				
	(a) Alpha emitter micro curie/ml	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	(b) Beta emitter micro curie/ml	10^{-6}	10^{-6}	10^{-7}	10^{-6}
29	Bio-assay test	(I)			
30	Manganese (as Mn)	2mg/L	2mg/L	--	2mg/L
31	Iron (as Fe)	3mg/L	3mg/L	--	3mg/L
32	Vanadium (as V)	0.2mg/L	0.2mg/L	--	0.2mg/L
33	Nitrate Nitrogen	10mg/L	--	--	20mg/L
34	Faecal Coliform, MPN/100ml for discharge*	onto land		into water	
		(J)	(K)	(J)	(K)
		1,000	10,000	1,000	10,000

Source: Environmental (Protection) Rules, 1986
**NRCD Guidelines for Faecal Coliforms*

Notes:
A. These standards shall be applicable only if such sewer leads to a secondary treatment including bio-logical treatment system; otherwise the discharge into sewers shall be treated as discharge into inland surface waters.
B. All efforts should be made to remove colour and unpleasant odour as far as practicable.
C. For process wastewater 100mg/L
D. For cooling water effluent 10% above total suspended matter of influent.
E. Shall pass 850micron IS Sieve
F. Floatable solids max. 3mm
G. Settleable solids max. 850microns
H. Shall not exceed 50C above the receiving water temperature.
I. 90% survival of fish after 96hours in 100% effluent
J. Desirable
K. Maximum permissible

This act has been not amended till now for any of standards. However, the Ministry of Environment, Forest and Climate Change has issued a draft notification on the Standards for Sewage Treatment Plant for public comments on April 2015. The new stringent standards are shown in the below table. These standards will be applicable for discharge in water resources as well as for land disposal. The standards for Fecal Coliform may not be applied for use of treated sewage in industrial purposes. Once notified, all new STPs will have to meet the fresh norms and existing treatment plants, which now follow guidelines for general effluents, will get five years to achieve them.

Table 2.3.4 Proposed Effuluent Standards for Sewage Treatment Plant

Sl. No.	Parameters	Parameters Limit	
		As per Act 1986	Standards for New STPs Design after notification date*
1	pH	5.5-9.0	6.5-9.0
2	BOD, mg/L	30	10
3	COD, mg/L	250	50
4	TSS, mg/L	100	20
5	NH_4-N, mg/L	50	5
6	N-total, mg/L	100	10
7	Faecal Coliform, MPN/100ml	Not specified	<100

Note: *Achievements of standards for existing STPs within 5 years from the date of notification.

Source: Ministry of Environment, Forest and Climate Change

Apart from this act, CPHEEO manual released in November 2013 in collaboration with JICA suggested some modifications for treated sewage, discharging to water bodies to be used as drinking water resource as presented in Table 2.3.5. In addition, CPCB has established effluent discharge standards for various 104 types of industries as stringent standards so far.

Table 2.3.5 Maximum Permissible Limits Standards recommended by CPHEEO

Sl. No.	Parameter	Maximum permissible limits Standards (Recommendation by CPHEEO)
1	BOD, mg/L	Less than 10
2	SS, mg/L	Less than 10
3	TN, mg/L	Less than 10
4	Dissolved P, mg/L	Less than 2
5	Faecal Coliform, MPN/100ml	Less than 230

Source: CPHEEO manual, 2013

The STP effluent standards of 2013 CPHEEO manual and other countries are shown in Table 2.3.6 and Table 2.3.7. BOD, a major water quality indicators, has set up in the 10-30mg/l in many country. Likewise, in many countries, COD is in 1 to 2 times of the BOD, and SS in less than 50mg/l respectively. Meanwhile, faecal coliform has not set in many country, but in case of set, less than or equal to 1,000MPN/100mL.

In Pakistan and Bangladesh, the neighboring countries of India, effluent standard in the STP can not be confirmed clearly, and only there the criteria of as industrial waste water. Also, the penalties in the case that did not meet standards in each country, may have been set separately.

The BOD and SS standards of STP effluent standards of 2013 CPHEEO manual (Table 2.3.5) is 10mg/l, this is without compares favorably with other countries, and enough and tough reasonable. Also, the new standards scheduled future (Table 2.3.4 right), accompanied the change of the reference item, are still sufficiently severe. Especially, standard of faecal coliform is changed 230MPN/100mL to 100MPN/100mL, this is severe more than twice as 2013 CPHEEO manual.

For the new STPs, compliance with 2013 CPHEEO manual stnadards, and the existing STPs, close to them step-by-step should be required respectively.

Table 2.3.6 Standards of Treated Water in the World (1/2)

Region	Country	Latest revised year	BOD	COD	SS	T-N	TKN	NH4-N	NO3-N
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Asia Oceania	India	2013	10	-	10	10	-	-	-
	Pakistan	1997/2005	80	150	150	40	-	-	-
	Bangladesh	1997	50	200	150	50	100	5	
	Australia (NSW)	1997	10	-	15	10	-	-	-
	China	2006	10	50	10	15	-	5 (>12℃), 8 (≦12℃)	-
	Japan	2003	15	-	40	20	-	-	-
	Malaysia	2009	20	120	50	-	-	5 (closed water course) 10(river)	10 (closed water course) 20(river)
	Philippine	1990	30	60	50	-	-	-	-
	Singapore	2000	20	60	30	-	-	-	20
	Sri Lanka	2008	30	250	50	-	150	50	-
	Thailand	2010	20	-	30	20	-	-	-
	Vietnam	2008	30	-	50	-	-	5	30
Europe	EU	1991	25 or elimination factor>70～90%	125 or elimination factor>75%	30 or elimination factor>90%	only at specified area, 10 or elimination factor>70～80%	-	-	-
	Norway	2007	25 or elimination factor>70～90%	125 or elimination factor>75%	35 or elimination factor>90%	only at specified area, 15 (sewered population;<100,000) 20 (ditto;10,000 to 100,000) or elimination factor>70～80%	-	-	-
	Switzerland	1998	15 and elimination factor>90%	-	15	Only at specified area. Total reduction target is there.	-	If there is a concern of adverse effects, 2 and elimination factor>90% (water temp.>10℃)	-
Middle East Africa	Israel	2010	monthly ave. 10 max 15	monthly ave. 70 max 100	monthly ave. 10 max 15	monthly ave. 10 max 15	-	monthly ave. 1.5 max 2.5	-
	Oman	1993	15	150	15	-	5	5	50
	Saudi Arabia	-	10	-	10	-	-	5	10
	Seychelles	1995	30	80	30	-	-	-	15
	South Africa	1984	-	75	25	-	-	6	15
America	Canada	2012	25 as Nitrification inhibition(C-BOD)	-	25	-	-	15℃ conversion, 1.25 as free anmonia	-
	Colombia	1984	elimination factor>80%	-	elimination factor>80%	-	-	-	-
	Mexico	1996	30 (monthly ave.) 60 (daily ave.)	-	40 (monthly ave.) 60 (daily ave.)	15 (monthly ave.) 25 (daily ave.)	-	-	-
	USA	1984	as 30days ave. 30 and elimination factor>85% as 7days ave. 45	-	as 30days ave. 30 and elimination factor>85% as 7days ave. 45	-	-	-	-

Source: MinoLab, SBK, Graduate School of Frontier Sciences, The University of Tokyo (http://www.mwm.k.u-tokyo.ac.jp:8080/Plone/outcome/discharge_regulations)
Pakistan environmental legislation and NEQS
Department of environment Bangladesh (EQSB)

Table 2.3.7 Standards of Treated Water in the World (2/2)

Region	Country	Latest revised year	NO2-N	T-P	PO4-P	Coliforms	Fecal coliforms	Escherichia coli	remarks
			mg/l	mg/l	mg/l			MPN/100ml	
Asia Oceania	India	2013	-	2	-	-	230 MPN/100mL	-	2013 CPHEEO manual p.5-120
	Pakistan	1997/2005	-	-	-	-	-	-	for municipal & liquid industrial effluents
	Bangladesh	1997		8			1000 MPN/100mL		Industrial Project Effluent
	Australia (NSW)	1997	-	0.3	-	-	-	200MPN/100ml	90 percentile
	China	2006	-	0.5	-	-	1000 MPN/mL	-	Class 1-A(The most severe)
	Japan	2003	-	3	-	3000MPN /ml	-	-	
	Malaysia	2009	-	5 (only at closed water course)	-	-	-	-	A-new construction
	Philippine	1990	-	-	-	3000MPN /100ml	-	-	Class A,B,SB-new construction
	Singapore	2000	-	-	2	-	-	-	Controlled watercourse
	Sri Lanka	2008	-	-	-	-	40 MPN/100mL	-	
	Thailand	2010	-	2	-	-	-	-	
	Vietnam	2008	-	6	-	3000 MPN /100mL	-	-	Discharge to water course used as domestic water
Europe	EU	1991	-	only at specified area, 1 or elimination factor>80%	-	-	-	-	STP which sewered population is over 100,000
	Norway	2007	-	only at specified area, 1 (sewered population:<100,000) 2 (ditto:10,000 to 100,000) or elimination factor>80%	-	-	-	-	STP which sewered population is over 10,000
	Switzerland	1998	0.3 (recomennded)	only at specified area, 0.8 and elimination factor>80%	-	-	-	-	STP which sewered population is over 10,000
Middle East Africa	Israel	2010	-	monthly ave. 1 max 2	-	-	-	monthly ave. 200 MPN/100mL max 800 MPN/100mL	Large scale STP which dischare to river
	Oman	1993	-	0.02	-	-	200 MPN/100mL	-	A-1, more severe reuse standard
	Saudi Arabia	-	-	-	-	-	2.2 MPN/100mL	-	Third process
	Seychelles	1995	1	-	5	500 MPN /100mL	100 MPN/100mL	-	
	South Africa	1984	-	-	10	-	1000 MPN/100mL	-	
America	Canada	2012	-	-	-	-	-	-	
	Colombia	1984	-	-	-	-	-	-	New construction
	Mexico	1996	-	5 (monthly ave.) 10 (daily ave.)	-	-	-	-	riverC
	USA	1984	-	-	-	-	-	-	

Source: MinoLab, SBK, Graduate School of Frontier Sciences, The University of Tokyo (http://www.mwm.k.u-tokyo.ac.jp:8080/Plone/outcome/discharge_regulations)
Pakistan environmental legislation and NEQS
Department of environment Bangladesh (EQSB)

CHAPTER 3 Current Status of Water Supply and On-going/Planned Water Supply Project

<Objective of the Survey>
Current status of water supply organization and projects was surveyed.
<Result of the Survey>
In the State of Uttar Pradesh (UP), UP Jal Nigam (UPJN) is responsible for planning and design, construction/implementation of water supply facilities and the Varanasi Municipal Corporation (VMC) is responsible for provision of basic services such as water supply, sewerage and storm water drainage and undertakes their operation and maintenance through the Jal Kal Department (Jal Kal). The District Urban Development Authority (DUDA) is involved in housing development in the slum area.
The Varanasi water supply is managed by the Jal Kal Department under the Varanasi Municipal Corporation. At present, Varanasi water supply takes surface water from the Ganga River and ground water through tube wells. On-going projects were also studied.

3.1 Organizations and their Responsibilities Concerned with Water Supply

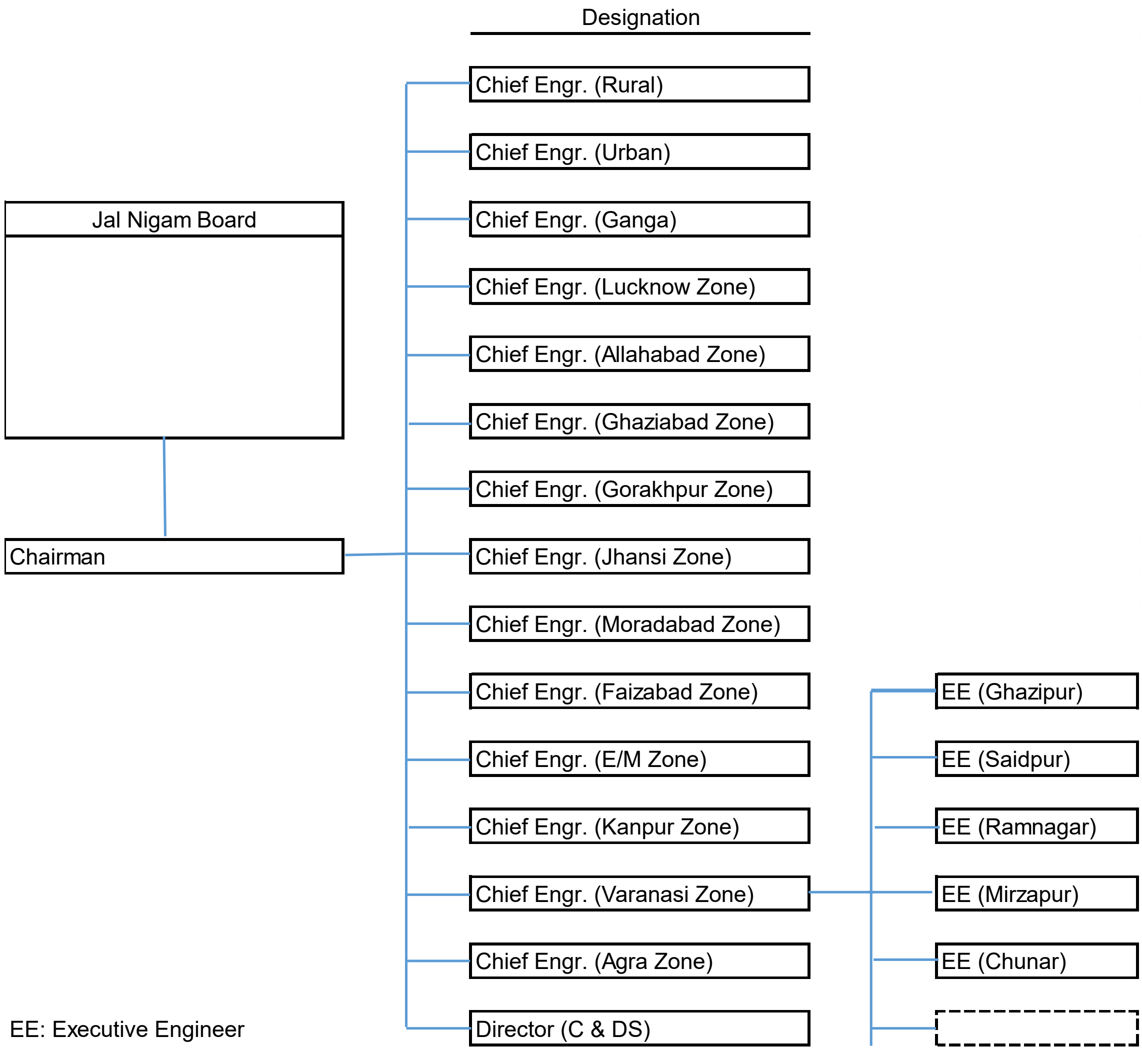
In the State of Uttar Pradesh (UP), UP Jal Nigam (UPJN) is responsible for planning and design, construction/implementation of water supply facilities and the Varanasi Municipal Corporation (VMC) is responsible for provision of basic services such as water supply, sewerage and storm water drainage and undertakes their operation and maintenance through the Jal Kal Department (Jal Kal). Jal Kal may also participate in planning and design, and construction /implementation of such small-scale projects. The District Urban Development Authority (DUDA) is involved in housing development in the slum area. Their role sharing is summarized in **Table 3.1.1**.

Table 3.1.1 Roles and Responsibilities of VMC and Parastatals

Urban Infrastructure Services	Planning and Desin	Construction / Implementation	O&M
Water supply	UPJN, Jal Kal (small projects)	UPJN, Jal Kal ((small projects)	Jal Kal
Sewerage and Drainage	UPJN, Jal Kal (small projects)	UPJN, Jal Kal (small projects), DUDA	UPJN, Jal Kal, VMC, DUDA

Source: "City Development Plan for Varanasi, 2041", March 2015, Capacity Building for Urban Development Project (CBUD)

UPJN divides the state area into eleven (11) zones and places the chief engineer in respective zones for management. The Varanasi Zonal office is one of them and controls the field offices in the survey area under its jurisdiction.



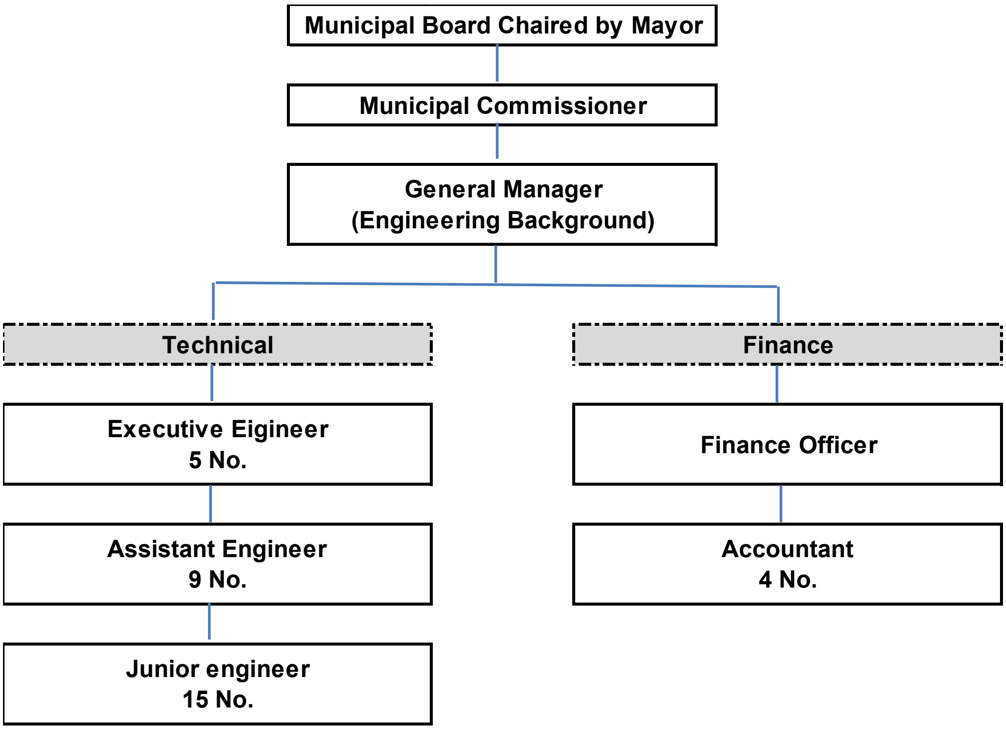
Source: JICA Survey Team

Figure 3.1.1 Organizational Chart of UP Jal Nigam

3.2 Status of Varanasi Water Supply

3.2.1 Organization of Jal Kal

The Varanasi water supply is managed by the Jal Cal Department under the Varanasi Municipal Corporation.



Source: http://www.jalkalvaranasi.org/

Figure 3.2.1 Organizational Chart of Jal Kal Department, Municipal Corporation

3.2.2 Outline of Water Supply Facilities

The outlines of Varanasi Water supply is summarized as below.

Table 3.2.1 Salient Features of Water Supply in Varanasi

Sr. No.	Particulars	Unit
1	Present population	1,600,000 persons
2	Water demand @172.5 lpcd (150 lpcd+15% UFW)	276 MLD
3	Water production	335 MLD
	Water treatment plant	Bhelupur WTP (133 MLD)
	Tube wells	142 nos (188 MLD)
	Mini tube wells	80 nos (14 MLD)
	Hand pumps	2,514 nos
	Public stand post	1,402 nos
	Water tanker	19 nos
4	Non-revenue water (58 %)	194.3 MLD
5	Total chargeable water	140.7 MLD
6	Shortfall	135.3 MLD
7	Water availability	84 lpcd
8	Total pipe length	1,500 km
9	No. of water connections (67%)	102,592

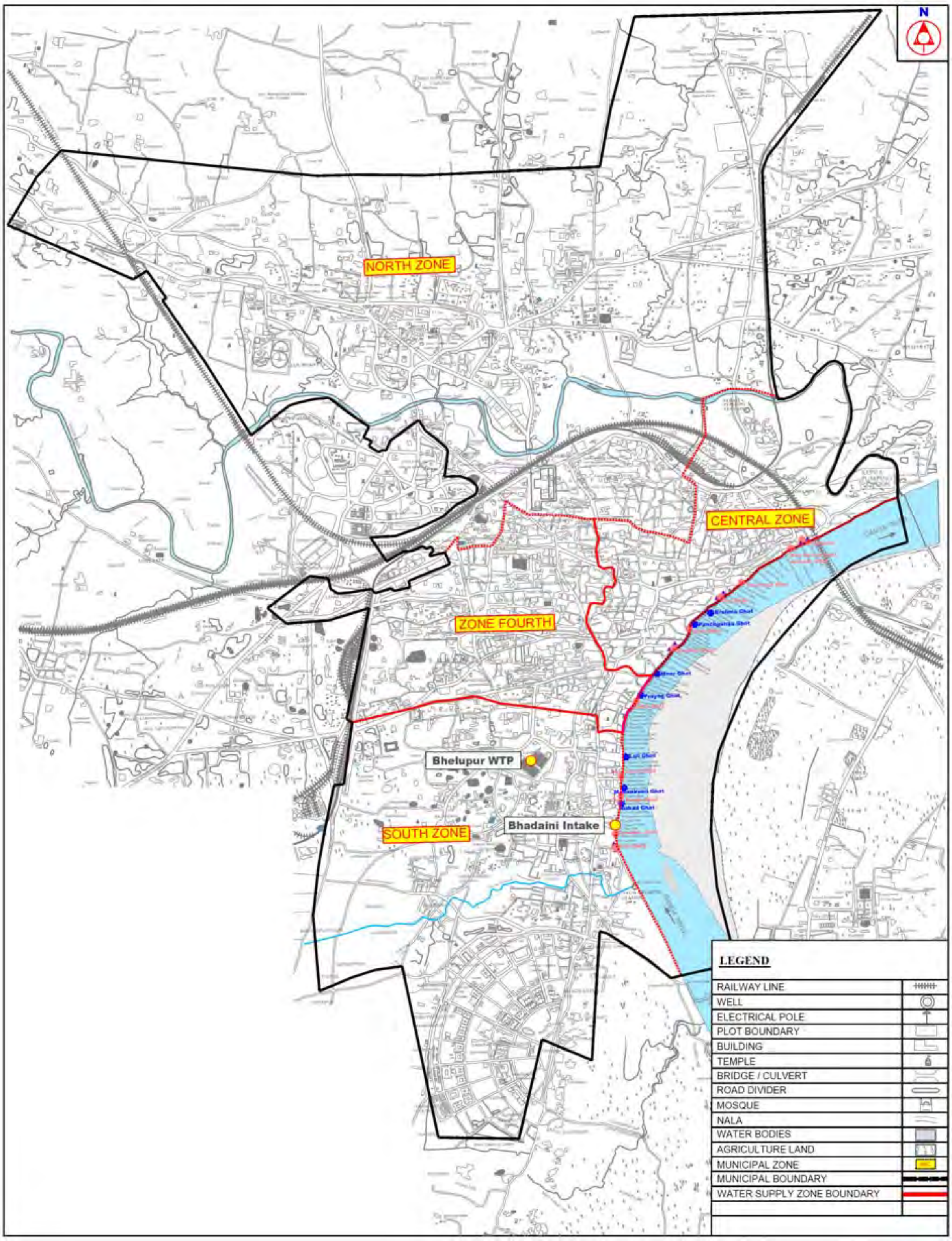
Source: Jal Kal, Varanasi

1) Water supply zone

Water supply system for Varanasi is as old as 100 years since it was introduced in year 1892. Varanasi is mainly divided into 2 district areas, Cis-Varuna and Trans-Varuna. For the purpose of water supply, the city has been divided into 4 administrative zones: North zone, Central zone, South zone, Zone fourth as shown in **Figure 3.2.2**.

2) Water source

The present water demand of 276 MLD for the city is met by the surface flow of Ganga River and the underground sources. At present, Varanasi water supply takes surface water from the Ganga River (40%) and ground water through tube wells and mini tube wells (60%) as shown in **Table 3.2.2**. There is only one conventional water treatment plant at Bhelupur, the centre of the Cis Varuna and that supplies treated water for the area. Entirely Trans-Varuna and some part of Cis-Varuna are exclusively dependent on groundwater source.



Source: JICA Survey Team

Figure 3.2.2 Water supply zones in Varanasi

Table 3.2.2 Production volume per water source in Varanasi

Source		No. of facility	Production volume (MLD)	%
Surface water	Ganges River (Bhelupur WTP)	1	133	40
Ground water	Tube well	142	188	56
	Mini tube well	80	14	4
	Hand pump	2,514	ND	-
Total			**335**	**100**

Source: Jal Kal, Varanasi

3) Water treatment facility

The surface water extracted from Ganga River at Bhadeni gets treated through coagulation-sedimentation, rapid sand filtration and disinfection processes at Bhelupur water treatment plant (WTP). Treated water is then stored in two underground clear reservoirs of 25 ML capacity each, and one OHT of 1.14 ML at Bhelupur WTP, and also distributed to other storage tanks all over the city. The original treatment capacity of Bhelupur water treatment plant is 250 MLD but at present it is treating only around 125 MLD due to limitation of current water intake capacity.

This Bhelupur WTP has laboratory facility for testing of water samples for physico-chemical and bacteriological parameters. Jal Kal Varanasi supplies treated water from this WTP with acceptable water quality in dry and rainy season (**Table 3.2.3**, **Table 3.2.4**). Meanwhile, there are many complaints on polluted water supply (15% of total complaints from water consumers), which supposed that it is caused by pipe leakage and contamination due to the old distribution line.

Table 3.2.3 Water quality at Bhelupur WTP

Items	Dry season (Jan. 2016)		Rainy season (Aug. 2015)		CPHEEO Standard	
	Raw water	Clear water	Raw water	Clear water	Acceptable	Cause for Rejection
Turbidity (NTU)	81.7	1.1	2100	1.1	1	10
pH	7.73	7.32	7.72	7.31	7.0 to 8.5	6.5 to 9.2
DO (mg/L)	4.1	6.8	4.2	6.8	-	-

Note: Monthly average (N=30) *Source: Jal Kal, Varanasi*

Table 3.2.4 Water quality at CWR and Public stand post

Items	Sample		CPHEEO Standard	
	CWR at Bhelupur WTP	Public stand post	Acceptable	Cause for Rejection
Residual chlorine (mg/l)	0.4	0.3	0.2	1
Fecal Coliform (MPN/100ml)	ND	ND	ND	ND

Note: Sampled on 28th Jan 2016 *Source: Jal Kal, Varanasi*

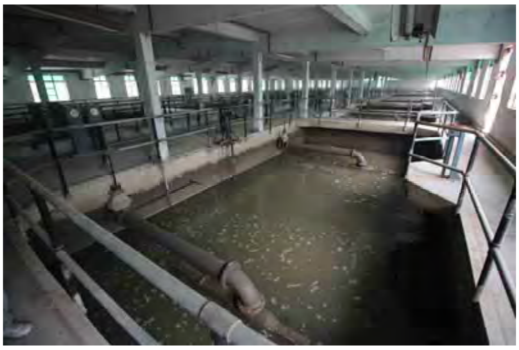
 Water intake from Ganga, Bhadani pumping station	 Inlet chamber
 Alum dosing tank (4 nos)	 Inlet channel with baffle wall (to Settling tank)
 Settling tank, effluent point (4 nos, HRT: 2-3 hr)	 Rapid sand filter (26 nos)
 Chlorination house	 Distribution pump

Figure 3.2.3 Water treatment facilities for surface water in Varanasi (Bhelupur WTP)

At present, the volume of the ground water has been increasing according to the recent population growth. The ground water is currently extracted from 222 deep tube wells operated by Jal Kal and hand pumps by Jal Kal and by privately owned ones. The treatment process includes only disinfection process by chlorine injection inside of the tube well chamber. The extracted water has been supplied to consumers through storage tanks as well as direct pumping.

Tube-well pump house

Tube-well

Chlorination tank

Hand pump

Figure 3.2.4 Tube well and hand pump in Varanasi

4) Water storage

There are 17 Over Head Tanks (OHTs) with total storage capacity of 17.8 ML along with 7 Under Ground Reservoirs (UGRs) with total storage capacity of about 62 ML. Total storage capacity including both OHTs and UGRs is about 79.8ML. Details of OHTs and UGRs are listed in **Table 3.2.5**. Present storage available is 79.8 ML, which is only 30% of the daily demand of 267ML. The present storage capacity is insufficient to meet the present demand as well as the future demand of the city.

Table 3.2.5 Water reservoirs in Varanasi

Sr. No.	Location	Storage type	Capacity (ML)	Areas Covered
1	Bhelupur	UGR	25 25	Bhelupur ward, Part of Nagwa ward, Chauk, Chetganj, Jaitpura, Kotwali and Adampur ward.
2	Maidagin Old		1.5	Daranagar, Ausanganj, Maidagin, Ishwariganga, Jaitpur, Salempura, Madhyameshwar and other Mahals
3	Maidagin New		1.5	
4	Rajghat		1.5	Rajghat, Pralhad ghat, Part of Madhyameshwar, Kayastha tola, Chhitanpura, Jalalipura
5	Gopal Bagh		1.25	Sheshman Bazar, part of Ishwariganga, Udhavpura, Gopal Bagh, Dingiaagaganj, Azad park
6	Beniya		0.75	Muletan, Haripura, part of Chauk, Resham Karta, Thatheri Bazar, Golagali Mikhadidas, Nandan Sahu lane, Hadaha Sarai
7	Bhelupur	OHT	1.14	Bhelupur and Water works area
8	Tulsipur		1	Sundarpur, Brig enclave colony,Sundarpur village, Dashmi, Batuapura, Gayatri nagar colony, Teliyana square
9	Mogawir area		1	Mogawir colony, Nariya area, Rashmi nagar colony, part of Lanka, Shukulpura, Sankatmochan area
10	Sundarpur area		1	Sundarpur, Brig enclave colony, Sundarpur village, Dashmi, Batuapura, Gayatri nagar colony, Teliyana square
11	Nagar Nigam Park		1	Madhopur
12	Lahartara area		1	Lahartara complete area
13	Sonia area		1.5	Sonia, Kazipura, Lallapura, part of Aurangabad
14	Beniya area		1.5	Badi Piyari, part of Kabir chura, Chetganj
15	Banaras Club		1.2	Golghar, Pakki Bazaar, DIG colony, Varuna Pul, Sikril village, Ardali Bazaar, Khajuri, Makbul Alam road, Pahadpura
16	Mint House area		0.8	Nadesar, Raj Bazaar, Ghausabad, Mint house area
17	Maladhiya		1.25	Maladhiya
18	Natiniya Dai		1	Nitiniya Dai, Gautam Vihar, Mirapur, Basahi, Taktakpur
19	UP college		1	Bhojubir, Chuppepur, Sushma nagar, Laxmanpur
20	Kadipur		1	Kadipur, Shivpur Bazaar, Shivpur kote, Bharlai
21	Lalpur		1	Pandaypur, Chota Lalpur, Soyepur, Pandaypur colony
22	Pahadiya		1	Ashapur, Mawaiya, Sarnath, Purana pul, Pulkohana, Ashok Vihar, Chanda, Chauraha, Paigambarpur
23	Chaukaghat		1.25	Dhelwariya, Nakkhighat, Shakkar talab, Badi Bazaar, Usmanpura, Kamalgaddha, Badi Bazaar, Usmanpura, Kamalgaddha,
	TOTAL	**24**	**79.8***	

Note: UGR: Underground reservoir, OHT: Overhead Tank *Source: Varanasi CDP, 2015*

**: Noted as the original figure*

Overhead tank at Bhelupur WTP

Underground reservoir (UGR) at Bhelupur WTP

Figure 3.2.5 Water storage reservoirs in Varanasi

5) Distribution network

Rising mains are in good condition as they were maintained well under different schemes. The total pipe length of the distribution network as of now is 1,500 km. Diameter of the pipes varies from 90 to 750mm in different parts of the city and system consists of AC, DI, CI and PVC pipes. Distribution mains in some parts of the city are in bad condition. Some of the problems related to the distribution network is:

✓ Some of the lines are as old as 100 years, which are broken as they are deep under the ground due to landfilling and needs replacement.

✓ In some parts of the city the distribution lines pass through sewer lines, open drains, nallas contaminating drinking water due to seepage of sewage in the pipes.

6) No. of water tap connections

As shown in **Figure 3.2.2**, Varanasi municipal water supply area has been managed by 4 administrative zones which consist of North zone (Trans-Varuna), Central zone, South zone and Zone forth (Cis-Varuna). No. of connections is 102,592 against 152,430 households in Varanasi, and the coverage of water supply connections is 67% at present.

Table 3.2.6 No. of water tap connections, administrative zone wise

Sr. No.	Zone Name	Total No. of Households	Households with Water tap Connection	Households without Water tap Connection
1	North zone	32,486	21,286 (66%)	11,200 (34%)
2	Central zone	47,625	32,794 (69%)	14,831 (31%)
3	South zone	39,528	27,721 (70%)	11,807 (30%)
4	Zone fourth	32,791	20,791 (63%)	12,000 (37%)
	Total	**152,430**	**102,592 (67%)**	**49,838 (33%)**

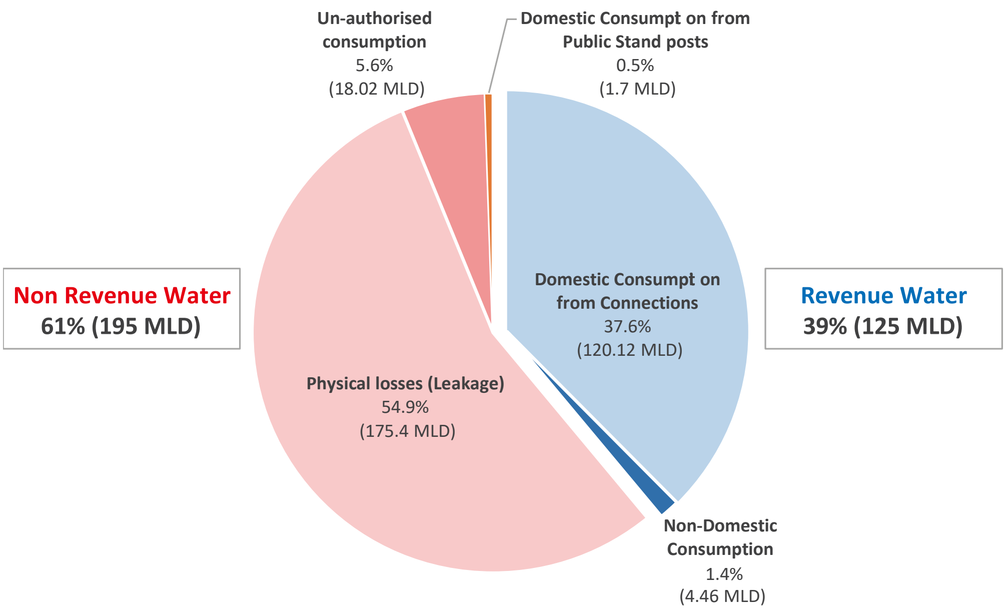
Note: (%: Ratio to the Total No. of Households) *Source: Jal Kal Varanasi*

3.2.3 Current Key Issues on Varanasi Water Supply

1) Non-revenue water

A compulsory study on non-revenue water in Varanasi was conducted through "Developing Strategy for Reduction of NRW" under a World Bank funded project "Capacity Building for Urban Development". Over 100 years has passed since water supply facilities in Varanasi were originally constructed. Water flow meters are not installed at water intake or water distribution facilities. So water intake and distribution flow were estimated based on the pump capacity and working hours. Water consumption at each household was also unknown since there are no functional water meters there either. Therefore, water consumption was estimated based on the sample surveys at 252 households.

The study results are shown in **Figure 3.2.6** and the Rate of NRW was concluded as 61%. Physical leakage from old water pipe lines and facilities was concluded as a major cause of NRW, which is about 55% of the total water production. Negligence or non-efficiency of Water bill collection is not a major cause. In order to reduce NRW, updates and replacement of water supply systems are required. High level of NRW is a weakness of water supply system as it seriously affects the financial viability and sustainability of water utilities. This should be brought to the desired benchmark of 20% before developing the system to expand capacity. In this way actual water demand could be calculated accurately.



Source: Prepared by JICA Survey Team, based on Capacity Building for Urban Development (CBUD)

Figure 3.2.6 Revenue and Non-revenue water on Varanasi water supply

2) Tariff regulation

The current water tariff is set low-for political reasons- and revenue from water bills is not enough to cover expenditure for operation and maintenance works of Jal Kal and much of the costs are covered by state government of their electricity bills and salaries for managers. The decision on whether this financial support will be continued or not is made in accordance with discussion between the state government and the VMC. If the state government ceases financial support in the future, increasing revenue will be essential.

3) Water source and quality

Pollution of Ganga water, as only one surface source for the city, directly affects the water supply quality. One of the major problems is that Assi Nala discharges its waste 1km upstream of water intake works. Regarding to pH, DO and BOD, the water quality at Bhadeni water intakes is suitable to the CPCB standard most likely due to dilution effect. However, highly polluted Assi Nala is considered to have been affecting the total coliform at the intakes, which is more than twice the standard.

Table 3.2.7 Water quality at Assi Nala mouth and Bhadeni water intake

Items	Unit	Assi Nala Mouth	Bhadeni water intake	Primary Water Quality Criteria*
PH	-	7.96	8.11	6 to 9
Dissolved oxygen	mg/L	0.8	6.2	4 or more
BOD_5 (20ºC)	mg/L	83.0	< 2.0	3 or less
Total coliform	MPN/100 ml	41,000	13,000	5,000

Note: Sampled on Dec. 2015

** CPCB Criteria for Drinking water source after conventional treatment and disinfection*

Source: JICA Survey Team

At this moment, 60% of the water source is from underground. Excessive use of groundwater might cause ground settlement and contamination of water quality. The groundwater resource in Varanasi area has been reported to be contaminated with high level of nitrate[1], which may cause Methemoglobinemia for especially infants. The occurrence of nitrate in groundwater suggests anthropogenic pollution contributed by nitrogenous fertilizers for agricultural purpose, industrial effluents, and leachates from animal/human and industrial waste dump. It has been also reported that the ground water table dropped by 2.13 m (7 feet) in 2006 from a level of 17.68 m (58 feet) in 2005, and the ground water in the city is depleting at a rate of 23 cm/a, and especially in densely populated area of the southern part of the city, lowering of ground water in the southern part is 9 times faster than the rest part of the city[1]. Furthermore, the life of tube wells is estimated to be till 2031 as per the Varanasi CDP report in 2015. Hence, water supply capacity will have to be developed in addition to the current intake works.

4) Slum area

Varanasi city has a total of 209 slums with 78,253 households. The survey under Rajiv Awas Yojana scheme reported that a significant portion of 54% of the slum households does not have access to individual tap connections, and are dependent on public taps, hand pumps, tube wells and on neighbour households who have access to water supply connections (**Table 3.2.8**), which needs to be dealt immediately.

Table 3.2.8 Water source for slum households

Source	No. of Households	%
Individual Tap	36,218	46.3
Public Tap	13,486	17.2
Tube well/ Bore well / Hand pump	15,871	20.3
Open Well	3,343	4.3
Tank / Pond	20	0.03
River/Canal/ Pond	25	0.03
Water Tanker	2	0.00
Others	9,288	11.9
Total	78,253	100.0

Source: Slum Free City Plan of Action for Varanasi, 2014

[1] Kshitij Mohan et al., "Ground Water in the City of Varanasi, India: Present Status and Prospects", Quaestiones Geographicae 30 (2011) 47-60

3.2.4 On-going / Planned Project for Varanasi Water Supply

1) Water demand projection

Future water demand was estimated as follows in some reports (**Table 3.2.9**). The population forecast is quite different between CSP 2011 and CDP 2015. The projected population in CDP 2015 among these is reliable since that is based on census population 2011.

Table 3.2.9 Future water demand

Year	Population	Rate for Water demand	Water demand
Detailed Project Report for water supply components under JNNURM, 2007			
Year	**Population**	**Rate for Water demand**	**Water demand**
2025	2,523,700	150 lpcd + 15% (UFW) for General 40 lpcd + 15% (UFW) for Slum	403 MLD
2040	3,367,900		528 MLD
City Sanitation Plan for Varanasi, 2011			
Year	**Population**	**Rate for Water demand**	**Water demand**
2020	2,261,433	150 lpcd + 20% (UFW) for General 55 lpcd + 20% (UFW) for Slum	402 MLD
2030	2,806,759		500 MLD
2040	3,367,900		601 MLD
City Development Plan for Varanasi, 2015			
Year	**Population**	**Rate for Water demand**	**Water demand**
2021	1,879,397	150 lpcd x 1.15	324 MLD
2031	2,299,288		396 MLD
2041	2,825,756		487 MLD

Source: As shown in the table

2) On-going project

Under JNNURM, three projects in the water supply sector are being taken up and mainly include the augmentation of water resources, new WTP for Trans-Varuna area, distribution network and increasing the number of storage facilities. The projects were designed for a period of 30 years considering 2010 as base year and ultimate year as 2040. The project components and progress are as follows.

Table 3.2.10 Components and current progress of JNNURM project for Varanasi water supply

Sl. No.	Description of works	Proposed	Completed	Commissioned	Remarks
1	***Water Supply Component-Priority-I Phase-I for Cis Varuna Area of Varanasi City***				
1.1	Source of Water Supply				
	a) Renovation of Intakewells at Bhadaini	Job	Job	Job	
	b) Replacement of Raw Water Pumps (Nos)	5	5	5	
	c) Raw Water Transmission line 1600 mm dia (Additional)	1.8 km	1.8 km	1.8 km	
1.2	Water Treatment Plant				
	a) Renovation of water Treatment Plant	Job	Job	Job	
	b) Independent Electricity Feedermain 33kVA	3 km	-	-	
	c) New Substation 33 KVA	Job	Job	-	
	d) Installation of new clear water pumps (Nos)	18	18	-	
1.3	Clear Water Transmission System				
	a) New Feeder line	20.82 km	20.82 km	20 km	-
	b) Replacement of old feedermain from Bhelupur to Benia CWR	2.2 km	2.15 km	-	-
1.4	Service Reservoir				
	a) CWR (Nos.)	27	27	22	
	b) OHT (Nos.)	17	17	13	
	c) Independent Feeder line For Zonal Pumping Station (Nos)	28	-	-	
1.5	SCADA System for Tubewell (Nos)	108	106	106	
1.6	Leak Detection Equipment	4 set	1 set	1 set	
	Over all progress: 95%, Target date for completion: December 2015				
2	***Water Supply Component-Priority-I Phase-II for Cis Varuna Area of Varanasi City***				
2.1	a) Laying and Jointing of pipe line and appurtenant works	466.271 km	465.05 km	241.178 km	Road cutting permission awaited for remaining Works.
2.2	b) Supply and fixing for Domestic Water meter	2 lacs	-	-	Approval of Tender awaited at Head Quarter level.
	Over all progress: 70%, Target date for completion: March 2017				
3	***Water Supply Component-Priority-II for Trans-Varuna Area of Varanasi City***				
3.1	Source of Water Supply				
	a) New Tube-wells (Nos)	10	10	9	W/S Increased by 16.20 mld.
	b) Rebore Tube-wells (Nos)	4	3	3	W/S Increased by 5.25 mld.
	c) Intake at river Ganga	1 (200 mld)	25%	-	15.85 m. concreting & 15.35 m sinking completed.
	d) T.W. Water Rising main	6.86 km	5.886 km	1.8 km	
	e) River Water Rising main	16.3 km	5.278 km	-	Work held up for want of permission from NHAI to lay pipes along NH-29
3.2	Sarnath Water Treatment Plant				
	a) Treatment Plant	1 (100 mld)	5%	-	
	b) Treated Water Feedermain	28.79 km	22.23 km	-	-
3.4	Sevice Reservoir				
	a) Ground level Reservoir (Nos)	30	19	4	3 no. under progress, land for 9 no. not available/disputed
	b) Over Head Tank (Nos)	26	23	6	Land for 3 OHT not yet available/disputed.
3.5	Distribution System	228.47 km	198.935 km	54.721 km	
	Over all progress: 65%, Target date for completion: March 2017				

Current progress on Nov. 2015

Source: UP Jal Nigam Varanasi

With completion of these works, Varanasi water supply system will be able to cover the demand for 2041 of the city, except for the treatment capacity (**Table 3.2.11**). This treatment capacity is for only surface water, hence the capacity gap on 2041 will be filled by ground water resource or capacity augmentation for the existing water treatment plants.

Table 3.2.11 Capacities at present and after the on-going project, against projected demand

Sl. No.	Component	2015			2021		2041	
		Present	Ongoing	Total	Demand	Gap	Demand	Gap
1	Water source (MLD)	330	200	**590**	324	Surplus	487	Surplus
2	Treatment capacity (MLD)	250*1	100*2	**350**	324	Surplus	487	137
3	Reservoir capacity (ML)	79.8	80	**159.8**	108	Surplus	162	Surplus
4	Distribution network (km)	1500	700	**2200**	1280	Surplus	1280	Surplus

*Note: *1Bhelpur WTP, *2Sarnath WTP*

Source: CDP 2015, modified by JICA Survey Team

3) Planned project

According to the Varanasi CDP report in 2015, improvement plan for Varanasi water supply sector was provided as additional components to the on-going JNNURM project (**Table 3.2.12**). Regarding this plan, it is also mentioned in the CDP that the entire project ranging from source augmentation to installation of water meters can be developed on the public-private partnership mode.

Table 3.2.12 Capital investment plan for water supply sector proposed in CDP

Project	Sub project	Estimated cost (Rs. Crores)
Water source*1	Refurbishment of intake well in Bhadaini	7
Storage reservoirs*2	Refurbishment of 80 MLD of existing OHTs	64
Distribution network	Refurbishment of 800 km of old distribution network to reduce leakages in the system	175
Metering and leak detection and installation of SCADA system	Installation of 2 lakhs domestic water meters across the city*3	90
	House connections for households already having water supply connection	40
	Installation of SCADA system to monitor the water supply losses in distribution network and source, including bulk flow meters on tube wells, intake wells, and storage reservoirs	70
Water quality assessment units	System for monitoring water quality	2
Training	Institutional level training	21
Total investment identified 2021		**469**
(Total investment required for 2041)		**(773)**

Note: Base year as 2014 and design year 2041

**1 The life of tube wells is estimated to be till 2031. Hence, new water source will have to be developed to meet the demand.*

**2 There is no gap in the provision of storage capacity. However, the existing OHT will be demand to be rehabilitated by 2021 for proper functioning.*

**3 Metering was a component of the on-going JNNURM project, however procurement of meters has not been done. So, a* *provision equivalent to the cost of meters has been made in the CDP.*

Source: CDP, 2015

Out of these proposed components, some works will be likely funded under AMRUT (Atal Mission for Rejuvenation and Urban Transformation) as listed in **Table 3.2.13**. Five hundred cities, including Varanasi and Mirzapur, will be taken up under AMRUT. VMC has already submitted SLIPs (Service Level Improvement Plans) to the Urban Development department of U.P. Govt. The SLIPs from the ULBs of the target cities was aggregated into the SAAP (State Annual Action Plan) by the U.P. Govt. The project will start from 2016.

Table 3.2.13 Proposed project components for Varanasi water supply under AMRUT

Sl. No.	Project component	Target Indicator	Baseline 2015	Annual Targets					Project Cost (Cr)
				FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
1	(a) To provide house service connection (b) To bridging the gap in existing network	Coverage network	67%	71%	76%	79%	85%	-	75 71.47
2	(a) Implementation of SCADA with MIS (b) Survey, 100% metering and Leak detection and repair	NRW	58%	-	40%	35%	30%	-	2.20 151.33
3	Development of new water sources, strengthening of water treatment plant, replacement of rising and distribution main	Per Capita	127 LPCD	-	-	132 LPCD	135 LPCD	-	169
4	Strengthening of lab and online water quality monitoring system	Water quality	96%	96.5%	97%	97.5%	98%	-	0.7
Total									**469.7**

Source: AMRUT SLIPs (Varanasi)

3.3 Surrounding Towns

3.3.1 Water Sources

The water sources are summarized as shown in **Table 3.3.1**. Except for surface water used in a part of Varanasi and Mirzapur, ground water is used through mainly tube wells in other towns and partly hand pumps.

Table 3.3.1 Water Sources for Water Supply in the Survey Area

Town	Surface water		Ground water		Total	
	Intake (MLD)	Source	Intake (MLD)	Means	Intake (MLD)	Dependence Rate on GW
Varanasi	133	Ganga River	202	T/W: 142 nos Mini T/W: 80 nos (H/P: 2,514 nos)	335	60.3%
Mirzapur	6	Tanda Reservoir (2300ML capacity)	27	T/W: 63 nos Mini T/W: 450 nos (H/P: 1,511 nos)	33	81.8%
Ramnagar	-		12	T/W: 16 nos (H/P: 160 nos)	12	100%
Chunar	-		8	T/W: 26 nos (H/P: 425 nos)	8	100%

Source: JICA Survey Team

3.3.2 Current Service Levels on Water Supply Sector

Nagar Palika Parishad for the cities as well as Varanasi Jal Kal department have a duty to submit annual service level benchmarking (SLB) score sheet to MoUD of the UP state, every fiscal year. The benchmarks prescribed by MoUD indicate the service levels to be ultimately achieved by the ULB/State Government in provision of urban civic services. Current service level status on water sector of the target cities are presented in **Table 3.3.2**.

Water metering system has not been installed or functioned in all of the target cities, therefore they have adopted flat rate tariff system to collect water charges from users; this is one of the reason for low cost recovery in the cities.

Regarding their NRW status, no assessment has been done so far on their water supply system, except for Varanasi. These NRW rates are calculated based on total volume of water billed against that of water produced although they have no water metering system as mentioned above. These status, hence, are suggested that it does not show their actual situation on NRW. As shown in the below table, 30% of NRW rate for Varanasi is quite different from 61% analysed under CBUD project (See **Figure**

3.2.6), and NRW rates of other cities are tended to be low. NRW assessment should be implemented before adding capacity to the system.

Table 3.3.2 Service level status on water supply sector of the target cities

Indicators	Service level status				MOUD Benchmark
	Varanasi	Mirzapur	Ramnagar	Chunar	
Coverage connections	69%	55%	91%	95%	100%
Per capita supply	190 LPCD	132 LPCD	163 LPCD	141 LPCD	135LPCD
Non-revenue water (NRW)	30%	17%	5%	17%	20%
Metering of connections	0%	0%	0%	0%	100%
Continuity of water supply	10 hours	6.5 hours	12 hours	11 hours	24 hours
Redressal of customer complaints	97%	98%	93%	100%	80%
Quality of water supplied	94%	99%	100%	100%	100%
Cost recovery	79%	22%	13%	9%	100%
Efficiency in collection charges	68%	75%	131%	92%	100%

Note: Status information on FY 2013-2014, See break downs in Annexure 3.1

Source: JICA Survey Team, based on SLB code sheet for the cities

3.3.3 Water Quality

A study reported high lead (Pb) pollution in water resources of Mirzapur on their assessment of heavy metals[2]. As per the study, concentration of lead was found to be much higher than WHO maximum concentration limit (10 ppb) as well as that of BIS (50 ppb) in all samples taken from ground water and surface water, even in supplied water. Against the maximum limits, the maximum concentration was 214.4 ppb in the ground water sample. Although lead may be present in source waters in Mirzapur, possible risks posed by lead in drinking water should be assessed in localities where lead has been extensively used in materials of plumbing. Likewise, cadmium (Cd) and zinc (Zn) concentration are also crossing the maximum limits for each metal in many samples.

As for arsenic (As) pollution in ground water in the Middle Gangetic Plain, tube wells in Holocene Newer Alluvium entrenched channels and floodplains have arsenic-contaminated ground water. How-

2 Krishna et al, "Assessment of Heavy Metals in the Water Resources of Mirzapur, U.P., India", nternational Journal for Scientific Research & Development, 3 (2015) 1230-1233

ever, the major town area of Varanasi, Chunar and Mirzapur are located on Older Alluvium upland surfaces which has arsenic-safe groundwater.[3]

3.3.4 On-going and Planned project

Mirzapur, Ramnagar and Chunar have no on-going project on their water supply sector at present. Meanwhile, augmentation/rehabilitation plans for Mirzapur water supply system have been proposed under AMRUT. Nagar Palika Parishad Mirzapur will plan to shift ground source to surface water source from the river Ganga. In order to do that, new intake structure & WTP replacing of old and damage pipeline of distribution network and additional storage capacity will be needed in the future. Construction of new WTP has been not proposed yet under this AMRUT project.

Table 3.3.3 Proposed project components for Mirzapur water supply under AMRUT

Sl. No.	Project component	Project Cost (Cr)	Share (Cr)	
			GoI	State, ULB
1	To Provide house service connection	3.89	1.945	1.945
2	Construction of intake structure at Ganga River	27	13.5	13.5
3	Extension of distribution (254km old line + 36km newly area)	87	43.75	43.75
4	Construction of OHT and reconstruction of existing OHT	2.8	1.4	1.4
5	(a) Establishment of water treatment plant (b) Implementation of online water testing & monitoring systems and water testing vans	5.9	2.95	2.95
6	(a) Solar energy for continuous electricity supply (b) Replacement of inefficient pumps and re-bore tube wells	4.93	2.465	2.465
7	(a) Metering system in water supply system (b) Online billing, tracking system & spot billing machine	7.66	3.83	3.83
Total		**139.18**	69.59	69.59

Source: AMRUT SLIP (Mirzapur)

[3] Babar Ali Shah, "Arsenic-contaminated groundwater in Holocene sediments from parts of Middle Ganga Plain, Uttar Pradesh, India", Current Science, 105 (2010) 1359-1365

CHAPTER 4 Current Status of Storm Water Drainage System

<Objectives of the Survey>

General Drainage Condition in Varanasi City, Mirzapur, Chunar, Ramnagar, Saidpur and Ghazipur was confirmed by references and field surveys for confirmation of current status.

<Result of the survey>

Maintenance has not been done for the drainages and status of flow was poor with a lot of solid wastes and garbage inside the drainages. Water quality observed in the drainages was almost raw sewage since sewerages has not been constructed except for a part of VNN and Mirzapur. Since NMCG is going to apply Interception and Diversion with Treatment (ID/T) in light of prompt construction of sewerages and lower construction cost for municipalities with population below 1 lakh, and the system does not include construction of sewer network, the drainages will be left as existing in this case and sewage will flow down in the open channels up to diversion point to flow into interceptors.

<Analysis of the Result>

Keeping sanitary condition and removal of wastes along the open channels must be carefully taken care of even after the construction of ID/T to avoid clogging of the interceptors.

4.1 General Drainage Condition

4.1.1 General Drainage Condition in Varanasi City

The Assi Nala and the river Varuna are the two tributaries of river Ganga and also aid in the natural drainage of the city. Wastewater generated in unsewered area or wastewater from most of the branch sewers is discharged into open drains. Major drains discharging directly into river Ganga are Varuna and Assi Nala.

The Assi Nala acts as a major outlet for the city’s storm water and wastewater. The drains and nalas of the city are prone to chocking owing to the unregulated solid waste dumping by the citizens. This leads to stagnant puddles of water, which leads to health hazards, unhygienic conditions and acts as breeding grounds for mosquitoes. The existing drain network cannot be used for water harvesting owing to the heavy siltation, flow of grey water and accumulation of solid waste in the drains.

Inundation in the monsoons is one of the major issues in the city. The areas prone to frequent inundation are the Chaukaghat Water Tank, Gurabagh, the Jal Kal area, Vikas Pradhikaran Colony, Shivpur, the Nakkigthat area, Mahmoorganj, Ravindrapuri colony, Central Jail Compound area, Dingia Mohall area, Shivpurwa, Nawab Ganj, Bada Lalpur area, GT Road area, Nirala Nagar, Karaudi area, Chuppepur colony, Slaughter House area, Jaiprakash Nagar, Bazerdiha area, Khushall Nagar, Ka-

malagarha, Manduadih area, Brijenclave colony area, Paigamberpur, Salarpur, etc.
To solve the problem of inundation, pumps were installed to pull water from streets on a temporary basis. The list of pumping stations is as below:

- Deo Pokhari
- Jakha
- Moti Jheel
- Parch Perwa
- Sigra
- Manduadih
- Sivdaspur

4.1.2 General Drainage Condition in Mirzapur City

In general, the City is well drained with relatively high coverage of storm water drainage network as shown in **Table 4.1.1**. However, there are local pockets of inundation especially in areas where the tractive force of the drains has been reduced either due to encroachment or blockage. Such floodings have been observed in Tarka pur, Kajrahwaha Pokhra and Ghurahu Patti almost every year during rains. In the newly developed areas, while the developer is responsible for the provision of internal surface water drainage, the linking of these drains to the larger local drains and nalas is neglected, causing inundation at some places.

Table 4.1.1 Storm Water Drainage Indicators in Mirzapur City

Coverage of storm water drainage network (%)	Incidence of flooding
74%	583

Source: Mirzapur City Program Implementation Plan under National Urban Health Mission prepared by District Health Officials

4.1.3 General Drainage Condition in Ghazipur City

The topographical configuration of Ghazipur City is almost flat and slightly sloping towards River Ganga. From the route survey in this project the ground level (GL) at nearest road to River Ganga is around T.P. 69m and the highest point near railway in the target area is around T.P 73m. Due to this ground condition the existing rivers and drains flow to River Ganga almost in parallel and some stagnations of wastewater in the drains can be found in the city area.

4.2 Existing Drainage System

4.2.1 Existing Drainage System in Varanasi City

Major drains (nalas) in Varanasi City are Varuna, Assi Nala, Nakhi drain, Nagwa drain etc. Flow measured in the year 2001 indicates that drain Varuna receives approximately 110 MLD and Assi Nala receives approximately 44.5 MLD of wastewater generated in the City. There are more than 15 nalas discharging sewage into river Ganga including Assi Nala and Varuna River. There are around 14 nalas discharging sewage into river Varuna River.

List of major drains discharging into river Ganga and Varuna mentioned in JICA Master Plan are given in **Table 4.2.1** and the locations of drains are shown in **Figure 4.2.1**. The more detailed list of existing drains is tabulated in **Table 4.2.4**. In Varanasi at many places, domestic sewer lines have been connected to open drains and carry significant sewage flows during dry weather. These drains are also significant sources of pollution during wet weather when cow dung and human waste that accumulates during the dry season are flushed away by runoff.

Flow measurement of these drains was done in 2000 by UPJN. The total wastewater flow was measured as 240 MLD in 26 nalas, out of which 12 nalas were found to carry 180 MLD of wastewater to Ganga River, while 14 nalas carry 60 MLD of wastewater to Varuna River. Under GAP I, pump stations were implemented to divert 102 MLD of sewage to Dinapur, Bhagwanpur and DLW STPs.

Table 4.2.1 List of Drains in Varanasi City (as per JICA Master Plan)

Location	SL. No	Name Of Drains	Year 2015	Year 2030	Remark
Ganga River	1	Nakkhi Drain			Almost Dry
	2	Samne Ghat Drain			Almost Dry
	3	Assi Nala	56.31	53.44	
	4	Shiwala Drain	4.8	4.06	Intercepted and diverted to the city's sewer
	5	Harishchandra Ghat Drain	2.18	1.85	Near Harishchandra Ghat SPS, Itercepted and diverted to the city's sewern
	6	Mansarovar Drain	2.18	1.85	Near Mansarovar Ghat SPS, Intercepted and diverted to the city's sewer
	7	Dr. R. P. Ghat Nala (Ghora Nala)	21.81	18.47	Near Dr.R.P. Gaht SPS, Intercepted and diverted to the city's sewer
	8	Jalesan Drain	3.27	2.77	Near Jalesan Ghar SPS, Intercepted and diverted to the city's sewer
	9	Sankatha Ghat	0.26	0.22	Intercepted and diverted to the city's sewer
	10	Trilochan Ghat Drain	3.05	2.58	Intercepted and diverted to the city's sewer
	11	Telia Nala	2.62	2.22	Near Trilochan Ghat SPS, Intercepted and diverted to the city's sewer
	12	Bhainsasur Nala	0.35	0.3	
	13	Rajghat Railway Nala	0.03	0.02	
	14	Rajghat Outfall			500m d/s of Malviya bridge Intercepted and diverted to the city's sewer
		sub total	**96.86**	**87.78**	
Varuna River (Right Bank)	1	Phulwaria Nala	12.46	16.03	Open channel
	2	Sadar Bazar Nala	3.28	4.22	Open channel
	3	Drain Of Hotels	0.34	0.43	Open channel
	4	Raja Bazar Nala	0.16	0.21	Open channel
	5	Teliabagh Nala	29.51	37.95	Open channel
	6	Nala Near Nakhi Ghat	0.11	0.11	Open channel
Varuna River (Left Bank)	7	Central Jail Nala	10.66	13.71	
	8	Orderly Bazar Nala	11.48	14.76	
	9	Chamrautia Nala	4.92	6.33	
	10	Nala Of Khajurl Colony	2.46	3.16	
	11	Banaras Nala No.5	1.64	2.11	
	12	Hukulgang Nala	4.1	5.27	
	13	Nala Of Nai Basti	4.92	6.33	
	14	Narokhar Nala	12.3	15.82	
		sub total	**98.34**	**126.44**	
	Total		**195.2**	**214.22**	

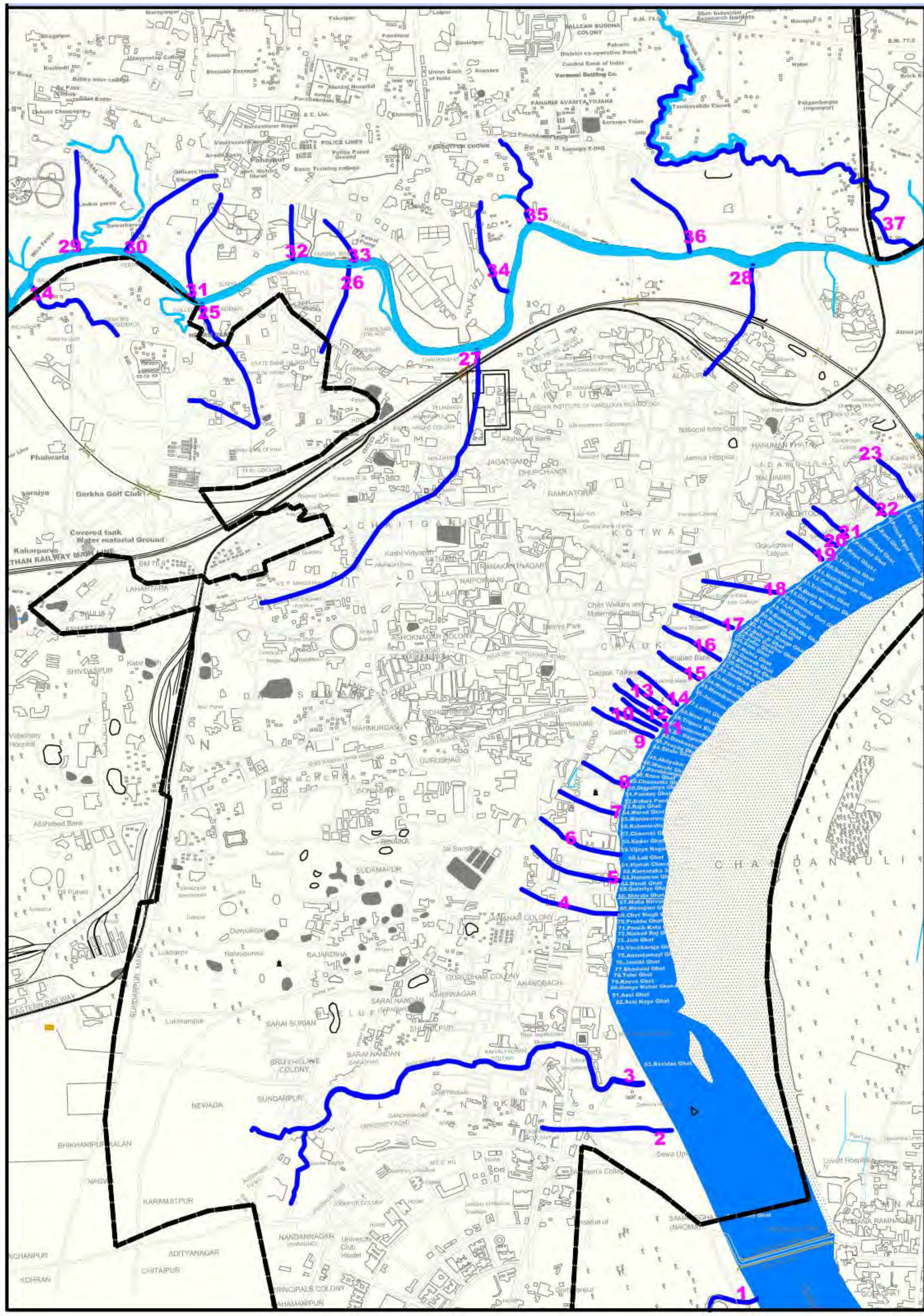
Source: The Study on Water Quality Management Plan for Ganges River in the India, Final Report, Vol.3, JICA City Development Plan for Varanasi

Table 4.2.2 List of Existing Drains in Varanasi City

Sr. No.	Description	Specification Dia(m)	Nature of Drainage	Year laid
A Bhelupur & Dashashwamedh Zone				
1	Main drainage from Sarai Nandan market to Assi Nala via Kabir Nagar	1800x1.50x1.80	Channel covered with RCC slab	1986
A	Road side drain connected with main drain from Sudamapur, Bezerdiha, Duhiapond to Sarai Nandan market via Kirihiya.	1800x0.60x1.20	Channel with RCC slab	1989
B	Teliyana to Sarai Nandan	1100x0.45x0.75	Channel with RCC slab	2000
2	Main drainage from SheelNagar Colony to Assi Nala atthe point of SunderpurTihara viaManduadih railway station DLW road	2100	RC pipe with dia 1200mm	2002
A	Road side drain connectedwith main drain fromBazerdiha police chowki toDLW road via Deo Pokhariand Lakharaon.	1200	RC pipe with dia. 600mm dia.	2002
3	Main drain from Chetmani to Assi Nala via Ravindrapuri colony.	600	RC pipe with dia. 600mm dia.	2002
		300	RC pipe with dia. 900mm dia.	2002
4	Road side drain connected with railway main drain from Nirala Nagar to railway colony via lane no. 6	800	RC pipe with dia. 300mm dia.	2000
5	Road side drain connected with railway main drain from Chhittupur Tiraha to railway drain via Ghantimill road.	400x0.45x0.45	Open channel	1998
6	Main drain from Hotel Padmini Mahmoorganj to Chaukaghat Vruna river via Shastri Nagar, Sigra Thana	2300x2x(0.9+3.0)/2	Channel with cover slab	1986
A	Road side drain connected with main drain from Lallapura muslim school to Sigra Thana	1000x0.30x(0.60+1.8)/2	Channel with cover slab	1998
B	Road side drain connected with main drain from Chittupur Telephone colony to Sigra Thana	350x0.60x (0.90+1.80)/2	Channel with cover slab	1989
C	Road side drain connected with main drain from Bhadshahbagh colony to Fathaman road	150x0.60x(0.60+0.75)/2	Channel with cover slab	1998
B Adampur Zone				
1	Road side drain from Saraiya Nala police chawki to Varuna River	300x (0.60+(0.9)/2x1.5	Open channel	1997
		350	Kachcha drain	-
2	Road side drain from Kamali Baba Mazar near Chaukaghat water tank to Nakki ghat turning.	300x0.60x1.2	Open channel	1980
3	Storm water drainage connected with Bakari-ya Kund from Doshipura ground	140x1.2x1.2	'U' shape openDrain	1982
4	Drainage from Kali Mandir temple to Dhel-waria crossing the G.T. road Chaukaghat	200x1.5x (1.2+1.5)/2	Open Drain	1982
5	Drainage from Kazishahdullapura tube-well to Varuna River via Chaukaghat water tank	950x0.60x1.0	'U' shape pucca	1990
		650	RC pipe with dia. 600mm dia.	1990

Sr. No.	Description	Specification Dia(m)	Nature of Drainage	Year laid
6	Drainage from Chhohara Chhamuhani to Kamal Garha Slaughter House and from GT road to Vaurna River via Shakkar talab pullia	250x0.90x(0.90+1.5)/2	Channel with covered slabs	1972
		320x(1.8+2.75)/2 x2.5	Channel with covered slabs	1972
		600x2.5	Covered slab	-
		400x1.2(1.2+1.5)/2	Kachcha drain	-
		518x1.2x1.5	Kachcha drain	-
7	Drainage from Jalalipura railway line to Shakkar talab pullia	400x0.60x1.0	'U' shape pucca	1987
C Trans Varuna Zone				
1	Road side drainage from Shivpur Safai chauki to Varuna River via Central Jail Road, Si-kaural Village and Bheem Nagar.	135x0.60x0.90	Deep drain	1990
		255x0.65x1.00	Deep drain	1990
		570x1.00x1.20	Deep drain	1990
2	Road side drain from Shivpur Lal Kuan to Shivpur Safai Chauki	300x0.45x0.45	Deep drain	1990
	Road side drainage from Natiniadai (Khusha-hal Nagar) to Varuna River via Bhojuveer Crossing	650x0.45x0.45	Deep drain	1998
		900	RC pipe with dia. 600mm	1998
		1100 x 0.90 (0.60+1.20)/2	Open drain	1998
3	Road side drainage from Tulsi Vihar Colony to Varuna River via Laxmanpur, Uchawan Lodge colony, Gilat Bazar and Sadar Tehsil	1500	RC pipe with dia. 450mm	1997
4	Drainage from Mental Hospital Pullia to Maqbool Alam Road petrol pump near pullia via Police line	400	RC pipe with dia. 1600mm	1998
		800	RC pipe with dia. 1400mm	1998
5	Drainage from Kharbuja Sayeed Marge to Railway pullia through behind Dainik Jagaran press	600	RC pipe with dia. 600mm	2006
6	Drainage from Sanskrit University Main Gate to Chaukaghat Nala	300	RC pipe with dia. 900mm	2000
		600	RC pipe with dia. 600mm	2001
7	Drainage near from Chandra Chauraha to Narokhar Nala through main road.	600	RC pipe with dia. 900mm	2003
		600	RC pipe with dia. 600mm	2004
8	Road side drain from Yadav Basti (Ghazipur Road) to Narokhar Nala (Pucca drainage till Income-tax colony)	800	RC pipe with dia. 600mm	2004
9	Road side drainage from Pandeypur Crossing near Sudhakar Mahila Mahavidyalaya to Baghawa Nala via Panchkoshi Road	800x1.20x2.1	Open channel	1986

Source: City Development Plan for Varanasi



DETAILS OF EXISTING NALA OF VARANASI

Drain No.	Drains Joining Ganga	Drain No.	Drains Joining Varuna	Right/Left Bank
1	Nakkha Nala	24	Phulwaria Nala	Right Bank
2	Samne Ghat Nala	25	Sadar Bazar Nala	Right Bank
3	Asi Ghat /Nagwa Nala	26	Raja Bazar Nala	Right Bank
4	Shivala Ghat Nala	27	Telia Nala	Right Bank
5	Harish Chandra Ghat Nala	28	Saraiya / Nakki Ghat Nala	Right Bank
6	Man Sarowar Ghat Nala	29	Central Jail Nala	Left Bank
7	Man Mandir Ghat Nala	30	Chamrautha Nala	Left Bank
8	Pandey Ghat Nala	31	Banaras Nala	Left Bank
9	R.P. Ghat Nala	32	Arderly Bazar Nala	Left Bank
10	Mir Ghat Nala	33	Khajuri Colony Nala	Left Bank
11	Lalita Ghat Nala	34	Hukulganj Nala	Left Bank
12	Manikarnika Ghat Nala	35	Nai Basti Nala	Left Bank
13	Jalesan Ghat Nala	36	Sarang Talab Nala	Left Bank
14	Sankatha Ghat Nala	37	Narokhar Nala	Left Bank
15	Mehta Ghat Nala			
16	Ram Ghat Nala			
17	Panch Ganga Ghat Nala			
18	Brahma Ghat Nala			
19	Lal Ghat Nala			
20	Trilochan Ghat Nala			
21	Telia Ghat Nala			
22	Bhainsasur Ghat Nala			
23	Raj Ghat Nala			

Source: GAP-II Project Team

Figure 4.2.1 Drains in Varanasi City

Varanasi has poor storm water drainage system. Storm water is drained off through a very old and incomplete underground and kachcha open drainage system. The underground drainage network is only 117 km long and kachcha open drainage system (in other words "pucca drains") is 189 km long. Most of the drains have been connected to branch sewers, which leads to the mixing of sewage with storm water. This increases the load on the sewage pumps and the STPs, especially during the monsoons. Apart from this, some storm water drains also flow out directly into river Ganga and river Varuna. Open drains are unlined and pollute the ground water owing to the porous nature of alluvium. These drains carry the grey water discharged from the settlements along their path and is also used as disposal site for solid waste.

Most of the old drains are named after the Ghats where they discharge like Ghora Ghat drain, Trilochan Ghat drain, Mansarovar Ghat drain, Harischandra Ghat drain, Shivala Ghat drain, Brahma Ghat drain, Jawala Sen Ghat drain, Mani Karnika Ghat drain, Rajghat drain, Ganesh Ghat drain, Naradghat drain, Telia Nala drain. These drains are known as Nawabi drains. Apart from these, Assi Nala and Nakhi drain are two major drains discharging into river Ganga.

4.2.2 Existing Drainage System in Ramnagar City

In Ram Nagar City which belongs to Varanasi District, there are a lot of problems of inundation during the rainy seasons because the coverage of storm water drainage network is limited to approximately 50% (primarily kutcha) of the city. There is no proper drainage or sewerage network in the city, but Nagar Palika Parishad made temporary small structures of drains to collect storm water. There are five such existing drains carrying waste water in the city to the River Ganga. The names of drains are listed as follows and the locations of drains are shown in **Figure 4.2.2**.

Table 4.2.3 List of Existing Drains in Ramnagar City with Discharges

Sl. No.	Drain Name	Flow (MLD)		
		Minimum Discharge	Peak Discharge	Average Discharge
1	Ram Bagh Nala	0.75	17.58	7.95
2	Shakti Ghat Nala	0.07	0.75	0.33
3	Salotri Ghat Nala	0.01	0.22	0.05
4	Balua Ghat Nala	0.07	0.9	0.38
5	Hanuman Ghat Nala	0.02	0.61	0.08
	Total	0.91	20.07	8.79

Source: DPR Ramnagar I&D

Note: Flow measurement date: 15/05/2015 to 18/05/2015

List of Nala	
Sr. No.	Description
1	Balua Ghat Nala
2	Salotri Nala
3	Shakti Ghat Nala
4	Ram Bagh Nala
5	Hanuman Ghat Nala

LEGEND:-

Road

Nala

0 500 1000m

Project Name

PREPARATORY SURVEY ON GANGA REJUVENATION PROJECT IN THE STATE OF UTTAR PRADESH, INDIA

インド国ガンジス川浄化事業準備調査

Drawing Title

EXISTING DRAINS IN RAMNAGAR CITY

Scale: 1:10,000

Drawing No. SEW-xx

Source: JICA Survey Team based on Route Survey and DPR Ramnagar

Figure 4.2.2 Drains in Ramnagar City

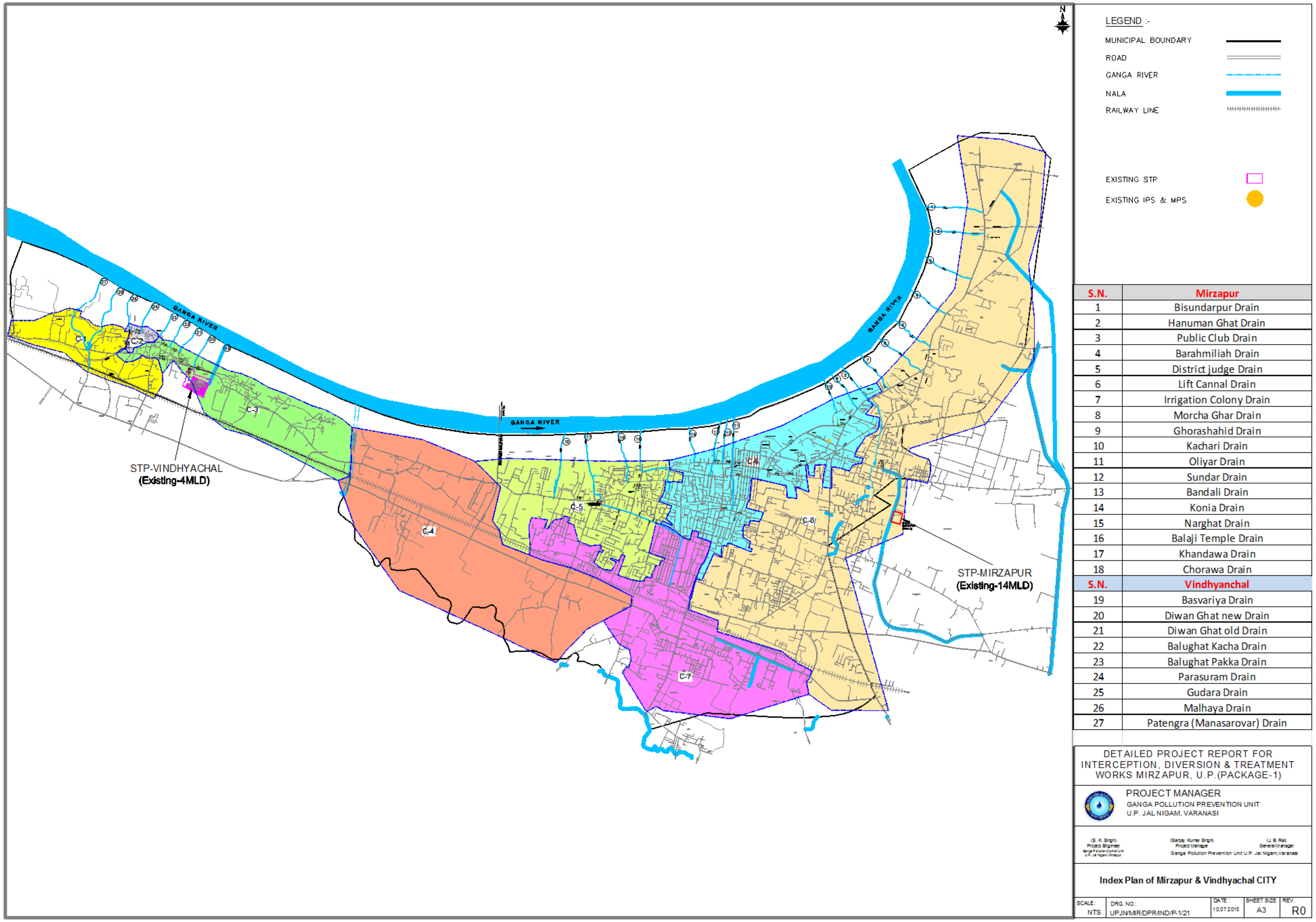
4.2.3 Existing Drainage System in Mirzapur City

Mirzapur City is generating around 27 MLD municipal sewage at present. There are 27 drains (nalas) falling into river Ganga in Mirzapur out of which 18 nalas are in Mirzapur sewerage district and 9 nalas are in Vindhyachal sewerage district as shown in Table 4.2.4 and Figure 4.2.3. Six drains in Mirzapur Zone and four drains in Vindhyachal Zone are already intercepted under GAP I and remaining are proposed to be tapped and diverted via proposed sewer/ pumping station to STP for treatment, under present DPR.

Table 4.2.4 List of Existing Drains in Mirzapur City with Discharges and Intercepted Flow

Drain No	Name of Drain	Drain Discharge in MLD			Intercepted Flow in MLD at Present		
		Minimum	Average	Peak	Minimum	Average	Peak
(A)	**Mirzapur Zone**						
1	Bisundarpur Drain	0.97	1.58	2.18			
2	Hanumanghat Drain	0.42	0.68	0.94			
3	Public club Drain	0.37	0.60	0.83			
4	Barahmiliah Drain	0.24	0.39	0.54			
5	District judge Drain	0.25	0.40	0.55			
6	Lift cannal Drain	0.25	0.40	0.55			
7	Irrigation colony Drain	0.02	0.03	0.05			
8	Morcha Ghar Drain	1.01	1.64	2.26			
9	Ggoreshahid Drain	4.68	7.60	10.49			
10	Kachari Drain	0.74	1.20	1.66	0.74	1.20	1.66
11	Oliyar Drain	0.19	0.31	0.43	0.19	0.31	0.43
12	Sundar Drain	0.15	0.24	0.33	0.15	0.24	0.33
13	Bandali Drain	0.24	0.39	0.53	0.24	0.39	0.53
14	Konia Drain	0.01	0.02	0.02			
15	Narghat Drain	0.48	0.78	1.08	0.48	0.78	1.08
16	Balaji Temple Drain	1.36	2.20	3.04			
17	Khandawa Drain	2.59	4.20	5.80	2.59	4.20	5.80
18	Chorawa Drain	0.16	0.25	0.35			
	Sub-total	**14.13**	**22.91**	**31.63**	**4.39**	**7.12**	**9.83**
(B)	**Vindhyachal Zone**						
19	Basvariya Drain	0.70	1.13	1.56			
20	Diwan Ghat new Drain	0.01	0.02	0.03			
21	Diwan Ghat old Drain	0.06	0.10	0.14	0.06	0.10	0.14
22	Balughat Kacha Drain	0.01	0.01	0.02			
23	Balughat Pakka Drain	0.10	0.17	0.23	0.10	0.17	0.23
24	Parasuram Drain	0.86	1.39	1.92	0.86	1.39	1.92
25	Gudara Drain	0.12	0.20	0.28	0.12	0.20	0.28
26	Malhaya Drain	0.17	0.27	0.37			
27	Patengra (manasarovar) Drain	0.46	0.74	1.02			
	Sub-total	**2.49**	**4.03**	**5.57**	**1.14**	**1.86**	**2.57**
	Total	**16.62**	**26.94**	**37.20**	**5.53**	**8.98**	**12.40**

Source: DPR Mirzapur arranged by JICA Survey Team



S.N.	Mirzapur
1	Bisundarpur Drain
2	Hanuman Ghat Drain
3	Public Club Drain
4	Barahmiliah Drain
5	District judge Drain
6	Lift Cannal Drain
7	Irrigation Colony Drain
8	Morcha Ghar Drain
9	Ghorashahid Drain
10	Kachari Drain
11	Oliyar Drain
12	Sundar Drain
13	Bandali Drain
14	Konia Drain
15	Narghat Drain
16	Balaji Temple Drain
17	Khandawa Drain
18	Chorawa Drain
S.N.	**Vindhyanchal**
19	Basvariya Drain
20	Diwan Ghat new Drain
21	Diwan Ghat old Drain
22	Balughat Kacha Drain
23	Balughat Pakka Drain
24	Parasuram Drain
25	Gudara Drain
26	Malhaya Drain
27	Patengra (Manasarovar) Drain

Source: DPR Mirzapur I&D revised by JICA Survey Team

Figure 4.2.3 Drains in Mirzapur City

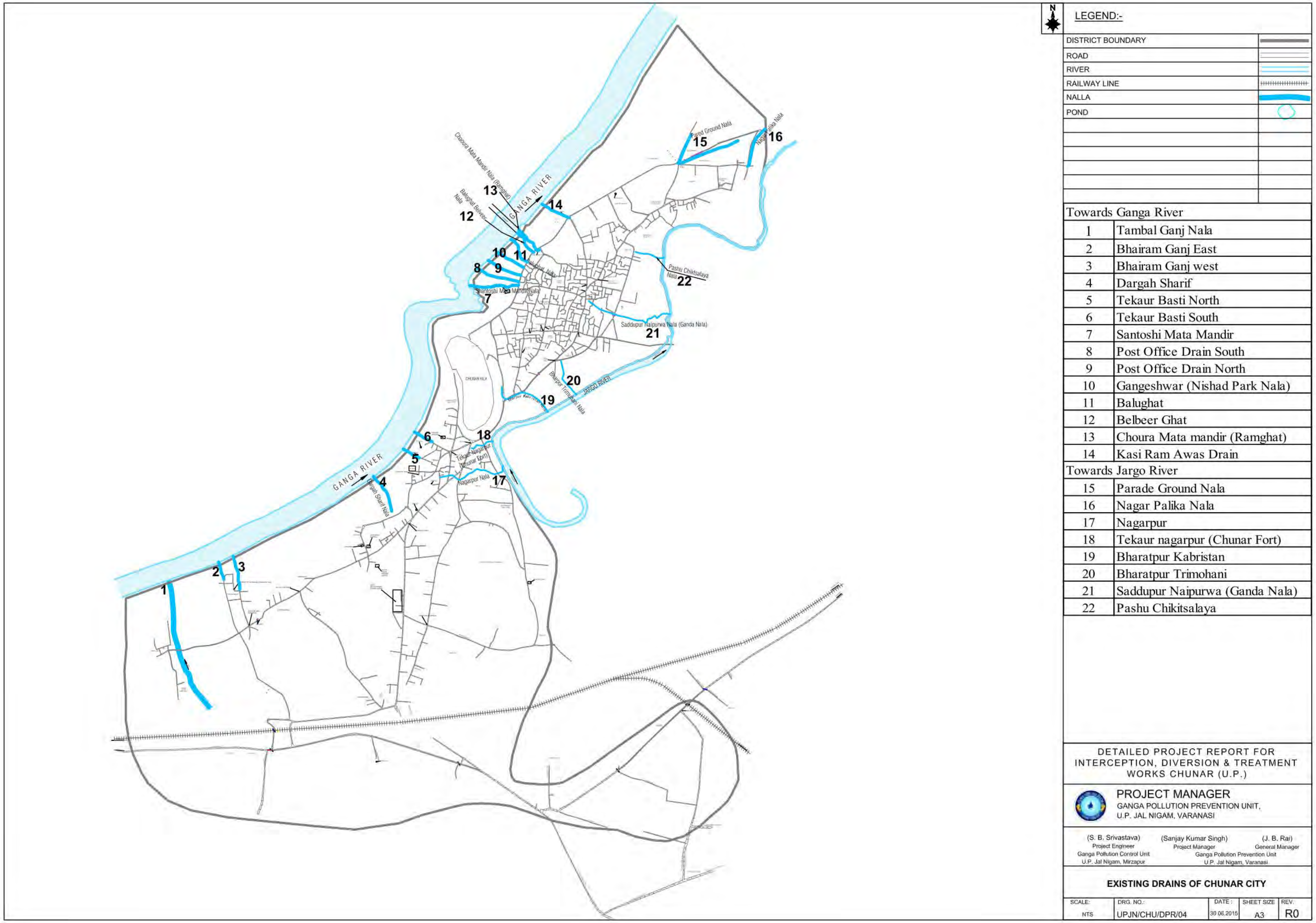
4.2.4 Existing Drainage System in Chunar City

At present Chunar City in Mirzapur District is completely unsewered town. Municipal wastewater generated in city is flowing directly in to River Ganga and River Jagro through 22 Major nalas. Out of which 14 nalas are flowing into River Ganga and 8 are flowing into river Jagro. River Jagro is meeting Ganga after travelling 16 km which is almost dry when it meets Ganga.

Table 4.2.5 List of Existing Drains in Chunar City with Discharges

Drain No	Name of Nala	Nala Discharge 2015			Remarks
		Minimum	Peak	Avg	
1	Tambal Ganj Nala	0.368	0.827	0.597	Discharging into river Ganga
2	Bhairam Ganj East	0.049	0.110	0.079	-------- do ---------
3	Bhairam Ganj West	0.041	0.093	0.067	-------- do ---------
4	Dargah Sharif	0.233	0.523	0.378	-------- do ---------
5	Tekaur Basti North	0.060	0.135	0.098	-------- do ---------
6	Tekaur Basti South	0.056	0.127	0.091	-------- do ---------
7	Santoshi Mata Mandir	0.034	0.076	0.055	-------- do ---------
8	Post Office Drain South	0.195	0.439	0.317	-------- do ---------
9	Post Office Drain North	0.180	0.405	0.293	-------- do ---------
10	Gangeshwar (Nishad Park Nala)	0.104	0.259	0.181	-------- do ---------
11	Balughat	0.045	0.113	0.079	-------- do ---------
12	Belbeer Ghat	0.023	0.056	0.039	-------- do ---------
13	Choura Mata Mandir (Ramghat)	0.068	0.169	0.118	-------- do ---------
14	Kasi Ram Awas Drain	0.064	0.159	0.112	-------- do ---------
15	Parade Ground Nala	0.101	0.228	0.165	Discharging into river Jargo
16	Nagar Palika Nala	0.056	0.127	0.091	-------- do ---------
17	Nagarpur	0.064	0.143	0.104	-------- do ---------
18	Tekaur nagarpur (Chunar Fort)	0.068	0.152	0.110	-------- do ---------
19	Bharatpur Kabristan	0.094	0.211	0.152	-------- do ---------
20	Bharatpur Trimohani	0.062	0.140	0.101	-------- do ---------
21	Saddupur Naipurwa (Ganda Nala)	0.578	1.299	0.938	-------- do ---------
22	Pashu Chikitsalaya	0.056	0.127	0.091	-------- do ---------
	Total Discharge in MLD	**2.60**	**5.92**	**4.26**	

Source: DPR Chunar I&D Volume-I Main Report



Source: DPR Chunar I&D Volume-I Main Report revised by JICA Survey Team

Figure 4.2.4 Drains in Chunar City

4.2.5 Existing Drainage System in Ghazipur City

The topographical configuration of Ghazipur City is almost flat and slightly sloping towards River Ganga. There are 16 drains in the city which carry storm water to River Ganga. Out of 16 drains, the names of 7 drains were confirmed from UPJN interview as listed in Table 4.2.6 and the locations of 12 drains based on route survey are shown in Source: DPR Ghazipur, UPJN

Figure 4.2.5 with additional names set by JICA Survey Team for 5 drains from nearby landmarks.

The existing drains are not in good condition but anyhow working. Due to the insufficient slope of the drains, stagnation of wastewater was found in the city and many backyard ponds with inflow of wastewater were found in the city.

Table 4.2.6 List of Existing Main Drains in Ghazipur City

No.	Name of Drain
1	Navapurva Ghat Nala
2	Masool Ghat Nala
3	DM Residence Nala
4	Collector Ghat Nala
5	Gola Ghat Nala
6	Shamshaan Ghat Nala
7	Cheetnath Ghat Nala

Source: DPR Ghazipur Comprehensive (2015)

4.2.6 Existing Drainage System in Saidpur City

In Saidpur City which belongs to Ghazipur District, the disposal of effluent and wastewater is discharged to the natural drainage existing in the city through drains. The wastewater ultimately finds its way into the open fields and larger drains. In some locations such as centre of the city around the Nagal Nigam Office and the nearby areas to Ganges River, some underground drainage facilities with manholes and box culverts/pipes which cross the roads/public spaces can be found. Such structures were constructed around 15 years ago by Saidpur Nagal Nigam.

There are 10 drains (nalas) in total in Saidpur City and 8 drains flow into Ganges River after meeting of drains according to interview to UPJN. The names of nalas are listed in **Table 4.2.7** and the locations are shown in **Figure 4.2.6**. According to interview to neighbours in the area near Drain No.6, there has been no flooding from Ganges River for at least several years. However, in the upstream of Drain No.7 as the biggest drain in the city the choking of drain in the road bridge was observed and it may have been causing the flooding.

Table 4.2.7 List of Existing Drains in Saidpur City

No.	Name of Nala
1	Code Ghat Nala / Samshan Ghat Nala
2	Budhe Mahadev Ghat Nala
3	Pakka Ghat Nala
4	Sangat Ghat Nala
5	Mahabir Ghat Nala
6	Malahiya Nala
7	Rang Mahall Ghat Nala
8	Jaohar Ganj Nala/Koluha Ghat Nala

Source: UPJN

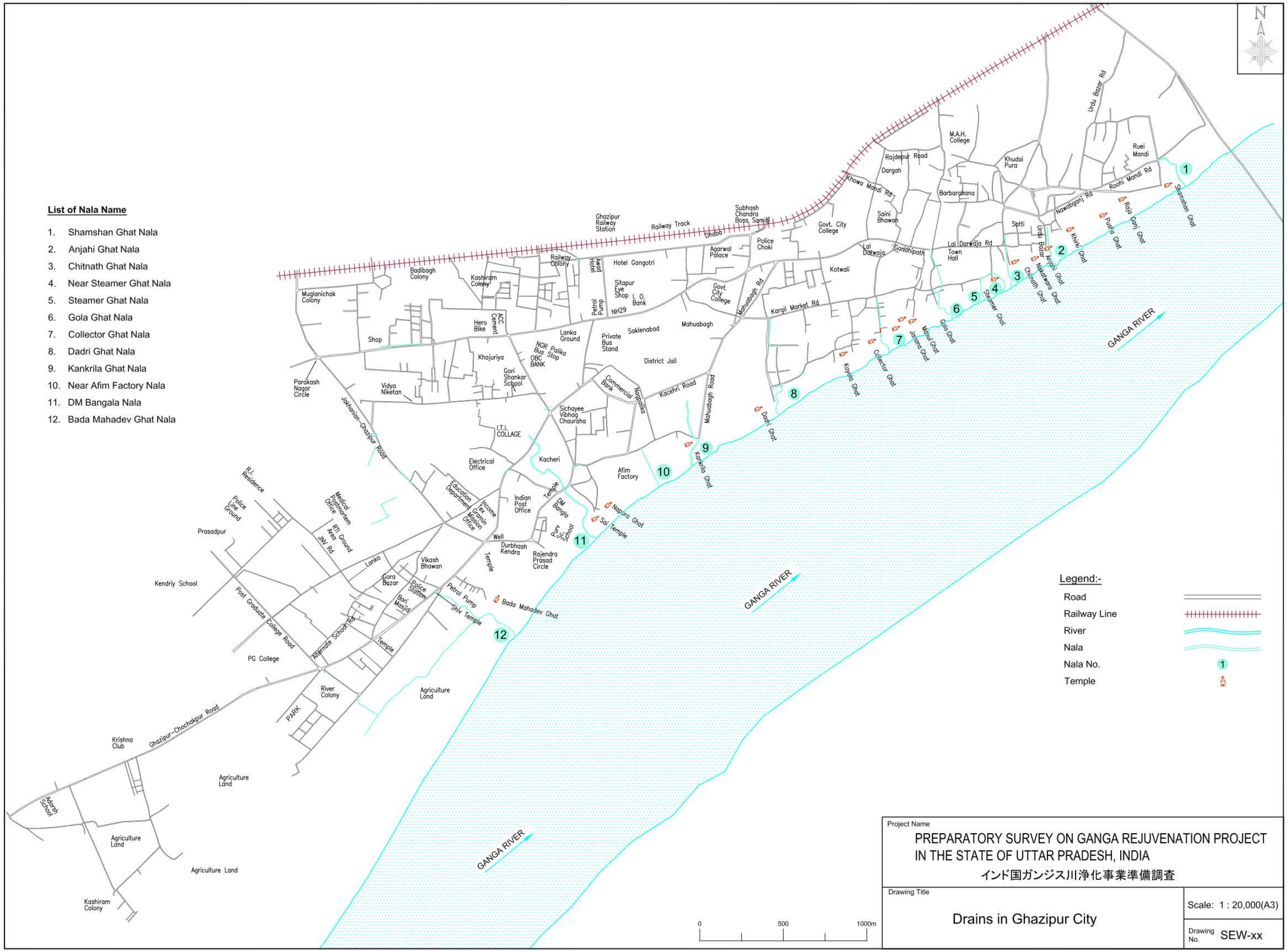
According to “Estimate for Interception – Diversion of Nala at Saidpur Town District : Ghazipur under Ganga Action Plan – Phase II” prepared by UPJN in 1997, there are four main nalas flowing through the town, carrying wastewater and discharging into the river Ganga, creating serious pollution. The main nalas of the town are given as below which are in order from upstream to downstream side of the town. The average daily discharge measured in May and June, 1993 and BOD of nalas were examined by Dept. of Civil Engineering, Motilal Nehru Regional Engineering College, Allahabad.

Table 4.2.8 List of Existing Main Drains in Saidpur City with Discharges and BOD

No.	Name of Nala	Average Discharge (MLD)	BOD (mg/L)
1	Ram Ghat Nala	0.040	164
2	Sangat Nala	0.057	204
3	Mahabir Nala	0.003	120
4	Pakka Ghat Nala	0.382	246
			Average: 183.5

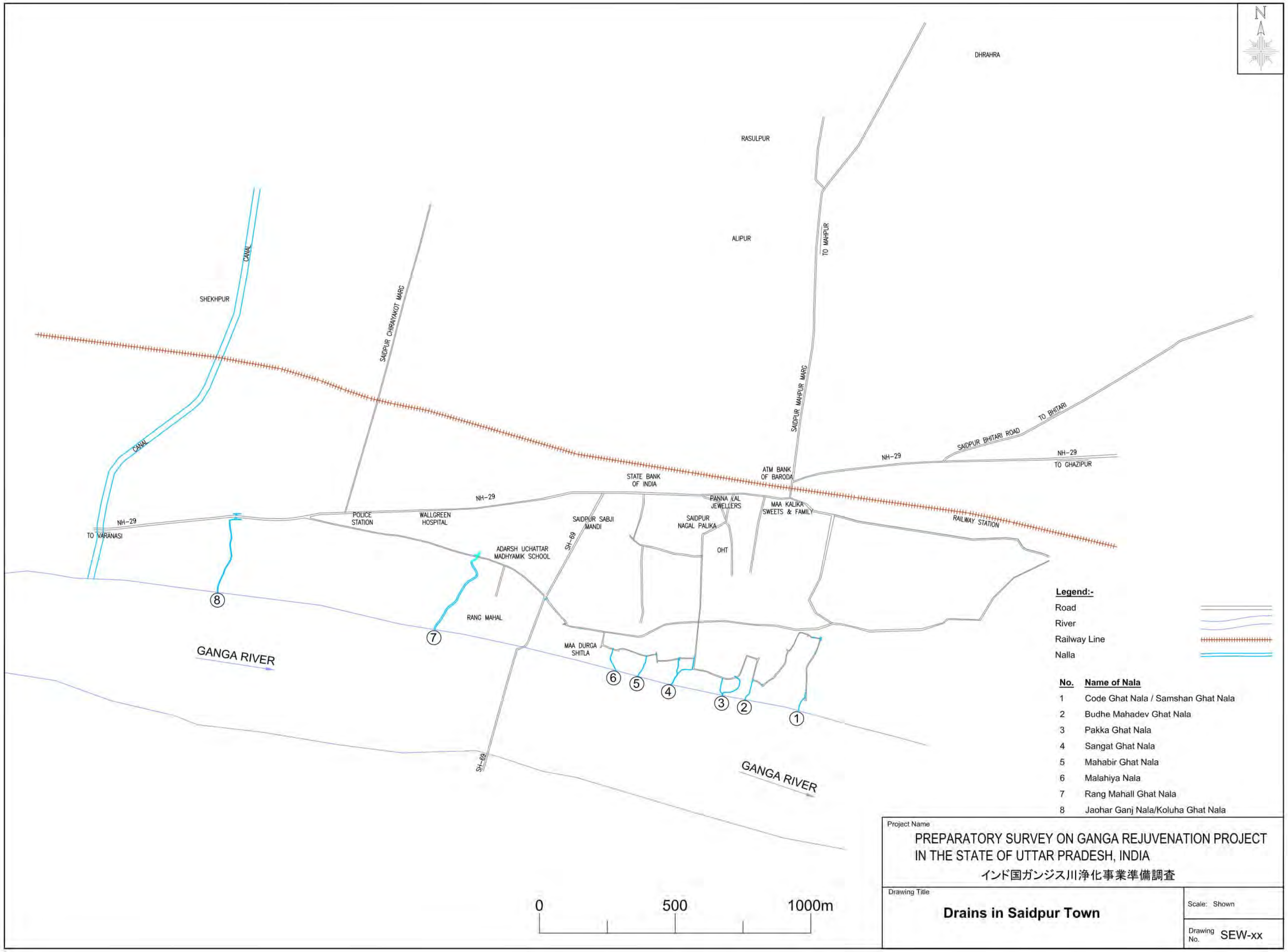
Note: Flow and BOD measurement: May and June, 1993

Source: DPR Saidpur I&D (1997)



Source: DPR Ghazipur, UPJN

Figure 4.2.5 Drains in Ghazipur City



Source: JICA Survey Team based on Interview to UPJN and Route Survey

Figure 4.2.6 Drains in Saidpur City

4.3 Drainage Maintenance System

4.3.1 Maintenance of Drainage in Varanasi City

Roles and responsibilities on storm water drainage and sewerage works in Varanasi City are shown in Table 8.2. The Health Department of VMC is involved in cleaning the drains.

Table 4.3.1 Roles and Responsibilities on Drainage and Sewerage Works in Varanasi City

Stage	Planning and design	Construction/ Implementation	O&M
Responsible Agency	UP Jal Nigam, Jal Kal (small projects)	UP Jal Nigam, Jal Kal (small projects), DUDA	UP Jal Nigam, Jal Kal, VMC, DUDA

Source: City Development Plan for Varanasi 2041

The drainage systems in the other target cities are all maintained by Nagal Nigams of each city. However, the maintenance conditions are poor in general in all the cities.

4.3.2 Maintenance of Drainage in Mirzapur City

In Mirzapur City, maintenance of drains is 'reactive' with the common practice to desilt the drains and dump the sludge near the edge of the drains to dry out before lifting. In practice, sludge either gets blown away or ends up in open drains.

4.3.3 Maintenance of Drainage in Other Target Cities

The urban local bodies in each city (Ghazipur NPP, Ramnagar NPP, Chunar NPP, Saidpur NP) are in charge of maintenance of drainage system. Observed from the site visits to each city, there have been insufficient maintenances in common. However, out of all the cities Chunar and Saidpur Cities are relatively better condition without much accumulation of garbage and Ghazipur is worst condition with much garbage in the road side drains and sometimes it causes stagnation of wastewater.

CHAPTER 5 Current Status of Sewerage Facilities and On-going Sewerage Projects

<Objective of the survey>

Confirmation of current status and identification of issues was conducted by references and field survey for each site of the facilities.

<Result of the Survey>

Sewage Collection and Pumping System was surveyed by interview to ULB as well as study of references and field survey in Varanasi City, Mirzapur City, Chunar City, Ramnagar City Saidpur City and Ghazipur City to confirm the current status. Ongoing Project for Sewers and Pumping Stations was also surveyed. Existing sewage treatment plants in Varanasi and Mirzapur were surveyed as well. Dinapur STP and Bhagwanpur STP in VNN and Mirzapur STP and Vindhyachal STP in Mirzapur. Condition of Operation and maintenance was also confirmed for the understanding of current status and issues.

5.1 Sewage Collection and Pumping System

Out of 6 target cities only Varanasi and Mirzapur Cities have existing sewerage systems and ongoing work can be found in Varanasi City. The details of the systems are stated from 5.1.1 to 5.1.3 below:

5.1.1 Existing Sewerage in Varanasi City

1) Existing Wastewater Disposal in Varanasi City

The existing sewerage system was designed exclusively to carry domestic sewage only, but owing to the traditional pattern of open drains laid in the core city area storm water also enters the trunk sewer directly or through manholes and branch sewers. This brings about lots of problems on the sewerage network, especially during monsoons. Due to such false-combined system, the STPs become ineffective during rainy season leading to more pollution of River Ganga and Varuna. Apart from the areas, which are not served by the sewer network, direct discharge of the sewage into River Ganga, Varuna or Assi Nala, has been polluting the rivers.

According to the City Development Plan Varanasi, the following issues are raised as summary with respect to the existing sewerage system:

- The existing sewerage system is very old and dilapidated.
- Coverage of the sewerage network is low.
- Due to dumping of garbage in the sewer lines, the capacity of the pipes gets drastically reduced, resulting in overflow/flooding of sewage on roads.
- More than half of the sewage discharged in water bodies is untreated.

2) Sewage Generation

In Varanasi 290 MLD wastewater is generated, out of which 102 MLD is being treated in the STPs and remaining 188 MLD is discharged into River Ganga. At present around 33% of the sewage generated within the City is collected and treated at three sewage treatment plants. The remaining 67% is discharged directly into the River Ganga and its tributary River Varuna. Additionally, unsewered areas discharge wastewater to the Assi Nala (drain) and other open drains. Out of 290 MLD sewage generated in the city only 102 MLD is treated in the STPs and balance 188 MLD is being drained untreated into river Ganga.

3) Sewerage Network and Collection System in Varanasi City

a) Sewerage District

Varanasi City is divided into four sewerage districts as shown in **Figure 5.1.1**. District I is Central city including the core old city. District II is sub divided into Zone 2A (Cis Varuna) and Zone 2B & 2C are Trans Varuna area. District III is BHU/ Assi district.

District I, II & III are partly sewered. District IV is unsewered area and is outside Municipality limits. Under GAP Ph-I, three STPs were constructed in District I as described below.

Varanasi is not completely covered with sewerage network. Existing sewerage system in City's core area is very old and not functioning properly.

The sewerage network is divided into two zones: cis-Varuna and trans-Varuna. Currently, the existing system is partly over ground and underground. Just over 30% of the city is covered with sewerage network of around 400 km, which means that the remaining households are either connected through septic tanks, pits, or service latrines or do not have access to toilets. Most of this 400 km long network caters to the old city, comprising mainly of the Ghat area. 18% of the total households do not have access to independent, shared, or community toilets. The trans-Varuna area is completely without sewerage. However, projects are being undertaken to cover trans-Varuna with underground sewerage network.

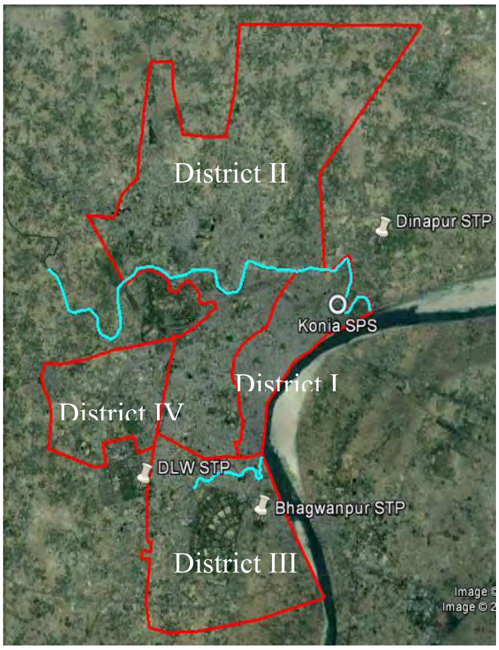


Figure 5.1.1 Sewerage Districts in Varanasi City

Nearly 50% Cis- Varuna area is unsewered. Since the existing sewer lines in the city are more than 100 years old after having been laid in early 1900s, it is prone to clogging and leakages. Due to silting and dumping of wastes in the sewer lines, the carrying capacity gets drastically reduced resulting in choking and overflow of sewage on the roads. The natural water bodies and the river Ganges in the city are in a critical state in terms of water quality due to the flow of untreated sewage and waste entering the rivers.

The wastewater management system includes three main sewers namely Old Trunk Sewer (OTS), Orderly Bazar Sewer and Ghat Intercepting Sewers and three STPs namely 80 MLD Dinapur, 9.8 (8+1.8) MLD at Bhagwanpur, BHU and 12 MLD at Diesel Locomotive Works (DLW).

b) Sewer Network and Pump Stations in District-I

The area is sewered having branch sewers connected to the old trunk sewer and the Orderly Bazaar trunk sewer. A part of the OTS is 7.2 km in length and size varies from 750 to 2400 mm in diameter. It carries wastewater from densely populated Central Drainage Zone and discharge into Konia Pump Station.

Orderly Bazar sewer was laid from Collectorate's office connected to old Main Trunk Sewer after crossing the Varuna River and railway line. Bridge supporting the sewer across Varuna river was washed away and presently, its flow is discharging into Varuna River. Only the tail reach of the sewer, beyond the Varuna Bridge, discharges into OTS near Anand Mandir Cinema Hall. Ghat Interceptor Sewer was laid along the Ghats on bank of River Ganga to intercept wastewater from a number of old drains from Meer Ghat to Trilochan Ghat in GAP-II. It consists of 300 mm dia CI pipe of 1,184 m length and the outfall of the sewer was at Trilochan Ghat. Under GAP I scheme I&D work was carried out to intercept the flow from six major drains along the ghats on river bank through five Ghat pump stations. These pumping stations lift sewage into OTS. The map and list of drains connected with Ghat PSs are shown in **Figure 5.1.2**.

Wastewater generated in the area is collected and conveyed via OTS to 80 MLD STP at Dinapur through Konia Main pump station (MPS).

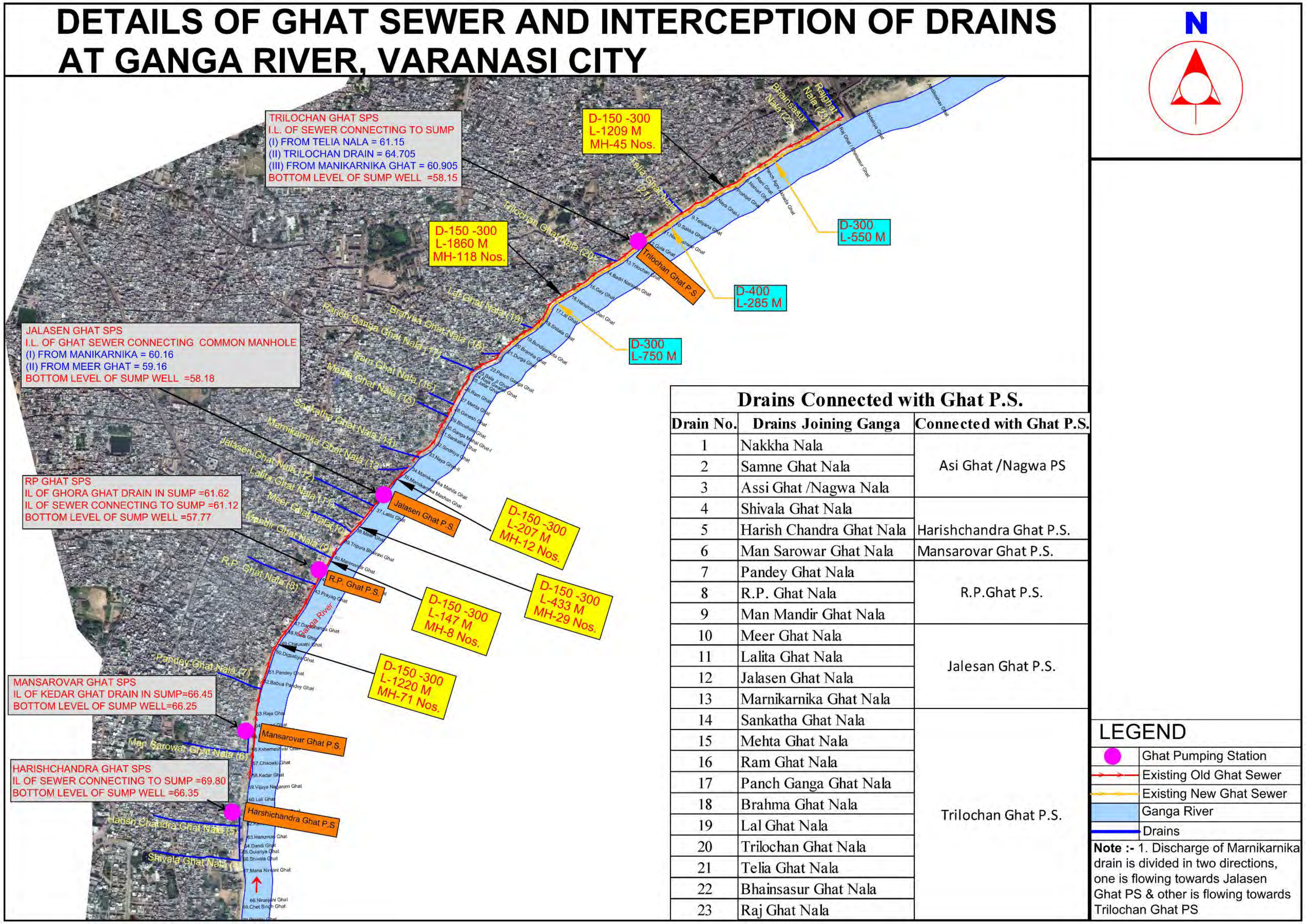
i) Sewer

The existing sewers in District I is tabulated in Table 5.1.1 and the major ones are shown in **Figure 5.1.3**. The detail of the diameters and lengths are not available but the old downtown near Ghats is the sewered area with high coverage rate.

Table 5.1.1 Existing Sewers in District I of Varanasi

SL. No.	Location	Node / MH No.		Description	
		From	To	Diameter (mm)	Length (m)
1	Mugalsarai Road	Near Slaughter House	Konia Pumping Station	1000/1200	2,158
2.1	Adampur Thana Road	Nati Imli Chauraha	Near Raja ji Puram Colony	300	653
2.2	Adampur Thana Road	Raja ji Puram Colony	Adampur Thana	450	671
2.3	Pathani tola Road	Adampur Thana	Adampura via Amiya Mandi	600	512
3	Jwala Devi Temple road	Near D.A.V. College gate	Near Post Office Visheshwar ganj	300	1,120
4	Lohatiya Road	Near Ausan ganj	Near Bada Ganesh Lohtiya	300	335
5	Harthirath Chauraha	Harthirath Chauraha	Near Santh Chetan Math	225	511
6	Harthirath Chauraha	Harthirath Chauraha	Near Adampur Thana Cross-ing	300	291
7	Katua Pura	Katuapura	Near Santh Chetan Math	225	511
8	Katua Pura	Katuapura	Teliyana Near Navapokara	300	730
9	Suraj kund Road	Near Tekra Math	Near Sanatan Dharma Inter College	225	651
10	Iswar Tower	Back Of Mazada Cinema	Near Maha Mandleshwar SWAMI SRI VIDYANANDJI	225	200
11	Ratna kar park	Ratnnakar Park Near Masjid	Gurudham Chauk	600	710
12	Pandey Haweli Road	Near Bangali Tola	Godauliya Church	300	957
13	Old Trunk Sewer	Assi Nala	Konia Pumping Station	750-2400	7,172
		Assi Nala	Shiwala	750	924
		Shiwala	Godaulia	1200	1,740
		Godaulia	Benia Park	1800	697
		Benia Park	Kabirchaura Crossing	1950	595
		Kabirchaura Crossing	Baraganesh	2100	250
		Baraganesh	Machhodary Park	2250	1,511
		Machhodary Park	Konia PS	2400	1,455
14	Ghat Interceptor Sewer (old)	Kedar Ghat	Raj Ghat Nala	150-400	6,661
		Kedar Ghat	R.P. Ghat PS	150-300	1,220
		Manmandir Ghat	R.P. Ghat PS	150-300	147
		Tripura Bhairavi Ghat	Jalesen Ghat PS	150-300	433
		Mamikamika Mahila Ghat	Jalesen Ghat PS	150-300	207
		Mamikamika Mahila Ghat	Trilochan Ghat PS	150-300	1,860
		Raj Ghat Nala	Trilochan Ghat PS	150-300	1,209
		Bramha Ghat	Trilochan Ghat PS	300	750
		Bhainsasur Nala	Teliyana Ghat	300	550
		Teliyana Ghat	Trilochan Ghat PS	400	285
	Total				23,842
15	Old sewer network	Ghat area		N/A	N/A

Source: DPR Varanasi District-I, GAP-II Consultant

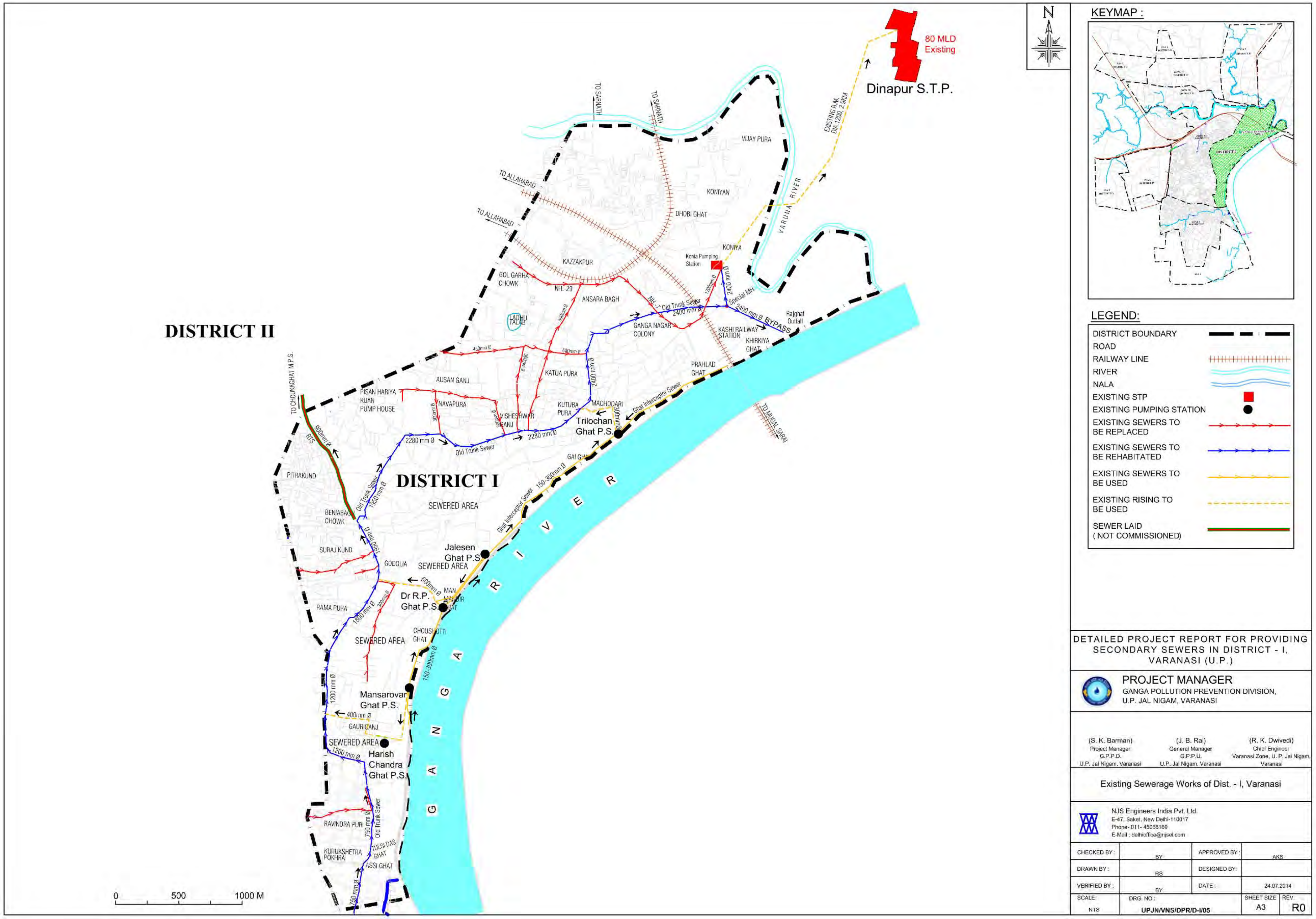


Drains Connected with Ghat P.S.

Drain No.	Drains Joining Ganga	Connected with Ghat P.S.
1	Nakkha Nala	Asi Ghat /Nagwa PS
2	Samne Ghat Nala	
3	Assi Ghat /Nagwa Nala	
4	Shivala Ghat Nala	Harishchandra Ghat P.S.
5	Harish Chandra Ghat Nala	
6	Man Sarowar Ghat Nala	Mansarovar Ghat P.S.
7	Pandey Ghat Nala	R.P.Ghat P.S.
8	R.P. Ghat Nala	
9	Man Mandir Ghat Nala	
10	Meer Ghat Nala	Jalesan Ghat P.S.
11	Lalita Ghat Nala	
12	Jalasen Ghat Nala	
13	Marnikarnika Ghat Nala	
14	Sankatha Ghat Nala	Trilochan Ghat P.S.
15	Mehta Ghat Nala	
16	Ram Ghat Nala	
17	Panch Ganga Ghat Nala	
18	Brahma Ghat Nala	
19	Lal Ghat Nala	
20	Trilochan Ghat Nala	
21	Telia Ghat Nala	
22	Bhainsasur Ghat Nala	
23	Raj Ghat Nala	

Source: GAP-II Project Team

Figure 5.1.2 Drains connected with Ghat PSs in District-I, Varanasi



Source: DPR Varanasi revised by JICA Survey Team

Figure 5.1.3 Major Existing Sewers in District-I, Varanasi

ii) Old Trunk Sewer (OTS)

Old Trunk Sewer (OTS) was constructed from Assi Nala to Raighat Outfall in the downstream of Ganga River in 1917 with the diameters from 750mm to 2400mm for the storm water drainage purpose at the time. After the construction of 4 Ghat pumping stations beside River Ganga to intercept and transmit the wastewater to OTS by rising mains and Konia Pumping Station near Varuna River in 1962, the purpose of OTS was shifted to trunk sewer. However, since there was no sewage treatment plant until the construction of STP Dinapur in 1992, OTS had been the diversion of wastewater from Ghat area beside Ganga River and the wastewater was discharged to Varuna River without any treatment. At this moment the wastewater generated in the old city in District I is transmitted to OTS from 5 Ghat pumping stations and the secondary sewers near OTS and flown to special manhole (SMH) with gate structure near Konia MPS. Since the total wastewater flow exceed the capacity of Konia MPS and Dinapur STP, much excess wastewater diverted by gate is discharged from Raighat Outfall to Ganga River through Bypass (formerly a part of OTS) without treatment.

After nearly 100 years have passed after the construction, OTS is seriously deteriorated. Hence the CCTV inspection for a part of OTS alignment was conducted to confirm the internal condition of OTS from May to July 2014 as the sample photos are shown as follows.

S5, MH28 to MH29 — Severe corrosion and ground water is seeping through the pipe's crown.

S7, MH49 to MH50 — Here we can see the circumferential cracks leaking into the pipe.

Source: Inspection & Conditional Assessment of Old Trunk Sewer at Varanasi using COMPASS, KLEEN WATER TECHNOLOGIES, July 2014

Photo 5.1.1 CCTV Inspection Photos

The inspection revealed the following facts:

1. The pipes are severely corroded at almost all locations.
2. While at most places the corrosion has caused the mortar to become lose, at other areas, specifically the crown location, the mortar has completely vanished.
3. Continued Corrosion has caused bricks breakdown falling from their locations. At other locations the mortar lining between the bricks has started eroding.

4.The ground water is infiltrating into the sewer at almost all locations. At certain locations, the infiltration is severe and can be clearly seen as a stream of water enters the pipe, at most locations it can be seen as water droplets along the crown area.

5.Many laterals made into the pipe have been badly constructed. The grouting is not proper and leakages can be seen around the lateral.

6.The Sewer line is heavily silted. It is estimated that the level of siltation is almost 50-60% of the pipe vertical height. Silt percentage by pipe height is maximum for smaller sewers. The surveyor was not able to profile the pipe due to excessive silt in some stretches since the profiler which is placed under the waterline could not find sufficient clearance due to high silt bed.

iii) Ghat PSs

The specifications of 5 Ghat PSs can be listed as follows;

Table 5.1.2 Existing Ghat P/Ss in District I of Varanasi

Item	Specification
1. Harischandra Ghat SPS	
Dimensions	6m dia circular sump cum pump house sump floor is 6.5 m below the operating platform
Installed capacity	146 lps
Installed pumps	1 x 50 HP – 5000 lpm @ 24 m head 1 x 25 HP – 2600 lpm @ 13.5 m head 1 x 10 HP – 1150 lpm @ 9.5 m head
Diesel Generating Sets	1 x 70 kVA
Rising Main	400 mm dia CI
2. Mansarovar Ghat SPS	
Dimensions	9m dia circular sump cum pump house sump floor is 11m below the operating platform
Installed capacity	173 lps
Installed pumps	2 x 10 HP – 1300 lpm @ 15 m head 3 x 25 HP – 2600 lpm @ 21 m head
Diesel Generating Sets	1 x 100 kVA
Rising Main	400 mm dia CI
3. Dr. R.P. Ghat SPS	
Dimensions	6.1m dia circular sump cum pump house sump floor is 18.3 m below the operating platform
Installed capacity	793 lps
Installed pumps	2 x 125 HP – 15000 lpm @ 23 m head 2 x 75 HP – 8800 lpm @ 22 m head
Diesel Generating Sets	3 x 160 kVA
Rising Main	600 mm dia CI
4. Jalesan Ghat SPS	
Dimensions	6.1m dia circular sump cum pump house sump floor is 16.3 m below the operating platform
Installed capacity	160 lps

Item	Specification
Installed pumps	2 x 30 HP – 3600 lpm @ 20 m head 2 x 15 HP – 1200 lpm @ 15 m head
Diesel Generating Sets	1 x 70 kVA
Rising Main	250 mm dia CI
5. Trilochan Ghat SPS	
Dimensions	6.1m dia circular sump cum pump house sump floor is 18.3 m below the operating platform
Installed capacity	182 lps
Installed pumps	2 x 35 HP – 4100 lpm @ 20.5m head 2 x 12 HP – 1365 lpm @ 18 m head
Diesel Generating Sets	1 x 160 kVA
Rising Main	300 mm dia CI

Source: DPR Varanasi District-I

iv) Konia MPS

It was originally commissioned in 1962 for discharging raw sewage into Ganga via rising main (Dia. 900, Hume Steel Pipe) and renovated in 1992 for pumping the sewage to Dinapur STP via new rising main.

Commissioning: 1992
Capacity (Average Flow): 100 MLD
Pumps: see Table 5.1.3
Rising Main (new):
Diameter: 1200 mm
Type of Pipe: PSC
Length: 2,900m

Table 5.1.3 Pump Capacities in Existing Konia MPS in District I of Varanasi

Pumping station	Installed Capacity (lps)	Effective capacity (lps)	Average (mld)
Konia stage 1 - present	3 x 1158 lps = 3474	67% = 2,316	100
Konia stage 2 - present	3 x 420 = 1260 lps 3 x 740 = 2220 lps	67% = 2,320	

Source: DPR Varanasi District-I

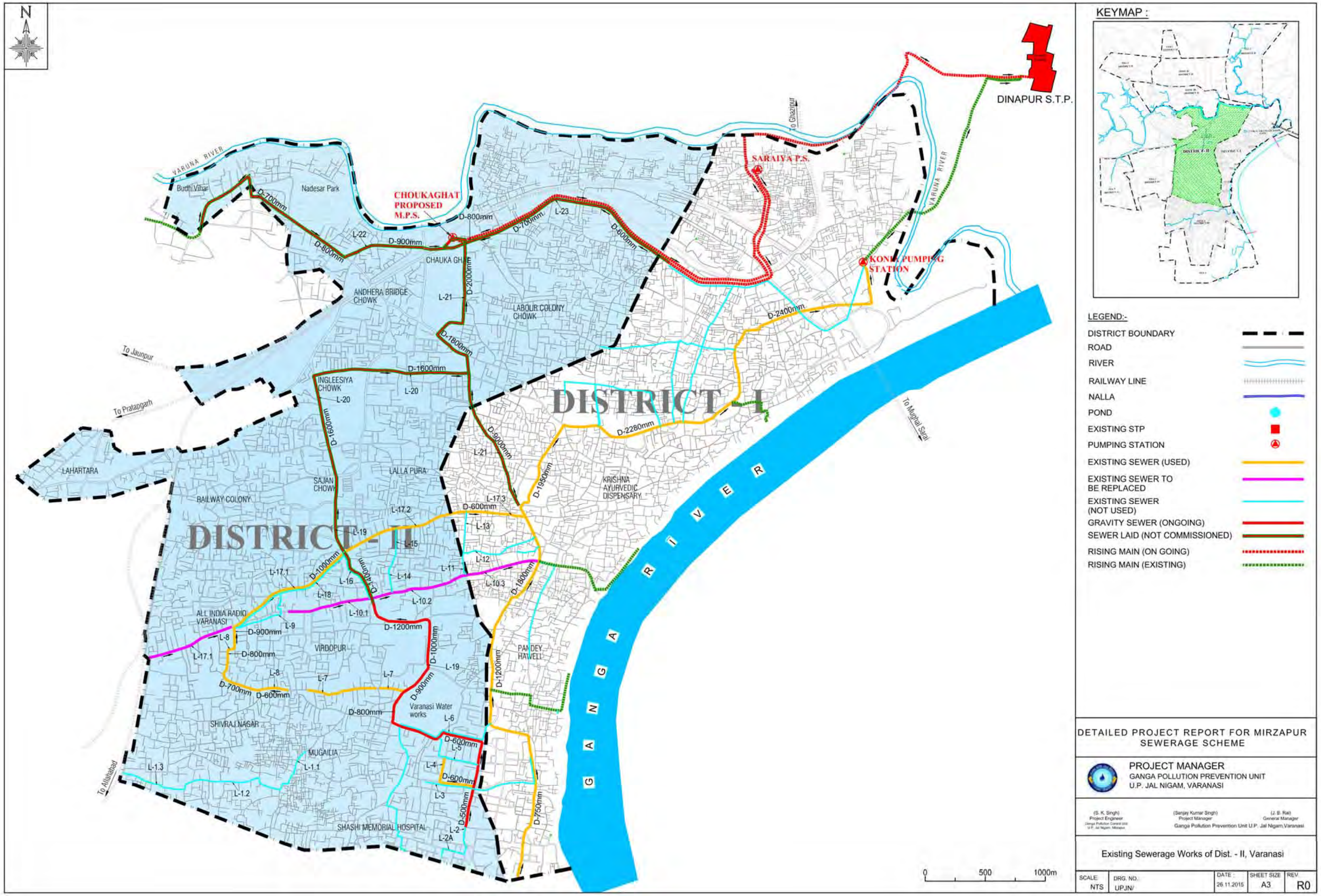
c) Sewer Network in District-II

District II is Trans Varuna area and sub-central district on the CIS-Varuna side west of the city centre. Entire Trans Varuna and 50% of Cis Varuna area is unsewered. Overflow from septic tanks flows into open plots or open drains ultimately reaching river Ganga. A part of wastewater flow from the district is also conveyed to Dinapur STP through Old trunk sewer. Remaining wastewater is discharged into river Varuna through drains. The details of existing sewers and ones under ongoing work in GAP-II in District-II are shown in **Table 5.1.4** and **Figure 5.1.4**.

Table 5.1.4 Description of Existing and Under Execution Sewers in District II of Varanasi City

SL. No.	Ward No.	Location	Node / MH No.		Existing Sewer Descripton		Remarks
			From	To	Size (mm)	Length (m)	
1-	Existing Old Sewer :						
1.1	25/38	Bajardiha Road	Mugailia	Near Bajardiha Temple	300	595.3	Old Sewer needs to be replaced by new Sewer.
1.2	38/13	Bajardiha Road	Near Bajardiha Temple	Devpokhra	400	439.76	
1.3	13	Bajardiha Road	Devpokhra	Lakhgaon	600	813.26	
2	8	Durga Temple Road	Dayal Tower	Durga Temple Crossing	400	126.76	
2.A	8/13	Durga Kund Crossing	Durga Kund Crossing	Kabir Nagar in District 3	225	317.58	
2.B	13/43	Khojwa Road	Shankuldhara Pokhra	Assi nala at Manas Nagar in District 3	225	1091.2	
3	43/14	Jawahar Nagar colony Road	Ram Janki Temple	Gurudham Chauk	200	404.06	
4	14	Gurudham Road	Jawahar Nagar Extension	Gurudham Chauk via Awas Vikas Colony	600	484	
5	44/14	Durga Temple Road	Jawahar Nagar Extension	Petrol pump	200	487.18	
6	43/44/65/39	Bhelupur Shankuldhara Road	Near Bhelupur Shankuldhara	I P Vijya via Annpurna Sweet	300	905	
7	44	Bhelupur Road	Kamachha Vinayaka	Back of Varanasi Water Works	400-450	851.98	
8	2/38/12	Mohini Kunj Road	Bari Gaibi Chowk	Near Uphaar Nursing Home	600-900	1031.14	
9	12/53/40	Rathyatra Road	Near Kohali Furniture	Sigra Road via Narsingh Apartment	250	616.44	
10.1	53	Rathyatra Road	Near Maruti Show Room	Rathyatra Crossing	250	703.7	
10.2	53/72	Luxa Road	Rathyatra Crossing	Ram Krishan Mission Seva Shram	300	795.29	
10.3	72	Luxa Road	Ram Krishan Mission Seva Shram	Godauliya Church	600	663.62	
11	72/61	Luxa Aurangabad Road	Tekra Math	Luxa Tri-Crossing Near Ram Krishan Mission Seva Shram	225	194.67	
12	72	Nai Sadak Road	Near Tekra Math	Near Maha Mandleshwar Swami sri Vidyanand ji	225	455.55	
13	61	Luxa Aurangabad Road	Tekra Math	Police Station Aurangabad	225	335.15	
14	72/60	Chhoti Gaibi Road	Near Shiv Temple	Near Telwala Dharamshala	225	207.68	
15	60	Sri Sharda Math Road	Near Shiv Temple	Near Sidhgiri Bagh	225	357.15	
16	60/53	Sigra Road	Rathyatra Crossing	Sigra Crossing	300	458	
17.1	12/53/40/60	Mahmoorganj Road	Mahmoorganj Police chauki	Sigra Chowk	300	1890.87	
17.2	60	Sidhgiri Bagh Road	Sigra Chaowk	Aurangabad Pump House Near Mazar	400	883	
17.3	60	Nai Sadak Road	Aurangabad Pump House Near Mazar	Near Police Station Aurangabad	600	727.96	
					Total	15836.3	
2-	New Sewer Line :						
A-	Laid Sewer-						
20	40/9/37/21	RTS D/S (Exist)	Near Bharat Seva Ashram Sangh	Lahurabir Chowk via Englishia Line	1600	2374.4	RCC and MS pipe in running condition Laid
21.1	21	RTS D/S (Exist)	Beniabagh to Lahurabir	Lahurabir Chowk	900	1210	RCC and MS pipe
21.2	21/24	RTS D/S (Exist)	Lahurabir Chowk	Jagat Ganj	1800	450.35	RCC and MS pipe running condition
21.3	24/75/11	RTS D/S (Exist)	Near Sampoornanand Sanskrit University gate	Chauka Ghat Crossing	2000	1071.02	RCC and MS pipe running condition
					Total	5105.77	
B-	Under Execution -						
18	12/53/40/60	Sigra Road	Mahmoorganj Tiraha Crossing, Opposite Petrol Pump	Sigra Chauraha	1000	1067.48	Proposed under State Govt. Project
19	8/14/39/65/44/43/2/53/60/40	RTS U/S	Durga Kund Temple	Bharat Seva Ashram Sangh	500-1400	4028	Proposed Under JICA Project
22	11/75/22	Varuna U/S Interceptor	Neharu park Near Jhv. Cinema	Chauka Ghat Crossing	700-900	2626	Under JICA Project running condition
23	46/84/23/81/86/75/11	Varuna D/S Interceptor	Slaughter House	Chauka Ghat Crossing	600-800	2109	Proposed Under JICA Project running condition
					Total	9830.48	

Source: DPR Varanasi District-II



Source: DPR Varanasi District-II

Figure 5.1.4 Existing Sewers in District-II, Varanasi

d) Sewer Network in District-III

District III is partly (20%) sewered as shown in **Table 5.1.5**. BHU area in District III is fully sewered. Bhagwanpur STP receives flow from BHU area for the treatment. Area other than BHU is not sewered and discharges sewage into Assi Nala through nearby drains. Master Plan prepared under JICA assistance proposed to intercept Assi Nala and provide sewer along the nala. The work is taken up under JICA assisted project and is in progress.

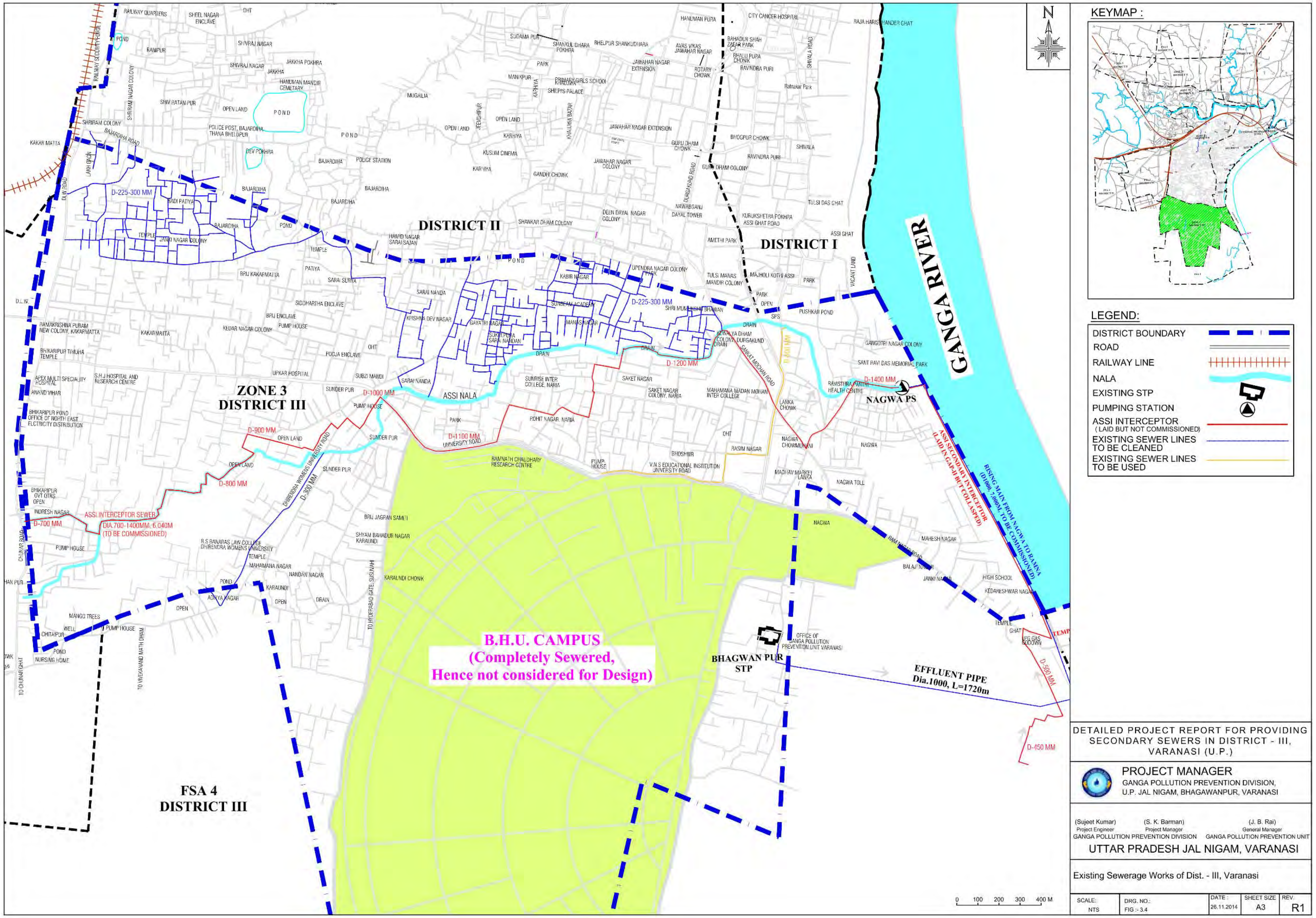
Secondary sewers of approximately 40 km in length exists in areas like Bajardiha, Badi Patiya, Jankai Nagar Colony Sarai Nanda, Krishna Dev Nagar, Gayatri Nagar, Sukul Pura, Manas Nagar, Sunbeam Academy, etc. 20km length of existing sewer can be used after rehabilitation works. Apart from this approximately 20kms of existing sewer is in very bad condition. Assi Nala Interceptor is under execution under JICA Project. Details of the existing sewers in District III, Varanasi other than BHU area is given in table below.

Although about 15% of 150-200 mm dia sewer may be used after proper cleaning and repair, existing branch sewers which are not under use and lacking adequate capacity, will be dismantled and new sewers will be laid. House connections will also be transferred from old sewers to new sewers. Only 200mm dia sewer will be basically utilized.

Table 5.1.5 Existing Sewers and Conditions in District III of Varanasi

Sr. No.	Ward No.	Ward Name	Location	Dia mm	Length km	Condition
A. Existing Sewers- To be used after Rehab						
1	28	Bhikharipur	Dhirendra Mahila College	300	1	Available after cleaning & rehab.
2	32	Nariya	Manas Nagar near Sunbeem Academy	225	4	
3	13		Upendra Nagar Colony	225	3	
4	13		Krishnadev Nagar	225	2	
5	13/32		Shukulpura Sarai Nandan	250	4	
6	10		Gayatri Nagar	300	3	
7	28		Janki Nagar Colony Kakarmutta	250	4.7	
			Total Length of old sewer		**21.7**	**km**
B. Existing/New- To be used						
8	8		Nariya Trimohani via Rashmi Nagar	600	1.66	Running
9	28 10 32 8	Bhikharipur Sunderpur Nariya Lanka	Assi Interceptor Sewer	700-1400	8.537	Construction ongoing under JICA
Total Length of New sewer					**10.197**	**km**
C. Old Sewer-To be Dismantled						
10	NA	NA	NA	NA	20	Not usable. To be dismantled
Total Length of sewer to be dismantled					**20**	**km**

Source: DPR Varanasi III



Source: DPR Varanasi District-III

Figure 5.1.5 Existing Sewers in District-III, Varanasi

e) Existing Trunk Sewer and Pumping Stations in Whole Varanasi City

The existing sewers and pumping stations can be summarised as follows in terms of years of commissioning.

Table 5.1.6 Existing Trunk Sewers and Pumping Stations in Varanasi City

Sl. No.	Sewerage Component	District	Year of Commissioning
1	Old Trunk Sewer (OTS)	District I	1917
2	Konia Pumping Station • Old (for Raw Sewage) 2 sets of pumps with 29000 lpm, 8.51 m head, 110 kW 1 set of Archimedean screw pump with 17000 lpm, 16.6 m head, 110 kW • New (80 mld) First stage pumping 3 sets of Archimedean screw pump with 1158 lps, 8.51 m head, 160 kW 1 set of Archimedean screw pump with 1158 lps, 8.51 m head, 160 kW under installation in Package 5 of GAP-II Second stage pumping 3 sets of centrifugal pumps with 740 lps, 15 m head, 160 kW 3 sets of centrifugal pumps with 420 lps, 17.5 m head, 110 kW 1 set of centrifugal pump with 740 lps, 15 m head, 160 kW and under installation in Package 5 of GAP-II 1 set of centrifugal pump with 420 lps, 17.5 m head, 110 kW and under installation in Package 5 of GAP-II Electrical Equipment Transformer: 3 sets with 1000 kVA each LV main switchboard Starter panels with DOL for 3 sets of Archimedean pumps with 160 kW Starter panels with DOL for 3 sets of centrifugal pumps with 740 lps, 15 m head, 160 kW Starter panels with DOL for 3 sets of centrifugal pumps with 420 lps, 17.5 m head, 110 kW Starter panels with soft starter for 1 set of centrifugal pumps with 740 lps, 15 m head with 160 kW under installation in Package 5 of GAP-II, Starter panels with soft starter for 1 set of centrifugal pumps with 420 lps, 17.55 m head with 160 kW under installation in Package 5 of GAP-II Diesel generator set: 4 sets with 500 kVA	District I	1962 1992
3	Ghat Pumping Station • R.P. Ghat PS Mechanical Equipment 2 sets of vertical centrifugal pumps with 15000 lpm, 23 m head, 90 kW 2 sets of vertical centrifugal pumps with 8800 lpm, 22 m head, 55 kW 4 sets of pumps above mentioned under being replaced with 15000 lpm, 23 m head, 90 kW in Package 5 of GAP-II	District I	1962 (Renovated in 1991)

	Electrical Equipment 2 sets of transformer with 600 kVA, 11/0.4 kV, LV main switchboard, Starter panels with DOL for 2 sets of pumps with 90 kW and 2 sets of pumps with 55 kW, Theses starter panels under being replaced with 4 new ones for new pumps with 90 kW, 3 sets of diesel generator sets with 160 kVA, 2 out of 3 sets under being replaced with 1 se of new one with 320 kVA, 1 number of auto synchronizing panel additionally under installation in Package 5 of GAP-II Items below under installation in Package 5 of GAP-II, 1 number of ultrasonic level transmitter, 1 number of electromagnetic flow meter on rising main with 600 mm dia., 1 set of PLC for water level based automatic pump control, • Jalesan PS Mechanical Equipment 2 sets of vertical centrifugal pumps with 3600 lpm, 20 m head, 22 kW 2 sets of vertical centrifugal pumps with 1200 lpm, 15 m head, 11 kW 4 sets of pumps above mentioned under being replaced with 2500 lpm, 27 m head, 18.5 kW in Package 5 of GAP-II Electrical Equipment 1 set of transformer with 100 kVA, 11/0.4 kV, LV main switchboard, Starter panels with DOL for 2 sets of pumps with 22 kW and 2 sets of pumps with 11 kW, Theses starter panels under being replaced with 4 new ones for new pumps with 18.5 kW, 1 set of diesel generator sets with 70 kVA under being replaced with 1 set of 160 kVA from Trilochan ghat pumping station, Items below under installation in Package 5 of GAP-II, 1 number of ultrasonic level transmitter, 1 number of electromagnetic flow meter on rising main with 250 mm dia., 1 set of PLC for water level based automatic pump control • Trilochan PS Mechanical Equipment 2 sets of vertical centrifugal pumps with 4100 lpm, 20.5 m head, 26 kW 2 sets of vertical centrifugal pumps with 1365 lpm, 18 m head, 11 kW 4 sets of pumps above mentioned under being replaced with 3 sets of 5300 lpm, 27 m head, 37 kW and 1 set of 2600 lpm, 27 m head, 18.5 kW in Package 5 of GAP-II Electrical Equipment 1 set of transformer with 630 kVA, 11/0.4 kV from UPPCL, New 1 set of transformer with 250 kVA under installation for exclusively pumping station in Package 5 of GAP-II, LV main switchboard under being replaced with new one consisting of 1 incomer and outgoing feeders in Package 5 of GAP-II,		

	Automatic power factor correction panel under installation in package of GAP-II Starter panels with DOL for 2 sets of pumps with 26 kW and 2 sets of pumps with 11 kW, Theses starter panels under being replaced with 4 new ones for 3 new pumps with 37 kW and 1 new pump with 18.5 kW, 1 set of diesel generator sets with 160 kVA under being replaced with 1 set of 200 kVA , Dismantled 160 kVA diesel generator set under installation at Jaleshan ghat pumping station in Package 5 of GAP-II, Items below under installation in Package 5 of GAP-II, 1 number of ultrasonic level transmitter, 1 number of electromagnetic flow meter on rising main with 450 mm dia., 1 set of PLC for water level based automatic pump control • Harischandra PS Mechanical Equipment 1 set of vertical centrifugal pump with 5000 lpm, 24 m head, 37 kW 1 set of vertical centrifugal pump with 2600 lpm, 13.5 m head, 18.5 kW 1 set of vertical centrifugal pump with 1150 lpm, 9.5 m head, 7.5 kW, 3 sets of pumps above mentioned under being replaced with 2 sets of 6800 lpm, 15 m head, 30 kW and 1 set of 3500 lpm, 15 m head, 18.5 kW in Package 5 of GAP-II Electrical Equipment 1 set of transformer with 100 kVA, 11/0.4 kV from UPPCL, New 1 set of transformer with 100 kVA under installation for exclusively pumping station in Package 5 of GAP-II, LV main switchboard under being replaced with 2 numbers of new distribution switchboard in Package 5 of GAP-II, Automatic power factor correction panel under installation in package of GAP-II Starter panels with DOL for 1 set of pumps with 37 kW, 1 set of pump with 18.5 kW and 1 set of pump with 7.5 kW, Theses starter panels under being replaced with 3 new ones for 2 new pumps with 30 kW and 1 new pump with 18.5 kW, 1 set of diesel generator sets with 160 kVA, Items below under installation in Package 5 of GAP-II, 1 number of ultrasonic level transmitter, 1 number of electromagnetic flow meter on rising main with 400 mm dia., 1 set of PLC for water level based automatic pump control		
	• Mansarovar PS Mechanical Equipment 3 sets of vertical centrifugal pumps with 2600 lpm, 21 m head, 18.5 kW under being replaced with 3 sets of 2600 lpm, 21 m head, 18.5 kW 2 sets of vertical centrifugal pumps with 1300 lpm, 15 m head, 7.5 kW Electrical Equipment 1 set of transformer with 100 kVA, 11/0.4 kV, LV main switchboard, Automatic power factor correction panel under installation in	District I	1991

	package of GAP-II Starter panels with DOL for 3 sets of pumps with 18.5 kW being replaced with 3 new ones for 3 new pumps with 18.5 kW in Package of GAP-II Starter panels with DOL for 2 sets of pumps with 7.5 kW, 1 set of diesel generator sets with 70 kVA, 1 set of control panel for the existing generator under installation in Package 5 of GAP-II, Items below under installation in Package 5 of GAP-II, 1 number of ultrasonic level transmitter, 1 number of electromagnetic flow meter on rising main with 300 mm dia., 1 set of PLC for water level based automatic pump control		
4	BHU SPS (4 mld, 6 mld) with Rising Mains to Bhagwanpur STP	District III	N/A
5	Assi MPS (6 mld) with Rising Main to Bhagwanpur STP	District III	N/A (not working)
6	Nagwa PS (80 mld) with Rising Main up to proposed Ramna STP site	District III	Constructed in 2010 but not yet commissioned

Source: Interview to UPJN and GAP-II Project Team

5.1.2 Ongoing Project for Sewers and Pumping Stations in Varanasi City

In Varanasi, the works of sewerage system (sewer lines) at present as Ganga Action Plan (GAP) - II are being carried out under two different schemes viz. JnNURM and JICA. The proposals under these schemes are given below.

1) Under JnNURM

- Branch sewer lines
- Sewage treatment plant and pumping station

Project status – the project is under implementation. Due to land acquisition issues, a new site (Goithaha) for construction of sewerage treatment plant has been identified by the district administration. Meanwhile, 127 Km of sewer line was laid. The project will get completed in next two years after land for STP is made available.

About 140 Km of sewer and trunk sewer was sanctioned under JNNURM for Trans-Varuna area, which is under execution.

2) Under JICA

- Interceptor Sewer along Assi river front bank (Assi Interceptor: 6.04km)

Package P2

- Pumping station- 3 No. (140 MLD, 3.7 MLD & 7.6 MLD)
- Upstream and downstream of left bank of Varuna river. (Varuna U/S and D/S Interceptors)
- Rising Main- 10.24 Km

Contract Agreement No. :	04/G.M./2013-14, Dated 15.07.2013
Name of Contractor :	M/S UEM India Pvt Ltd JV EMS Infracon
Commencement Date :	19.08.2013
Completion Date (Contract) :	18.08.2015
Projected Completion Date :	17.05.2016 (Expected)

a) Phulwaria Pumping Station – 7.6 MLD

More than 60% of the construction work has been progressed as of the end of September 2015 as shown in Figure 5.1.6.

Outlines of mechanical and electrical works are as follows;

Mechanical Equipment 2 sets (1 working + 1 standby) of bar screens with spacing of 20 mm, 360 m^3/hr, 0.75 kW, 1 set of belt conveyer with 0.75 kW, 3 sets (2 working + 1 standby) of submersible pumps with 360 m^3/hr, 26 m head, 55 kW, 2 sets (1 working + 1 standby) of submersible pumps with 160 m^3/hr, 17 m head, 18.5 kW,
Electrical Equipment 2 sets (1 working + 1 standby) of transformer with 160 kVA, 11/0.4 kV, LV Main switchboard, Automatic power factor correction panel, MCC and starter panels with DOL for 2 sets of coarse bar screens with 0.75 kW, 1 set of belt conveyer with 0.75 kW, soft starters for 3 sets of pumps with 55 kW and soft starters for 2 sets of pumps with 18.5 kW, 1 set of diesel generator set with 160 kVA, 1 number of ultrasonic level transmitter for controlling pumps, 2 pairs of level switches for controlling coarse bar screens, 1 number of electromagnetic flow meter on rising main with 350 mm dia.,

b) Chaukaghat Pumping Station – 140 MLD

More than 20% of the construction work has been progressed as of the end of September 2015 as shown in Figure 5.1.7.

Outlines of mechanical and electrical works are as follows;

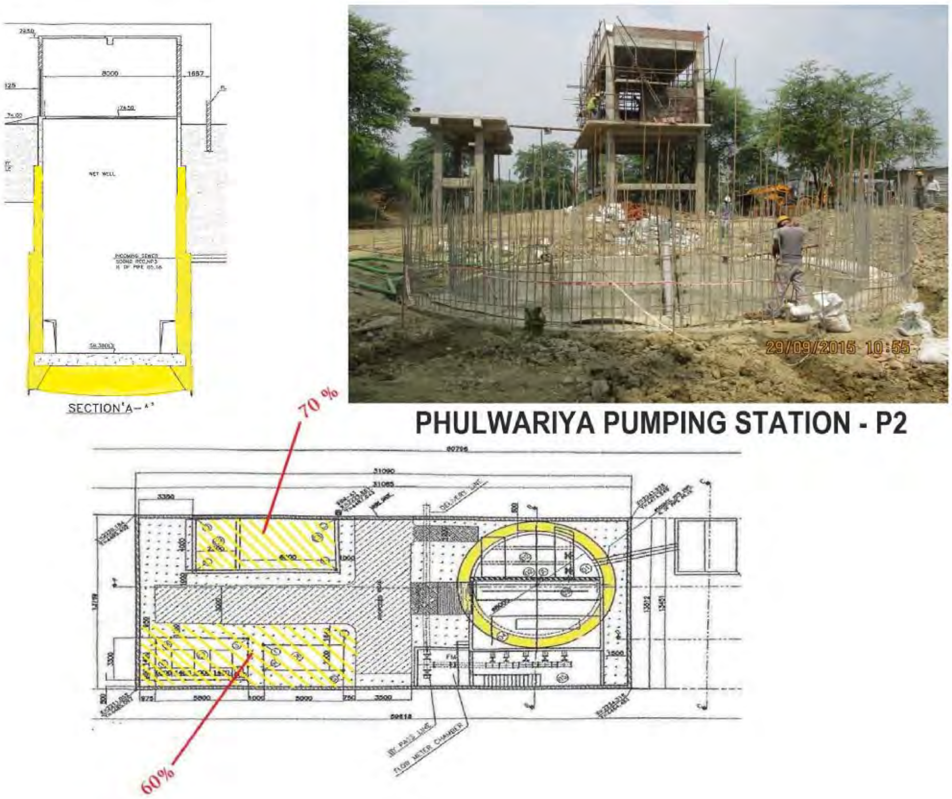
Mechanical Equipment 3 sets (2 working + 1 standby) of coarse bar screens with spacing of 65 mm, 5830 m^3/hr, 0.75 kW, 1 set of belt conveyer with 0.75 kW, 9 sets (6 working + 3 standby) of horizontal centrifugal pumps with 2088 m^3/hr, 42 m head, 355 kW,
Electrical Equipment 2 sets (1 working + 1 standby) of transformer with 2500 kVA, 33/0.4 kV, LV Main switchboard, Automatic power factor correction panel, MCC with DOL for 3 sets of coarse bar screens with 0.75 kW, 1 set of belt conveyer with 0.75 kW, Starter panels with soft starters for 9 sets of pumps with 355 kW each, 4 sets of diesel generator set with 625 kVA each, 1 number of ultrasonic level transmitter for controlling pumps, 3 pairs of level switches for controlling coarse bar screens, 1 number of electromagnetic flow meter on rising main with 1500 mm dia.,

c) Saraiya Pumping Station – 3.7 MLD

More than 70% of the construction work has been progressed as of the end of September 2015 as shown in Figure 5.1.8.

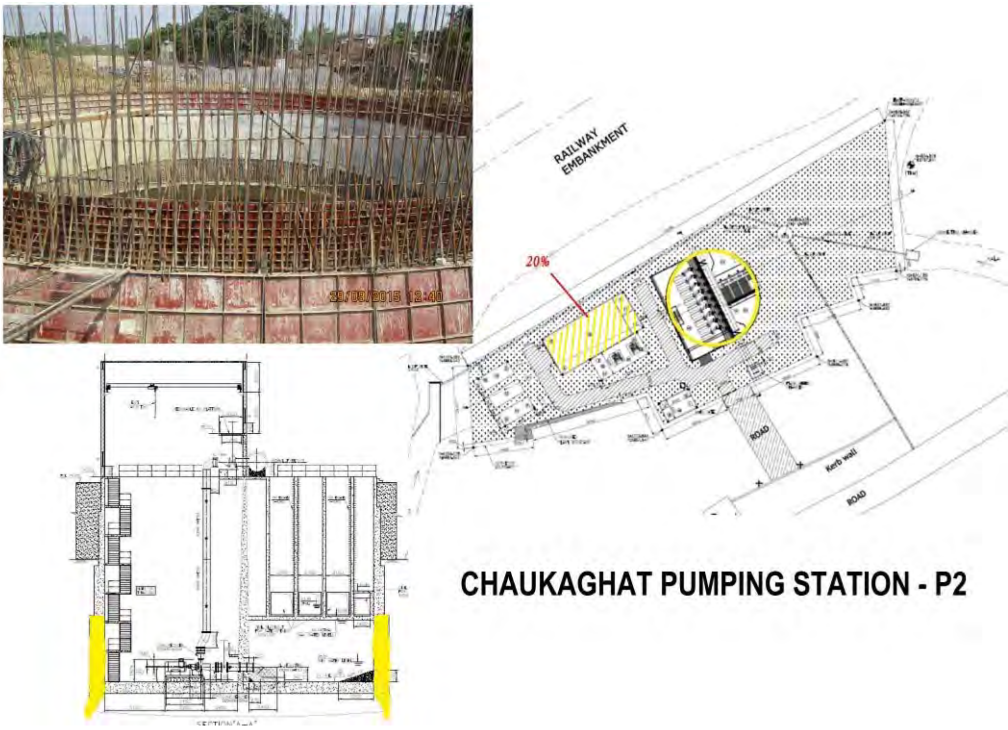
Outlines of mechanical and electrical works are as follows;

Mechanical Equipment 2 sets (1 working + 1 standby) of bar screens with spacing of 20 mm, 463 m^3/hr, 0.75 kW, 1 set of belt conveyer with 0.75 kW, 3 sets (2 working + 1 standby) of submersible pumps with 198 m^3/hr, 22.5 m head, 22 kW, 2 sets (1 working + 1 standby) of submersible pumps with 96 m^3/hr, 12 m head, 7.5 kW,
Electrical Equipment 2 sets (1 working + 1 standby) of transformer with 100 kVA, 11/0.4 kV, LV Main switchboard, Automatic power factor correction panel, MCC with DOL for 2 sets of coarse bar screens with 0.75 kW, 1 set of belt conveyer with 0.75 kW, soft starters for 3 sets of pumps with 22 kW each, soft starters for 2 sets of pumps with 7.5 kW each, 1 set of diesel generator set with 100 kVA, 1 number of ultrasonic level transmitter for controlling pumps, 2 pairs of level switches for controlling coarse bar screens, 1 number of electromagnetic flow meter on rising main with 450 mm dia.,



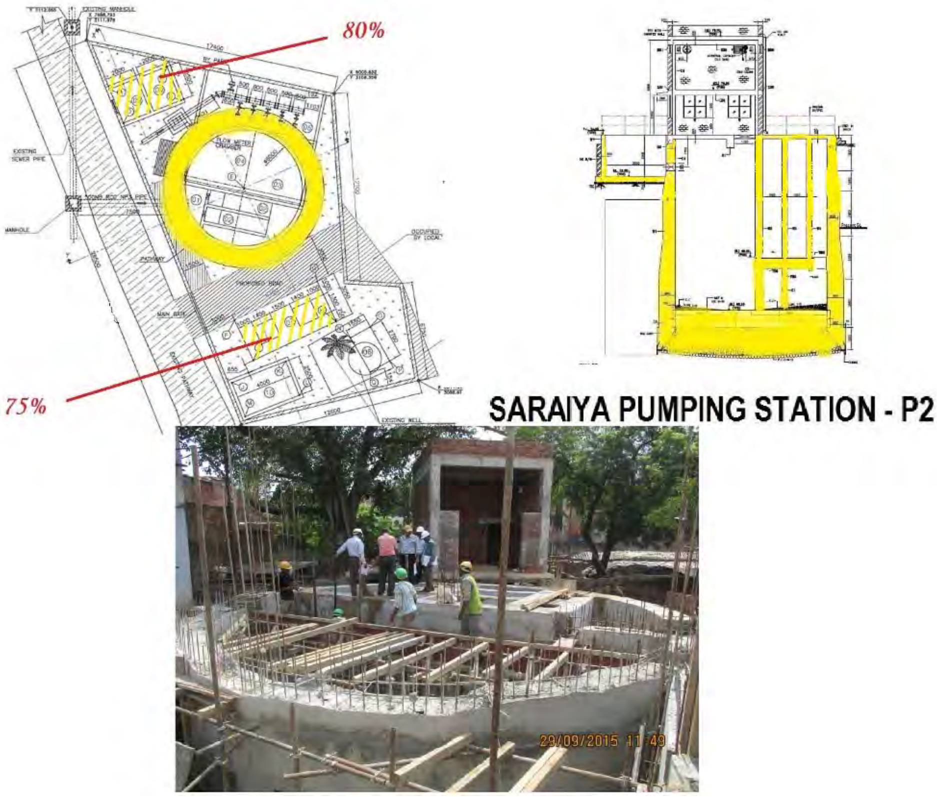
Source: Monthly Report Of Project Management Consultants September 2015, JICA-assisted Ganga Action Plan Project (Varanasi) under National Ganga River Basin Authority (NGRBA)

Figure 5.1.6 Ongoing Construction Work on Phulwariya Pumping Station



Source: Monthly Report Of Project Management Consultants September 2015, JICA-assisted Ganga Action Plan Project (Varanasi) under National Ganga River Basin Authority (NGRBA)

Figure 5.1.7 Ongoing Construction Work on Chaukaghat Pumping Station



Source: Monthly Report Of Project Management Consultants September 2015, JICA-assisted Ganga Action Plan Project (Varanasi) under National Ganga River Basin Authority (NGRBA)

Figure 5.1.8 Ongoing Construction Work on Saraiya Pumping Station

3) Status of Ongoing Sewerage Works

The current status of existing and ongoing sewer networks and pumping stations in terms of each sewerage system are shown in the following table and the map showing the locations of each facility is shown in **Figure 5.1.9**.

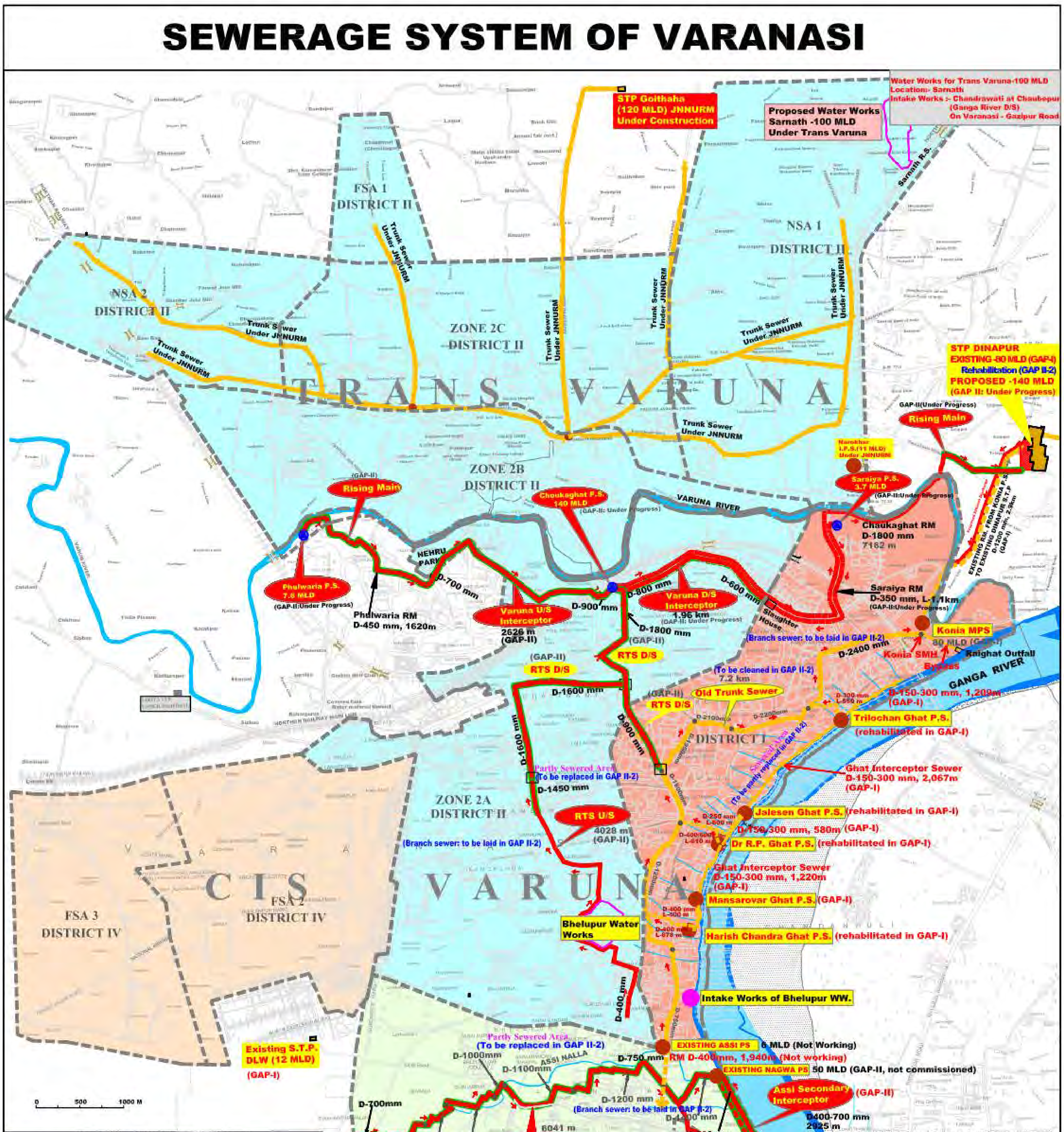
Table 5.1.7 Existing and Ongoing Sewers and Pumping Stations in Varanasi City

No.	Facility	Dimension	Fund	Commissioning	Status as of Nov 2015
(1) Dinapur STP System					
Existing					
1	Old Trunk Sewer (OTS)	Dia 750-2400 7,172m	(UK)	1917	Working but need to be rehabilitated. Cleaning of sands and silts is ongoing before rehabilitation
2	Secondary Sewers	More than 300km	(UK)	N/A	Almost working
3	Ghat PSs (4 nos.)	-	JICA (GAP-I)	1962 (1991)	Working
4	Mansarovar Ghat PS	173 lps	JICA (GAP-I)	1991	Working
5	Ghat Interceptor Sewer	1,184m	JICA (GAP-I)	1991	Working
6	Konia PS (new)	80MLD	JICA (GAP-I)	1992	Working
7	RM from Konia	Dia 1200, 2.9km	JICA (GAP-I)	1992	Working
Ongoing					
1	Phulwaria PS	7.6 MLD	JICA (GAP-II)	<May 2016>	Under construction (Package P2)
2	Phulwaria Rising Main	Dia. 450, 1620m	JICA (GAP-II)	-	Laid but not commissioned (Package P1)
3	Varuna U/S Interceptor	2626m	JICA (GAP-II)	<Aug 2016>	Under construction (Package P1)
4	Choukaghat PS	140 MLD	JICA (GAP-II)	<May 2016>	Under construction (Package P2)
5	Saraiya PS	3.7 MLD	JICA (GAP-II)	<May 2016>	Under construction (Package P2)
6	Saraiya RM	Dia 350mm	JICA (GAP-II)	<Aug 2016>	To be laid (Package P1)
7	Varuna D/S Interceptor	Dia. 600-800mm	JICA (GAP-II)	-	Laid but not commissioned (Package P1)
8	Choukhagat RM	Dia. 1800 mm	JICA (GAP-II)	<Aug 2016>	Under construction (Package P1)
9	RTS D/S	Dia. 900, 1600, 1800mm	JICA (GAP-II)	-	Laid but not commissioned
10	RTS U/S	Dia 400-1450mm	JICA (GAP-II)	<Aug 2016>	Under construction (Package P1)
1 11					
(2) Bhagwanpur STP System					
1	Sewers in BHU campus	Dia. 200-250mm	To be confirmed	1992	Working

No.	Facility	Dimension	Fund	Commissioning	Status as of Nov 2015
(3) Ramna STP System					
1	Assi Interceptor	Dia. 700-1400mm	JICA (GAP-II)	-	Laid but not commissioned
2	Branch sewers for Assi Interceptor	-	JICA (GAP-II)	-	Under construction
3	Existing Nagwa PS	50 MLD	JICA (GAP-II)	-	Constructed but not commissioned
4	RM from Nagwa	7km	JICA (GAP-II)	-	Laid but not commissioned
5	Assi Secondary Interceptor	2,446m	JICA (GAP-II)	-	To be laid
(4) Goithaha STP System					
1	Trunk Sewer	Up to Dia. 2400	JNNURM	-	Laid but not commissioned
2	Secondary Sewer	Dia. 150mm-, Approx. 130km	JNNURM	-	Under construction
		Total 142.5km			

Source: JICA Survey Team based on DPR and interviews to UPJN and GAP-II Project Consultant Team
Note: ( ) means years of renovation/rehabilitation, < > means expected completion at present

GM: Gravity main, RM: Rising main



DETAILS OF EXISTING NALA OF VARANASI				
Drain No.	Drains Joining Ganga	Drain No.	Drains Joining Varuna	Right/Left Bank
1	Nakkha Nala	24	Phulwaria Nala	Right Bank
2	Samne Ghat Nala	25	Sadar Bazar Nala	Right Bank
3	Asi Ghat /Nagwa Nala	26	Raja Bazar Nala	Right Bank
4	Shivala Ghat Nala	27	Tela Nala	Right Bank
5	Harish Chandra Ghat Nala	28	Saraiya / Nakki Ghat Nala	Right Bank
6	Man Sarowar Ghat Nala	29	Central Jail Nala	Left Bank
7	Man Mandir Ghat Nala	30	Chamrautha Nala	Left Bank
8	Pandey Ghat Nala	31	Banaras Nala	Left Bank
9	R.P. Ghat Nala	32	Arderly Bazar Nala	Left Bank
10	Mir Ghat Nala	33	Khajuri Colony Nala	Left Bank
11	Lalita Ghat Nala	34	Hukulganj Nala	Left Bank
12	Manikarnika Ghat Nala	35	Nai Basti Nala	Left Bank
13	Jalesan Ghat Nala	36	Sarang Talab Nala	Left Bank
14	Sankatha Ghat Nala	37	Narokhar Nala	Left Bank
15	Mehta Ghat Nala			
16	Ram Ghat Nala			
17	Panch Ganga Ghat Nala			
18	Brahma Ghat Nala			
19	Lal Ghat Nala			
20	Trilochan Ghat Nala			
21	Telia Ghat Nala			
22	Bhainsasur Ghat Nala			
23	Raj Ghat Nala			

Details of Packages Under JICA Assissted GAP II Project

Package-1	Construction of Assi Interceptor,Assi Secondary Interceptor,Varuna right bank U/S & D/S Interceptor & Rising Main from Choukaghat,Phulwaria & Saraiya P.S.
Package-2	Construction of 3 Pumping Station (Choukaghat,Phulwaria & Saraiya P.S.)
Package-3	Construction of 140 MLD STP at Dinapur & Effluent Conduit
Package-4	Rehabilitation of Old Trunk Sewer
Package-5	Rehabilitation of 5 Ghat P.S., Konia MPS and Bhagwanpur & Dinapur STP

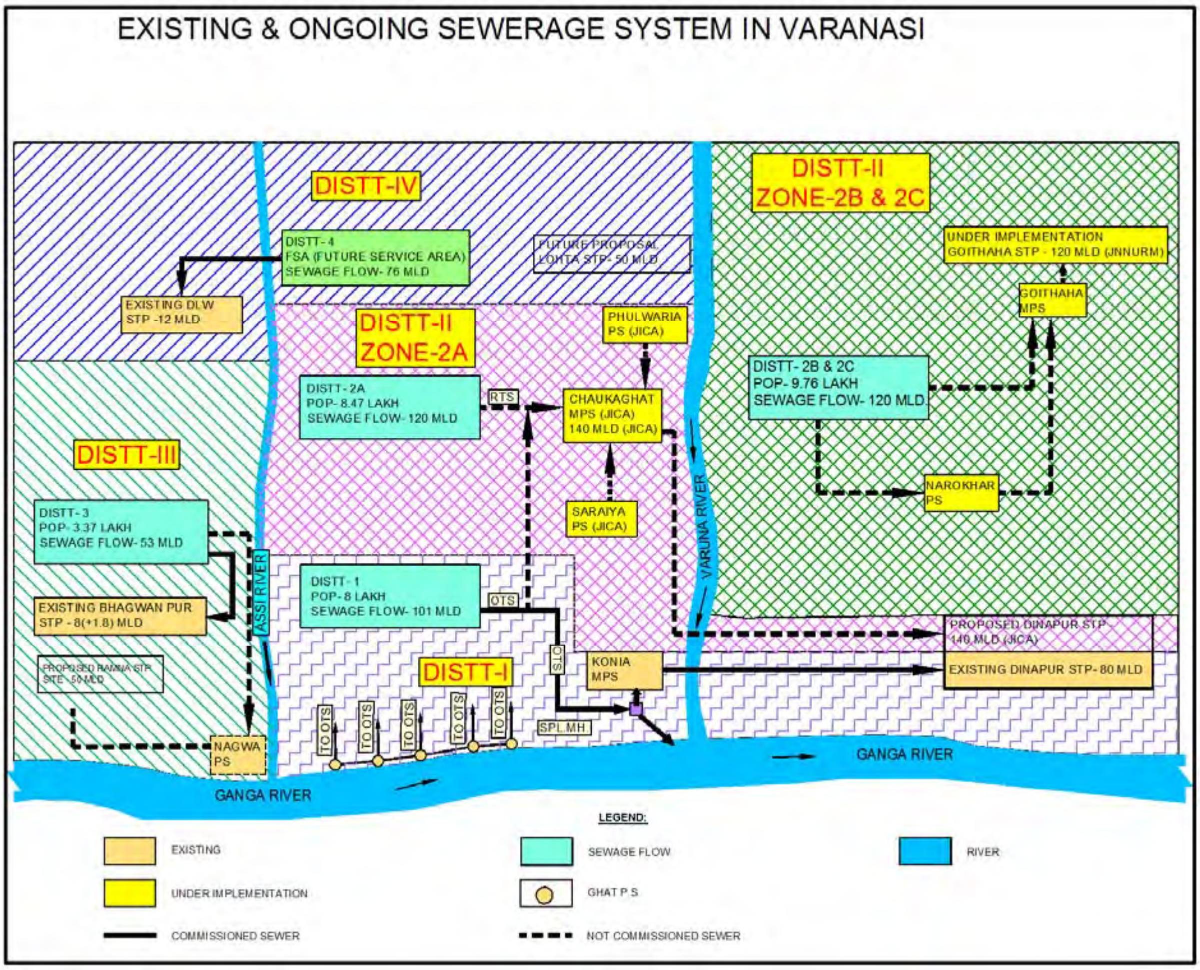
Legend

Gravity Sewer (Proposed)		Ghat P.S.	
Rising Main (Proposed)		River	
Sewer Laid (Not Commissioned)		Drain	
S.T.P		Existing Sewer Line	
Proposed P.S.		Existing Rising Main	

Figure 5.1.9 Existing and Ongoing Sewerage System in Varanasi City

Source: GAP-II Project Team revised by JICA Survey Team

The existing and ongoing sewerage system in Varanasi is shown in the following flow diagram:



Source: GAP-II Project Team revised by JICA Survey Team

Figure 5.1.10 Flow Diagram of Existing and Ongoing Sewerage System in Varanasi City

5.1.3 Existing Sewage Collection and Pumping System in Mirzapur City

1) Sewer

The existing sewage collection and pumping system in Mirzapur City was developed in GAP-I in Mirzapur Zone and in GAP-II in Vindhyachal Zone, and the commissioning years are 1994 and 2008, respectively. The Existing Trunk & Branch sewers in the city are majorly found to be functional according to DPR.

The details of existing sewers are listed in **Table 5.1.8**. According to Mirzapur City Program Implementation Plan under National Urban Health Mission prepared by District Health Officials with support from Urban Health Initiative, the current coverage of sewer network service is around 57%. The existing sewer networks and pumping stations in Mirzapur and Vindhyachal Zones are shown in **Figure 5.1.11**.

After only 7 years from the commissioning, the deterioration of pipes and manholes near IPS-3 pumping station in Vindhyachal Zone was found extremely rapid as observed on the site visit of JICA survey team and opening of manhole.

Table 5.1.8 Existing Sewer in Mirzapur City

(1) Existing Gravity Sewer in Mirzapur Zone					
Sr. No.	Material	Dia. (mm)	Length (m) To be used	To be replaced	Total
1	RCC	200	0	2,168	2,168
2	RCC	250	4,386	443	4,829
3	RCC	300	395	0	395
4	RCC	350	1,356	480	1,836
5	RCC	400	777	0	777
6	RCC	450	601	69	670
7	RCC	500	698	453	1,151
8	RCC	600	634	28	663
9	RCC	700	1,456	0	1,456
10	RCC	800	524		524
11	RCC	900	266		266
12	RCC	1000	582		582
13	RCC	1200	1,721		1,721
		Total Length	**13,396**	**3,641**	**17,037**
(2) Existing Gravity Sewer in Vindhyachal Zone					
Sr. No.	Material	Dia. (mm)	Length (m) To be used	To be replaced	Total
1	RCC	200			
2	RCC	250	408		408
3	RCC	300	320		320
4	RCC	350			0
5	RCC	400			0
6	RCC	450		438	438
7	RCC	500		553	553
8	RCC	600			0
9	RCC	700		85	85
10	RCC	800			
11	RCC	900			
12	RCC	1000			
13	RCC	1200			
		Total Length	**729**	**1,076**	**1,805**
(3) Existing Gravity Sewer Total					
Sr. No.	Material	Dia. (mm)	Length (m) To be used	To be replaced	Total
1	RCC	200	0	2,168	2,168
2	RCC	250	4,794	443	5,237
3	RCC	300	716	0	716
4	RCC	350	1,356	480	1,836
5	RCC	400	777	0	777
6	RCC	450	601	507	1,108
7	RCC	500	698	1,006	1,704
8	RCC	600	634	28	663
9	RCC	700	1,456	85	1,541
10	RCC	800	524		524
11	RCC	900	266		266
12	RCC	1000	582		582
13	RCC	1200	1,721		1,721
		Total Length	**14,125**	**4,717**	**18,842**
(4) Existing Rising Main					
Sr. No.	Material	Dia. (mm)	Length (m) Mirzapur	Vindhyachal	Total
1	DI	80		250	250
2	DI	300		100	100
3	DI	350	1,700		1,700
4	DI	700	1,370		1,370
		Total Length	**3,070**	**350**	**3,420**
(5) Grand Total Sewer			**20,107**	**2,155**	**22,262**

Source: DPR Mirzapur Comprehensive drawing confirmed by JICA Survey Team

2) Pumping Stations

a) Mirzapur Zone

i) Ex.IPS-1

Location: Imambara

Constructed under GAP-I and got commissioned in year 1994.

Rectangular in shape having dry well of 6 m x 3 m size

4 nos submersible pumps of 240 cum/hr

Rising main: Dia- 350mm, Length-1,700m, Material –DI

1 no. transformer 1 no. diesel generator set of 63 kVA

ii) Ex.MPS-2

Location: Kacheri.

Constructed under GAP-I and got commissioned in year 1994.

12.5m dia

5 nos centrifugal pumps of 435 cum/hr.

Rising main: Dia-700 mm, Length-1,370m, Material –DI

1 no. transformer and 1 no. diesel generator set of 160 kVA

3) Vindhyachal Zone

iii) Ex. IPS-3

Location: Near Ram Janki Mandir.

Constructed under GAP-II and got commissioned in year 2008.

Rectangular in shape having dry well of 5.15m x 3.3 m size and

Wet well of 4.45m x 3.05m size

2 nos horizontal pumps w/ 2.5 lit/sec.

Rising main: Dia-80mm, Length-250m, Material –DI

1 no. transformer and 1 no. diesel generator set

iv) Ex. MPS-4

Location: Near STP.

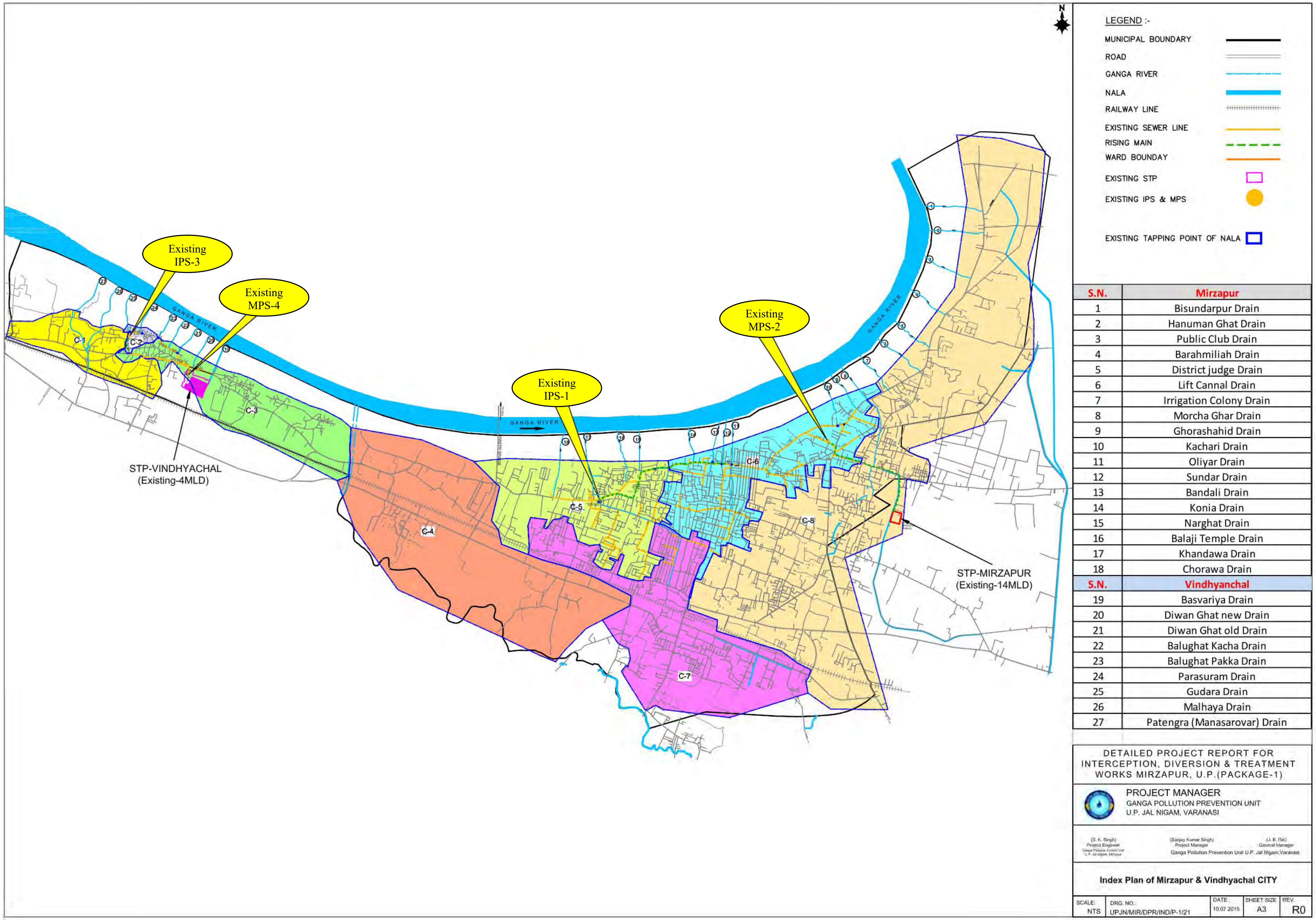
Constructed under GAP-II and got commissioned in the year 2008.

Rectangular 5.15m x 3.30m with wet well of 4.45mx3.05m size

4 nos centrifugal pumps (2 nos of 10 HP & 2 nos of 4 HP).

Rising main: Dia-300mm, Length-100m, Material -DI

1 no. transformer and 1 no. diesel generator set



Source: DPR Mirzapur I&D revised by JICA Survey Team

Figure 5.1.11 Existing Sewerage System in Mirzapur City

5.1.4 Existing Sewage Collection and Pumping System in Ghazipur City

There is no sewerage system as yet in Ghazipur City. The residents have constructed soak pits and septic tanks of their own for sewage disposal. Most of the people have connected to existing drains which discharge to River Ganga.

5.1.5 Existing Sewage Collection and Pumping System in Ramnagar City

There is no functioning sewerage system in Ramnagar. However, around 35 km of sewer/drain pipeline has been laid in the area near Nagar Palika office, which is not working at present. No detail of the system is available and could not be ascertained by topographical survey. At present the sewage is finding its way to Ganges River through open drains.

However, according to the site visit of JICA Survey Team, Ram Bagh Drain of which the outlet is north of Ramnagar works as sewerage system. Ramnagar Nagar Palika explained that the drain was laid around 100 years ago by United Kingdom but the detail drawing does not exist.

5.1.6 Existing Sewage Collection and Pumping System in Chunar City

There is no existing sewerage facilities in Chunar City. All the wastewater generated in the city find its way to nearby drains and ultimately discharges either into river Ganga or river Jargo within the municipality limits.

5.1.7 Existing Sewage Collection and Pumping System in Saidpur City

No sewer system/sewage treatment works exist in the area. For the population residing presently in the Nagar Panchayat Area the septic tanks and soak pits have been constructed. The disposal of effluent and wastewater is delivered into the natural drainage existing in the area through drains. The waste ultimately finds its way into the open fields and larger drains.

However, in some locations such as centre of the city around the Nagal Nigam Office and the nearby areas to Ganges River, some underground drainage facilities with manholes and box culverts/pipes which cross the roads/public spaces can be found. Such structures were constructed in around 15 years ago by Saidpur Nagal Nigam.

5.1.8 Outline of Existing Sewage Collection and Pumping System in Target Cities

Table 5.1.9 shows the abstract of aforementioned existing and ongoing sewer works in target cities.

Table 5.1.9 Abstract of Existing and Ongoing Sewer Works in Target Cities

No.	Item	Material	Dia. (mm)	Varanasi				Mirzapur		Ghazipur	Ramnagar	Chunar	Saidpur
				Dist-I	Dist-II	Dist-III	Other	Mirzapur	Vindhyachal				
A	Sewer (Rm)												
1	Existing & Commissioned												
	1) Gravity	RCC/CI	200		891	N/A		2,168					
		RCC	225	1,873	2,959	9,000							
		RCC/CI	250	0	1,320	8,700		4,829	408				
		RCC	300	4,086	4,644	4,000		395	320				
		RCC	350	0	0			1,836	0				
		RCC	400	0	1,450			777	0				
		RCC	450	671	852			670	438				
		RCC	500	0				1,151	553				
		RCC	600	1,222	2,689			663	0				
		RCC	700	0	1,031			1,456	85				
		RCC	800	0				524	0				
		RCC	900	0				266	0				
		RCC	1000	2,158				582	0				
		RCC	1200					1,721	0				
	Old Trunk Sewer (OTS)	Brick	750-2400	7,172									
	Ghat interceptor sewer	RCC	150-400	6,661									
	Old branch sewers	N/A	N/A	N/A		20,000							
		Sub-total of gravity		23,843	15,836	41,700		17,037	1,805	0	N/A	0	0
	2) Rising Main	DI	80					0	250				
		CI	250	600									
		DI	300					0	100				
		CI	300	550									
		DI	350					1,700	0				
		CI	400	1,158									
		CI	600	530									
		DI	700					1,370	0				
	from Konia MPS	PSC	1200				2,900						
		Sub-total of Rising Main		2,838			2,900	3,070	350	0	0	0	0
		Total of comissioned		26,681	15,836	41,700	2,900	20,107	2,155				
2	Not comissioned												
	(1) Laid sewer												
	1) Gravity	RCC	700			1,090							
		RCC	800			359							
		RCC	900	1,210		801							
		RCC	1000			172							
		RCC	1100			956							
		RCC	1200			1,855							
		RCC	1400			808							
		RCC	1600	2,374									
		RCC	1800	450									
		RCC	2000	1,071									
			Sub-total	5,105		6,041							
	2) Rising Main	DI	1000			7,000							
		Total of laid sewer		5,105		13,041							
	(2) Under execution	RCC	500-1400	4,028									
		RCC	600-800	2,109									
		RCC	700-900	2,626									
		RCC	1000	1,067									
			Sub-total	9,830									
		Total of not comissioned		14,935		13,041							
	(3) JNNURM			-	140km	-							
	Grand total			400+140km				20,107	2,155	0	0	0	0
B	Manhole	-	nos.	N/A	N/A	N/A		N/A	N/A	0	0	0	0
C	House Connection	-	nos.	N/A	N/A	N/A		N/A	N/A	0	0	0	0
D	Pump Station	-	nos.										
1	Existing & Commissioned												
	(1) Used												
	1) MPS			Konia 80MLD				MPS-2 14MLD	MPS-4 4MLD				
			Sub-total	1				1	1				
	2) IPS							IPS-1	IPS-3				
			Sub-total					1	1				
	3) Ghat PS		Sub-total	5	-	-							
		Total of PS comissioned		6	0	0	0	2	2	0	0	0	0
	(2) Not used			-	-	Assi MPS 6MLD	-	-	-				
	(3) Total			7				4		0	0	0	0
2	Not comissioned												
	(1) Constructed					Nagwa 50MLD							
			Sub-total			1							
	(2) Under construction			Saraiya 3.7MLD	Phulwaria 7.6MLD								
					Choukaghat 140MLD								
	Total of PS not comissioned			1	2	1							
			Total of PS	7	2	2		2	2	0	0	0	0
				11				4		0	0	0	0

Source: JICA Survey Team based on DPRs and CDP Varanasi

5.2 Sewage Treatment Plants (STPs)

5.2.1 General

Out of 6 target cities only Varanasi and Mirzapur Cities have existing STP and ongoing work can be found in Varanasi City. In Varanasi, there are three existing STPs, Dinapur STP (80MLD), Bhagwanpur STP (9.8 MLD) and Diesel Locomotive Works (DLW) STP (12MLD). DLP STP is treated sewage from diesel locomotive area in Varanasi only. The total existing and sanctioned (on-going) STP capacity in Varanasi is as follows:

Dinapur STP	80 MLD (under Renovation in Package 5 of GAP II)
	140 MLD (under construction in Package 2 of GAP-II)
Bhagwanpur STP	9.8 MLD (Existing)
Diesel Locomotive Works (DLW) STP	12 MLD (Existing)
Golthaha STP	120 MLD (under construction using JNNURM)
Total in Varanasi	361.8 MLD

The respective summary of exiting STP are described in the following sections.

5.2.2 Dinapur (Varanasi)

Existing 80MLD STP at Dinapur STP was operational in June 1994 under GAP-I. Capacity of Dinapur STP is 80 MLD at average flow and 160 MLD at peak flow condition. The STP is located in Trans Varuna zone and it receives sewage from old trunk sewer via Konia MPS via 1,200 mm dia. rising main. Konia MPS is equipped with screens and grit removal facility. Rehabilitation of Konia MPS is taken up under JICA assisted GAP-II Project. Further, a new 140MLD STP in existing STP area is under progress by GAP-II Project.

A former DPR for upgradation and augmentation of Dinapur & Bhagwanpur STP was prepared by UPJN. UPJN prepared the DPR for the Rehabilitation and Upgradation of 80 MLD Dinapur to 100MLD based on Sequence Batch Reactor (SBR) technology. However, as per Master Plan prepared under JICA study, only rehabilitation was suggested keeping the capacity same as 80MLD.

There are also some mechanical and electrical equipment under renovation/rehabilitation in Package 5 of GAP-II project.

Outline of Existing Dinapur STP is shown below:

Wastewater from District I and part of District II are treated by Trickling Filters and Activated Sludge methods. Actual inflow of wastewater is around 80 to 85 MLD through 1200mm diameter rising main from Konia Pump Station at south.

The treatment process of 80 MLD Dinapur STP is as follows:

- Wastewater is pumped into a wet well
- Solid waste is removed by bar screen
- Sand matter is removed at the Grid Camber
- Volume is measured by parshall flume and then flows into the primary clarifier
- Suspended solids (SS) are removed by the primary clarifier and then flow into the Trickling Filter Tank.
- Further treatment occurs at the Trickling Filter Tank then flows into the Aeration Tank.
- Organic matter is digested by the Aeration Tank. Surface mechanical aeration equipment is used to maintain MLSS (mixed liquor suspended solids) density between 2,500 to 3,500 mg/l and SVI (sludge volume index) between 80 to 120 and then flows into the Final Settling Tank.
- Overflow water from the Final Settling tank is discharge to the outside drain. There is no disinfection process.

- Sludge settled at the Final Settling Tank goes back to the Aeration Tank as a return sludge and used for digestion argent.
- Part of sludge goes back to the Primary Clarifier Tank and flows into the Sludge Digester Tank as Excess Sludge Tank.
- Digested sludge flows to a Sledge Drying Bed and Dries with sunshine.
- Dried sludge is utilised as fertilizer and sold at the price of 115 Rs/m^3.
- Digested gas was utilised for generators as a fuel.

Source: Data Collection and Clarification Study on Improvement of Environment in Varanasi City, Progress Report October, 2015, JICA, Kokusai Kogyo Co., Ltd., Sewerage Business Management Centre

Table 5.2.1 Major Process Units and M&E Equipment of Existing 80MLD Dinapur STP

Item	80MLD Dinapur STP
Head Works	Inlet Chamber Manual Screens Parshall Flume Distribution Chamber
Biological Treatment	Primary Clarifier Roughening Trickling Filter Aeration Tank Secondary Clarifiers
Sludge Treatment	Digesters Gas Holder Sludge Drying Beds
Pump Houses	Raw Sludge Pump House Return Sludge Pump House Treated Effluent Pump House Filtrate Pump House
Mechanical Equipment	Distribution Chamber Manual screens: 2 numbers, gap with 30 mm and 25 mm Primary Clarifier 3 numbers, 31.2 m dia., 3.5 m SWD (Side Water Depth) Sludge collectors with 1.5 kW under being replaced with new motors and gear boxes in Package 5 of GAP-II Trickling filters: 3 numbers with hydraulically driven, 22.5 m dia., 1 m depth, Aeration Tanks: 3 tanks, 60 x 20 m in rectangular x 3.75 SWD 9 aerators (3 at each tank) with 22.5 kW under being replaced in parts of motors and gear boxes in Package 5 of GAP-II,

	Secondary Clarifier 3 numbers, 40 m dia. 3.5 SWD Sludge collectors with 1.5 kW under being replaced with new motors and gear boxes in Package 5 of GAP-II Treated effluent pumps: 6 numbers with 22 kW, dewatering/drain pump: 1 number with 3.75 kW Raw sludge ump: 2 numbers with 22 kW, dewatering/drain pump : 1 number with 3.75 kW Return sludge pumps: 3 numbers with 45 kW under being replaced with new 2 pumps in Package 5 of GAP-II, dewatering/drain pump : 1 number with 3.75 kW Filtrate pumps at drying beds: 1 number with 22 kW, 1 number with 15 kW, 1 number with 11.5 kW, 1 number with 3.75 kW, these four submersible pumps under being replaced with new ones in Package 5 of GAP-II Digester 3 tanks, 3 mixers at each tank with 22 kW, Gas holders: 2 numbers, Wet type in 21 m dia. x 8.7 m H with capacity of 2500 m^3 Gas flare: manual type under being replaced with new one with automation for gas flare Chlorination system: under installation in Package 5 of GAP-II 2 sets of minimum 20 kg/hr capacity, chlorine tonner with 15 day usage, Chlorine adsorption / neutralization system and de-chlorination system
Electrical and Instrumentation Equipment	Transformers: 2 sets with 1200 kVA each 33 kV Switchboards: 5 numbers of panels comprising of 2 incoming panels, 1 bus connection panel and 2 outgoing feeder panels LV Switch boards: LV main switchboard at Sub Station Distribution board and Starter panels at Raw Sludge Pump House, Distribution board and starter panels for 2 primary sludge pumps with 22.5 k W under being replaced with new ones in Package 5 of GAP-II Distribution board and Starter panels at Return Sludge Pump House Distribution board and Starter panels at Treated Effluent Pump House Distribution board and Starter panels at Digester Control Room Distribution board and Starter panels at Filtrate Pump House, Distribution board and starter panels for 4 filtrate pumps under being replaced with new ones in Package 2 of GAP II Dual fuel engine generator sets: 4 sets of 500 kVA 3 sets of AVR for generator set under installation in Package 5 of GAP-II, Power factor correction panel with 8 sets of 50 kVar capacitor banks under in-stallation in Package 5 of GAP-II Level switch under installation in Package 5 of GAP-II at Effluent pump house

Source: Varanasi Dinapur STP & Bhagwanpur STP DPR and Contract Agreement for Package 5 of GAP-II

Photo-1 :

Note)
30-Sep-2015
Varanasi DinapurSTP-1
Trickling Filter

Photo-2 :

Note)
30-Sep-2015
Varanasi DinapurSTP-2
Aeration Tank

Photo-3 :

Note)
30-Sep-2015
Varanasi DinapurSTP-3
Final Sedimentation Tank

Photo-4 :

Note)
30-Sep-2015
Varanasi DinapurSTP-4
Digenstion Tank

Photo-5 :

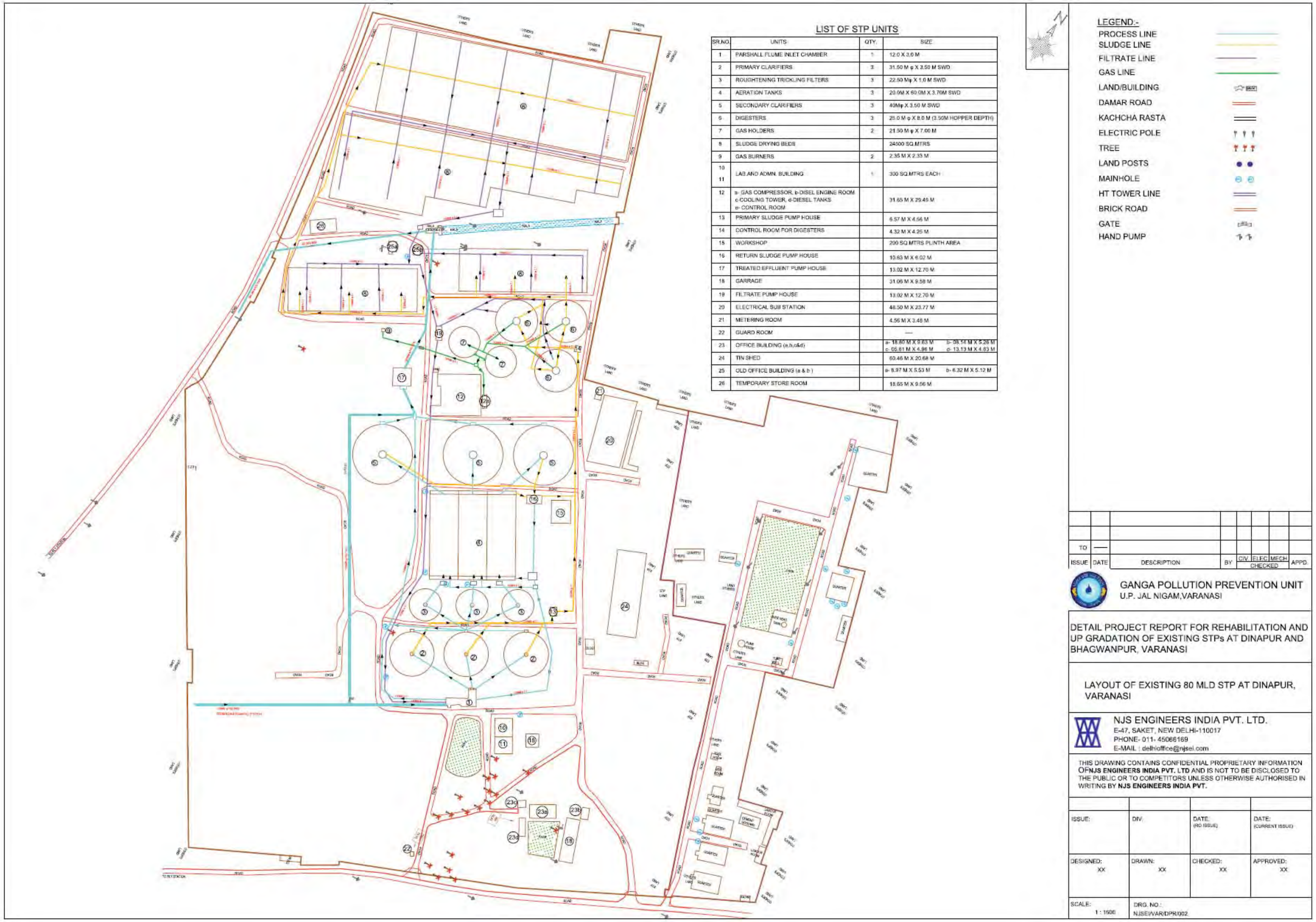
Note)
30-Sep-2015
Varanasi DinapurSTP-5
Drying Bed

Photo-6 :

Note)
30-Sep-2015
Varanasi DinapurSTP-6
Outlet Channel

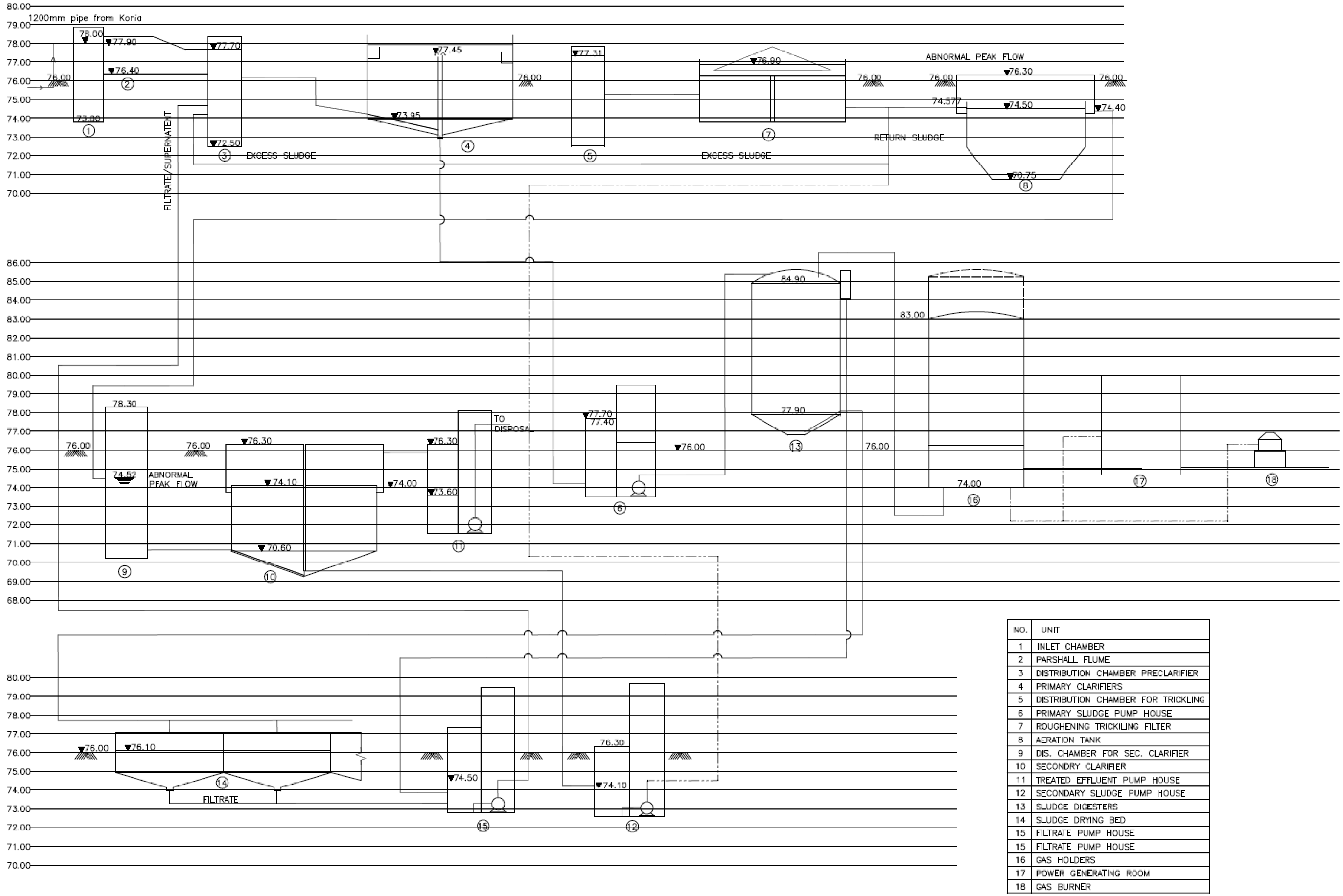
Source: JICA Survey Team

Photo 5.2.1 Existing Dinapur STP



Source: Dinapur & Bhagwanpur STP (Varanasi) DPR

Figure 5.2.1 Layout of Existing Dinapur STP



Source: Dinapur & Bhagwanpur STP (Varanasi) DPR

Figure 5.2.2 Hydraulic Flow Diagram of Existing Dinapur STP

The comments by visit of STP are shown below:

- STP is located away from the city centre, houses around less.
- Based on GAP-II, construction of the new facility is in progress.
- Trickling filter is arranged after the primary clarifier, but this is an old technology of a century ago. Adoption of the current of this system in Japan is none.
- Effluent water quality is clear.
- After digestion and sun-dried, sludge has been effectively used in the peripheral farmers.
- Since no appropriate channel around STP site, effluent water is discharged into the Ganga river through a few km of the discharge culvert.
- No instrumentation device and SCADA system is provided. Therefore, there has instrumentation devices and SCADA system been proposed in DPR for Rehabilitation / Upgradation of Existing sewage Treatment Plants at Dinapur and Bhagwanpur, Varanasi prepared in 2014.

5.2.3 Bhagwanpur (Varanasi)

There are two existing STPs at Bhagwanpur, one with a capacity of 8 MLD and the other with a capacity of 1.8 MLD. 8MLD plant which was commissioned in June 1994 receives sewage from Banaras Hindu University (BHU) campus and Assi SPS. 8MLD capacity is based on Activated Sludge Process and 1.8MLD capacity is based on trickling filter process. Treated effluent discharges upstream of the bathing ghats.

Mater plan recommended no capacity upgradation of Bhagwanpur STP. Bhagwanpur STP will be decommissioned at the end of its useful life. Flow from BHU area will be diverted to Ramna STP (sanctioned under GAP-II) through gravity sewer.

Outline of existing Bhagwanpur STP is shown below:

Wastewater from District III, BHU (Banaras Hindu University) and Assi areas. The 1.8 MLD line was constructed to treat wastewater for BHU but the line was stopped due to a malfunction of the Roughening Trickling Filter as of 22nd Jul 2015.The 8 MLD line adopted the Activated Sludge Process and Treated water is discharged to the surrounding river and some is used for irrigation. Sludge is utilized as fertilizer for agriculture after drying. Actual inflow is 10 to 12 MLD which exceeds the capacity but quality of inflow wastewater is around 60 to 80 mg/l BOD so the quality of treated water is reported within the discharge regulation.

Treatment process of 8 MLD line is as follows.

- Wastewater is pumped into a wet well
- Solid waste is removed by the bar screen

- Sand matter is removed by the Grit Chamber - Volume is measured by parshall flume then flows into the primary clarifier - Suspended solids (SS) are removed a by the primary clarifier then flow into Aeration Tank. - Organic matter is stabilised by the Aeration Tank. Surface mechanical aeration equipment is used to maintain MLSS (mixed liquor suspended solids) density less than 3000mg/l then flows into the Final Settling Tank. - Overflow water from the Final Settling tank is discharged to the outside drain. There is no dis-infection process. - Sludge settled at Final Settling Tank goes back to the Aeration Tank as return sludge and used for digestion argent. - Part of the sludge goes back to the Primary Clarifier Tank and flows into the Sludge Digester Tank as Excess Sludge Tank. - Digested sludge flows to a sludge Drying Bed. - Dried sludge is utilised as fertilizer for farmers free of charge.

Source: Data Collection and Clarification Study on Improvement of Environment in Varanasi City, Progress Report October, 2015, JICA, Kokusai Kogyo Co., Ltd., Sewerage Business Management Centre

Table 5.2.2 Major Process Units M&E Equipment of Existing Bhagwanpur STP

Item	8MLD Bhagwanpur STP
Head Works	Collection Chamber Mechanical and manual Screens Grit Channel with grit pumps and grit washing arrangement Parshall Flume Distribution Chamber
Biological Treatment	Primary Clarifier Aeration Tank Secondary Clarifiers
Sludge Treatment	Digesters Gas Holder Sludge Drying Beds
Pump Houses	Raw Sludge Pump House Recirculation Pump House Filtrate Pump House
Mechanical Equipment	Grit Chamber 2 number of inlet gates with manual sluice type, 2 numbers of manual screen at channel of 2 m L x 1 m H x 0.5 m D 1 number of mechanical screen with vertical one rake type at channel of 2 m L x 1 m H x 0.5 m D 2 numbers of outlet gates at screen channels with manual sluice type, Grit removal equipment comprising 1 number of grit pump with 0.5 kW and 1

	number of grit pump travelling equipment with 1.5 kW replaced in Package 5 of GAP-II 1 number of grit separator with 2.2 kW 1 number of grit conveyer with 1.5 kW 2 numbers of outlet gates at end of parshall flume with sluice gate type Primary Clarifier 2 numbers, 14 m dia., 3.5 m SWD (Side Water Depth) Sludge collectors with 2.2 kW replaced to new motors and gear boxes in Package 5 of GAP-II Aeration Tanks: 2 tanks, 16 m dia. x 3.5 SWD 2 aerators (1 at each tank) with 22.5 kW, Secondary Clarifier 2 numbers, 16 m dia. 3.5 SWD Sludge collectors with 2.2 kW replaced to new motors and gear boxes in Package 5 of GAP-II Raw sludge pump: 2 numbers with 3.7 kW replaced to new pumps and motors in Package 5 of GAP-II,, Return sludge pumps: 3 numbers with 5.5 kW under being replaced with new pumps and motors in Package 5 of GAP-II, Filtrate pumps at drying beds: 2 numbers with 3.7 kW, these two pumps and motors under being replaced with new ones in Package 5 of GAP-II Digester 2 tanks, 1 mixer at each tank with 15 kW under being replaced with new ones in Package 5 of GAP-II, Gas holder: Wet type in 7.5 m dia. x 4.0 m H Gas flare: manual type under being replaced with new one with automation for gas flare Chlorination system: under installation in Package 5 of GAP-II 2 sets of minimum 20 kg/hr capacity, chlorine tonner with 15 day usage, Chlorine adsorption / neutralization system and de-chlorination system
Electrical and Instrumentation Equipment	Transformers: 1 set of 160 kVA LV Switch boards: LV main switchboard at Sub Station Distribution board and Starter panels at Raw Sludge Pump House Distribution board and Starter panels at Recirculation Pump House Distribution board and Starter panels at Digester Control Room Distribution board and Starter panels at Filtrate Pump House, Distribution board and starter panels for 4 filtrate pumps under being replaced with new ones in Package 2 of GAP-II Dual fuel engine generator sets: 2 sets of 70 kVA and 1 set of 125 kVA Synchronizing panel and AMF panel under installation in Package 5 of GAP-II

Source: Varanasi Dinapur STP & Bhagwanpur STP DPR and Contract Agreement for Package 5 of GAP-II

Photo-1 :

Note)
30-Sep-2015
Varanasi BhagwanpurSTP-1
Administration Building

Photo-2 :

Note)
30-Sep-2015
Varanasi BhagwanpurSTP-2
Screening unit

Photo-3 :

Note)
30-Sep-2015
Varanasi BhagwanpurSTP-3
Aeration Tank & Digestion Tank

Photo-4 :

Note)
30-Sep-2015
Varanasi BhagwanpurSTP-4
Aeration Tank

Photo-5 :

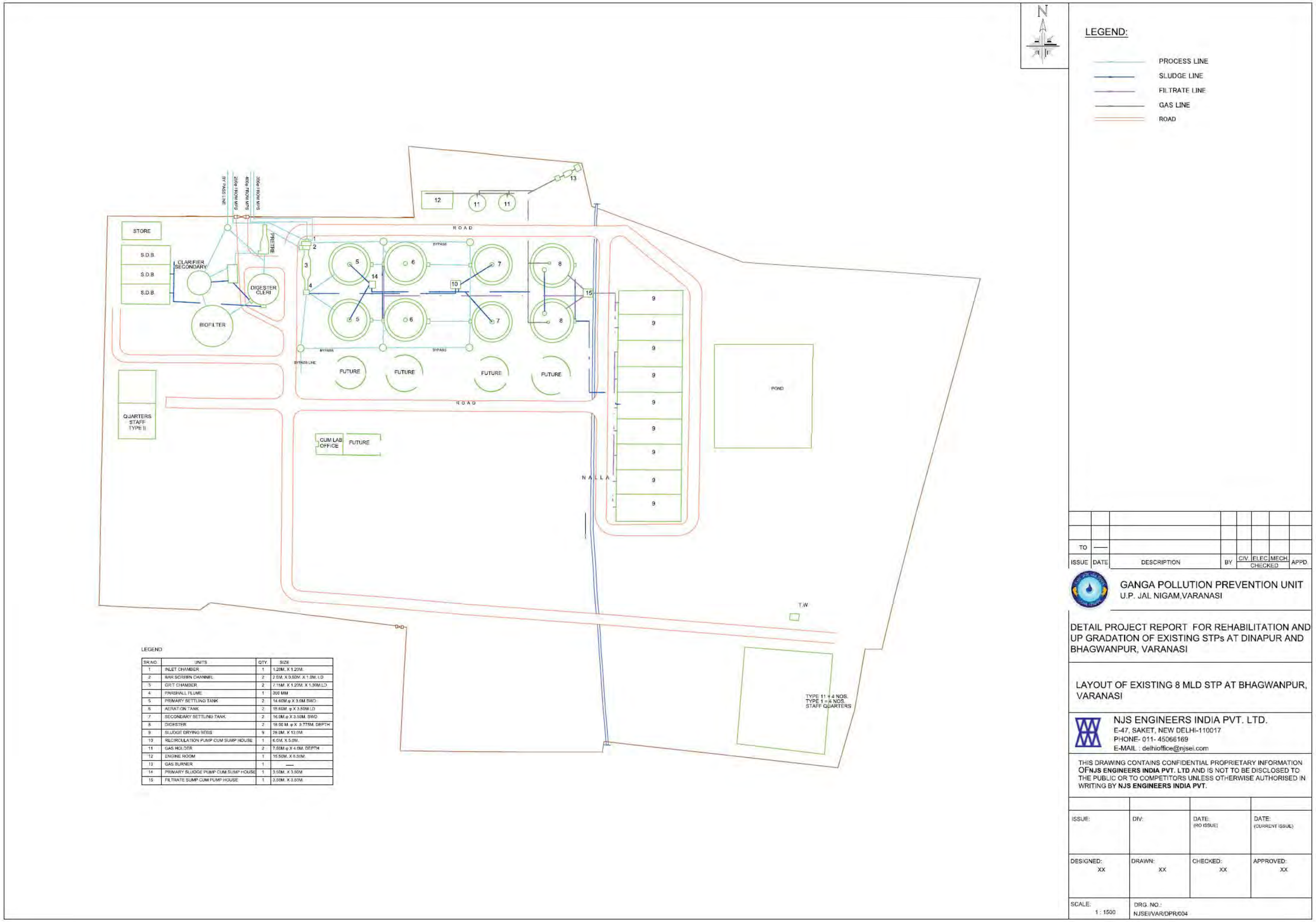
Note)
30-Sep-2015
Varanasi BhagwanpurSTP-5
Aerator

Photo-6 :

Note)
30-Sep-2015
Varanasi BhagwanpurSTP-6
Drying Bed

Source: JICA Survey Team

Photo 5.2.2 Existing Bhagwanpur STP



Note: Hydraulic Flow Diagram is not attached on DPR. *Source: Dinapur & Bhagwanpur STP (Varanasi) DPR*

Figure 5.2.3 Layout of Existing Bhagwanpur STP

The comments by visit of STP are shown below:

- STP is located in the city centre, near to BHU campus, and surrounded by houses or apartments.
- STP site is greened and become oasis of peripheral residents.
- 1 of the 2 series is stopped.
- Since more than 20 years passed since constructed, not only mechanical and electrical equipment but also civil structure is deteriorated, that is, cracking of mortar and concrete is observed.
- No instrumentation device and SCADA system is provided. Therefore, there has instrumentation devices and SCADA system been proposed in DPR for Rehabilitation / Upgradation of Existing sewage Treatment Plants at Dinapur and Bhagwanpur, Varanasi prepared in 2014.

5.2.4 Ongoing Project for STP in Varanasi City

There is a proposed new STP with 140 MLD under construction within the campus of the exiting 80 MLD Dinapur STP in Package 3 of JICA assisted GAP-II project commenced in February 2015 targeting completion in February 2017 by the Contractor of M/S VA Tech WABAG Ltd. And M/S Bahadur. The sewage to be treated in the proposed 140 MLD Sewage Treatment Plant will be pumped from the proposed on-going Chaukaghat Pumping Station. The treated effluent will be conveyed to the discharge point in the Varuna River by a gravity pipeline.

The 140 MLD STP is equipped with the PLC system, which can achieve a fully automatic operation of the STP in accordance with instrumentation devices provided at field processes. Further, the Operator Station based SCADA system may assist for the operating staffs to operate and/or maintain the STP smoothly/effectively through HMI graphics and reports in daily, monthly and yearly basis.

The values of treated effluent quality parameters are as below;

Treated Effluent Parameters	Values
- p H:	6.0 to 8.5
- BOD_5 @ 20 deg C:	20 mg/l
- TSS:	30 mg/l
- Faecal Coliform:	1000 MPN/100 ml
- Residual Chlorine (after chlorine contact tank):	0.2 mg/l

The outline of the on-going 140 MLD Dinapur STP is shown below;

Table 5.2.3 Major Process Units and M&E Equipment of Proposed 140 MLD Dinapur STP

Item	140 MLD Dinapur STP
Head Works	Inlet Chamber Mechanical Screen Manual Screen Distribution Chamber

	Grit Chamber Parshall Flume
Biological Treatment	Primary Clarifier Aeration Tank Secondary Clarifier
Chlorine Contact Tank	Chorine Mixing Tank Chlorine Contact Tank De-chlorination Chamber Outfall Structure
Sludge Treatment	Gravity Sludge Thickener for Primary Sludge DAF Thickener for Waste Sludge Digesters Centrifuge for Digested Sludge Dewatering Gas Holder Gas Flare Gas Scrubber Gas Engine Sludge Drying Beds Plant Drain Sump Plant Water Sump Sulphur Reactor Balancing Tank Settling Tank Sulphur Recovery Thickening Tank
Pump Statins	Primary Sludge Pump Station Return Activated Sludge Pump Station Thickener Sludge Pump House Digester Sludge Pump House
Mechanical Equipment	Inlet Chamber: 1 number, 7.5 m length, 1.6 m width, 3 m depth Motorized inlet gates: 5 numbers, 3.7 kW Motorized Bypass gate at inlet point: 1 number, 3.7 kW Mechanical fine screens: 4 numbers, screenmat type, 4.7 kW, 93.3 MLD Manual screen: 1 number, bar type, 140 MLD Screenings conveyer: 1 number, belt conveyer type, 600 mm wide, 2.2 kW, Motorized outlet gate: 5 numbers, 3.7 kW Motorized Bypass gate at outlet point: 1 number, 3.7 kW Motorized distribution gate at grit basin distribution chamber: 4 numbers, 3.7 kW Grit Chambers: 4 numbers (3 working + 1 standby), Vortex type, 5.5 m dia., Grit chamber mixers: 4 numbers, 1.5 kW, Grit transfer pumps: 4 numbers(3 working + 1 standby), submersible, 36 m^3/h, 5 m, 11 kW, Grit classifiers: 2 numbers, 30 m^3/h, 1.1 kW, Primary clarifier distribution chamber: 1 number, 5.5 m dia., 2.0 m SWD Motorized distribution gates: 4 numbers, 3.7 kW

	Primary clarifiers: 4 numbers, 46 m dia., 3.5 m SWD Sludge scrapers: 4 numbers, Central driven type, 1.5 kW Primary sludge mixer: 1 number, submersible type, 7.5 kW Primary sludge pumps: 3 numbers (2 working + 1 standby), screw type, 32 m^3/h, 15 m, 5.5 kW Primary scum pumps: 2 numbers(1 working + 1 standby), submersible, 20 m^3/h, 10 m, 4.2 kW Aeration Tanks: 4 numbers, 60 m length x 28 m width x 6 m SWD 6 process air blowers (4 working + 2 standby), turbo blower, 8290 Nm^3/h, 0.7 ksc, 200 kW Secondary Clarifier: 4 numbers, 45 m dia., 3.5 m SWD Sludge collectors: 4 numbers, central driven type, 1.5 kW RAS (Return Activated Sludge) Sludge Sump: 1 number, 22 m length x 19 m width x 3.5 m SWD RAS sludge mixer: 2 numbers, submersible type,18.5 kW RAS pumps: 6 numbers (4 working + 2 standby), centrifugal pump,1021 m^3/h, 10 m, 75 kW Waste sludge pumps: 3 numbers (2 working + 1 standby), centrifugal pump, 30 m^3/h, 15 m, 5.5 kW Dewatering/drain pumps: 2 numbers, submersible, 10 m^3/h, 10 m,1.5 kW Secondary scum pumps: 2 numbers(1 working + 1 standby), submersible, 20 m^3/h, 10 m, 4.2 kW Chlorine Contact Tank: 1 number, 32 m length x 33 m width x 4.65 m SWD Chlorination system: 3 numbers, vacuum chlorination type, chlorine dose of 10 mg/l (Maximum), capacity of 30 kg/h (Minimum), Sampling pump, 1 number, 1.5 kW Chlorine agitator: 1 number, turbine type,1.5 kW Chlorine booster pumps: 3 numbers, centrifugal pump, 36 m^3/h, 5 m, 5.5 kW Chlorine leak adsorption blowers: 2 numbers, 3.7 kW Absorbent circulation pumps: 2 numbers, centrifugal pumps, 30 m^3/h, 15 m, 5.5 kW De-Chlorination Chamber: 1 number, 5 m length x 4.5 m width x 4.5 m SWD De-chlorination agitator: 1 number, turbine type, 1.5 kW High pressure pumps for flushing: 2 numbers (1 working + 1 standby), centrifugal pump, 15 m^3/h, 40 m, 5.5 kW Sampling pump, 1 number, 1.5 kW SMBS (Sodium Meta-Bisulphite) tank agitator: 2 numbers (1 working + 1 standby), turbine type,1.5 kW SMBS dosing pumps: 2 numbers (1 working + 1 standby), metering type, 600 l/h, 2.5 kg, 0.55 kW Gravity sludge thickeners: 18 m dia., 4 m SWD Sludge scraper: 2 numbers, central driven type, 1.1 kW DAF thickeners: 2 numbers (1 working + 1 standby), 12.0 m dia., 4.5 m SWD DAF skimmer assembly: 2 numbers, 1.5 kW DAF revolving assembly: 2 numbers, 1.5 kW

	DAF recycle pumps: 4 numbers, centrifugal pump, 100 m^3/h, 65 m, 30 kW DAF Compressors: 2 numbers, reciprocating type, 100 Nm^3/h, 6.5 ksc, 18.5 kW Thickened sludge mixer: 1 number, submersible type, 7.5 kW Thickened sludge pumps: 6 numbers (4 working + 2 standby), screw pump, 10 m^3/h, 25 m, 3.7 kW Digesters: 4 numbers, anaerobic mesophilic sludge digestion, 22 m dia., 10 m SWD Digester recirculation pumps: 8 numbers (4 working + 4 standby), centrifugal pump, 30 m^3/h, 30 m, 3.7 kW Gas mixing compressor: 8 numbers (4 working + 4 standby), 1200 Nm^3/h, 12 m WC, 75 kW Digested sludge mixer: 1 number, submersible type,7.5 kW Digested sludge pumps:: 5 numbers (3 working + 2 standby), screw pump, 19 m^3/h, 25 m, 5.5 kW Centrifuge: 4 numbers (3 working + 1 standby) Main drives: 4 numbers, 37 kW Back drives: 4 numbers, 2.2 kW Poly dosing mixers: 2 numbers (1 working + 1 standby), turbine type, 2.2 kW Poly dosing pumps:: 5 numbers (3 working + 2 standby), metering pump, 1100 l/h, 2.5 kg, 0.55 kW Biogas utilization facilities Biogas holder: 2 numbers, Membrane type Biogas blowers: 2 numbers (1 working + 1 standby), PD type, 30 kW Gas flares: 2 numbers (1 working + 1 standby), self-aspirating type, 950 m^3/h Biogas scrubber: 1 LS, 950 m^3/h Spray water pumps: 2 numbers (1 working + 1 standby), centrifugal pump, 15 kW Sludge pumps: 2 numbers (1 working + 1 standby), centrifugal pump, 0.75 kW Caustic soda dosing pumps: 2 numbers (1 working + 1 standby), metering pump, 5.5 kW Air blowers for sulphur reactor: 2 numbers (1 working + 1 standby), PD type, 670 Nm^3/h, 0.5 ksc, 15 kW Gas engine with power generator: 3 numbers, biogas engine type, 853 kW, Heat exchanger: 3 numbers, plate and frame type, 300 kW, Water softener: 1 number, 3.7 kW Hot water tank: 1 number, 2.5 m dia. x 2.9 m height Hot water recirculation pumps: 2 numbers (1 working + 1 standby), centrifugal pump, 60 m^3/h, 50 m, 15 kW Engine cooling water pumps: 3 numbers (2 working + 1 standby), centrifugal pump,1.5 kW CT water recirculation pumps: 6 numbers (3 working + 3 standby), centrifugal pump, 1.5 kW Cooling tower fan: 3 numbers (2 working + 1 standby), 1.5 kW Plant drain sump: 1 number Plant drain pumps:: 2 numbers (1 working + 1 standby), submersible pump, 55 kW Plant Water Sump: 1 number,

	Plant water pumps: 2numbers, submersible, 250 m^3/h, 15 m, 18.5 kW Service water facilities Utility water transfer pumps: 2 numbers (1 working + 1 standby), centrifugal pump, 5 m^3/h, 20 m, 1.5 kW Borewell pumps: 2 numbers (1 working + 1 standby), borewell type, 20 m^3/h, 20 m, 2.2 Kw
Electrical, Instrumentation and SCADA system	Transformers: 2 sets with 3150 kVA each, 11/0.415 kV 11 kV Switchboards: 7 panels comprising of 2 incoming panels, 1 bus connection panel and 4 outgoing feeder panels LV Switch boards: LV main switchboard at Sub Station, 2 incomers with 5000 A ACBs, 2 incomers with 4000 A ACBs, 1 bus coupler with 5000 A ACB, outgoing feeders of 5 AVBs with 1600 A, 4 ACBs with 1000 A, 1 ACB with 800 A and 17 MCCBs, Power factor correction panels: 2 panels with 425 kVar capacitor banks each, Gas engine auxiliary panel for driving gas engine auxiliary components MCC-1 panel for driving secondary sludge related components, gas flare, gas scrubber, MCC-2 panel for driving primary clarifier related components, MCC-3 panel consisting of outgoing feeders for process air blowers, starters for driving process air blower related components, MCC-4 panel for gravity sludge thicker, plant drain system, centrifuge (dewatering units) including chemical dosing equipment and return sludge pump related components, MCC-5 panel for driving DAF facility, Chlorination and de-chlorination system, digester recirculation pumps and gas mixing compressor related components, Distribution boards for building services and other facilities, Gas engine power control centre panel, DC power equipment: 1 set consisting of; DC batteries with Nickel cadmium type, 110 V Battery charge with 110 V 110 V distribution board Biogas engine generator set: 4 numbers, synchronous alternator, 835 kW each, 415 V, 3 phase, 50 Hz, Instrumentation devices arranged as follow; Ultrasonic type differential level transmitter for mechanical screen, 4 numbers, Ultrasonic type level-flow converting flow meter at Parshall fume, 1 number Electro-magnetic flow meter on common discharge header of primary sludge pump, 1 number, DO meters with 2 numbers at each aeration tank, 8 numbers in total Ultrasonic type flow meter on air supply pipe at each aeration tank, 4 numbers Ultrasonic type flow meter on common header od process air blowers, 1 number Pressure transmitter on air supply pipe to each aeration tank, 4 numbers, Temperature transmitter on air supply pipe to each aeration tank, 4 numbers, Electromagnetic flow meter on common discharge header of RAS (Return Activated

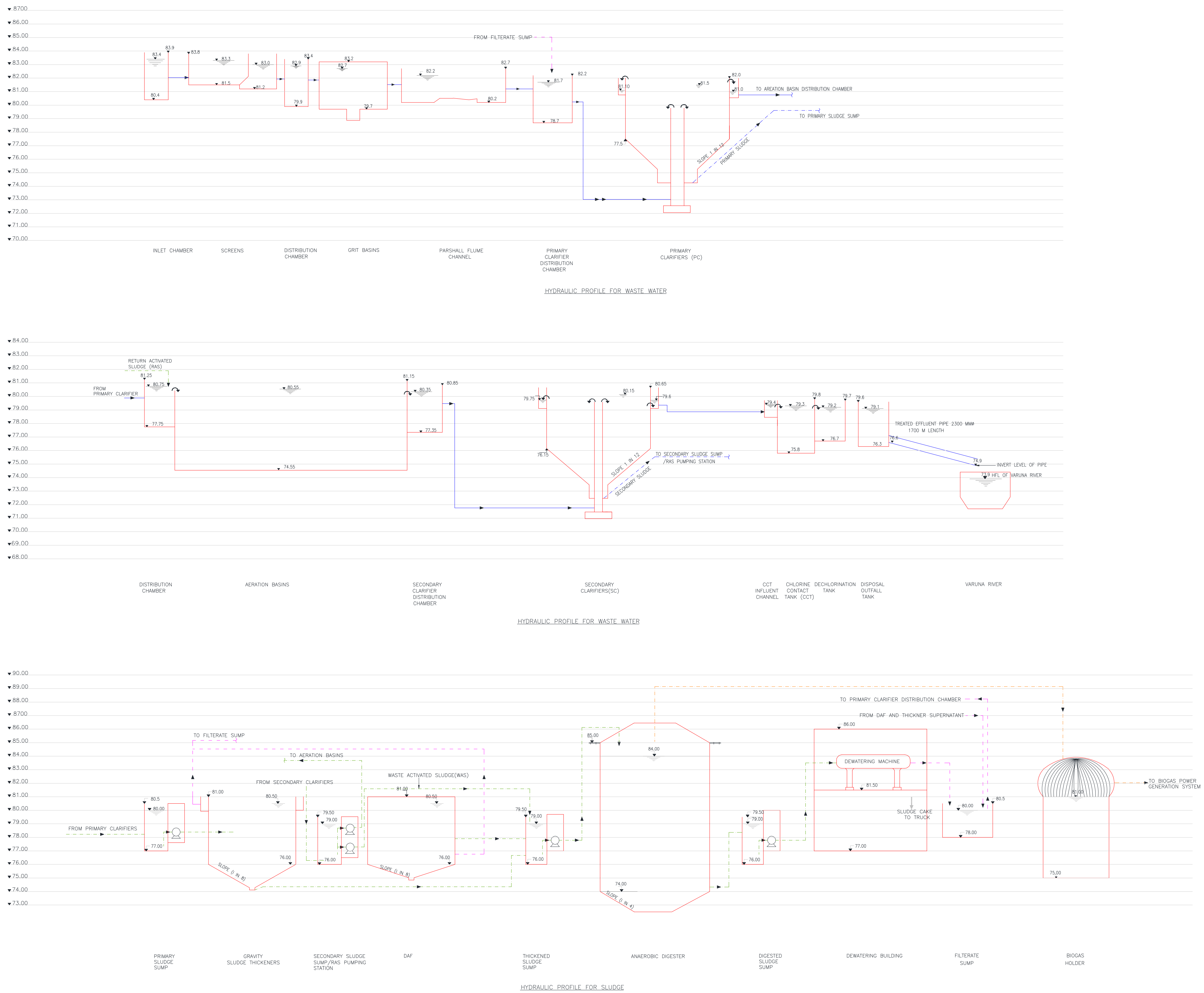
	Sludge) pumps, 1 number, Electromagnetic flow meter on common discharge header of WAS (Waste Activated Sludge) pumps, 1 number, Ultrasonic type level transmitter at secondary sludge sump, 1 number Level switches at secondary scum sump, 1 set of LL, L, H, and HH, Residual chlorine meter at chlorine contact tank and de-chlorine tank, 2 numbers, Ultrasonic type level transmitter at thickened sludge sump, 1 number Electromagnetic flow transmitter on each digested sludge feed line to centrifuge, 4 numbers Temperature transmitter at each anaerobic digester, 4 numbers, Level transmitter at each anaerobic digester, 4 numbers, Pressure transmitter at each anaerobic digester, 4 numbers, Ultrasonic type flow transmitter on each gas mixing line of digester, 4 numbers Pressure transmitter on each gas mixing line of digester, 4 numbers Pressure transmitter on each gas holder, 2 numbers Ultrasonic type level transmitter at each gas holder, 2 numbers Ultrasonic type flow transmitter on each biogas feed line to gas holder, 2 numbers Temperature transmitter at each gas holder, 2 numbers, Ultrasonic type flow transmitter on biogas feed line to scrubber, 1 numbers, Ultrasonic type flow transmitter on biogas feed line to each gas engine, 3 numbers, Electromagnetic flow transmitter on each digester sludge heating line, 4 numbers Electromagnetic flow transmitter on common discharge header of hot water recirculation pumps, 1 number Ultrasonic type level transmitter at digested sludge sump, 1 number Ultrasonic type level transmitter at each polymer dosing tanks, 2 numbers, Electromagnetic flow transmitter on each polymer doing line to centrifuge, 4 numbers Ultrasonic type level transmitter at plant drain sump, 1 number Level switches at plant drain sump, 1 set of LL, L, H, and HH, Electromagnetic flow transmitter on common discharge header of plant drain pumps, 1 number, Electromagnetic flow transmitter on plant service water lines, 2 number, SCADA system PLC based instrument control panel: Redundant hot standby configuration of power supply and CPU 3 sets of RIO panels for receiving/transmitting from/to field process Operator station function as HMI, engineering, SCADA system, reporting, Printers for reporting and alarms, Ethernet Hub switch

Source: Contract Agreement for Package 3 of GAP-II

PACKAGE -3 , 140 MLD STP AT DINAPUR VARANASI				
Civil Item				
S. No.	Item	Qty.	Working	Stand by
1	Inlet Chamber	1	1	0
2	Machanical Fine Screen	4	3	1
2A	Manual Fine Screen	1	1	0
3	Distribution Chamber	1	1	0
4	Grit separated	4	3	1
5	Pharashall flume	1	1	0
6	Distribution Chamber	1	1	0
7	Primary Clarifier	4	4	0
8	Distribution Chamber	1	1	0
9	Aeration Tank	4	4	0
10	Distribution Chamber	1	1	0
11	Secondary Clafifier	4	4	0
12	Treated Effluent Channel	1	1	0
13	Chlorination room / Chlorine Dosing Building	1	1	0
14	Chlorine Tonner Shed	1	1	0
15	Primary Sludge Sump	1	1	0
16	Primary Sludge Pump House (two floor)	1	1	0
17	Secondary Sludge Sump	1	1	
18	Secondary Sludge Pump House (two Floor)	1	1	0
19	Sludge Thickner	2	2	0
19A	DAF	2	2	0
20	Thickned sludge sump	1	1	0
21	Thickned sludge pump house	1	1	0
22	Anarobic Digester	4	4	0
23	Digester sludge sump	1	1	0
24	Digester sludge pump house	1	1	0
25	Filterate sump	1	1	0
26	Filterate pump house	1	1	0
27	Biogas holder	2	2	0
28	Chlorine Contact Tank Inlet Chamber	1	1	0
29	Chlorine Contact Tank	1	1	0
30	Dechlorination Tank	1	1	0
31	"Dewatering (BFP or Centrifuge) -ground Floor (Ground Floor of BFP Room)"	1	1	0
32	BFP Room (First Floor)	1	1	0
33	Service Water Overhead Tank	1	1	0
34	Flaring System- Only Foundation	2	2	0
35	Guard room	2	2	0
36	Aeration Blowers Building	1	1	0
37	Electrical Room for blower	1	1	0
38	HT Panel Room	1	1	0
39	Electrical Authority Room	1	1	0
40	Metering Room	1	1	0
41	Transformer Room - 1	1	1	0
42	Transformer Room - 2	1	1	0
43	MCC Room / LT Panel Room	1	1	0
44	Battery Room	1	1	0
45	Administration Building (Double story)	1	1	0
46	Workshop/Store Room	1	1	0
47	Power generation / Bio Gas Engine Building	1	1	0
48	Electrical Room For Engine	1	1	0
49	Shed for Bio gas Scrubber	1	1	0
50	Parking Shed	1	1	0
51	Substation Area	1	1	0
52	Chemical Building	1	1	0
53	Gas Compressor + MCC	1	1	0
54	Bypass Channel	1	1	0

Source: Contract Agreement for Package 3 of GAP-II

Figure 5.2.4 Layout of Proposed 140 MLD Dinapur STP



Source: Contract Agreement for Package 3 of GAP-II

Figure 5.2.5 Hydraulic Profile of Proposed 140 MLD Dinapur ST

5.2.5 Mirzapur (Mirzapur)

The existing STP at Mirzapur was constructed in 1994 under GAP-I. STP was design based on upflow anaerobic sludge blanket (UASB) process technology followed by polishing pond to achieve BOD: TSS levels as 30: 50 mg/lt. Under NGRBA treated effluent standards have been revised as BOD: TSS 20:30 mg/lt. Also it is desired to provide disinfection of the treated effluent to achieve Faecal Coliform levels less than 10,000 MPN/100ml.

Grit chamber was found not functioning satisfactorily in terms of grit removal and grit removal is presently by manual means. It is proposed to replace the existing grit chambers which shall affect the UASB performance. UASB are not functioning properly in terms of BOD removal. There is no disinfection unit in the existing STP. Plant performance report shows Faecal Coliform levels exceeding the permissible limits.

Outline of Existing Mirzapur STP is shown below:

Table 5.2.4 Major Process Units of Existing Mirzapur STP

Item	14MLD Mirzapur STP
Head Works	Inlet Chamber Grit Chamber Parshall Flume Outlet Chamber Distribution Chamber
Biological Treatment	UASB Reactor
Sludge Treatment	Sludge Drying Beds
Mechanical Equipment	Mechanical screen: 1 number, Sludge sump pump: 1 number, Gas holder: 1 number, Gas burner: 1 number,
Electrical Equipment	LV main switchboard 1 number, consisting of 1 incomer from UPSEB, 3 in-comers from diesel generator sets, bus coupler switches, starter for drain sump pump, outgoing feeders, Diesel generator sets, 1 number of 7.5 kVA, 2 numbers of 15 kVA

Source: JICA Survey Team

Photo-1 :

Note)
4-Dec-2015
MirzapurSTP-1
Grit Chamber

Photo-2 :

Note)
4-Dec-2015
MirzapurSTP-2
UASB Reactor

Photo-3 :

Note)
4-Dec-2015
MirzapurSTP-3
UASB Reactor

Photo-4 :

Note)
4-Dec-2015
MirzapurSTP-4
Channel betwenn UASB Reactor and Oxidation Pond

Photo-5 :

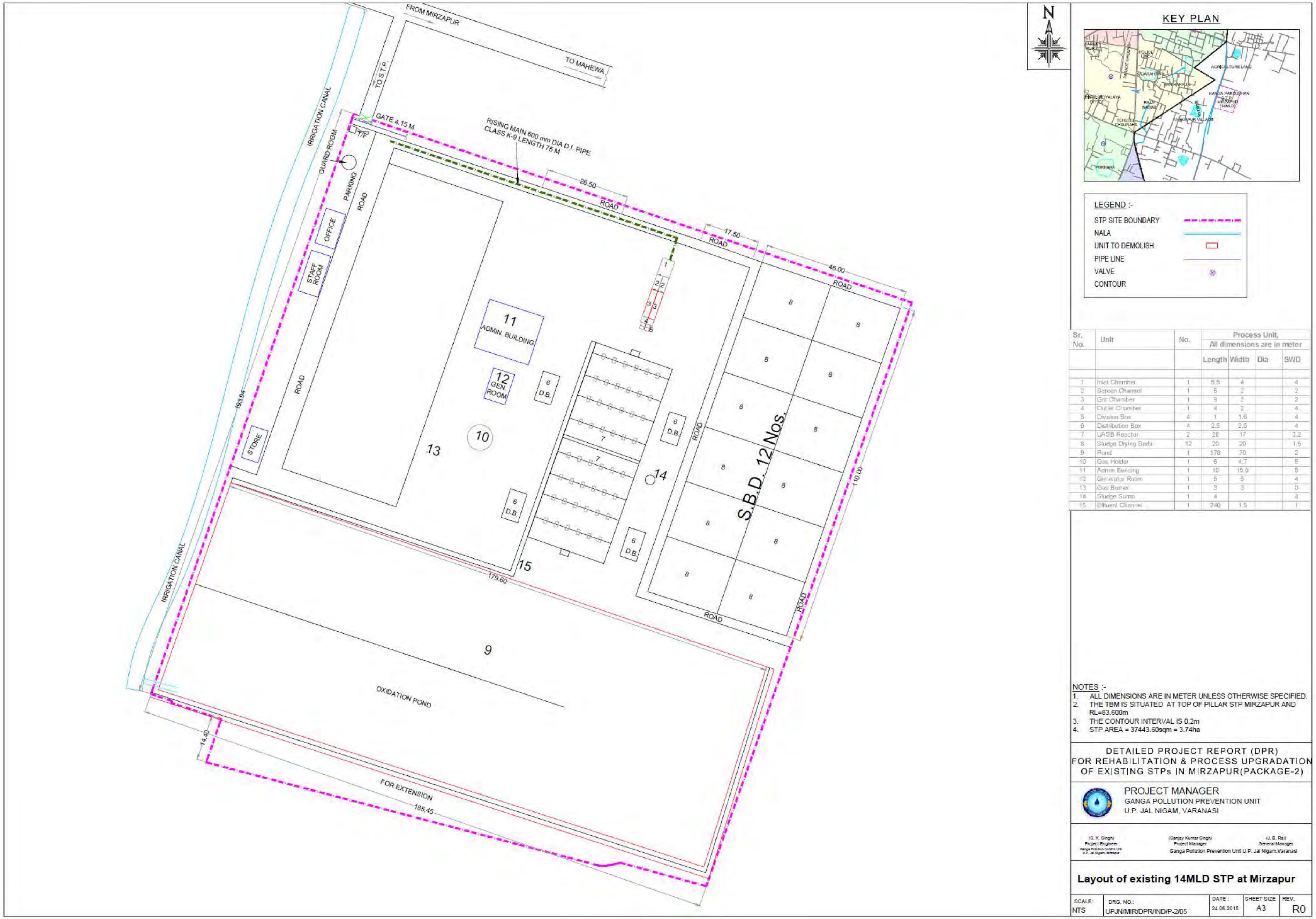
Note)
4-Dec-2015
MirzapurSTP-5
Oxidation Pond

Photo-6 :

Note)
4-Dec-2015
MirzapurSTP-6
Generation Room

Source: JICA Survey Team

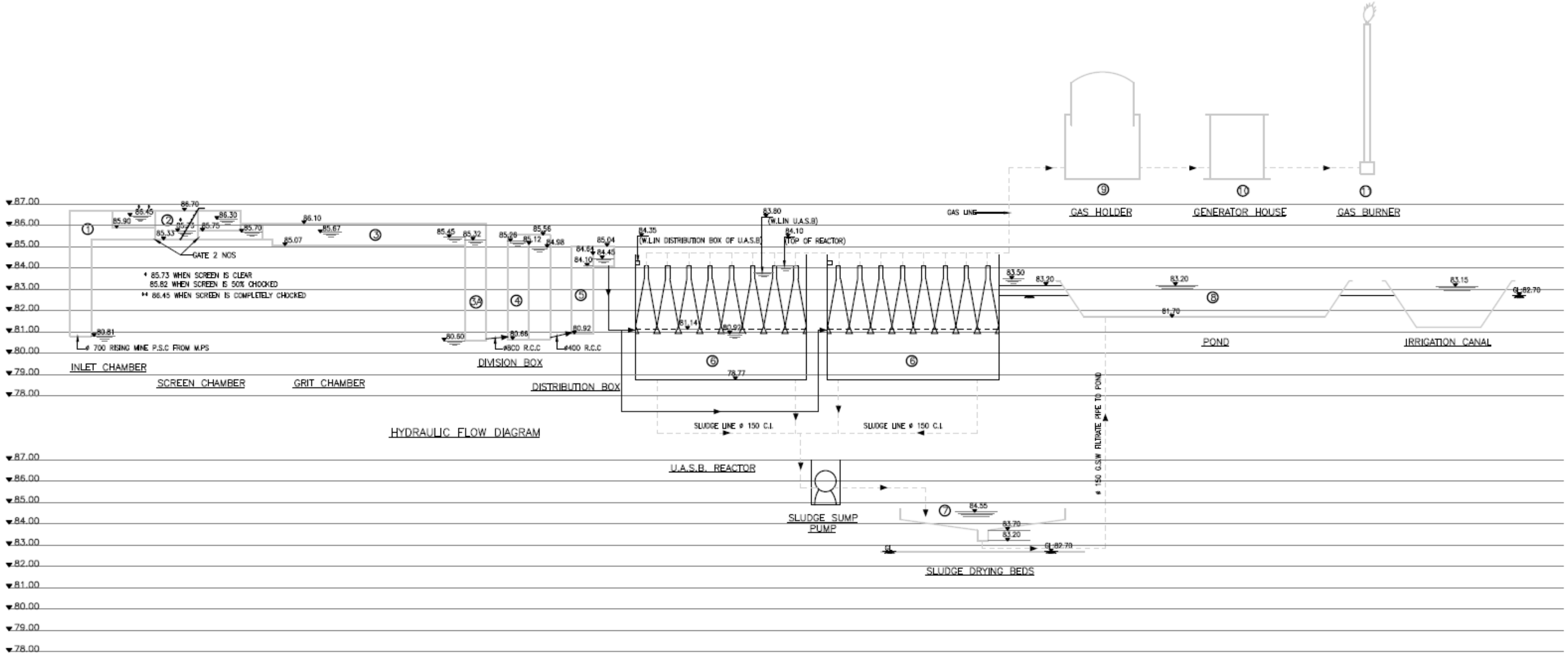
Photo 5.2.3 Existing Mirzapur STP



Sr. No.	Unit	No.	Process Unit, All dimensions are in meter			
			Length	Width	Dia	SWD
1	Inlet Chamber	1	5.5	4		4
2	Screen Channel	1	5	2		2
3	Grit Chamber	1	9	2		2
4	Outlet Chamber	1	4	2		4
5	Division Box	4	1	1.6		4
6	Distribution Box	4	2.5	2.5		4
7	UASB Reactor	2	28	17		3.2
8	Sludge Drying Beds	12	20	20		1.5
9	Pond	1	178	70		2
10	Gas Holder	1	6	4.7		5
11	Admin Building	1	10	15.0		5
12	Generator Room	1	5	5		4
13	Gas Burner	1	3	3		0
14	Sludge Sump	1	4			4
15	Effluent Channel	1	240	1.5		1

Source: Mirzapur DPR

Figure 5.2.6 Layout of Existing Mirzapur STP



Source: Mirzapur DPR

Figure 5.2.7 Hydraulic Flow Diagram of Existing Mirzapur STP

The comments by visit of STP are shown below:

- STP is located away from the city centre, houses around less.
- Since more than 20 years passed since constructed, not only mechanical and electrical equipment but also civil structure is deteriorated, that is, cracking of mortar and concrete is observed.
- On UASB upper part, floating sludge is scraped by human power. From the fact that the poor settling of the sludge, the lack of processing capacity is considered.
- UASB is lower capacity than activated sludge process, and effluent water is suspended and leaves odour.

5.2.6 Vindhyachal (Mirzapur)

The existing STP at Vindhyachal was constructed in 2008 under GAP-II. STP was design based on WSP technology to achieve BOD: TSS levels as 30: 50 mg/l. Under NGRBA treated effluent standards have been revised as BOD: TSS 20:30 mg/l and Faecal Coliform levels less than 10,000 MPN/100ml.

Main process units include Anaerobic Pond, Facultative Pond, and Maturation Ponds. Site Currently, the ponds are not functioning satisfactorily and not giving the requisite results in terms of BOD removal and Faecal Coliform levels were found exceeding the desired levels set by NGRBA.

Outline of Existing Vindhyachal STP is shown below:

Table 5.2.5 Major Process Units of Existing Vindhyachal STP

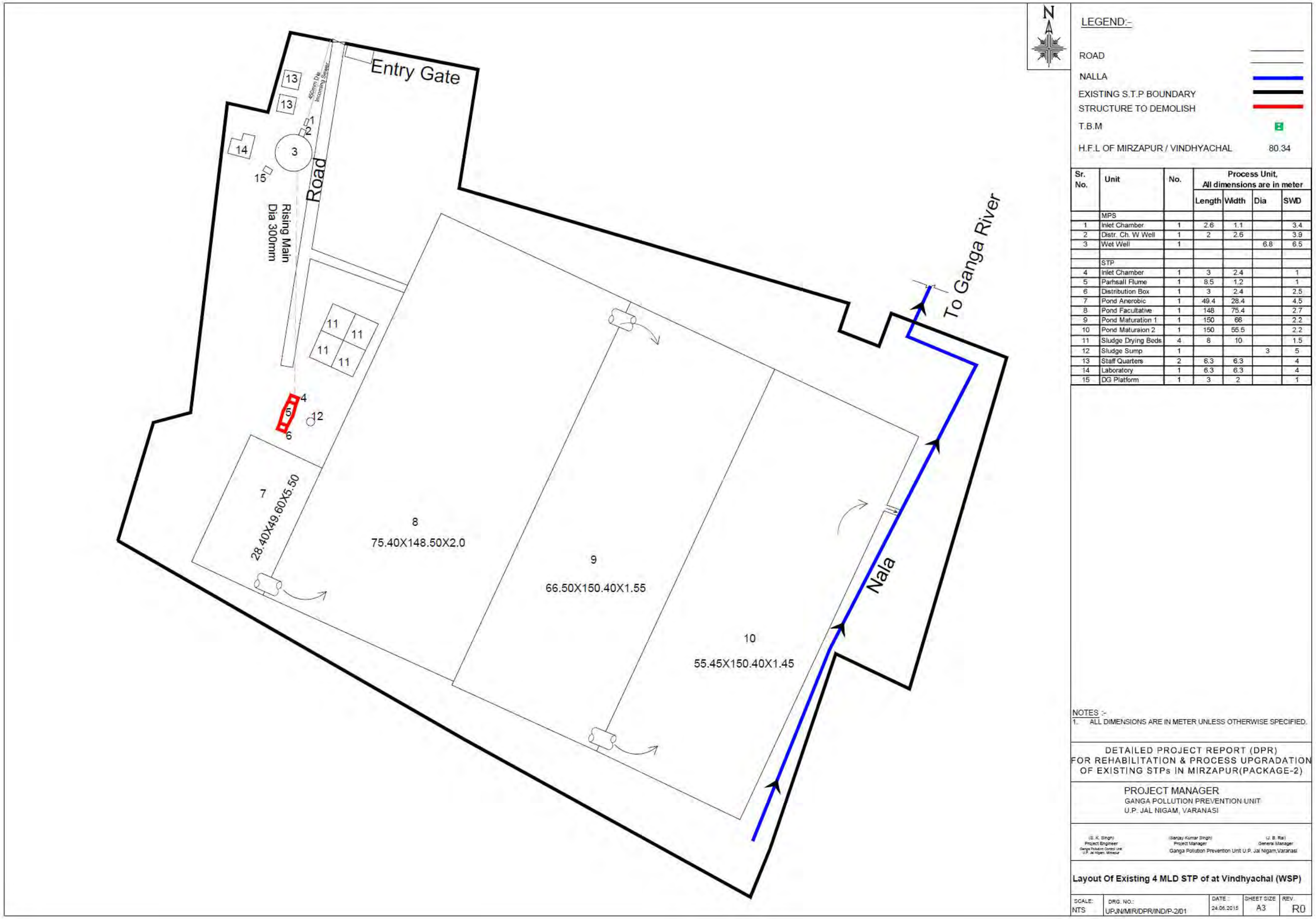
Item	4MLD Vindhyachal STP
Head Works	Inlet Chamber Parshall Flume Distribution Chamber
Biological Treatment	Anaerobic Pond Facultative Pond Maturation Pond
Sludge Treatment	Sludge Drying Beds
Pump Houses	NA

Source: JICA Survey Team

Photo-1 :	Photo-2 :
	
Note) 4-Dec-2015 VindhyachalSTP-1 Entrance Road	Note) 4-Dec-2015 VindhyachalSTP-2 Inlet Chamber and Sludge Bed
Photo-3 :	Photo-4 :
	
Note) 4-Dec-2015 VindhyachalSTP-3 Anaerobic Pond and STP Boundary (Short of sticks is STP area.)	Note) 4-Dec-2015 VindhyachalSTP-4 Aerobic Pond and STP Boundary (Short of walls is STP area.)
Photo-5 :	Photo-6 :
	
Note) 4-Dec-2015 VindhyachalSTP-5 Maturation Pond	Note) 4-Dec-2015 VindhyachalSTP-6 Effluent

Source: JICA Survey Team

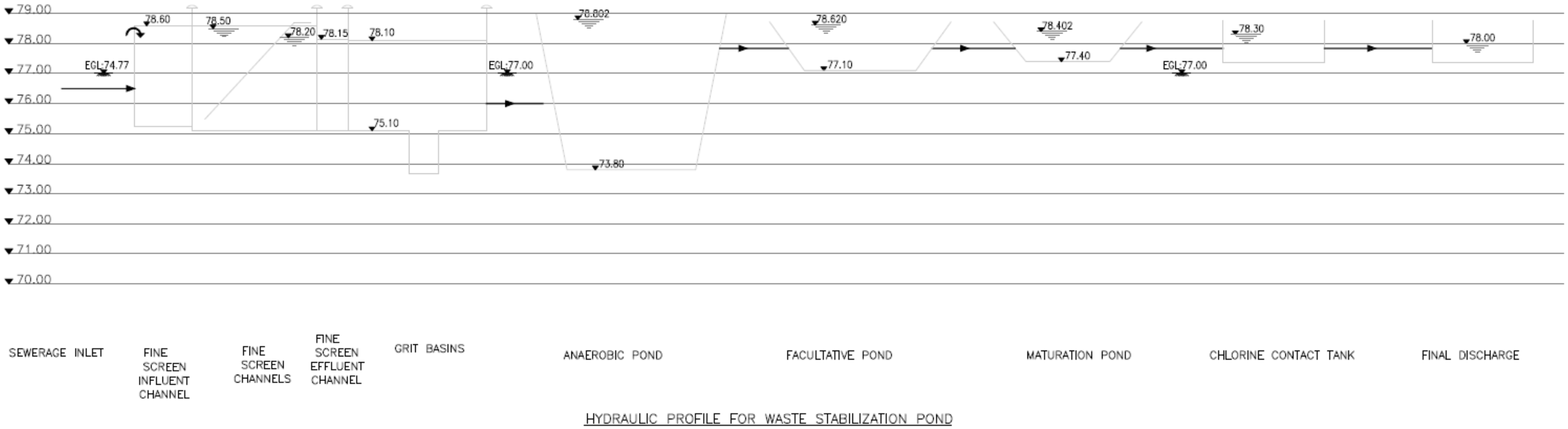
Photo 5.2.4 Existing Vindhyachal STP



Sr. No.	Unit	No.	Process Unit, All dimensions are in meter			
			Length	Width	Dia	SWD
	MPS					
1	Inlet Chamber	1	2.6	1.1		3.4
2	Distr. Ch. W Well	1	2	2.6		3.9
3	Wet Well	1			6.8	6.5
	STP					
4	Inlet Chamber	1	3	2.4		1
5	Parhsall Flume	1	8.5	1.2		1
6	Distribution Box	1	3	2.4		2.5
7	Pond Anerobic	1	49.4	28.4		4.5
8	Pond Facultative	1	148	75.4		2.7
9	Pond Maturation 1	1	150	66		2.2
10	Pond Maturaion 2	1	150	55.5		2.2
11	Sludge Drying Beds	4	8	10		1.5
12	Sludge Sump	1			3	5
13	Staff Quarters	2	6.3	6.3		4
14	Laboratory	1	6.3	6.3		4
15	DG Platform	1	3	2		1

Source: Mirzapur DPR

Figure 5.2.8 Layout of Existing Vindhyachal STP



Source: Mirzapur DPR

Figure 5.2.9 Hydraulic Flow Diagram of Existing Vindhyachal STP

The comments by visit of STP are shown below:

- STP is located away from the city centre, houses around less.
- As less than 10 years since constructed, almost facilities work well except for the manual screen.
- STP site is well maintained by cleaning staffs.
- Less odour, flies in site, and effluent water is clear

5.3 SCADA, GIS and MIS

5.3.1 SCADA System

There is no SCADA system provided in the existing sewerage system at Varanasi municipal corporation and Mirzapur municipal council except for the on-going 140 MLD Dinapur STP in Varanasi.

The local SCADA system is proposed at the 140 MLD Dinapur STP, which is still in progress of construction under JICA assisted GAP II as of May, 2016. A PLC based instrument control panel is proposed for automatic control of the STP process in association of instrumentation devices located at the field the field level, while a PC based SCADA system is proposed at the control room of the administration building.

The PLC is formulated in hot standby redundant CPU and power supply unit to achieve a reliable control system. The PLC controls the STP processes in a sequential control logic and/or a set-point control logic under automatic mode along with instrumentation devices. The PLC also collects the statuses of the plant equipment and the process values through three RIO panels and transmit them to the operator station, which is core component in the SCADA system. The three RIO panels are allocated at the field level such as the headworks, the plant air blower building and the solid/sludge process as auxiliary components under the PLC. The RIO panels interface between the filed level plant equipment and the PLC mounted in the instrument and control panel.

The PC based operator station functions as HMI (Human-machine interface), engineering the system, reporting the plant equipment statuses and process values, alarming the abnormal conditions of the plant equipment and the process values. Further, there are a printer and an Ethernet Hub switch at the control room of the administration building for reporting and alarming, and interconnecting the SCADA system components respectively.

5.3.2 GIS and MIS Components

1) Introduction:-

Under the National e-Governance Plan (NeGP) formulated by the Department of Electronics and Information Technology (DEITY), Department of Administrative Reforms & Public Grievances (DARPG), all municipal corporations, councils or town areas in all the states and union territories of India are committed to provide transparent, accountable and efficient local governance through the use of modern technologies especially in Information technology management and administration fields. Modern ITES oriented systems like “GIS database” & “GIS enabled MIS applications” are highly required to “**integrate all the workflows seamlessly”** for a faster and efficient service to the citizens, employees, and administrators.

"Geographical Information System" and "Management Information System" requirements study for the five municipal departments along the banks of Ganga has been covered under the JICA assisted preparatory survey on Ganga rejuvenation project. The municipal departments that will be covered under the Ganga rejuvenation project are:-

S.No	Urban Local Bodies	Description of each Urban Local Bodies	Existing IT Systems enabled at ULB's.
1	Varanasi Municipal Corporation (Nagar Nigam)	Varanasi city is located at 25.282°N latitude and 82.9563°E longitude. There are 91 wards in the Varanasi city under Varanasi Municipal Corporation. Total ward area is 76.78 SQ-KM. Varanasi has population of 3,676,841 of which male and female were 1,921,857 and 1,754,984.	IT services enabled at VMC are Property Tax, Death/Birth Certificate Complain Book, RTI Enquiry & Online Tender
2	Mirzapur Municipal Council (Nagar Palika Parishad)	Mirzapur is located between 25.139953° N latitude & 82.566639° E longitude. Mirzapur Municipal Council is divided into 35 wards. The total area of Mirzapur municipal council is spread over an area of 2088 Hectare.	No ITES services exist at Mirzapur municipal council.
3	Ramnagar Municipal Council (Nagar Palika Parishad)	Ram Nagar is located at 25.270174° N latitude and 83.030966° E longitude. There are 25 wards under Ramnagar municipal council. Total ward area is spread over an area of 494.66 hectares.	No ITES services exist at Ram Nagar municipal council.
4	Chunar Municipal Council (Nagar Palika Parishad)	Chunar is located at 25.103101°N latitude & 82.871864° E longitude. Chunar municipal council is divided into 25 wards. The Chunar municipal council has population of 37,185 of which 19,647 are males while 17,538 are females.	No ITES services exist at Chunar municipal council.
5	Ghazipur Municipal Council (Nagar Palika Parishad)	Ghazipur is located at 25.578880°N latitude & 83.575403° E longitude. The Ghazipur Municipal Council is divided into 25 wards. The Ghazipur Municipal Council has population of 1,10,698 of which 65,259 are males while 45,439 are females.	No ITES services exist at Ghazipur municipal council.

2) Existing Information Technology Infrastructure
3) presence at five municipal departments:-

Varanasi Municipal Corporation is the only corporation among the list that is using the GIS based property database for the collection of general tax (property tax). This GIS database has been developed few years back using the low/medium resolution satellite Imagery and it desperately needs update in terms of accurate property measurements with the help of latest high resolution satellite Imagery or aerial photographs, and with extensive field based surveys. The High resolution satellite Imagery of the entire Varanasi Urban area has been procured under the PMC-GAP-II Project for developing the detailed base map and asset database of the project components.

Once the proposed GIS enabled MIS systems, and GIS database are developed and implemented through Institutional Development Programme (IDP)-GAP-II project, the revenue generation model of VMC will be four times more than the existing revenue collection. The general tax payments to be made by the public will be based on the exact property area drawn from the updated GIS database.

The other IT enabled services presently available at Varanasi Municipal Corporation are:-

- Online Death/Birth Certificate
- Online Complain Book
- Online RTI Enquiry & Online Tender

There is limited IT Infrastructure availability in other five municipal departments. The ITES system that includes the GIS database & MIS enabled applications for other four municipal departments needs to be designed, developed and implemented from the basic.

4) "National mission mode project on municipalities":-

Under the JnNURM funded "National mission mode project on municipalities", Urban Development Department, Government of Uttar Pradesh (UP-UDD, Lucknow) has developed the e-Municipalities Central application in order to give services to citizens of Uttar Pradesh and employees of Urban Local Bodies. Latest trends and technologies like automatic notifications via SMS, USSD services, Mobile apps for Java/Symbian/Android Phones and IVR Call services etc., have been used to address citizens. It covers:-

- 14 Municipal Corporations commonly referred to as Nagar Nigams
- 195 Municipal Councils commonly known as Nagar Palika Parishads
- 426 Town Areas commonly known as Nagar Panchayats.
-

The mission under this project is to integrate the 75 Districts with 18 Divisional Headquarters, and urban populations of 4.44 crores. Uttar Pradesh has 635 Urban Local Bodies. The mission is to provide the services for citizens are:

- **Services for Citizens**
    - Birth/Death Certificate
    - Public Grievance
    - Tax Payments
    - License Certificates
    - e-procurements
    - RTI

The basic website for Varanasi, Ghazipur and Ram Nagar urban areas under E-Nagar Sewa Portal (UP Scale application) has been developed till date for public viewing. More services are expected to be provided in the near future.

5) Institutional Development Programme (IDP) under the JICA-assisted GAP-II, Varanasi

The Government of India (GoI), through the National River Conservation Directorate has received a loan from the Japan International Cooperation Agency to finance an Institutional Development Project for Uttar Pradesh Jal Nigam (UPJN) and the Jal Kal Vibhag (JKV), a department under the Varanasi Municipal Corporation (VMC). The objective of the Project is the sustainable management, operation and maintenance of current and future water supply and sewerage assets of both JKV-VMC and the UPJN Ganga Pollution Prevention Unit (GPPU) Varanasi, thereby improving the delivery of water supply and sewerage services to the people of Varanasi through organizational and management strengthening measures, training/ capacity development, and infrastructure enhancement.

6) Objective of Consulting Services under the IDP-GAP-II Project:-

The objective of the consulting services under the IDP for Varanasi Urban area is to achieve the efficient , proper preparation and implementation of the Project through the following works:-

1. Formulation of Asset Management Plan (GIS-enabled) for JKV, which includes the preparation of Operations Manual and Preventive and Corrective Maintenance Manual(s) for water supply and sewerage assets under JKV/ VMC and the sewerage assets under UPJN;
2. Design and development of State level GIS-based Management Information System and the required architecture to support the consumer and utility database of all the Urban Local Bodies of Uttar Pradesh, including the VMC/ JKV;

3. Conduct and/or facilitation of various training programs for capacity development of JKV, VMC and UPJN officers and staff, which will include key staff of NRCD and UP Government;
4. Technology transfer and guidance to the Institutional Development Cell (IDC) under UPUDD and co-located in both UPUDD and JKV/VMC.

CHAPTER 6 Water Pollution Status

<Objective of the survey>

Outline of river basin and cities/towns (Varanasi, Ramnagar, Chunar, Mirzapur, and Ghazipur) along the river and sanitary condition/water pollution status were clarified and reconfirmed by field tests and the information from the references

<Result of the survey>

Water balance and discharge, history of water quality change was clarified by field surveys and references. Preliminary water quality analysis was made by Pack test in the field. Field water sampling and analysis work for 100 points was conducted by outsourcing for three times in the dry season and wet season. Sanitary condition in each town and current status of CTCs were also clarified by field survey and confirmation of references.

6.1 Water Pollution of the Rivers in Varanasi

6.1.1 Results of PACK Test

Prior to water quality analysis by subcontractor, JICA study team conducted simple water quality check to the Varuna River, Assi River and Ganges River by using the quick measurement instrument, PACKTEST (Kyoritsu Chemical-Check Lab., Corp.).

1) Location of the sampling points

In the present situation, most of the sewage from populated area is directly discharged to the Var- una River and Assi River through the small drainage channels so called Nalas, and the both flows into the Ganges River. Considering this, the water sampling points are selected as listed in **Table 6.1.1** and shown in **Figure 6.1.1** Location of Water Sampling Points, **Photo 6.1.1**.

Table 6.1.1 Location of Water Sampling Points

Sl. No.	Location		GPS coordinates	Remarks
1	Varuna River	Varuna-	N25.34079°	Upper stream
2		Varuna-	N25.32973°	Lower stream
3	Assi River	Assi -Upper	N25.27422°	Upper stream
4		Assi-Mid	N25.28241°	Midstream
5		Assi -Lower	N25.28267°	Lower stream
6	Ganges River	Ganga-1	N25.28242°	Confluence to Assi River
7		Ganga-2	N25.30594°	Near the main ghat
8		Ganga-3	N25.30923°	Near the main ghat
9		Ganga-4	N25.32952°	Confluence to Varuna River

Conducted on 17th/Oct/2015

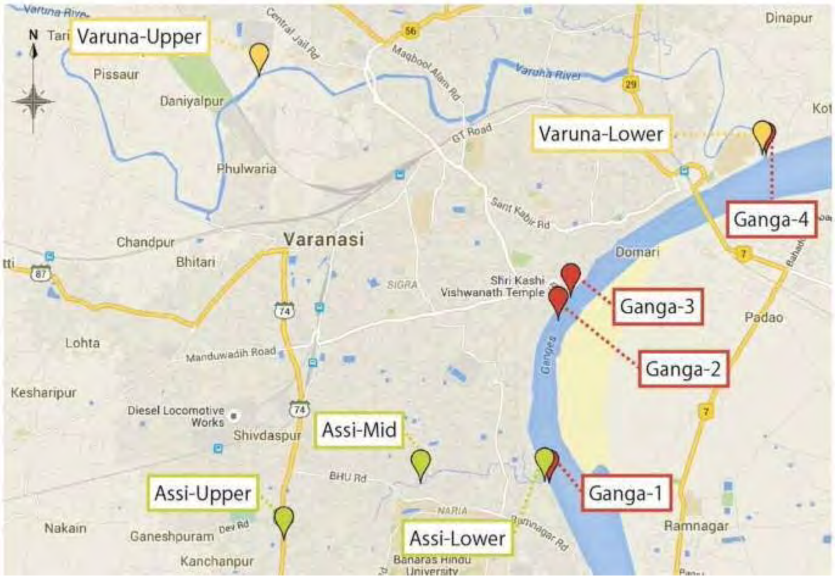


Figure 6.1.1 Location of Water Sampling Points

Photo 6.1.1 Sampling Points

2) Measurement method

PACKTEST utilize absorptiometry from corresponding Japanese official method (i.e. JIS K 0102) for its reaction principle, and is conducted as indicated in **Figure 6.1.2**. This simplified method shows value range of each testing item (**Table 6.1.2**), not actual values, hence the result is used to roughly grasp a water pollution status of the target environment. We checked the fol-lowing items: pH, Chemical oxygen demand (COD), Total nitrogen (T-N), Ammonium (NH_4-N), Nitrate (NO_3-N), and Phosphate (PO_4-P).

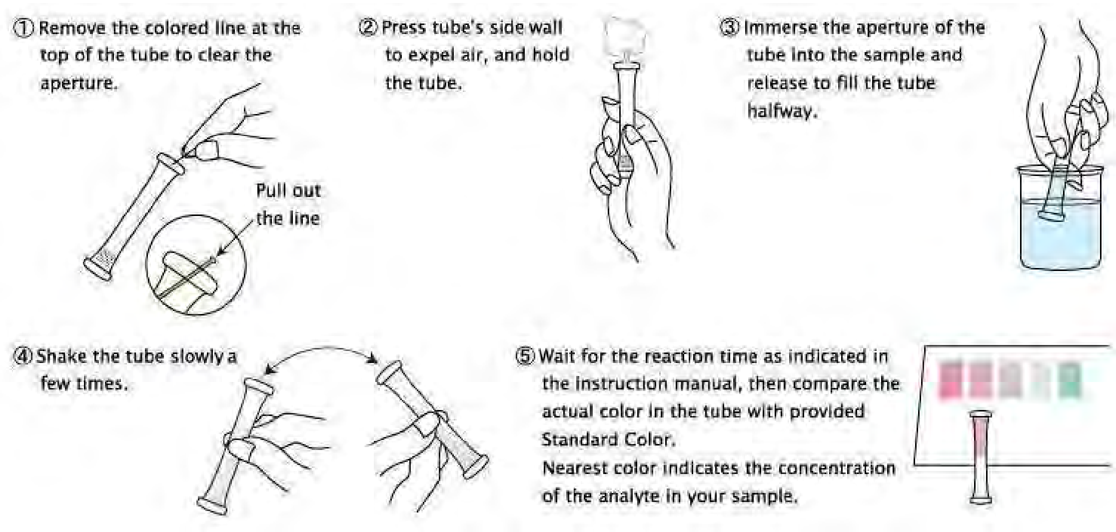


Figure 6.1.2 Implementation procedure of PACKTEST

Table 6.1.2 Measurable range of PACKTEST

Item	Measurable range
pH	5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5
COD	0, 30, 60, 120, 200, 250 mg/L (for High range) 0, 2, 4, 6, 8 mg/L (for Low range)
T-N	0, 5, 10, 25, 50, 100 mg-N/L
NH_4^+	0, 0.5, 1, 2, 5, 10, 20 mg-N/L
NO_3^-	0.2, 0.5, 1, 2, 5, 10 mg-N/L
PO_4^{3-}	0.66, 1.65, 3.3, 6.6, 16.5, 33 mg-P/L

3) Result

The results of PACKTEST checking are shown in **Table 6.1.3**. As for the Varuna and Assi River, the value of each water pollution index, i.e COD, nitrogen and phosphate, implies that sewage without treatment and the disposed waste induce the highly polluted environment.

On the other hand, these values of the Ganges River tends to be low in comparison with the both tributary. It can be said that the pollutant from the Varuna and Assi River is diluted by the large quantity of water after confluence to the Ganges even on dry season.

The sampling point Ganga-1 is located at the upstream side of the two confluence points and Varanasi main-ghat area. Compared to the Ganga-1, COD slightly increases in Ganga-2, 3, 4, suggesting to be impacted by the both confluence and maybe the religious bathing at ghats facing the Ganges.

Central Pollution Control Board (CPCB) regulates water quality standard for rivers by as shown in **Table 6.1.3**. Compared with B class (BOD5: 3 mg/l or less), BOD5 estimated based on inlet quality data of STP slightly exceed the level. However, it is difficult to clear the actual water quality status of target water bodies by this PACKTEST. The detailed 13 parameters shall be clarified by the water quality analysis at sampling points selected in consideration of this result.

Table 6.1.3 Result of Water Quality Check

Sl. No.	Sample	Item							
		Water Temp.	pH	COD (mg/L)	BOD* (mg/L)	T-N (mg-N/L)	NH_4^+ (mg-N/L)	NO_3^- (mg-N/L)	PO_4^{3-} (mg-P/L)
1	Varuna-	32	7.5-8.0	8-30	3.6-13.4	10-25	20	2	1.65
2	Varuna-	29	7.5	8-30	3.6-13.4	10-25	20	0.2	0.66
3	Assi-Upper	30	7.0	8-30	3.6-13.4	10-25	20	0.2	3.3
4	Assi-Mid	30	7.5	8-30	3.6-13.4	10-25	20	0.2	3.3
5	Assi-Lower	27	7.5	8-30	3.6-13.4	10-25	20	0.2	3.3
6	Ganga-1	27	8.0-8.5	6	2.7	0	0.5	0.2	0.66
7	Ganga-2	26	8.0-8.5	8	3.6	0	0.5	0.2	0.66
8	Ganga-3	26	8.0-8.5	8	3.6	0	0.5	0.2	0.66
9	Ganga-4	29	7.5	8	3.6	5	5	0.2	0.66

*BOD: Calculated by COD/BOD (2.24) based on the influent quality data to STPs

Table 6.1.4 Primary Water Quality Criteria Based on Best-Use

Designated-Best-Use	Class of Water	Criteria
Drinking water source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of wild life and fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Source: CPCB

6.1.2 Results of Water Quality Analysis (Sampled on December 8&9, 2015)

To understand the exact situation of water pollution in the River Ganga, forty-eight (48) points are selected for water quality analysis, focusing on the River Ganga, Varuna river, Assi River, Dinapur STP Baghwanpur STP and STP effluent outfalls as shown in **Figure 6.1.3** and エラー! 参照元が見つかりません。.

As found in エラー! 参照元が見つかりません。**4**, the centre flow of the River Ganga has not been affected by the inflow of various wastewater. Since the River Ganga is largely westwards curving in this span, the centrifugal force to push the river flow to the west side works so as to contain the mixing of river water.

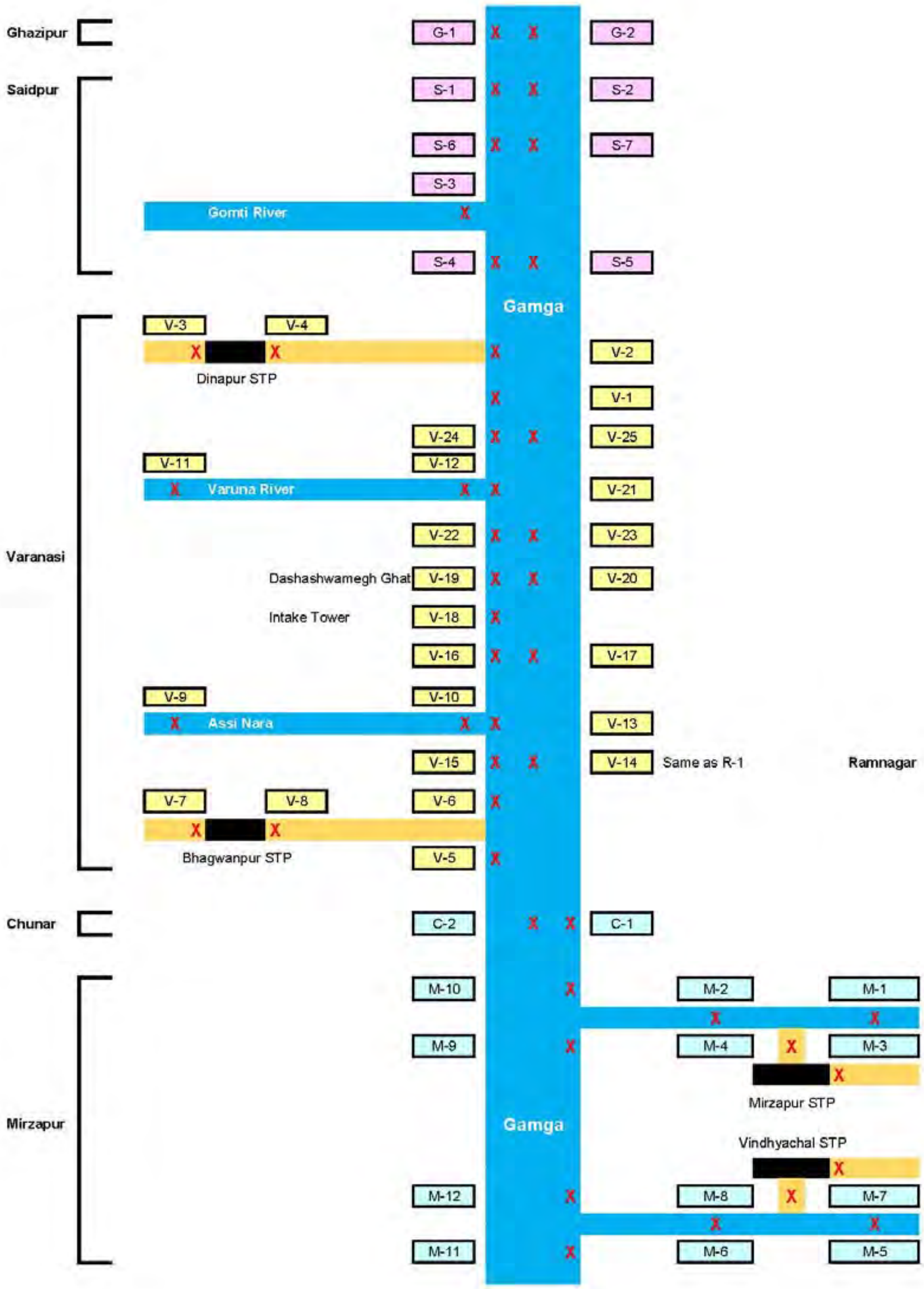


Figure 6.1.3 Location of Sampling Points

Table 6.1.5 Sampling Schedule

Spot					No.	Dec-2015	Mar-2016	Jul-2016	Sum
Chunar	Ganga River			shorefront	C-1		○	○	4
				center	C-2		○	○	
Ramnagar	Ganga River			shorefront	R-1			○	Same as C-14
Mirzapur	Mirzapur STP	Existing	Upstream of STP		M-1		○	○	24
			Downstream of STP		M-2		○	○	
			Raw Sewage		M-3		○	○	
			Treated Sewage		M-4		○	○	
	Vindhyachal STP	Existing	Upstream of STP		M-5		○	○	
			Downstream of STP		M-6		○	○	
			Raw Sewage		M-7		○	○	
			Treated Sewage		M-8		○	○	
	Ganga River		Upstream of Mirzapur STP	center	M-9		○	○	
			Downstream of Mirzapur STP	center	M-10		○	○	
			Upstream of Vindychal STP	center	M-11		○	○	
			Downstream of VIndychal STP	center	M-12		○	○	
Varanasi	Dinapur STP	Existing	Upstream on discharge point of effluent (Ganga)		V-1	○	○	○	54
			Downstream on discharge point of effluent (Ganga)		V-2	○	○	○	
			Raw Sewage		V-3	○	○	○	
			Treated Sewage		V-4	○	○	○	
	Bhagwanpur STP	Existing	Upstream on discharge point of effluent (Ganga)		V-5	○	○	○	
			Downstream of channel on discharge point of effluent (Ganga)		V-6	○	○	○	
			Raw Sewage		V-7	○	○	○	
			Treated Sewage		V-8	○	○	○	
	Assi Nala			upstreatm	V-9	○		○	
				downstream	V-10	○			
	Varuna River			upstreatm	V-11	○		○	
				downstream	V-12	○			
	Ganga River	Assi Nala mouth		shorefront	V-13	○			
		Upstream of Assi Nala mouth		center	V-14	○		○	
				shorefront	V-15	○		○	
		Downstream of Assi Nala mouth		shorefront	V-16	○		○	
				center	V-17	○		○	
		Near Intake Tower		shorefront	V-18	○		○	
		Near Gaht (Dashashwamegh Ghat)		shorefront	V-19	○		○	
				center	V-20	○		○	
		Varuna River mouth		shorefront	V-21	○			
		Upstream of Varuna River mouth		shorefront	V-22	○		○	
				center	V-23	○		○	
		Downstream of Varuna River mouth		shorefront	V-24	○		○	
				center	V-25	○		○	
Saidpur	Ganga River			shorefront	S-1		○	○	14
				center	S-2		○	○	
	Gomty River mouth			center	S-3		○	○	
	Ganga River	Upstream of Gomti River mouth		shorefront	S-4		○	○	
				center	S-5		○	○	
		Downstream of Gomti River mouth		shorefront	S-6		○	○	
				center	S-7		○	○	
Ghazipur	Ganga River			shorefront	G-1		○	○	4
				center	G-2		○	○	
Sum						25	31	45	100

(1) Fist Sampling (December 8 – 9, 2015) (see **Figure 6.1.4-6.1.5)**

DO

The DO concentrations cleared the target water quality of 5 mg/l or more at all points except for the discharge points from the Assi Nala and of the Dinapur STP effluent in the Ganga, while those in the Assi Nala and Varuna River were below the criterion, like 1.5 mg/l at the upstream and 0.8 mg/l at the downstream of the Assi Nala especially.

The DO concentrations ranged from 0.8 to 1.0 mg/l for the STP influent but were recovered to 4.8 - 5.4 mg/l for the effluent

BOD

The BOD concentrations were high especially at discharge points of the Assi Nala as 28.0 mg/l, Varuna River as 7.4 mg/l and Dinapur STP effluent as 17.0 mg/l. The wastewater discharged from the Varanasi urbanized area to the Ganga flows being pushed to the left bank due to the snaking of the Ganga. For this reason, the centre of the Ganga keeps BOD concentrations of below 2 mg/l. The discharge point of the Dinapur STP effluent is located in the closed water body blocked by a sandbank with the domestic wastewater inflow from the surrounding communities, which causes a higher BOD concentration during the dry season

The STP influent had relatively low BOD concentrations of 72.0 mg/l at the Dinapur STP and 62.0 mg/l at the Bhagwanpur STP which was rather below the design influent water quality of 250 mg/l.

The BOD was 42.0 mg/l at the upstream and 83.0 mg/l at the downstream of the Assi Nala nearly to the concentration of STP influent while they were 8.4 mg/l and 6.8 mg/l respectively for the Varuna River. This is caused by the small basin in the urbanized area for the Assi Nala and the big basin in the rural area for the Varuna River.

(2) Second Sampling (March 26 - 28, 2015) (see **Figure 6.1.6-6.1.7)**

DO

The lowest DO concentration in the Ganga was 6.2 mg/l and all the sampling points achieved the DO criterion of 5 mg/l or more

The DO concentrations were less than 1.0 mg/l for the STP influent, while for the STP effluent 4.2 mg/l for Dinapur, 5.7 mg/l for Bhagwanpur, 1.8 mg/l for Mirzapur and 1.8mg/l for Vindhyachal. The difference in the BOD concentrations is attributed to an aeration in a treatment process for Dinapur and Bhagwanpur in Varanasi and no aeration for Mirzapur and Vindhyachal in Mirzapur.

BOD

The highest BOD concentration in the Ganga was 2.4 mg/l and all the sampling points show a BOD concentration of less than 2 mg/l against the criterion of 3 mg/l or less.

In this examination, the influent BODs were also low as 84.0 mg/l for Dinapur, 37.0 mg/l for Bhagwanpur and 58.0 mg/l for Mirzapur except for 240.0 mg/l for Vindhyachal. But the O&M staff of the Vindhyachal STP told that the BOD was usually less than 100 mg/l.

(3) Third Sampling (July 18 - 20, 2016) (see **Appendix 6.1.3)**

In those days, the Ganga has been already swollen with rain and the entrance into the downstream of the intake tower for water supply has been banned. The pontoon bridge has been dismantled and the buoyage has been detained. The Ganga was flooded on August 26, 2016.

Some samples show the unexplainable values of BOD. There might be some problems in water sampling in the swollen river.

	
December 8, 2015	July 26, 2016

Photo 6.1.2 The Ganga during the Dry and Rainy Seasons at the Intake Tower

The results of three water quality examinations are given in **Appendix 6.1.1-6.1.3**.

Figure 6.1.4 Results of 1st Water Quality Examination (DO) (Sampled on December 8-9, 201)

Figure 6.1.5 Results of 1st Water Quality Examination (BOD) (Sampled on December 8-9, 201)

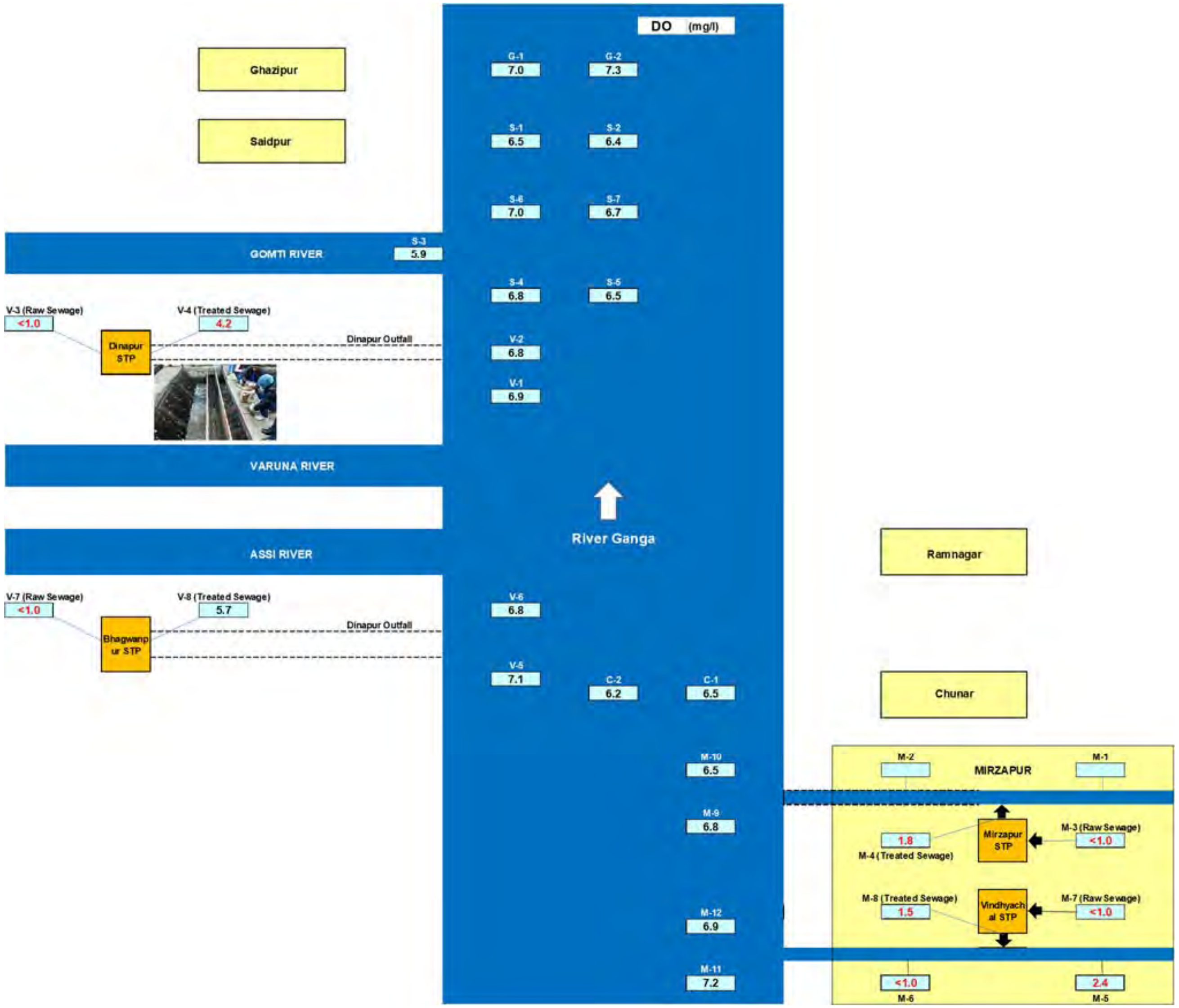


Figure 6.1.6 Results of 2nd Water Quality Examination (DO) (Sampled on March 26-28, 2016)

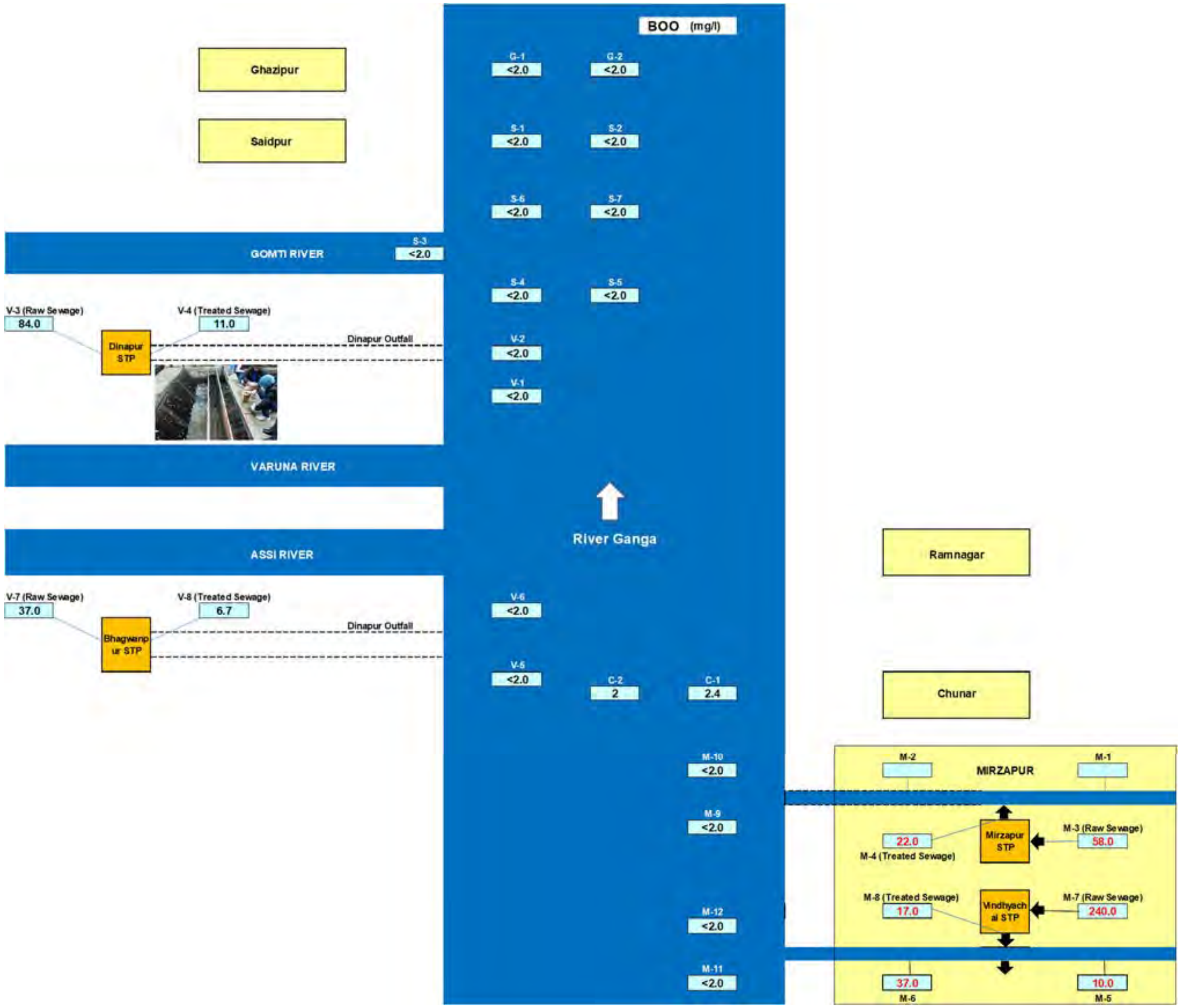


Figure 6.1.7 Results of 2nd Water Quality Examination (BOD) (Sampled on March 26-28, 2016)

6.2 Present Problems on Health Environment and Hygiene caused by lack of Sewerage System

This section will analyse the present condition of public health and outreach the City of Varanasi and surrounding municipalities. The section also discusses the survey results done to fulfil the goal of improving health environment and hygiene.

6.2.1 Health Environment and Hygiene in Varanasi area

1) Backgrounds

According to Indian statistics, half of Indian population, or at least 620 million people, defecate outdoors in India[1]. Moreover, rapid population growth will expose more Indians are exposed to more human waste than ever before[2]. Indian government have been working on the improvement. 100% sanitation was set as a goal during the 11th Five Year Plan. The Ministry of Urban Development (MoUD) officially launched a country-wide National Urban Sanitation Policy (NUSP) on November 12, 2008 with an objective to require individual states to draft their own strategies based on the NUSP, while taking into account of their own specific requirements. Moreover, many guidelines to ensure sanitation is prepared by Ministry of Health and Family Welfare. These guidelines includes from general public health guidelines to pregnancy matters.

Varanasi and its surrounding municipalities are no exception to this situation. In these municipalities, open defecation are rampant and education for public sanitation is also extremely poor. According to sanitation ranking by Ministry of Urban Development, City of Varanasi ranks 331st out of 423 cities[3]. It is under the red category which means that it is on the brink of public health and environmental-emergency and needs immediate remedial action.

Table 6.2.1 Sanitation score of Varanasi according to the NUSP

Attributes	Total points		Varanasi
Output related	Open defecation free cities Proportion of waste/waste water storm water safely treated	50	9.164 (18.38%)
Process related	All treatment plants are in place	30	10.60 (35.33 %/)
Outcome related	Improvement from baseline, water quality, disease pattern etc.	20	7.3(36.5%)

Source: City Sanitation Plan for Varanasi, CEPT University, 2011

In 2011, Varanasi Municipal Cooperation made the City Sanitation Plan (CSP) for Varanasi with the assistance with GIZ. The Plan contains the above mentioned national strategies as a part of the City Sanitation Plan. The NUSP defines the city sanitation plan as ―A comprehensive document

1 Spears, Dean. 2014. Increasing average exposure to open defecation in India, 2001-2011. Rice institute research paper.
2 Harris, Gardiner. 2014. Poor Sanitation in India may afflict well-fed children with malnutrition. NY times July 13, 2014
3 Varanasi Municipal Cooperation. 2011. City Sanitation Plan (CSP) for Varanasi

which details out the short, medium and long term plans for the issues related to governance, technical, financial, capacity building, awareness and pro-poor interventions to ensure 100% access to safe sanitation.

CSP contains the following five goals:

1. Awareness Generation and Behaviour Change
2. Open Defecation Free Cities
3. Integrated City-Wide Sanitation
4. Sanitary and Safe Disposal
5. Proper Operation & Maintenance of all Sanitary Installations

2) Census data analysis in five cities

Census 2011 shows each city's sanitary facilities. In Varanasi City, majority of on-site facilities are septic tanks with and without soak pits and constructed only for blackwater. The overflow from septic tanks leads to stormwater drains, while kitchen and bathroom wastes (greywater) are lead to existing drainage systems and then flow into rivers.

When residents install septic tanks, VNN and other municipalities pays the subsidy. Sludge in septic tanks is collected by VNN and other municipalities upon the request of private owners.

Table 4.5.1 shows the latest figures on the status of latrines among households in Varanasi City according to the 2011 census of India.

Table 6.2.2 Status of Latrine Use of Households in Varanasi City and other municipalities

<table>
<tr><th colspan="3">Area Name</th><th>Varanasi</th><th>Mirzapur</th><th>Ghazipur</th><th>Ramnagar</th><th>Chunar</th><th>Saidpur</th></tr>
<tr><td colspan="3">Total number of households</td><td>183,255</td><td>38,309</td><td>18,158</td><td>9,616</td><td>5,735</td><td>7,077</td></tr>
<tr><td colspan="3">Number of households having latrine facility within the premises</td><td>94.68</td><td>77.81</td><td>80.65</td><td>77.03</td><td>65.84</td><td>69.22</td></tr>
<tr><td rowspan="7">Type of latrine facility within the premises</td><td rowspan="3">Flush/pour flush latrine connected to:</td><td>Piped sewer system</td><td>77.56</td><td>40.28</td><td>11.31</td><td>52.89</td><td>9.00</td><td>13.58</td></tr>
<tr><td>Septic tank</td><td>13.58</td><td>31.52</td><td>66.95</td><td>21.81</td><td>52.96</td><td>37.59</td></tr>
<tr><td>Other system</td><td>1.21</td><td>1.75</td><td>0.97</td><td>1.03</td><td>2.60</td><td>4.01</td></tr>
<tr><td rowspan="2">Pit latrine</td><td>With slab/ ventilated improved pit</td><td>0.77</td><td>1.72</td><td>0.42</td><td>0.57</td><td>0.75</td><td>3.24</td></tr>
<tr><td>Without slab/ open pit</td><td>0.58</td><td>0.46</td><td>0.14</td><td>0.17</td><td>0.21</td><td>0.38</td></tr>
<tr><td rowspan="2">Other Latrine</td><td>Night soil disposed into open drain</td><td>0.43</td><td>0.85</td><td>0.50</td><td>0.55</td><td>0.23</td><td>0.32</td></tr>
<tr><td>Night soil removed by human</td><td>0.12</td><td>0.61</td><td>0.07</td><td>0.00</td><td>0.00</td><td>9.92</td></tr>
</table>

		Night soil serviced by animal	0.47	0.63	0.29	0.01	0.10	0.18
Non-service in the HH premise			5.32	22.19	19.35	22.97	34.16	30.78

Source: Housing Profile of UP State in the 2011 census of India
The total of HH is counted all the urban districts.

3) Varanasi Public Health Actual Expenditures

According to Varanasi City Development Plan in 2012, VNN has spent relatively large cost on public health. To see the actual spending, *Table 6.2.3 VNN Public Health Actual Expenditures in Last 5 Years* (2010-2015 was acquired at VNN in February 2016. Compared to 2009-2010, salaries has increased 2.2 times more and non-salaries has increased 2.4 times more in 2014-2015. The ratio of the public health salaries and non-salaries is 94.5% versus 5.5 % in the most recent statistics.

Similarly, JICA Collection and Clarification Study on Improvement of Environment in Varanasi City, started in 2015, discussed the situation by the Varanasi City Development Plan made in 2012. It analyses that more than 50% was used for salaries, and among salaries paid by each department, the amount paid by the Public Health Department (Rs. 4.5 hundred million), which employs more than 2,600 sanitary workers, is remarkably large. On the contrary, only Rs. 0.2 hundred million is used for operation and maintenance of solid waste management, reflecting the fact that mechanization is not in place.

Table 6.2.3 VNN Public Health Actual Expenditures in Last 5 Years (2010-2015)

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
Public Health related staff salaries						
Staff Salaries	258,116,919	290,000,000	384,543,841	413,681,431	482,049,337	586,893,511
Public Health non-salaries (breakdown)						
Outlay	2,877,340	2,863,585	2,288,791	4,000,000	8,770,134	9,900,000
Epidemic	2,142,007	2,500,000	350,572	3,381,709	3,360,824	4,500,000
vaccination	0	0	0	40,224	259,012	800,000
Birth & Death Registration	0	0	1,500,000	1,464,750	754,416	4,320,000
Veterinary Related	704,150	811,832	965,813	1,392,236	775,807	14,400,000
	5,723,497	6,175,417	5,105,176	10,278,919	13,920,193	33,920,000
	263,840,416	296,175,417	389,649,017	423,960,350	495,969,530	620,813,511
Ratio of salaries and non-salaries						
staff salaries	97.8	97.9	98.7	97.6	97.2	94.5
non-staff	2.2	2.1	1.3	2.4	2.8	5.5

Source: VNN 2016

4) Mirzapur Public Health Actual Expenditures

Mirzapur expenditures are shown as below. The rate of Varanasi expenditures are about 11 times more than Mirzapur. The expenditure of salaries occupies more than 95% of the total and it can be concluded that again in Mirzapur, they spend outstanding amount for the manual labors.

Table 6.2.4 Mirzapur Public Health Actual Expenditures in 5 Years 2010-2014

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Public Health related staff salaries					
Staff Salaries	16,493	21,684	25,120	33,216	43,051
Public Health non-salaries (breakdown)					
Outlay	0	0	0	0	0
Epidemic	0	0	0	0	0
Vaccination	0	0	0	0	0
Birth & Death Registration	222	252	288	312	336
Veterinary Related	2,311	1,045	2,893	2,174	1,730
Non-salary total	2,533	1,297	3,181	2,486	2,066
Total	19,026	22,981	28,301	35,702	45,117
Ratio of salaries and non-salaries					
Staff salaries	86.7	94.4	88.8	93.0	95.4
Non-staff	13.3	5.6	11.2	7.0	4.6

Source: Nagar Palika Mirzapur 2016
Note: As of April 2016, 2014-2015 is not available.

5) Ghazipur Public Health Actual Expenditures

Ghazipur actual expenditure is shown as Table 6.2.5 and the ratio of staff salaries has been approximately 80% and plus, and the most recent ratio of staff salaries and non-salaries compiled to 90.9% versus 9.1%. Compared to Varanasi and Mirzapur, the staff salaries ratio of Ghazipur is lower than those of two bigger cities.

Table 6.2.5 Ghazipur Public Health Actual Expenditures in 5 Years 2011-2015

	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Public Health related staff salaries					
Staff Salaries	28,024,079	28,201,066	34,268,335	38,953,830	37,666,245
Public Health non-salaries (breakdown)					
Outlay	---	---	---	---	---
Epidemic	---	---	---	---	---
Vaccination	---	---	---	---	---
Birth & Death Registration	18,666	1,071	2,244	2,442	424
Veterinary Related	5,764,327	7,107,359	5,569,292	5,673,503	3,766,986
Non-salary total	5,782,993	7,108,430	5,571,536	5,675,945	3,767,410

	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Total	33,807,072	35,309,496	39,839,871	44,629,775	41,433,655
Ratio of salaries and non-salaries					
Staff salaries	82.9	79.9	86.0	87.3	90.9
Non-staff	17.1	20.1	14.0	12.7	9.1

Source: Nagar Palika Ghazipur 2016
Note: As of April 2016, 2009-2010 is not available.

6.2.2 JICA-assisted Ganga Action Plan

1) Outline

JICA-assisted Ganga Action Plan (GAP) has been launched in 2014, and it plans to be completed in 2018. The project contains non-sewage component, which has a close relation to the component of public health and outreach in Ganga Rejuvenation Project. In Ganga Action Plan, the non-sewage component is supervised by Varanasi Nagar Nigam (VNN) Implementing Agency. The component contains four main activities: (1) Construction of CTCs (Community Toilet Complexes), (2) Construction & renovation of Dhobi Ghats, (3) Repair & improvement of bathing Ghats, and (4) **Public Awareness & Public Participation Program (PAPP)**. These activities are held in the City of Varanasi only. The budget outline of the Ganga Action Plan are shown as below.

Table 6.2.6 JICA-assisted Ganga Action Plan -Non Sewage Component

No.	Activity	Number of works	Amount-Rs (thousand)
1	CTCs	205	200,700
2	Dhobi Ghat	9 (3 new, 6 renovation)	53,700
3	Bathing Ghat	26	14,700
4	PAPP	-	47,500

Source: JICA-assisted Ganga Action Plan

The first three activities are the important sanitary infrastructure projects for Varanasi city to strengthen its public health. They include both renovation and new construction. Along with these three activities, the fourth activity, **PAPP,** is also important, as the lack of education in sanitation is one of the most critical issues nationwide[4].

2) Creation of CTCs and its impact

Pictures below are the CTC created by JICA Ganga Action Plan. Each CTC are 24/7 operation,

[4] Harris, Gardiner. 2014. Poor Sanitation in India may afflict well-fed children with malnutrition. NY times July 13, 2014

maintained by the caretakers dispatched from NGOs. The cells for men, women and disabled people are separated in all CTCs. The user charge of urine latrine is free, and the charge of toilets are 5 rupees per each use. At Macchodari Park CTC, one user gave a complaint to JICA Study Team that the user charge is too high for the poor. Varanasi Nagal Nigam-VNN is now reconsidering the fee renew, including issuing the monthly pass for the poor. Monitoring the usage of these CTCs are the keys for future projects to solve public health projects in these cities.

Source: JICA Study Team 2015
Right: CTC building in Ravindrapuri Crossing
Left: Separate booth for men, women, and disabled people in all CTCs

Photo 6.2.1 CTC Project by JICA Ganga Action Plan

3) Upgrading the Ghats

The Ghats characterize Varanasi City by the Ganges River. Not only it is deeply related to the local people lives, but also it attracts tourists from outside Varanasi as well as all over the world. Presently these Ghats in Varanasi contain the following eight issues due to lack of public health awareness and shortage of sanitary facilities such as toilets and sewer system:

1. Lack of Nagar Nigam cleaning staff.
2. Lack of boats for disposal of solid waste/Puja Materials/human hairs.
3. Use of soaps, oils etc. during bath at Ghats.
4. The animals roam in the open.
5. Open defecation.
6. Cleaning and washing of clothes by dhobis on bank of the Ganga River.
7. Encroachment due to temporary shops on the bank.
8. Open places in the Ghats using for preparation of cow dung cakes.

(Source: JICA assisted Ganga Actin Plan)

Maintaining the Ghats clean and attractive is important for Varanasi City in terms of economic, social and health concerns. In the Ganga Action Plan, Dhobi Ghats are constructed and bathing Ghats are targeted to be upgraded. In bathing Ghats, some of these Ghats are not only given the overall cleaning and sanitation education, but also with renovations of floors and stairs, construction of women's changing rooms, and cloak rooms.

6.2.3 JICA Data Collection and Clarification Study on Improvement of Environment in Varanasi City

The Project called the *JICA Data Collection and Clarification Study on Improvement of Environment in Varanasi City* executed from September 2015 until April 2016. It includes the citizen's survey for 300 samples (Varanasi 100, Ramnagar 50, Shivdaspur GP 50, Suzabad GP 50, and Sirgorbardhanpur GP 50). The filed survey was started in September 7^{th} 2015 and was completed in September 13^{th}.

The survey revealed the basic condition of water supply and sewerage, waste collection, sanitary facilities, and IEC (information, education, and communication) activities in public health. Here in this section Varanasi and Ramnagar are in focus, as these two municipalities are common focus cities in both study.

In the survey questionnaire, people are asked to name the urgent improvement needs in their cities and to rank the top five items. The top priority items in Varanasi City were electricity, drinking water, solid waste, drainage/liquid waste, and transportation. While in Ramnagar, they were solid waste, electricity, drainage/liquid waste, drinking water, and employment opportunities. Though not in the first concern, the drainage/liquid waste attains the high needs in both cities.

Regarding the condition of drainage/liquid waste, 74.7 % of both cities answered that they use the public sewerage system followed by road side drain (20.0 %), nearby open space (4.0%), nearby waterbodies (1.4%). In the case of water supply, 49.3 % answered that they have piped water into dwelling, 22.0 % piped water into yard/plat, 16.7% tube well/borehole, and 8.7% public tab.

Concerning the ownership of the toilet, 96.0 % in Varanasi and 80.0 % in Ramnagar answered they have their own toilet in their houses. In the question to be asked on the type of latrine among the latrine owners, 80.7 % answered that their latrines are connected to piped sewer system, 10.4% latrines connected to septic tank, 5.9% latrines connected to improved pit with slab, and 3.0% latrines discharged to road, drain, etc. in two cities.

As for solid waste collection, 62.7 % answered that there are some type of collection service existing. In Varanasi, 77% answered the collection service is existing, and 54.6 % is collected by local government, 41.6% by individual collectors. In Ramnagar, only 34.0% answered that the collection service is existing, and 23.5% is collected by local government, 76.5% by individual collectors. It can be sad that better conditions in waste collection in Varanasi City.

Looking at the IEC in public health matters, they are advised the following matters out of 332 cases:

Drink safe water (82), use a latrine (80), wash hands with soap (22), good food hygiene (34), wash hands (27), store water safely (8). 14.5 % of them answered they have never advised from anything on public health matters. The source of advice was taken mostly from the billboard advertisement (131), radio (44), neighbours (38), anganwadi workers (36), NGO/agency workers (23), relatives (23), school teachers (19), union leaders (15), government officers (7), community meetings (7) and others.

These results show that some favourable outcomes in the continued efforts in public health improvements in Varanasi and Ramnagar, but further improvements are needed for the areas.

6.2.4 Outline of Public Health Component in Ganga Rejuvenation Project

In addition to these two projects by JICA, the Ganga Action Plan and Data Collection and Clarification Study on Improvement of Environment in Varanasi City, *Ganga Rejuvenation Project* has started in September 2015. The Project's work in public health component is classified as two categories: detailed examinations of DPRs and monitoring of the Ganga Action Plan.

1) Analysis of DPRs

The DPRs are collected in 4 cities and 1 District in Varanasi (District III). 3 DPRs (Saidpur, Varanasi's District I and II) are missing. The existing DPRs include the cost of public communication/outreach and its breakdowns are now being reviewed by the Public Health and Outreach Experts.

Table 6.2.7 Cost for communication and public outreach

City name	Chunar		Saidpur	Mirzapur		Ghazipur	Ramnagar		Varanasi				
Reception	○	○	X	○	○	○	○	○	X	X	○	○	○
Providers	NJSEI	NJSEI	UPJN	NJSEI	NJSEI	UPJN	UPJN	UPJN	NJSEI	NJSEI	NJSEI	UPJN	NJSEI
DPR_	1)*	2)*		1)	2)	1)	1)	2)	DI	DII	DIII	Ramnar	Dinapur
Population	37,185		24,338	234,871		121,020	49,132						1,198,491
(year)	2011		2011	2011		2011	2011		2011	2011	2011	2011	2011
Cost (lac IDR)	20	20		40	40	15.33	10	10			20	10	100.55
US $	30,398	30,398		60,796	60,796	23,300	15,199	15,199			30,398	15,199	152,826

Source: Made from NJS-EI, UPJN 2016

Note: 1) Comprehensive, 2）Interception & Diversion

2) Breakdown of the PAPP cost

The breakdown of these cost made for DPRs are shown in Appendix 6-1. These cost contain three parts in all DPRs: 1. Awareness camps, 2. Workshops and seminars, 3. Publicity/Advertisement, 4. Observing special events on specific days, and 5. NGOs Services to implement the PAPP activities at the field level. These five categories are shown in the following breakdowns of activities.

Table 6.2.8 Varieties of Activities for PAPP

No.	Activity names
1.	**AWARENESS CAMPS**
1.1	Awareness camps with the women groups to cooperate
1.2	Awareness camps with the Citizen Forums for spreading and cooperation
1.3	Awareness camps with the school /college Students (Above 6th Class)
1.4	Awareness camps at Malls/Market locations for spreading the messages
1.5	Public consultations and Cleanliness Drives
2.	**WORKSHOPS AND SEMINARS**
2.1	Stakeholders Launching, Appraisal and Closing Workshop for wider awareness and support
2.2	Seminars/competitions with school/college students, Public representatives and social reformers.
2.3	Update the media with the progress of the project activities Press Meets with Media
2.3	Seminars/competitions with school/college students, Public representatives and social reformers.
2.4	Update the media with the progress of the project activities Press Meets with Media
3.	**PUBLICITY /ADVERTISEMENT**
3.1	Use the Local Newspapers & Print media for appealing and to provide information on progress of the project activities.
3.2	Printing of Pamphlets and Handbills with all the project details for the sake of information.
3.3	Advertisement /wall writings by appealing the stakeholders/people to cooperate
3.4	Local Cable network for wider awareness and support for timely completion of the project.
3.5	Use the services of the Local FM Radio for providing the information and appealing to the people to cooperate and support to complete the project activities on time.
3.6	Place the Hoardings /Banners at prominent places for sensitizing the people /stakeholders to cooperate and to support for the timely completion of the project activities.
3.7	To get the Local pulse and feeling Folk theatres/folk songs/ Nukkad natak/street Plays to be organize with the focused themes.
3.8	Cinema slides

No.	Activity names
3.9	Documentary film on health and sanitation and proper use of water
4.	**OBSERVING SPECIAL EVENTS ON SPECIFIC DAYS.**
4.1	To get the cooperation and support for various sections of the people it is suggested to observe certain important /special days like ***World Environment day***
4.2	To get the cooperation and support for various sections of the people it is suggested to observe certain important /special days like ***World Sanitation Day***
4.3	To get the cooperation and support for various sections of the people it is suggested to observe certain important /special days like ***World Health Day***
4.4	Sensitizing through Rallies/human chain and Marathon.
4.5	Exposure visits to the Opinion leaders and staff
5.	**NGOs Services to implement the PAPP activities at the field level.**
5.1	To meet the staff honorariums and administrative charges

Source: GAP 2016

6.2.5 Public Health and Outreach Condition for Citizens (Varanasi)

1) Outline of the survey

Public Health and Outreach Expert of Ganga Rejuvenation Projects identified that some essential aspects could be investigated by reviewing the non-sewage component of the GAP activities. However, the monitoring of the activities is not planned in the Plan itself. Therefore, the experts concluded that the specific questionnaire survey should be taken place in the public health and outreach component of Ganga Rejuvenation Project. The Appendix 6-2 represents the present survey designs of the citizens' opinion questionnaire.

The questionnaire is made to understand the profile of the households of Varanasi City, public health aspects, economic status and the source of awareness about the various activities related to public health and public outreach / other information related to the betterment of their life, accordingly appropriate measures will be proposed in the forthcoming project. The questionnaire also focus on the project CTCs, especially monitoring the constructed ones by the Ganga Action Plan.

Sample size of this survey is in 150 households (representing Low Income Group-LIG, Middle Income Group-MIG, and High Income Group-HIG)

•LIG : Living in their own houses in the areas lacking proper infrastructure, using the CTCs, source of income is unstable (50)

•MIG: Living in non-slums, in their own small houses, having definite source of income. Owner of at least one 2 wheeler (50)

•HIG : Living in their own houses, having at least one 4 wheeler (50)

Stratified Random sampling will be adopted to cover the diversified category of community /public service users. The 150 sample households will be represented from the 5 zones of Varanasi.

Table 6.2.9 Sample Selection of the Citizen Question (Varanasi)

Zone	LIG	MIG	HIG	Total
Zone 1	10	10	10	30
Zone 2	10	10	10	30
Zone 3	10	10	10	30
Zone 4	10	10	10	30
Zone 5	10	10	10	30
Total	50	50	50	150

Source: JICA Study Team 2015

The citizen survey took place in December 2015 and analysed in January 2016.

2) Basic Profile and Sanitary Conditions

The section looks at the results of the questionnaire of the followings:

a. basic profile,
b. diseases,
c. water supply,
d. toilet facilities at HHs,
e. CTC usage, and

a) Basic Profiles of each respondent

The respondents are 84.0% of male and 16.0% of female.

Table 6.2.10 The respondents gender among different income groups

	Total N	LIG 001-017	MIG 018-034	HIG 035-051	Total (%)	LIG (%)	MIG (%)	HIG (%)
Male	126	38	41	47	84.0	76.0	82.0	94.0
Female	24	12	9	3	16.0	24.0	18.0	6.0

Source: JICA Study Team 2016

Occupation of the respondents are as **Table 6.2.11** Occupation of the respondents. 49.3% has their own business, 19.3% government job, 16.0% daily wage,11.3% private sector job, 2.0% vending, 0.0% others. Business owners are mostly found in higher income groups. Daily waged people are only found in LIG (48.0%) and government job is found in all income groups.

Table 6.2.11 Occupation of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	74	8	30	36	49.3	16.0	60.0	72.0
2.Govt job	29	11	8	10	19.3	22.0	16.0	20.0
3.Private job	17	2	11	4	11.3	4.0	22.0	8.0
4.Daily wage	24	24	0	0	16.0	48.0	0.0	0.0
5.Family profession	3	2	1	0	2.0	4.0	2.0	0.0
6.Vending	3	3	0	0	2.0	6.0	0.0	0.0
7. Others	0	0	0	0	0.0	0.0	0.0	0.0
Total	150	50	50	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The family number is about 8.4 per household, contains 3.0 male members, and 2.7 female members, and 2.7 children. The higher the income, the more family members in the house. The gap is about 2.5 person between the poorest and the richest.

Table 6.2.12 Average number of family members

	Total	LIG(%)	MIG(%)	HIG(%)
1.Total No. of Family Member	8.4	7.1	8.4	9.6
2.Male Members (more than 18 years) :	3.0	2.3	3.0	3.5
3.Female Members (more than 18 years) :	2.7	2.2	2.8	3.1
4.Child Less than 18 years:	2.7	2.5	2.6	3.1

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are the graduate school degree holders (30.0 %), followed by College (10+) (16.7%), read & write (16.7%), post-grad school (13.3%), and 5th grade (12.7%). As expected, the higher the income, the higher the level of education.

Table 6.2.13 Education Level of the Respondents

	Total	LIG	MIG	HIG	Total	LIG(%)	MIG(%)	HIG(%)
1.Read & Write	25	18	4	3	16.7	36.0	8.0	6.0
2.5th grade	19	16	3	0	12.7	32.0	6.0	0.0
3.10th grade	16	6	6	4	10.7	12.0	12.0	8.0
4.10+ College	25	6	12	7	16.7	12.0	24.0	14.0
5.Grad school	45	3	19	23	f30.0	6.0	38.0	46.0
6.Post-grad school	20	1	6	13	13.3	2.0	12.0	26.0
	150	50	50	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

Looking at the religion of the respondents, 82.0% are Hindu and 18.0% are Muslims. More Muslims are found in higher income families.

Table 6.2.14 Religion of the respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Hindu	123	45	42	36	82.0	90.0	84.0	72.0
2.Muslim	27	5	8	14	18.0	10.0	16.0	28.0
3.Christian	0	0	0	0	0.0	0.0	0.0	0.0
4.Others	0	0	0	0	0.0	0.0	0.0	0.0
	150	50	50	50	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The question of how long they have lived in the area, average is 29.6 years, and the higher the income, the longer they live in the same place.

Table 6.2.15 Settled years of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	29.6	17.5	28.7	30.9

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is Rs. 24,340.0 The richest families has as much as five times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 6.2.16 Average monthly income of the respondents (Rs)

Type	All	LIG	MIG	HIG
Amount（Rs）	24340.0	8500.0	21380.0	43140.0

Source: JICA Study Team 2015

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all three categories. Apart from savings, all 3 income groups spend on education in the second most money and LIG spend on health thirdly. MIGs' third, fourth, and fifth most spending items are cooking fuel, electricity, and the vehicle fuel. HIG's thirdly, fourthly and fifthly spending items are vehicle fuel, clothing, electricity and cooking fuel.

Table 6.2.17 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.Food	7,268.7	3,566.0	6,620.0	11,620.0
2.Clothing	1,553.0	465.0	814.0	3,380.0
3.House Rent	-	-	-	-
4.House Tax	129.37	86.8	97.5	203.8
5.Electricity	1,185.3	421.0	987.0	2,148.0
6.Water/Sewerage service	101.8	43.9	119.5	142.0
7.Water	-	-	-	-
8.Sewerage service	-	-	-	-

	All	LIG	MIG	HIG
9.Cooking Fuel	946.7	561.0	1,027.0	1,252.0
10.Vehicle Fuel	1,710.0	260.0	930.0	3,940.0
11.Health/treatment	716.6	610.4	595.5	944.0
12.Education	2,876.7	621.0	2,055.5	5,953.5
13.Saving	3,548.8	920.3	3,381.9	6,344.3
14.Others	4,305.7	944.6	4,760.1	7,212.4
Total	24,340.0	8,500.0	21,380.0	43,140.0

Source: JICA Study Team 2015

The questions to be asked on what are the major sources of information in the house, TV is the by far the most important information source in all income groups (95.3%), followed by newspapers /magazines (67.3%), neighbours and friends (60.7%), internet (18.7%) is only important in HIG and 52.0% of them using internet as the info source.

Table 6.2.18 Major source of information of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.T.V.	143	95.3	90.0	96.0	100.0
2.Radio	7	4.7	8.0	2.0	4.0
3.News Paper/Magazine	101	67.3	8.0	100.0	94.0
4.Internet	28	18.7	0.0	4.0	52.0
5.Pamphlets/posters	13	8.7	4.0	16.0	6.0
6.Govt. announcements	11	7.3	0.0	6.0	16.0
7.NGOs/CBOs	8	5.3	0.0	10.0	6.0
8.Neighbors/Friends	91	60.7	46.00	74.0	62.0
9.Others	0	0.0	0.00	0.0	0.0
Total	402				

Source: JICA Study Team 2015

The questions to be asked on the priority of life for the respondents, the following answers are acquired. Respondent thinks that the water supply is the first priority, followed by education, sewerage, health facilities, and public/community toilet and solid waste disposal. If looked at the total count, water supply is the most frequent, followed by sewerage and drainage, solid waste disposal, education, health facilities, education, and public/community toilet. More detailed review of the results showed that education priority has some discrepancy between the rich and the poor.

Table 6.2.19 Priority of the daily life

	No.1	No.2	No.3	No.4	No.5	Total
1. Water Supply	63	45	14	12	10	144
2. Sewerage/Drainage system	25	44	33	18	18	138
3. Public/Community Toilet	6	6	13	20	20	65
4. Solid waste disposal	6	13	22	25	72	138
5. Health Facilities	10	23	27	58	18	136
6. Education	40	19	41	17	12	129
7. Others	0	0	0	0	0	0
8. Not Knowing	0	0	0	0	0	0
Total	150	150	150	150	150	750

Source: JICA Study Team 2015

Note: No. 1 shows the number of people answered each item as the first priority, No.2 for second, No.3 for third and so on.

Corresponding to the previous question, the question to be asked to the responsibility of the improving each item, 58.7% think the state government should have the responsibility, followed by the local government (48.0%), leaders of their locality (28.7%), community as a whole including themselves (17.3%), NGOs (2.7%), and central government (0.7%).

Table 6.2.20 Responsible bodies of the improvement for the priority of the daily lives

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Individual household	14	9.3	8.0	4.0	16.0
2.Leaders of your locality	43	28.7	18.0	44.0	24.0
3.Community as a whole incl. yourself	26	17.3	28.0	4.0	20.0
4.Local government Municipality/ Gram Panchayat	72	48.0	70.0	20.0	54.0
5.State Govt.	88	58.7	32.0	88.0	56.0
6.Central Govt.	1	0.7	0.0	2.0	0.0
7.N.G.O.	4	2.7	0.00	4.00	4.00
8.Others					

Source: JICA Study Team 2015

b) Disease

The question to see whether any of the family members had disease in the last one year, 54.7 % answered yes, and 45.3 % no. LIG is more vulnerable to disease incident rate (80.0%), while MIG and HIG are more unsusceptible to diseases, and they are at the same rate (42.0%).

Table 6.2.21 Disease incident rate for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	82	54.7	80.0	42.0	42.0
2.No	68	45.3	20.0	58.0	58.0

Source: JICA Study Team 2015

Those who answered yes in the disease question, they showed the specific diseases they had and the most frequent one is paratyphoid (34.2%), Malaria (28.1%), cholera (8.5%), typhus (8.5%), and dengue (8.5%) and flue (3.7%).

Table 6.2.22 Type of disease for the past one year

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Paratyphoid	28	13	4	11	34.2	32.5	19.1	52.4
2.Cholera	7	5	0	2	8.5	12.5	0.0	9.5
3.Typhoid/Typhus	7	4	2	1	8.5	10.0	9.5	4.8
4.Dysentery	0	0	0	0	0.0	0.0	0.0	0.0
5.Dengue	7	4	1	2	8.5	10.0	4.8	9.5
6.Malaria	23	12	7	4	28.1	30.0	33.3	19.1
7.Flue	3	1	2	0	3.7	2.5	9.5	0.0
8.Others	37	24	7	7	45.1	60.0	33.3	33.3
	112	63	23	27				

Source: JICA Study Team 2015

c) Water supply service

Regarding the possession of the water supply service, 71.3% answered they have some type of water supply service. Looking at the income group, only 52.0% LIG have water supply services, while 88.0% for MIG and LIG.

Table 6.2.23 Possession of the water supply service

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	107	71.3	52.0	88.0	74.0
2.No	43	28.7	48.0	12.0	26.0
3.Other sources					
1. Private source	21	14.0	18.0	8.0	16.0
2. Ground water	22	14.7	30.0	4.0	10.0

Source: JICA Study Team 2015

In regard to the amount of the water supply charge, the following results are acquired. Overall, 30.8 % is paying around Rs. 1,500, 22.4% for around Rs. 800, 16.8% for Rs. 2,000, 10.3% for Rs. 1,000, 8.4% for Rs. 2,500, 7.5% for more than Rs. 2,500. All LIG are paying less than 1,500. The higher the incomes are, the higher their payments are.

Table 6.2.24 Amount of the water supply charge per month (Rs)

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Around Rs. 800*	24	13	10	1	22.4	50.0	22.7	2.7
2.Around Rs. 1000	11	5	5	1	10.3	19.2	11.4	2.7
3.Around Rs. 1500	33	5	12	16	30.8	19.2	27.3	43.2
4.Around Rs. 2000	18	0	8	10	16.8	0.0	18.2	27.0
5.Around Rs. 2500	9	0	6	3	8.4	0.0	13.6	8.1
6.More than Rs. 2500	8	0	3	5	7.5	0.0	6.8	13.5
7. Not paying	4	3	0	1	3.7	11.5	0.0	2.7
	107	26	44	37	100	100	100	100

Source: JICA Study Team 2015

As for the question to see how you rate the water service you are mainly using, 39.1% answered very satisfactory, followed by relatively satisfactory (29.1%), average (17.3%), very unsatisfactory(9.1%), and relatively satisfactory (6.4%).

Table 6.2.25 Satisfactory rate of the water supply services

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Very satisfactory	43	39.1	57.1	24.4	43.2
2.Relatively satisfactory	32	29.1	21.4	33.3	29.7
3.Average	19	17.3	10.7	20.0	18.9
4.Relatively unsatisfactory	7	6.4	10.7	6.7	2.7
5.Very unsatisfactory	10	9.1	3.6	15.6	5.4
6. Don’t know	39	35.5	75.0	11.1	35.1
	150	100.9	103.6	100.0	100.0

Source: JICA Study Team 2015

Regarding the questions which types of problems on the present main water supply, 39.3% claims that there is no transparency of water, 24.7% bad smell or taste, 13.3% water amount is not enough, 4.7% insufficient water pressure, 2.7% frequent stop of water service, and 1.3% of high tariff.

Table 6.2.26 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Bad taste (smell)	37	24.7	10.0	32.0	32.0
2.Water is dirty (not transparent)	59	39.3	18.0	62.0	38.0
3.Frequent stop of water service	4	2.7	0.0	6.0	2.0
4.Water amount is not enough	20	13.3	10.0	22.0	8.0
5.Insufficient water pressure	7	4.7	2.0	8.0	4.0
6.High Tariff	2	1.3	0.0	4.0	0.0
7.Others	0	0.0	0.0	0.0	0.0
	129				

Source: JICA Study Team 2015

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered Rs. 59.3 per month. LIG and MIG are about the same, Rs. 45.0 and Rs. 44.6 respectively, and Rs. 86.5 for HIG.

Table 6.2.27 WTP for the water supply services

	All	LIG	MIG	HIG
Rs./month	59.3	45.0	44.6	86.5

Source: JICA Study Team 2015

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 84.7% answered yes. While both MIG and HIG answered 100.0% of them have a toilet in their houses, only 54.0 % of LIG answered so.

Table 6.2.28 Toilet possessions

	All	LIG	MIG	HIG
Yes	127	27	50	50
No	23	23	0	0
All	150	50	50	50
Yes (%)	84.7	54.0	100.0	100.0
No (%)	15.3	46.0	0.0	0.0
All %)	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

The questions asked which disposal system is connected to their home toilets, 88.2 % of them answered that they are connected to sewer, followed by septic tanks (7.9%), pits (2.4%), and direct discharges to ditch, drain or river (1.6%).

Table 6.2.29 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG(%)	HIG (%)
1.Sewer connection	112	88.2	70.4	88.0	98.0
2.Septic tank (connecting with a soak pit or trench)	10	7.8	22.2	6.0	2.0
3.Pit latrine (not using water)	3	2.4	0.0	6.0	0.0
4.Direct discharge into ditch, drain or river	2	1.6	7.4	0.0	0.0
5.Others	0	0.0	0.0	0.0	0.0
	127	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

When asked how they evaluate the pit latrine to those who answered sewer connection, 88.2% answered very satisfactory, 7.9% relatively unsatisfactory, 2.4% average, and 1.6% relatively unsatisfactory. The higher the income, the more the satisfaction exists.

Table 6.2.30 Evaluation of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Very satisfactory	53	88.2	70.4	88.0	98.0
2.Relatively satisfactory	13	7.8	22.2	6.0	2.00
3.Average	20	2.4	0.0	6.0	0.0
4.Relatively unsatisfactory	5	1.6	7.4	0.0	0.0
5.Very unsatisfactory	21	0.0	0.0	0.0	0.0
	112	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

Concerning the frequency of the septic tank cleaning, those who answered that they have a septic tank connected to toilets, 70.0% says that they clean once a year, 20.0% less than once a year, and 10.0% says twice in a year.

Table 6.2.31 Frequency of the septic tank cleaning

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Once a month	0	0.0	0.0	0.0	0.0
2.Once a bi-monthly	0	0.0	0.0	0.0	0.0
3.Twice a year	1	10.0	16.7	0.0	0.0
4.Once a year	7	70.0	66.7	100.0	0.0
5.Less than once a year	2	20.0	16.7	0.0	100.0
	10	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

Questions asked who cleans the tank 60.0 % answered it is by private sectors, followed by municipality

(30.0%), and CBOs/NGOs (10.0%).

Table 6.2.32 Septic tank cleaners

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Municipality	3	30.0	0.0	100.0	0.0
2.Community based organizations / NGOs	1	10.0	16.7	0.0	0.0
3.Private Sector	6	60.0	83.3	0.0	100.0
4.Family member	0	0.0	0.0	0.0	0.0
5.Others	0	0.0	0.0	0.0	0.0
	10	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

Regarding the questions on the reasons for the dissatisfaction of the sewer connection, 34.7% answered that pipe clogging, followed by overflow of wastewater (29.3%), offensive odour (20.7%), and the delay in problem solving (20.7%).

Table 6.2.33 Reason for dissatisfaction of the sewer connection

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Offensive odour (bad smell)	31	20.7	2.0	30.0	30.0
2.Pipe clogging	52	34.7	4.0	68.0	32.0
3.Overflow of wastewater	44	29.3	6.0	48.0	34.0
4.Delay in problem solving	31	20.7	2.0	36.0	24.0
5.Others	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2015

When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered Rs. 56.8.

Table 6.2.34 WTP for the sewer connection

	All	LIG	MIG	HIG
Rs./month	56.8	57.5	40.3	84.3

Source: JICA Study Team 2015

When asked to all person who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, the answers are as follows. Those who answered the reasons say that they do not want to have sewage think that they prefer septic tanks (75.0%) or they are used to use CTCs (25.0%).

Table 6.2.35 Sewage demand in non-sewer HHs

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Yes	31	79.5	75.0	100.0	100.0
2.No	8	20.5	25.0	0.0	0.0
	39	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, the average of their answer is Rs. 660.0 Similarly, to those who do not have sewer connection and they would like to have in future, if asked how much are you willing to pay for sewer user charge per month, they answer that they pay average Rs. 59.2/month.

Table 6.2.36 WTP for connection and monthly fee (Rs.)

	All	LIG	MIG	HIG
WTP for connection (Rs.)	660.0	408.3	1,900.0	500.0
WTP for monthly fee (Rs.)	59.2	58.1	40.0	200.0

Source: JICA Study Team 2015

CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the respondents answered that Rs. 4.2, and LIG is willing to pay higher than MIG and HIG.

Table 6.2.37 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.2	5.0	4.4	3.9

Source: JICA Study Team 2015

Question asked that how they evaluate the present public/community toilet service in the community, 32.0% answered relatively satisfactory, 23.3% satisfactory, 14.0% average, and 5.3% relatively unsatisfactory and very unsatisfactory.

Table 6.2.38 CTC's satisfaction rate of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Very satisfactory	35	23.3	38.0	20.0	12.0
2.Relatively satisfactory	48	32.0	18.0	42.0	36.0
3.Average	21	14.0	10.0	12.0	20.0
4.Relatively unsatisfactory	8	5.3	6.0	4.0	6.0
5.Very unsatisfactory	8	5.3	4.0	10.0	2.0
6.I don't know	30	20.0	24.0	12.0	24.0
	150	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

When asked the reason that CTCs are not " very satisfactory", 64.4% answered that it is dirty, 42.6% overflow of wastewater is not good, 8.7% claims congestion, 7.0% long distance to the toilet, 4.4% too high charge, 1.7% it should be free of charge, and 1.7% lack of proper facility.

Table 6.2.39 Reasons for dissatisfaction of the CTCs (multiple answers)

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Dirty	74	18	27	29	64.4	58.1	67.5	65.9
2.Overflow of wastewater	49	8	21	20	42.6	25.8	52.5	45.5
3.Congestion	10	3	3	4	8.7	9.7	7.5	9.1
4.Long distance to the toilet	8	1	4	3	7.0	3.2	10.0	6.8
5.Charge is too high	5	4	0	1	4.4	12.9	0.0	2.3
6.I do not want to pay	2	2	0	0	1.7	6.5	0.0	0.0
7.Facility that we want to use is not installed	2	2	0	0	1.	6.5	0.0	0.0
8.Others	0	0	0	0	0.00	0.00	0.00	0.00
	150	38	55	57				

Source: JICA Study Team 2015

When asked the WTP for CTC per usage, the average is Rs. 6.2, 0 for LIG, Rs. 5.9 for MIG, and Rs. 6.5 for HIG.

Table 6.2.40 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	6.2	0	5.9	6.5

Source: JICA Study Team 2015

When asked how they think the present public/community toilet service should be improved, 87.3 % answered more public/community toilets are necessary, 56.7% public/community toilets should be cleaned, 14.7% charging system should be reviewed (ex. Introduction of a family pass or monthly pass), 7.3 % shower facility should be installed, 3.3 % washing space should be installed.

Table 6.2.41 Type of improvements needed in the present CTCs (multiple answers)

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.More public/community toilets are necessary	131	87.3	82.0	94.0	86.0
2.Public/community toilets should be cleaned	85	56.7	50.0	64.0	56.0
3.Shower facility should be installed	11	7.3	6.0	6.0	10.0
4.Washing space should be installed	5	3.3	6.0	2.0	2.0
5.Charging system should be reviewed ex. Introduction of a family pass or monthly pass	22	14.7	16.0	20.0	8.0
6.Others	1	0.7	2.0	0.0	0.0

Source: JICA Study Team 2015

3) Public Outreach

This section summarized the public outreach section of the survey.

a) Participation of the activities

Question asked if there are any community-based activities on sanitary programs in your community, 84.0 % of them answered that they know the activities, and 16.0 % of them says that they do not know whether the activities are existing or not. It can be said that the higher the income, the more they know about these activities.

Table 6.2.42 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Yes	126	84.0	74.0	88.0	90.0
2.No	24	16.0	26.0	12.0	10.0

Source: JICA Study Team 2015

Questions asked whether they know what kind of public health activities exist in their cities, they answered that they know solid waste collection/cleaning (83.3%), operate water supply system (22.7%), operate (cleaning) public toilets (14.7%), environmental awareness enhancement campaign (11.3%), health/hygiene education/training program (8.7%), community meetings regarding sanitation issues (3.3%).

Table 6.2.43 Type of public health activities observed in the city

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Operate (cleaning) public toilets	22	14.7	18.0	16.0	10.0
2.Operate water supply system	34	22.7	24.0	12.0	32.0
3.Solid waste collection/cleaning	125	83.3	72.0	88.0	90.0
4.Health/hygiene education/training program	13	8.7	6.0	12.0	8.0
5.Environmental awareness enhancement campaign	17	11.3	8.0	14.0	12.0
6.Community meetings regarding sanitation issues	5	3.3	2.0	4.0	4.0

7.Others	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2015

Question asked whether they have ever participated in or contributed to these community based activities, 31.0% answered that they participated, and 66.7% not participated. Among the respondents who participated, the activities they have participated are 79.5% in solid waste collection/cleaning, 28.2% environmental awareness enhancement campaign, 25.6% operation of water supply system, 23.1% health/hygiene education/training program, 15.4% community meetings regarding sanitation issues, and 12.8% operate (cleaning) public toilets.

Table 6.2.44 Type of community based activities participated in or contributed to (multiple answers)

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes, I have participated in/contribute to:	39	31.0	59.5	13.6	24.4
i.Operate (cleaning) public toilets	5	12.8	18.2	0.0	9.1
ii.Operate water supply system	10	25.6	27.3	50.0	9.1
iii.Solid waste collection/Cleaning	31	79.5	86.4	116.7	45.5
iv.Health/hygiene education/training program	9	23.1	13.6	33.3	36.4
v.Environmental awareness enhancement campaign	11	28.2	13.6	33.3	54.6
vi.Community meetings regarding sanitation issues	6	15.4	4.5	16.7	36.4
vii. Others	0	0.0	0.0	0.0	0.0
2. No	84	66.7	37.8	84.1	73.3
3. Don't know the specific activities	3	2.38	2.70	2.27	2.2
1~3 Total	126	-	-	-	-

Source: JICA Study Team 2015

Concerning questions how they think community-based sanitation improvement activities such as cleaning the community and education program/training on sanitary issues are necessary, 95.3% think that it is very necessary and 4.7% somewhat necessary. It can be concluded that all respondents think that these community-based sanitation improvement activities, and this pattern is almost the same in all income groups.

Table 6.2.45 Necessity of community-based sanitation improvement activities

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Very necessary	143	95.3	96.0	98.0	92.0
2.Somewhat necessary	7	4.7	4.0	2.0	8.0
3.Not very necessary	0	0.0	0.0	0.0	0.0
4.Not necessary at all	150	100.0	100.0	100.0	100.0

Source: JICA Study Team 2015

Question asked if they have a chance, they are willing to participate in community-based sanitation improvement activities, 94.0% answered that they are willing to participate, and 6.0% are not interested in participation. Among the respondents who want to participate, 52.7% of them answered that education program/training on sanitation, 50.7% campaigns for raising awareness of people, 27.3% cleaning our community, 4.7% operating (cleaning) public/community toilet, 2.7% community meetings regarding sanitation issues.

Table 6.2.46 Willingness to participate in community-based sanitation improvement activities

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
Yes	141	94.0	92.0	94.0	96.0
1. participate in operating (cleaning) public/community toilet	7	4.7	14.0	0.0	0.0
2. participate in cleaning the community	41	27.3	44.0	14.0	24.0
3. participate in campaigns for raising awareness of people	76	50.7	64.0	42.0	46.0
4. participate in education program/training on sanitation	79	52.7	18.0	80.0	60.0
5. participate in community meetings regarding sanitation issues	4	2.7	4.0	0.0	4.0
No	9	6.0	8.0	6.0	4.0
Total	150	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Question asked whether they have taught or informed environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste, 75.5 % answered yes, and 24.7% answered no.

Table 6.2.47 Knowledge on environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1. Yes	113	75.3	84.0	64.0	78.0
2. No	37	24.7	16.0	36.0	22.0

Source: JICA Study Team 2015

To those who answered that they have knowledge in hygiene, if asked who taught these to them, 48.0% of them answered community people and neighbours, 39.3% TV programs, 37.3% family members, 27.3% newspaper and magazines, 14.7% municipal cooperation, 6.7% pamphlets, booklets, and posters, 5.3% internet, 4.7% NGO/CBO, 2.7% school, 2.0% radio programs, and 0.7% central/state government.

Table 6.2.48 Bodies/people that taught the hygiene knowledge to the respondents

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Family members	56	37.3	32.0	30.0	50.0
2.Community people/Neighbours	72	48.0	70.0	30.0	44.0
3.School	4	2.7	0.0	2.0	6.0
4.Municipal Corporation	22	14.7	26.0	4.0	14.0
5.Central/State government	1	0.7	0.0	0.0	2.0
6.NGO/CBO	7	4.7	0.0	6.0	8.0
7.Donor agencies	0	0.0	0.0	0.0	0.0
8.TV program	59	39.3	32. 0	34.0	52.0
9.Radio program	3	2.0	0.00	6.0	0.0
10.Newspaper and magazine	41	27.3	4.0	36.0	42.0
11.Pamphlet, booklet, posters	10	6.7	2.0	8.0	10.0
12.Internet	8	5.3	0.0	0.0	16.0
13.Others	0	0.0	0.00	0.0	0.0
	283				

Source: JICA Study Team 2015

b) Services provided by the cities

Regarding the question whether they know about various services provided by VNN or not, all people answered that they know about the services.

Table 6.2.49 Knowledge on various service by VNN

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	150	100.0	100.0	100.0	100.0
2.No	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2015

Concerning the services they are using, 96.7% of them answered solid waste management, 94.0% water supply services, 70.0% public toilets, 68.7% tax collection, 11.3% health/health education/training program, 7.3% environmental awareness enhancement campaign, and 3.3% community meetings regarding sanitation issues.

Table 6.2.50 VNN services they are using (Multiple answers)

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.Public toilets	105	70.0	76.0	76.0	58.0
2.Water supply system	141	94.0	90.0	96.0	96.0
3.Solid waste collection	145	96.7	96.0	100.0	94.0
4.Health/health education/training program	17	11.3	2.0	16.0	16.0
5.Environmental awareness enhancement campaign	11	7.3	4.0	6.0	12.0
6.Community meetings regarding sanitation issues	5	3.3	8.0	2.0	0.0
7.Tax Collection	103	68.7	40.0	90.0	76.0
8.Others	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2015

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 6.2.51 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax		0	0	0
2. Water tax	1,416.8	741.8	1,138.6	2,370.0
3. Sewage tax	1,213.4	522.6	1,433.7	1,684.0
4. E. P. E. tax	0.6	-	1.8	-
5. Education, Petroleum, and Environment	-	-	-	-

Source: JICA Study Team 2015

Note: E.P.E = Export Processing Enterprises

6.2.6 Public Health and Outreach Condition for Citizens (Mirzapur)

1) Outline of the Survey

The JICA experts identified that it is important to take the citizens' opinion questionnaire in Mirzapur. The questionnaire is made to understand the profile of the households of the Mirzapur, public health aspects, economic status and the source of awareness about the various activities related to public health and public outreach / other information related to the betterment of their life, accordingly appropriate measures will be proposed in the forthcoming project. The questionnaire also focus on the project CTCs, especially monitoring the constructed ones by the Ganga Action Plan.

The breakdown of each income group is as below:

Table 6.2.52 Sample selection of the Citizen Question (Mirzapur)

Zone	LIG	MIG	HIG	Total
Mirzapur	17	17	17	51

Source: JICA Study Team 2016

The citizen survey took place in January 2016 and analysed in February 2016.

2) Basic Profile and Sanitary Conditions

This section looks at the results of the questionnaire in this order.

a. basic profile,
b. diseases,
c. water supply,
d. toilet facilities at HHs,
e. CTC usage, and

a) Basic Profiles of each respondent

The respondents are 86.3% of male and 13.7% of female.

Table 6.2.53 The respondents gender among different income groups

	Total N	LIG 001-017	MIG 018-034	HIG 035-051	Total (%)	LIG (%)	MIG (%)	HIG (%)
Male	44	14	16	14	86.3	82.4	94.1	82.4
Female	7	3	1	3	13.7	17.6	5.9	17.6

Source: JICA Study Team 2016

Average age of total and each income group is as follows. Average age of total population is 42.5 years.

Table 6.2.54 Average age of total population

	Total	LIG	MIG	HIG
Age	42.5	38.4	41.6	47.4

Source: JICA Study Team 2016

Occupation of the respondents are as follows. 52.9% has their own business, 11.8% private sector job, 11.8% daily wage, 9.8% government job, 9.8% vending, 3.9% others. Daily wage is only found in LIG and government job is more conspicuously found in higher incomes.

Table 6.2.55 Occupation of the respondents

	Total	LIG	MIG	HIG	Total	LIG (%)	MIG (%)	HIG (%)
1.Business	27	4	12	11	52.9	23.5	70.6	64.7
2.Govt job	5	0	2	3	9.8	0.0	11.7	17.7
3.Private job	6	2	2	2	11.7	11.7	11.7	11.8
4.Daily wage	6	6	0	0	11.7	35.3	0.0	0.0
5.Family profession	0	0	0	0	0.0	0.0	0.0	0.0

6.Vending	5	5	0	0	9.8	29.4	0.0	0.0
7. Others	2	0	1	1	3.9	0.0	5.9	5.9
Total	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The family number is about 8.8 per household, contains 3.2 male members, and 2.9 female members, and 2.7 children. The higher the income, the more family members in the house. The gap is about 2.7 persons between the poorest and the richest.

Table 6.2.56 Average number of family members

	Total	**LIG (%)**	**MIG (%)**	**HIG (%)**
1.Total No. of Family Member	8.8	7.8	7.1	11.5
2.Male Members (more than 18 years) :	3.2	2.7	3.0	4.1
3.Female Members (more than 18 years) :	2.9	2.5	2.2	4.1
4.Child Less than 18 years:	2.7	2.7	1.9	3.4

Source: JICA Study Team 2015

Regarding the education level of the respondent, the highest are College (10+) (25.5%), followed by the read & write (23.5%), 10th grade (13.7%) graduate school degree (13.7 %), post-grad school (7.8%), and 5th grade (5.9%). As expected, the higher the income, the higher the level of education.

Table 6.2.57 Education Level of the Respondents

	Total	**LIG**	**MIG**	**HIG**	**Total(%)**	**LIG(%)**	**MIG(%)**	**HIG(%)**
0. Illiterate	5	5	0	0	9.8	29.4	0.0	0.0
1.Read & Write	12	7	4	1	23.5	41.2	23.5	5.9
2.5th grade	3	1	2	0	5.9	5.9	11.8	0.0
3.10th grade	7	0	4	3	13.7	0.0	23.5	17.7
4.10+ College (10+)	13	3	3	7	25.5	17.6	17.7	41.2
5.Grad school	7	0	3	4	13.7	0.0	17.7	23.5
6.Post-grad school	4	1	1	2	7.8	5.9	5.9	11.8
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Looking at the religion of the respondents, 82.3% are Hindu and 17.7% are Muslims. More Muslims are found in higher income families.

Table 6.2.58 Religion of the Respondents

	N	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Hindu	42	15	14	13	82.4	88.2	82.4	76.5
2.Muslim	9	2	3	4	17.7	11.8	17.7	23.5
3.Christian	0	0	0	0	0.0	0.0	0.0	0.0
4(Others	0	0	0	0	0.0	0.0	0.0	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The question of how long they have lived in the area, average is 42.4 years, much longer than the Varanasi residents settled years (29.6 years). The result shows that the higher the income, the longer they live in the same place.

Table 6.2.59 Settled years of the Respondents (yrs.)

Type	All	LIG	MIG	HIG
Year	42.4	38.4	41.4	47.4

Source: JICA Study Team 2015

The question of average income of the respondents are shown as below, and the average is Rs. 22,098.0. The richest families has as much as five times more incomes than the poorest ones, twice as big as the middle-income ones.

Table 6.2.60 Average monthly income of the respondents (yrs.)

Type	All	LIG	MIG	HIG
Amount（Rs）	22,098.0	8,470.6	17,823.5	40,000.0

Source: JICA Study Team 2016

The question of average expenditure of the respondents are shown as below, and the food expenditures are the largest in all three categories in all three income categories. Higher two categorized people spending patterns are similar, as they spend more on clothing, education, vehicle fuel, and electricity. LIG spend more on cooking oil, electricity, and health/treatment, compared to their total income.

Table 6.2.61 Average monthly expenditure of the respondents (Rs)

	All	LIG	MIG	HIG
1.Food	7637.3	3,676.5	6,411.8	12,823.5
2.Clothing	2311.8	317.6	2,205.9	4,411.8
3.House Rent	0.0	-	-	-
4.House Tax	17.9	12.8	18.5	22.2
5.Electricity	862.8	511.8	917.7	1,158.8
6.Water/Sewerage service	19.1	14.9	21.3	20.9
7.Water	0.0	-	-	-
8.Sewerage service	0.0	-	-	-

	All	LIG	MIG	HIG
9.Cooking Fuel	723.5	535.3	800.0	835.3
10.Vehicle Fuel	1086.3	29.4	1,035.3	2,194.1
11.Health/treatment	125.5	217.7	70.6	88.2
12.Education	1600.0	488.2	1,311.8	3,000.0
13.Saving	4755.4	1,494.4	3,385.6	9,386.2
14.Others	2958.7	1,172.0	1,645.2	6,058.8
(Total)	22098.0	8,470.6	17,823.5	40,000.0

Source: JICA Study Team 2016

The questions to be asked on what are the major sources of information in the house, TV is by far the most important information source in all income groups (96.1%), followed by neighbours and friends (62.8%), and newspapers /magazines (52.9%). Internet (41.2%) is relatively important in MIG and HIG, which shows that 29.4% for MIG and 94.1% of HIG are using the internet for gathering information, while 0.00% for LIG.

Table 6.2.62 Major source of information of the respondents

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.T.V.	49	96.1	88.2	100.0	100.0
2.Radio	3	5.9	11.8	5.9	0.0
3.News Paper/Magazine	27	52.9	5.9	52.9	100.0
4.Internet	21	41.2	0.0	29.4	94.1
5.Pamphlets/posters	0	0.0	0.0	0.0	0.0
6.Govt. announcements	3	5.9	0.0	0.0	17.7
7.NGOs/CBOs	1	2.0	0.0	0.0	5.9
8.Neighbours/Friends	32	62.8	47.1	64.7	76.5
9.Others	0	0.0	0.0	0.0	0.0
Total	136				

Source: JICA Study Team 2016

The questions to be asked on the priority of life for the respondents, the following answers are acquired. Respondent thinks that the sewerage/drainage system is the most important, followed by water supply, health facilities, education, and public/community toilet, and solid waste disposal. If looked at the total count, water supply, sewerage/drainage system are the same count, followed by education, health facilities, public/community toilets, and solid waste disposal.

Table 6.2.63 Priority of the daily life

	No.1	No.2	No.3	No.4	No.5	Total
1. Water Supply	11	17	10	6	0	44
2. Sewerage/Drainage system	31	7	2	2	2	44
3. Public/Community Toilet	0	3	3	10	19	35
4. Solid waste disposal	0	3	7	7	8	25
5. Health Facilities	4	5	9	10	11	39
6. Education	0	11	15	11	6	43
7. Others	0	0	0	0	0	0
8. Not knowing	5	5	5	5	5	25
Total	51	51	51	51	51	255

Source: JICA Study Team 2016

Note: No. 1 shows the number of people answered each item as the first priority, No.2 for second, No.3 for third and so on.

Corresponding to the previous question, the question to be asked to the responsibility of the improving each item, 88.2% think the leaders of your locality should have the responsibility, followed by the local government (52.9%), community as a whole including themselves (13.7%), and the state government NGOs (5.9%). The less the income, the more they think that leaders of their locality should take care of the improvements.

Table 6.2.64 Responsible bodies of the improvement for the priority of the daily lives

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Individual household	0	0.0	0.0	0.0	0.0
2.Leaders of your locality	45	88.2	100.0	88.2	76.5
3.Community as a whole incl. yourself	7	13.7	11.8	5.9	23.5
4.Local government Municipality/ Gram Panchayat	27	52.9	52.9	58.8	47.1
5.State Govt.	3	5.9	5.9	5.9	5.9
6.Central Govt.	0	0.0	0.0	0.0	0.0
7.N.G.O.	0	0.0	0.0	0.0	0.0
8.Others	0	0.0	0.0	0.0	0.0
	82				

Source: JICA Study Team 2016

b) Disease

The question to see whether any of the family members had disease in the last one year, 15.7 percent answered yes, and 84.3 % no. LIG is more vulnerable to disease incident rate (35.3%), and MIG and HIG are more unsusceptible to diseases, and they are at the same rate (5.9%).

Table 6.2.65 Disease incident rate for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Yes	8	15.7	35.3	5.9	5.9
2.No	43	84.3	64.7	94.1	94.1

Source: JICA Study Team 2016

Those who answered yes in the disease question showed the specific diseases they had in the last year as the following table. The most frequent one is paratyphoid (25.0%), and others (75.0%). Those who answered "others" indicated that they had fever.

Table 6.2.66 Type of disease for the past one year

	All	All (%)	LIG(%)	MIG (%)	HIG (%)
1.Paratyphoid	2	25.0	33.3	0.0	0.0
2.Cholera	0	0.0	0.0	0.0	0.0
3.Typhoid/Typhus	0	0.0	0.0	0.0	0.0
4.Dysentery	0	0.0	0.0	0.0	0.0
5.Dengue	0	0.0	0.0	0.0	0.0
6.Malaria	0	0.0	0.0	0.0	0.0
7.Flue	0	0.0	0.0	0.0	0.0
8.Others	6	75.0	66.7	100.0	100.0
	8				

Source: JICA Study Team 2016

c) Water supply service

Regarding the possession of the water supply service, 64.7% answered that they have some type of water supply service as below. Looking at the income group, 70.6 % HIG and LIG possess water supply service, 70.6% for LIG. Only 52.9% of MIG own water supply services and 35.3 % dependent on groundwater.

Table 6.2.67 Possession of the water supply service

	All	LIG	MIG	HIG	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Yes	33	12	9	12	64.7	70.6	52.9	70.6
2.No	18	5	8	5	35.3	29.4	47.1	29.4
Other sources than water supply service								
1. Private source	10	3	2	5	19.6	17.7	11.8	29.4
2. Ground water	8	2	6	0	15.7	11.8	35.3	0.0

Source: JICA Study Team 2016

In regard to the amount of the water supply charge, the following results are shown. Tendency is shown below that the higher the incomes are, the higher their payments become. Overall, 68.6 % is paying around Rs. 800, 2.0% for 1,000, and 29.4% for not paying. All the respondents are paying less than Rs. 1,000, and interestingly, and people paying the most are from LIG.

Table 6.2.68 Amount of the water supply charge per month (Rs)

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Around Rs. 800*	30	9	9	12	90.9	75.0	100.0	100.0
2.Around Rs. 1,000	1	1	0	0	3.0	8.3	0.0	0.0
3.Around Rs. 1,500	0	0	0	0	0.0	0.0	0.0	0.0
4.Around Rs. 2,000	0	0	0	0	0.0	0.0	0.0	0.0
5.Around Rs. 2,500	0	0	0	0	0.0	0.0	0.0	0.0
6.More than Rs. 2,500	0	0	0	0	0.0	0.0	0.0	0.0
7. Not paying	2	2	0	0	6.1	16.7	0.0	0.0
	33	12	9	12	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

As for the question to see how you rate the water service you are mainly using, 76.5% answered very satisfactory, followed by relatively satisfactory (13.7%), average (3.9%), and very unsatisfactory (3.9%), relatively satisfactory (2.0%). MIG, who use the groundwater the most is the most unsatisfied with the water supply.

Table 6.2.69 Satisfactory rate of the water supply services

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Very satisfactory	39	12	11	16	76.5	70.6	64.7	94.1
2.Relatively satisfactory	7	5	1	1	13.7	29.4	5.9	5.9
3.Average	2	0	2	0	3.9	0.0	11.8	0.0
4.Relatively unsatisfactory	1	0	1	0	2.0	0.0	5.9	0.0
5.Very unsatisfactory	2	0	2	0	3.9	0.0	11.8	0.0
Total	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Regarding the questions which types of problems on the present main water supply, 15.7% claims that there is no transparency of water, 7.8% bad smell or taste, 5.9% not enough water amount, and 3.9% frequent stop of water services.

Table 6.2.70 Problems on the present main water supply (multiple answers)

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Bad (taste smell)	4	7.8	5.9	11.8	5.9
2.Water is dirty (not transparent)	8	15.7	23.5	17.7	5.9
3.Frequent stop of water service	2	3.9	0.0	11.8	0.0
4.Water amount is not enough	3	5.9	5.9	11.8	0.0
5.Insufficient water pressure	0	0.0	0.0	0.0	0.0
6.High Tariff	0	0.0	0.0	0.0	0.0
7.Others	0	0.0	0.0	0.0	0.0
	17				

Source: JICA Study Team 2016

When asked how much they are willing to pay (WTP) for the water services which all the above mentioned issues are solved, they answered Rs. 89.0 per month, Rs. 126.0 for LIG, and Rs.52.0 for MIG.

Table 6.2.71 WTP for the water supply services

	All	LIG	MIG	HIG
Rs/month	89.0	126.0	52.0	-

Source: JICA Study Team 2016

d) Toilet facilities

The questions asked whether they have a toilet in their houses, total 84.3% answered yes. While 100.0% of HIG and 94.1% of MIG have a toilet in their houses, only 58.8 % of LIG answered so.

Table 6.2.72 Toilet possessions

	All	LIG	MIG	HIG	All	LIG (%)	MIG(%)	HIG(%)
Yes	43	10	16	17	84.3	58.8	94.1	100.0
No	8	7	1	0	15.7	41.2	5.9	0.0
	51	17	17	17	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

The questions asked which disposal system is connected to their home toilets, 23.3 % of them answered that they are connected to sewer. Septic tanks have the most users (51.2%) followed by direct discharges to ditch, drain or river (25.8%).

Table 6.2.73 Disposal system for the toilets

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Sewer connection	10	23.3	10.0	31.3	23.5
2.Septic tank (connecting with a soak pit or trench)	22	51.2	30.0	56.3	58.8
3.Pit latrine not using water	0	0.0	0.0	0.0	0.0
4.Direct discharge into ditch, drain or river	11	25.6	60.0	12.5	17.7
5.Others	0	0.0	0.0	0.0	0.0
	43				

Source: JICA Study Team 2016

When asked how they evaluate the pit latrine to those who answered sewer connection, 80.0 % answered very satisfactory, and 20.0% relatively unsatisfactory. MIG has the least satisfaction in the sewer connection.

Table 6.2.74 Evaluation of the sewer connection

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1. Very satisfactory	8	1	3	4	80.0	100.0	60.0	100.0
2.Relatively satisfactory	2	0	2	0	20.0	0.0	40.0	0.00
3.Average	0	0	0	0	0.0	0.0	0.0	0.0
4.Relatively unsatisfactory	0	0	0	0	0.0	0.0	0.0	0.0
5.Very unsatisfactory	0	0	0	0	0.0	0.0	0.0	0.0
	10	1	5	4	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Concerning the frequency of the septic tank cleaning, those who answered that they have a septic tank connected to toilets, 90.1% says that they clean less than once a year, and 9.1% says that they do not know the frequency.

Table 6.2.75 Frequency of the septic tank cleaning

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Once a month	0	0.0	0.0	0.0	0.0
2.Once a bi-monthly	0	0.0	0.0	0.0	0.0
3.Twice a year	0	0.0	0.0	0.0	0.0
4.Once a year	0	0.0	0.0	0.0	0.0
5.Less than once a year	20	90.9	100.0	100.0	80.0
6. Don't know	2	9.1	0.0	0.0	20.0
	22	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Questions asked who cleans the tank 90.9 % answered it is by private sectors, followed by "do not know" (9.1%).

Table 6.2.76 Septic tank cleaners

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Municipality	0	0.0	0.0	0.0	0.0
2.Community based organizations/NGOs	0	0.0	0.0	0.0	0.0
3.Private Sector	20	90.9	100.0	100.0	80.0
4.Family member	0	0.0	0.0	0.0	0.0
5.Others	0	0.0	0.0	0.0	0.0
6.Don't know	2	9.1	0.00	0.0	20.0
Total	22	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Regarding the questions on the reasons for the dissatisfaction of the sewer connection, 60.0% answered that pipe clogging, followed by overflow of wastewater (40.0%). All these answers came from MIG.

Table 6.2.77 Reason for dissatisfaction of the sewer connection

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Offensive odour (bad smell)	0	0.0	0.0	0.0	0.0
2.Pipe clogging	3	60.0	0.0	60.0	0.0
3.Overflow of wastewater	2	40.0	0.0	40.0	0.0
4.Delay in problem solving	0	0.0	0.0	0.0	0.0
5.Others	0	0.0	0.0	0.0	0.0
	5	100.0	0.0	100.0	0.0

Source: JICA Study Team 2016

When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered Rs. 80.0.

Table 6.2.78 WTP for the sewer connection

	All	LIG	MIG	HIG
Rs/month	80.0	50.0	87.5	-

Source: JICA Study Team 2016

When asked to all person who answered they have no sewer connection in their houses, whether they want to have a sewer connection in their house, 95.1% says they would like to have sewage in future and 4.9% says they do not need in future. Those who answered that they do not want have sewage think that they are sufficient with the septic tanks (100.0%).

Table 6.2.79 Sewage demand in non-sewer HHs

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Yes	39	95.1	100.0	100.0	84.6
2.No	2	4.9	0.0	0.0	15.4
	41	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

To those who do not have sewer connection and they would like to have in future, if asked how much they are willing to pay for connection of sewer to their house, When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered they are willing to pay Rs. 955.1. The higher the income, the higher the willing to pay for the connection fee, and the richest are willing to pay approximately 250% more than the poorest.

When asked the WTP for the sewer connection to those who answered the present sewer connection is unsatisfactory, in the condition that all previous issues are solved, they answered they are willing to pay 55.0 Rs. WTP of LIG and MIG are approximately at the same level and HIG are willing to pay 150% more than the poorer ones.

Table 6.2.80 WTP for connection and monthly fee (Rs.)

	All	LIG	MIG	HIG
WTP for connection (Rs)	955.1	637.5	858.3	1,522.7
WTP for monthly fee (Rs).	55.0	47.5	47.1	73.2

Source: JICA Study Team 2016

e) CTC usage

CTC is the complex of the community toilets, and if asked the WTP for CTC per usage, the respondents answered that Rs.4.5, and MIG pay higher than LIG and HIG.

Table 6.2.81 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.5	4.1	5.0	4.3

Source: JICA Study Team 2016

Question asked that how they evaluate the present public/community toilet service in the community, 17.7% answered relatively satisfactory, 11.8% very satisfactory, 11.8% average, 7.8% very unsatisfactory and 3.9% relatively unsatisfactory. 47.1 % say that they are not aware of the condition, which represents more disinterest in the CTCs in Mirzapur than Varanasi.

Table 6.2.82 CTC's satisfaction rate of the respondents

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Very satisfactory	6	11.8	0.0	17.7	17.7
2.Relatively satisfactory	9	17.7	11.8	23.5	17.7
3.Average	6	11.8	23.5	11.8	0.0
4.Relatively unsatisfactory	2	3.9	5.9	5.9	0.0
5.Very unsatisfactory	4	7.8	17.7	5.9	0.0
6.I don't know	24	47.1	41.2	35.3	64.7
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

When asked the reason that CTCs are not "very satisfactory", 100.0% answered that it is dirty, 52.4% overflow of wastewater is not good, 23.8% claims congestion, 19.1% too high charge, 19.1% says that it should be free of charge, 4.8% lack of proper facility, 0.0% long distance to the toilet.

Table 6.2.83 Reasons for dissatisfaction of the CTCs (multiple answers)

	All	LIG	MIG	HIG	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Dirty	21	10	8	3	100.0	100.0	100.0	100.0
2.Overflow of wastewater	11	6	4	1	52.4	60.0	50.0	33.3
3.Congestion	5	4	1	0	23.8	40.0	12.5	0.0
4.Long distance to the toilet	0	0	0	0	0.0	0.0	0.0	0.0
5.Charge is too high	4	1	3	0	19.1	10.0	37.5	0.0
6.I do not want to pay	4	4	0	0	19.1	40.0	0.0	0.0
7.Facility that we want to use is not installed	1	1	0	0	4.8	10.0	0.0	0.0
8.Others	0	0	0	0	0	0	0	0
ALL	46	26	16	4				

Source: JICA Study Team 2016

When asked the WTP for CTC per usage, the average is Rs. 4.7, Rs. 4.4 for LIG, Rs. 5.0 for MIG, and Rs. 5.0 for HIG.

Table 6.2.84 WTP for CTC per usage

	All	LIG	MIG	HIG
Rs.	4.7	4.4	5.0	5.0

Source: JICA Study Team 2016

When asked how they think the present public/community toilet service should be improved, 72.6 % public/community toilets should be cleaned, 39.2% answered more public/community toilets are necessary, 5.9 % washing space should be installed, 5.9% charging system should be reviewed (ex. Introduction of a family pass or monthly pass), 0.0 % shower facility should be installed.

Table 6.2.85 Type of improvements needed in the present CTCs (multiple answers)

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.More public/community toilets are necessary	20	39.2	41.2	47.1	29.4
2.Public/community toilets should be cleaned	37	72.6	76.5	70.6	70.6
3.Shower facility should be installed	0	0.0	0.0	0.0	0.0
4.Washing space should be installed	3	5.9	11.8	5.9	0.0
5.Charging system should be reviewed (ex. Introduction of a family pass or monthly pass)	3	5.9	11.8	0.0	5.9
6.Others	0	0.0	0.0	0.0	0.0

3) Public Outreach

This section summarized the public outreach section of the survey.

a) Participation of the activities

Question asked if there are any community-based activities on sanitary programs in your community, 88.2 % of them answered that they know the activities, and 11.8 % of them says that they do not know whether the activities are existing or not.

Table 6.2.86 Existence of the community-based activities on sanitary programs in your community

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Yes	47	92.2	88.2	94.1	94.1
2.No	4	7.8	11.8	5.9	5.9
All	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Questions asked whether they know what kind of public health activities exist in their cities, they answered that they know solid waste collection/cleaning (100.0%), operate water supply system (4.3%), community meetings regarding sanitation issues (2.1%). 6.4% of the respondents say that they know activities are existing but they do not know the particular names of specific activities.

Table 6.2.87 Type of public health activities observed in the city (multiple answers)

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Operate (cleaning) public toilets	0	0.0	0.0	0.0	0.0
2.Operate water supply system	2	4.3	0.0	6.3	6.3
3.Solid waste collection/cleaning	47	100.0	100.0	100.0	100.0
4.Health/hygiene education/training program	0	0.0	0.0	0.0	0.0
5.Environmental awareness enhancement campaign	0	0.0	0.0	0.0	0.0
6.Community meetings regarding sanitation issues	1	2.1	0.0	0.0	6.3
7.Others	0	0.0	0.0	0.0	0.0
8. Not knowing the particular names of specific activities	3	6.4	13.3	6.3	0.0

	53				

Source: JICA Study Team 2016

Question asked whether they have ever participated in or contributed to these community based activities, only 8.5% answered that they participated, and 91.5% not participated. Among the respondents who participated, the activities they participated are: 75.0% community meetings regarding sanitation, 50.0% in solid waste collection/cleaning, and 25.0% health/hygiene education/training program, issues.

Table 6.2.88 Type of community based activities participated in or contributed to (Multiple answers)

	All	All (%)	LIG（%）	MIG (%)	HIG (%)
1.Yes, I have participated in/contribute to:	4	8.5	0.0	0.0	25.0
i.Operate (cleaning) public toilets	0	0.0	0.0	0.0	0.0
ii.Operate water supply system	0	0.0	0.0	0.0	0.0
iii.Solid waste collection/Cleaning	2	50.0	0.0	0.0	50.0
iv.Health/hygiene education/training program	1	25.0	0.0	0.0	25.0
v.Environmental awareness enhancement campaign	0	0.0	0.0	0.0	0.0
vi.Community meetings regarding sanitation issues	3	75.0	0.0	0.0	75.0
vii. Others	0	0.0	0.0	0.0	0.00
2. No	43	91.5	100.0	100.0	75.0
3. Don't know the specific activities	0	0.0	0.0	0.0	0.0
1~3 Total	47	-	-	-	-

Source: JICA Study Team 2016

Concerning questions how they think community-based sanitation improvement activities such as cleaning the community and education program/training on sanitary issues are necessary, 58.8% think that it is very necessary and 41.2% somewhat necessary. HIG is by far very interested in the sanitation improvement activities (82.4%), followed by LIG (52.9%) and MIG (41.2%). Overall, 100.0 % of the respondents think that sanitation improvement activities are important.

Table 6.2.89 Necessity of community-based sanitation improvement activities

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Very necessary	30	58.8	52.9	41.2	82.4
2.Somewhat necessary	21	41.2	47.1	58.8	17.7
3.Not very necessary	0	0.0	0.0	0.0	0.0
4.Not necessary at all	0	0.0	0.0	0.0	0.0
Total	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Concerning the question asked if they have a chance, they are willing to participate in community-based sanitation improvement activities, 66.7% answered that they are willing to participate, and 33.3% are not interested in participation. The reason for disinterest is lack of time to spare for these activities for all people who responded that they are not interested. Among the respondents who want to participate, 52.9% of them answered campaigns for raising awareness of people, 32.4% on education program/training on sanitation, 20.6% cleaning our community, 2.9% operating (cleaning) public/community toilet, 0.0 % community meetings regarding sanitation issues. The more the income, the more the interest in participating to the community-based sanitation improvement activities, and the richest ones are approximately three times more willing to participate in these activities than the poorest ones.

Table 6.2.90 Willingness to participate in community-based sanitation improvement activities

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
Yes	34	66.7	35.3	64.7	94.1
1. participate in operating (cleaning) public/community toilet	1	2.9	16.7	0.0	0.0
2. participate in cleaning the community	7	20.6	50.0	18.2	12.5
3. participate in campaigns for raising awareness of people	18	52.9	33.3	81.8	56.3
4. participate in education program/training on sanitation	11	32.4	16.7	54.6	37.5
5. participate in community meetings regarding sanitation issues	0	0.0	0.0	0.0	0.0
No	17	33.3	64.7	35.3	5.9
Total	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Question asked whether they have taught or informed environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste, 56.9% answered Yes, and 43.1% answered No. HIG is much more aware of these environmental and hygiene issues (88.2%), and LIG people know as little as one fourth of HIG (23.5%).

Table 6.2.91 Knowledge on environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1. Yes	29	56.9	23.5	58.8	88.2
2. No	22	43.1	76.5	41.2	11.8
	51	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

To those who answered that they have knowledge in hygiene, if asked who taught these to them, 100.0% for TV programs, 62.1 % internet, 62.1 % community people and neighbours, 55.2% newspaper and magazines, 10.3 % municipal cooperation,13.8% family members, and 3.5% central/state government.

Compared to Varanasi, people spend more on TV, community people and neighbours, internet, and newspaper and magazines.

Table 6.2.92 Bodies/people that taught the hygiene knowledge to the respondents

	All	All (%)	LIG(%)	MIG(%)	HIG(%)
1.Family members	4	13.8	0.0	10.0	20.0
2.Community people/Neighbours	18	62.1	75.0	60.0	60.0
3.School	0	0.0	0.0	0.0	0.0
4.Municipal Corporation	3	10.3	0.0	0.0	20.0
5.Central/State government	1	3.5	0.0	0.0	6.67
6.NGO/CBO	0	0.0	0.0	0.0	0.0
7.Donor agencies	0	0.0	0.0	0.0	0.0
8.TV program	29	100.0	100.0	100.0	100.0
9.Radio program	0	0.0	0.0	0.00	0.0
10.Newspaper and magazine	16	55.2	0.0	40.0	80.0
11.Pamphlet, booklet, posters	0	0.0	0.0	0.0	0.0
12.Internet	18	62.1	0.0	40.0	93.3
13.Others	0	0.0	0.0	0.0	0.0
	89				

Source: JICA Study Team 2016

b) Services provided by the cities

Regarding the question whether they know about various services provided by Mirzapur city, all people answered that they know about the services.

Table 6.2.93 Knowledge on various service by Mirzapur city

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Yes	51	100.0	100.0	100.0	100.0
2.No	0	0.0	0.0	0.0	0.0

Source: JICA Study Team 2016

Concerning the services they are using, 94.1% of them answered solid waste management, 11.8% water supply services, 68.6% tax collection. Compared to Varanasi, water supply system is extremely low and variety of the services know to the responded are limited (three out of seven) compared to VNN case.

Table 6.2.94 services provided by Mirzapur City they are using (Multiple answers)

	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Public toilets	0	0.0	0.0	0.0	0.00
2.Water supply system	6	11.8	0.0	5.9	29.4
3.Solid waste collection	48	94.1	100.0	94.1	88.2

4.Health/health education/training program	0	0.0	0.0	0.0	0.0
5.(Environmental awareness enhancement campaign)	0	0.0	0.0	0.0	0.0
6.(Community meetings regarding sanitation issues)	0	0.0	0.0	0.0	0.0
7.(Tax Collection)	35	68.6	58.8	58.8	88.2
8.Others	0	0.0	0.0	0.0	0.0
	89				

Source: JICA Study Team 2016

When asked to people who know about the city services whether they pay the following taxes, and how much do you pay for the tax, they answered the followings.

Table 6.2.95 Average amount of tax payment conditions

	All	LIG	MIG	HIG
1. House tax	216.4	154.5	223.8	270.0
2. Water tax	230.7	180.3	257.9	253.9
3. Sewage tax	-	-	-	-
4. E. P. E. tax	-	-	-	-
5. Education, Petroleum, and Environment	-	-	-	-

Source: JICA Study Team 2016

Note: E.P.E = Export Processing Enterprises

6.2.7 Comparison of Varanasi and Mirzapur

This section describes the two bigger cities of the Project, Varanasi and Mirzapur. The section will compare two cities in basic profiles of each respondent, diseases, water supply, toilet facilities at HHs, CTC usage, and public participation and public outreach.

1) Basic profiles of each respondent

a) Average number of family members

This section describe the basic profiles of the respondents. Table below shows the average number of family members, and in Mirzapur more family members in one household exist in family numbers than Varanasi.

Table 6.2.96 Average number of family members in 2 cities

	Varanasi	Mirzapur
1.Total No. of Family Member	8.4	8.8
2.Male Members (more than 18 years) :	3.0	3.2
3.Female Members (more than 18 years) :	2.7	2.9
4.Child Less than 18 years:	2.7	2.7

Source: JICA Study Team 2016

b) Education Level

The more educated people answered the questionnaire survey in the Varanasi district. About 60.0 % of people are above college degree, while 47 % are so in Mirzapur. No illiterate people are in Varanasi, while 9.8% of Mirzapur people are illiterate.

Table 6.2.97 Education Level of the Respondents in 2 cities

	Varanasi		**Mirzapur**	
	Total	Total (%)	Total	Total (%)
0.Illiterate	0.0	0.0	5	9.8
1.Read & Write	25	16.7	12	23.5
2.5th grade	19	12.7	3	5.9
3.10th grade	16	10.7	7	13.7
4.10+ College	25	16.7	13	25.5
5.Grad school	45	f30.0	7	13.7
6.Post-grad school	20	13.3	4	7.8
	150	100.0	51	100.0

Source: JICA Study Team 2016

c) Average time spent

The longer time spent in the same place in Mirzapur, and it is 42.4 years for Mirzapur while 29.6 years for Varanasi.

Table 6.2.98 Settled years of the respondents (yrs.) in 2 cities

Type	**Varanasi**	**Mirzapur**
Year	29.6	42.4

Source: JICA Study Team 2015

d) Basic Income

Basic income of the respondents are more in Varanasi area, and the difference is about Rs. 2,200.

Table 6.2.99 Average monthly income of the respondents in 2 cities (Rs)

Type	Varanasi		Mirzapur	
	All	LIG	MIG	HIG
Varanasi	24,340.0	8,500.0	21,380.0	43,140.0
Mirzapur	22,098.0	8,470.6	17,823.5	40,000.0

Source: JICA Study Team 2016

2) Diseases

Disease crisis rate is much higher in Varanasi than in Mirzapur. In Varanasi, 54.7 % say that they have some disease in the past one year, while only 15.7% of Mirzapur people say so. The richer the people are, the less likely to get disease are the same tendency in both cities, and the poorest are twice as much in Varanasi and six times as much in Mirzapur contingent to diseases.

Table 6.2.100 Disease incident rate for the past one year in 2 cities

	Varanasi					Mirzapur				
	All	All (%)	LIG (%)	MIG (%)	HIG (%)	All	All (%)	LIG (%)	MIG (%)	HIG (%)
1.Yes	82	54.7	80.0	42.0	42.0	8	15.7	35.3	5.9	5.9
2.No	68	45.3	20.0	58.0	58.0	43	84.3	64.7	94.1	94.1

Source: JICA Study Team 2016

The most seen disease in these two cities are “others,” representing 45.1% and 75.0%, followed by paratyphoid, 34.2% and 25% each. “Others” are mostly appeared as fevers.

Table 6.2.101 Type of disease for the past one year in 2 cities (Multiple answers)

	Varanasi		Mirzapur	
	All	**All (%)**	**All**	**All (%)**
1.Paratyphoid	28	34.2	2	25.0
2.Cholera	7	8.5	0	0.0
3.Typhoid/Typhus	7	8.5	0	0.0
4.Dysentery	0	0.0	0	0.0
5.Dengue	7	8.5	0	0.0
6.Malaria	23	28.1	0	0.0
7.Flue	3	3.7	0	0.0
8.Others	37	45.1	6	75.0
	112		8	

Source: JICA Study Team 2016

3) Water supply service

Varanasi people have more water supply connections than Mirzapur people and there exist 6.6% difference. Ground water is at the same level, while private source is more common in Mirzapur than Varanasi.

Table 6.2.102 Possession of the water supply service in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Yes	107	71.3	33	64.7
2.No	43	28.7	18	35.3
3.Other sources				
1. Private source	21	14.0	10	19.6
2. Ground water	22	15.7	8	15.7

Source: JICA Study Team 2016

Varanasi people pay more than Mirzapur people and the most common monthly fee for them is around Rs. 1,500 (30.8%), followed by around Rs. 2,000 (16.8%). On the other hand, 90.9 % of people are paying around Rs. 800 in Mirzapur.

Table 6.2.103 Amount of the water supply charge per month in 2 cities (Rs)

	Varanasi		Mirzapur	
	All	**All (%)**	**All**	**All (%)**
1.Around Rs. 800*	24	22.4	30	90.9
2.Around Rs. 1,000	11	10.3	1	3.0
3.Around Rs. 1,500	33	30.8	0	0.0
4.Around Rs. 2,000	18	16.8	0	0.0
5.Around Rs. 2,500	9	8.4	0	0.0
6.More than Rs. 2,500	8	7.5	0	0.0
7. Not paying	4	3.7	2	6.1
	107	100.0	33	100.0

Source: JICA Study Team 2016

Water supply services in Varanasi is less satisfactory than Mirzapur and the rate of people who say that existing water service is “very satisfactory” is 39.1 % in Varanasi and 76.5 % in Mirzapur.

Table 6.2.104 Satisfactory rate of the water supply services in 2 cities

	Varanasi		Mirzapur	
	All	**All (%)**	**All**	**All (%)**
1.Very satisfactory	43	39.1	39	76.5
2.Relatively satisfactory	32	29.1	7	13.7
3.Average	19	17.3	2	3.9
4.Relatively unsatisfactory	7	6.4	1	2.0
5.Very unsatisfactory	10	9.1	2	3.9

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
6. Don't know	39	35.5	0	0.0
	150	100.0	51	100.0

Source: JICA Study Team 2016

4) Toilet facilities at HHs

Public toilet facilities of both cities are shown as below. The possession rate in 84.7% in Varanasi and 84.3% in Mirzapur. The non-possession is conspicuous in low income HHs in both cities.

Table 6.2.105 Toilet possessions in Varanasi and Mirzapur in 2 cities (number and %)

	Varanasi				Mirzapur			
	All	LIG	MIG	HIG	All	LIG	MIG	HIG
Yes	127	27	50	50	43	10	16	17
No	23	23	0	0	8	7	1	0
	150	50	50	50	51	17	17	17
Yes(%)	84.7	54.0	100.0	100.0	84.3	58.8	94.1	100.0
No (%)	15.3	46.0	0.0	0.0	15.7	41.2	5.9	0.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: JICA Study Team 2016

Disposal system for toilets in two cities are shown as below and high connection rate to sewers is seen Varanasi (88.2%) and low in Mirzapur (23.3%). Septic tanks are the most frequently seen in Mirzapur (51.2%), while the second most seen in Varanasi (7.8%). Mirzarpur's second most conspicuous way for disposal is the direct discharge into ditch, drain or river (25.6%), worse for environmental pollution.

Table 6.2.106 Disposal system for the toilets in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Sewer connection	112	88.2	10	23.3
2.Septic tank (connecting with a soak pit or trench)	10	7.8	22	51.2
3.Pit latrine (not using water)	3	2.4	0	0.0
4.Direct discharge into ditch, drain or river	2	1.6	11	25.6
5.Others	0	0.0	0	0.0
	127	100.0	43	100.0

Source: JICA Study Team 2016

5) CTC usage

The satisfaction rate of CTCs are low in Mirzapur (29.5%, totalling for "very satisfactory" and "relatively satisfactory"), while Varanasi people say 53.3% say that the CTCS are more than "relatively satisfactory." Mirzapur people also are ignorant of the existence of CTCs and 47.1 % of people are not aware of the situation of CTCs and while Varanasi people's rate is 20.0%.

Table 6.2.107 CTC's satisfaction rate of the respondents in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Very satisfactory	35	23.3	6	11.8
2.Relatively satisfactory	48	32.0	9	17.7
3.Average	21	14.0	6	11.8
4.Relatively unsatisfactory	8	5.3	2	3.9
5.Very unsatisfactory	8	5.3	4	7.8
6.I don't know	30	20.0	24	47.1
	150	100.0	51	100.0

Source: JICA Study Team 2016

Both cities users complain that the CTCs are dirty (64.4% and 100.0 %), followed by overflow of wastewater (42.6% and 52.4%) and then the congestion (8.7% and 23.8%).

Table 6.2.108 Reasons for dissatisfaction of the CTCs in 2 cities (multiple answers)

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Dirty	74	64.4	21	100.0
2.Overflow of wastewater	49	42.6	11	52.4
3.Congestion	10	8.7	5	23.8
4.Long distance to the toilet	8	7.0	0	0.0
5.Charge is too high	5	4.4	4	19.1
6.I do not want to pay	2	1.7	4	19.1
7.Facility that we want to use is not installed	2	1.	1	4.8
8.Others	0	0.0	0	0.0
ALL	150		46	

Source: JICA Study Team 2016

When asked how the present CTCs should be improved, Varanasi people answered that more public/community toilets are necessary (87.3%) while Mirzapur people answered public/community toilets should be cleaned (72.6%). Second most frequently-heard complaint for Varanasi is that public/community toilets should be cleaned by 56.7%, while 39.2% of Mirzapur people complain about the quantity issue. 14.7% of Varanasi and 5.9 % of Mirzapur people raised the issue that charging system should be reviewed such as introduction of a family pass or monthly pass. In summary, O&M, quantity and charge systems are raised as critical issues in both cities.

Table 6.2.109 Type of improvements needed in the present CTCs in 2 cities (multiple answers)

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.More public/community toilets are necessary	131	87.3	20	39.2
2.Public/community toilets should be cleaned	85	56.7	37	72.6
3.Shower facility should be installed	11	7.3	0	0.0
4.Washing space should be installed	5	3.3	3	5.9
5.Charging system should be reviewed ex. Introduction of a family pass or monthly pass	22	14.7	3	5.9
6.Others	1	0.7	0	0.0

Source: JICA Study Team 2016

6) Public outreach

Concerning the community-based activities on sanitation matters, 84.0% in Varanasi and 92.2% in Mirzapur answered that they know the activities.

Table 6.2.110 Existence of the community-based activities on sanitary programs in the respondents community in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Yes	126	84.0	47	92.2
2.No	24	16.0	4	7.8
	150	100.0	51	100.0

Source: JICA Study Team 2016

In regard to the type of public health activities observed in the two cities asked to those who say that they know the activities, major differences are seen between the two cities. In Varanasi, most seen activities is the health/hygiene education/training program (79.5%), while 100.0% of Mirzapur people say that solid waste management system. Varanasi people also say that they have seen operate (cleaning) public toilets (31.0%) and community meetings (28.2%). On the other hand, Mirzapur people say they do not know the particular names (6.4%), operate water supply system (4.3%) and community meetings regarding sanitation issues (2.1%). In summary, Varanasi people are more aware of public health activities.

Table 6.2.111 Type of public health activities observed in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Operate (cleaning) public toilets	39	31.0	0	0.0
2.Operate water supply system	5	12.8	2	4.3
3.Solid waste collection/cleaning	10	25.6	47	100.0
4.Health/hygiene education/training program	31	79.5	0	0.0
5.Environmental awareness enhancement campaign	9	23.1	0	0.0
6.Community meetings regarding sanitation issues	11	28.2	1	2.1
7.Others	6	15.4	0	0.0
8. Not knowing the particular names of specific activities	0	0.0	3	6.4
Total	84		50	

Source: JICA Study Team 2016

People answered rather inactive responses in the participation of community based activities. 66.7% of Varanasi people and 91.5% of Mirzapur people are not participated in any activities. Some of the same type of active people attend many activities. Most attended activities in Varanasi are: solid waste collection/cleaning (79.5%), environmental awareness enhancement campaign (28.2%), and water supply system (12.8%), while in Mirzapur, they are: community meetings regarding sanitation issues (75.0%), solid waste collection/cleaning (50.0%), and health/hygiene education/training program (25.0%).

Table 6.2.112 Type of community based activities participated in or contributed to in 2 cities (Multiple answers)

	Varanasi		Mirzapur	
	All	**All (%)**	**All**	**All (%)**
1.Yes, I have participated in/contribute to	39	31.0	4	8.5
i.Operate (cleaning) public toilets	5	12.8	0	0.0
ii.Operate water supply system	10	25.6	0	0.0
iii.Solid waste collection/cleaning	31	79.5	2	50.0
iv.Health/hygiene education/training program	9	23.1	1	25.0
v.Environmental awareness enhancement campaign	11	28.2	0	0.0
vi.Community meetings regarding sanitation issues	6	15.4	3	75.0
vii. Others	0	0.0	0	0.0
2.No	84	66.7	43	91.5
3.Don't know the specific activities	3	2.38	0	0.0
1~3 Total	126		47	

Source: JICA Study Team 2016

Varanasi people are more aware of the necessity of community-based sanitation improvement activities than Mirzapur people in the rate of very necessary, 95.3 % versus 58.8%.

Table 6.2.113 Necessity of community-based sanitation improvement activities in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Very necessary	143	95.3	30	58.8
2.Somewhat necessary	7	4.7	21	41.2
3.Not very necessary	0	0.0	0	0.0
4.Not necessary at all	0	0.0	0	0.0
	150	100.0	51	100.0

Source: JICA Study Team 2016

Varanasi people are much more willing to participate in community-based sanitation improvement activities than Mirzapur people (94.0% versus 66.7%). Popular activities are participation in education program/training on sanitation (52.7% versus 32.4%), raising awareness of people (50.7% versus 52.9%), and cleaning the community (27.3% versus 20.6%).

Table 6.2.114 Willingness to participate in community-based sanitation improvement activities in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
Yes	141	94.0	34	66.7
1. participate in operating (cleaning) public/community toilet	7	4.7	1	2.9
2. participate in cleaning the community	41	27.3	7	20.6
3. participate in campaigns for raising awareness of people	76	50.7	18	52.9
4. participate in education program/training on sanitation	79	52.7	11	32.4
5. participate in community meetings regarding sanitation issues	4	2.7	0	0.0
No	9	6.0	17	33.3
Total	150	100.0	51	100.0

Source: JICA Study Team 2016

In respect to the question whether they know environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste or not, 75.3 % of Varanasi and 56.9% of Mirzapur people say that they know the environmental and hygiene issues.

Table 6.2.115 Knowledge on environmental and hygiene issues such as the health and environmental impacts caused by polluted water or solid waste in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1. Yes	113	75.3	29	56.9
2. No	37	24.7	22	43.1

Source: JICA Study Team 2015

Rather big differences between Varanasi and Mirzapur are seen in the question that who taught them the knowledge on environmental and hygiene issues. 48.0% of Varanasi people answered community people and neighbours, 39.3% TV programs, 37.3% family members, 27.3% newspaper and magazines, 14.7% municipal cooperation, 6.7% pamphlets, booklets, and posters, 5.3% internet, 4.7% NGO/CBO, 2.7% school, 2.0% radio programs, and 0.7% central/state government. On the other hand, Mirzapur people say that 100.0% for TV programs, 62.1 % internet, 62.1 % community people and neighbours, 55.2% newspaper and magazines, 13.8% family members, 10.3 % municipal cooperation, and 3.5% central/state government. In Mirzapur, compared to Varanasi, more people depends on TV, community people and neighbours, and newspaper and magazines. Interestingly internet plays much more important role in Mirzapur than Varanasi (more than 10 times difference).

Table 6.2.116 Bodies/people that taught the hygiene knowledge to the respondents in 2 cities (multiple answers)

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Family members	56	37.3	4	13.8
2.Community people/Neighbours	72	48.0	18	62.1
3.School	4	2.7	0	0.0
4.Municipal Corporation	22	14.7	3	10.3
5.Central/State government	1	0.7	1	3.5
6.NGO/CBO	7	4.7	0	0.0
7.Donor agencies	0	0.0	0	0.0
8.TV program	59	39.3	29	100.0
9.Radio program	3	2.0	0	0.0
10.Newspaper and magazine	41	27.3	16	55.2
11.Pamphlet, booklet, posters	10	6.7	0	0.0
12.Internet	8	5.3	18	62.1
13.Others	0	0.0	0	0.0
	283		89	

Source: JICA Study Team 2015

Regarding the question whether they know about various services provided by each city or not, all people answered that they know about some services.

Table 6.2.117 Knowledge on various service in 2 cities

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Yes	150	100.0	51	100.0
2.No	0	0.0	0	0.0

Source: JICA Study Team 2015

Concerning the services they are using, 96.7% in Varanasi and 94.1% in Mirzapur answered that they use solid waste management. Similarly, 68.7% and 68.6% say that they know about tax collection. On the other hand, there exists a big difference in water supply services, 94.0% in Varanasi and 11.8 % in Mirzapur say that they use the water supply. Similarly, 70.0% in Varanasi and 0.0 % in Mirzapur say that they use public toilets. In Varanasi, other services such as health/health education/training program (11.3%), environmental awareness enhancement campaign (7.3%), and community meetings regarding sanitation issues (3.3%) are known to people, while in Mirzapur, they do not know other services than solid waste, tax collection and water supply.

Table 6.2.118 Municipality services they are using in 2 cities (Multiple answers)

	Varanasi		Mirzapur	
	All	All (%)	All	All (%)
1.Public toilets	105	70.0	0	0.0
2.Water supply system	141	94.0	6	11.8
3.Solid waste collection	145	96.7	48	94.1
4.Health/health education/training program	17	11.3	0	0.0
5.Environmental awareness enhancement campaign	11	7.3	0	0.0
6.Community meetings regarding sanitation issues	5	3.3	0	0.0
7.Tax Collection	103	68.7	35	68.6
8.Others	0	0.0	0	0.0
Total	527		89	

Source: JICA Study Team 2015

6.2.8 Ghat Conditions in Varanasi

1) Outline of the survey

In Ganga Rejuvenation Plan, The objective of the Ghat question is to understand the impact/usefulness of the facilities provided under the JICA Loan Project in selected Ghat and to assess the need for more facilities for the benefit of the users. The Appendix 6-3 represent the survey designs of the Ghat monitoring questionnaire.

Sample size is determined as 60. In the selected 12 Ghats, the surveyors will interview 5 respondents from each Ghat, represented by Varanasi Nagal Nigam Concerned official, sanitary supervisors, pilgrim, boatmen, other Ghat Vendors/Pujaris. Public Health experts care to cover 10% of the sample size should be women.

The figure below shows the 12 Ghats selected in this survey.

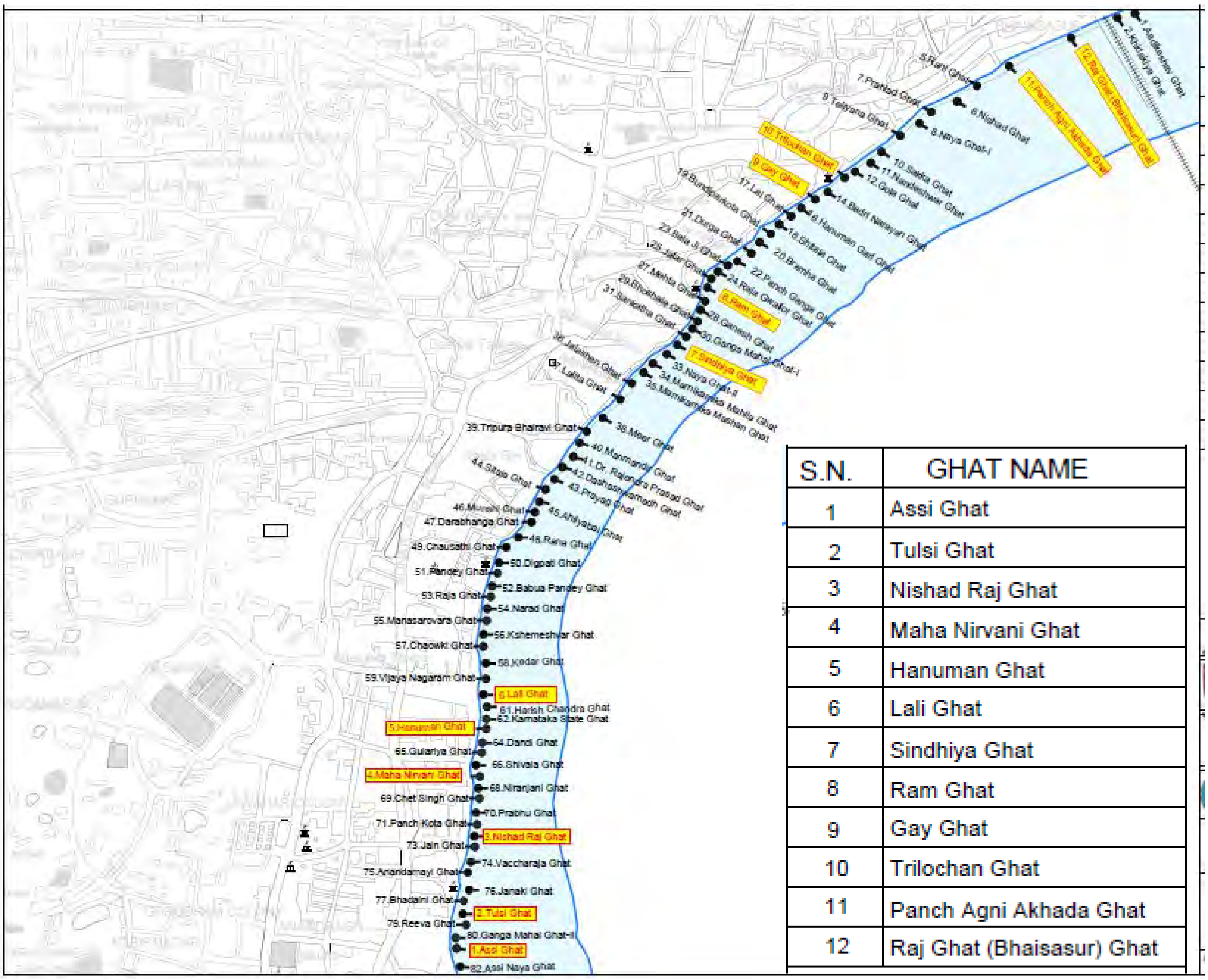


Figure 6.2.1 Map of Ghats surveyed in the questionnaire survey

Source: JICA Study Team 2015

Random sampling will be adopted to cover the diversified category of respondents (one person from each above mentioned category) form the 12 selected Ghats out of 26 under the JICA assisted project. The selected Ghats are shown in the Table 6.2.119 ID Numbers of the Ghat Question. The samples are as taken from Government related people, pilgrims, boatmen, pujaris (Priests) and Ghat Vendors.

Table 6.2.119 ID Numbers of the Ghat Question

	Ghat Name	Government*	Pilgrim	Boatman	Pujari (Priest)	Ghat Vendor	Total
1	Assi Ghat	1	1	1	1	1	5
2	Tulsi Ghat	1	1	1	1	1	5
3	Nishad Ghat	1	1	1	1	1	5
4	Mahaniravani Ghat	1	1	1	1	1	5
5	Hanuman Ghat	1	1	1	1	1	5
6	Lali Ghat	1	1	1	1	1	5
7	Scindia Ghat	1	1	1	1	1	5
8	Ram Ghat	1	1	1	1	1	5
9	Gay Ghat	1	1	1	1	1	5
10	Trilochan Ghat	1	1	1	1	1	5
11	Panch Agni Akhada Ghat	1	1	1	1	1	5
12	Raj Ghat (Bhaisasur) Ghat	1	1	1	1	1	5
	Total	12	12	12	12	12	60

*Note: *Includes Concerned officials / sanitary supervisors /others*
Source: JICA Study Team 2015

Questions asked here are the present satisfaction of each Ghat, present issues, satisfaction rate of the Ganga Action Plan renovations, and public activities pursued in Ghats. It was pursued in 15-19 December 2016.

Among GAP renovation questions, there are some differences in the facilities in each Ghat. Both floors and steps are renovated in 2 facilities but changing facilities are made in only 7 locations. Regarding cloaks, those by private sectors are being used in several locations.

Most of the Ghats are reconstructed in 1980s. However, the original constructions dates back in 17th century in the age of Maratha Empire. All the Ghats are renovated by GAP first phase and it started in November 2013, ended in June 2014.

Table 6.2.120 Conditions of each Ghat

No.	Ghat Name	Changing rooms	floors	Steps	Cloaks
1	Assi Ghat	X	X	X	*
2	Tulsi Ghat	X	X	X	*
3	Nishad Ghat		X	X	*
4	Mahaniravani Ghat		X	X	*
5	Hanuman Ghat		X	X	*
6	Lali Ghat		X	X	*
7	Scindia Ghat	X	X	X	*
8	Ram Ghat	X	X	X	*

No.	Ghat Name	Changing rooms	floors	Steps	Cloaks
9	Gay Ghat	X	X	X	*
10	Trilochan Ghat	X	X	X	*
11	Panch Agni Akhada Ghat		X	X	*
12	Raj Ghat (Bhaisasur) Ghat	X	X	X	*
	Total	7	12	12	-

Source: GAP 2016

Note: Cloaks or lockers are equipped by the private sectors.*

1) Outcomes of the survey

The Ghat survey outcomes were analysed in January 2016. This section looks at the following 8 categories.

a. Basic profiles of each respondent
b. Ghats' management, main use, and daily basing needs
c. Changing rooms for women
d. Floor renovation of each Ghat
e. Step renovation pf each Ghat
f. Cloak facilities of each Ghat
g. Ghat renovation responsibility
h. Public health activity at the Ghat

a) Basic profiles of each respondent

The purpose of the respondents visits are thought as the sample selection criteria so the results are as below. The Pujaris are the priest who involves in the ritual services.

Table 6.2.121 Respondents relations with Ghats

	Government*	Pilgrims	Boatmen	Pujaris (Priests)	Ghat Vendors	Others	Total
N	12	12	12	11	12	1	60
%	20.0	20.0	20.0	18.3	20.0	1.7	100

*Note: *Includes Concerned officials / sanitary supervisors /others*

Source: JICA Study Team 2015

The table below shows the respondents attributes of the survey, and it shows that most of them are the business owners (31.7%), followed by government job (18.3%), daily wage (18.3%), family profession (11.7%), vending activity (6.7%), family profession (5.0%) and others (5.0%).

Table 6.2.122 Respondents attributes

	Business	Government job	Daily wage	Private job	vending activity	Family profession	Others	Total
N	19	11	11	7	4	3	5	60
%	31.7	18.3	18.3	11.7	6.7	5.0	8.3	100.0

Source: JICA Study Team 2015

b) Ghats' management, main use, and daily basing needs

The management of the Ghats is shown as below. One third of the Ghats are managed by private foundation (4), followed by banks (3), VNN and NGO (2), hospital and research center (1).

Table 6.2.123 Main bodies of the Ghat management

	Private Foundation	Banks	VNN	NGOs	Hospital	Research Centre	Total
N	4	3	2	2	1	1	13*
%	33.33	25	16.67	16.67	8.33	8.33	100.00

Note: Trilochan Ghat is managed by both NGO and a bank. Therefore the total of the management bodies bec omes 13.

Source: JICA Study Team 2015

Main purpose of visiting the Ghats are daily bathing (100.0%), washing clothes (81.7%), religious bathing (76.7%), human hair cutting (43.3%), cow dung making (11.7%), and dead body burning (1.7%).

Table 6.2.124 Main purposes of the Ghat use

	Daily bathing	Washing clothes	Religious bathing	Human hair cutting	Cow dung cake making	Dead body burning	Others	Total
N	60	49	46	26	7	1	0	189
%	100.0	81.7	76.7	43.3	11.7	1.7	0	-

Source: JICA Study Team 2015

Table below shows the bathing patterns observed in each Ghat. 91.7% of the respondents says that the Ghat is used for bathing every day, followed by once in two days (3.3%), Sundays (3.3%), and specific days (1.7%).

Table 6.2.125 The frequency of daily bathing

	Every day	Once in two days	Only on Saturdays	Only on Sundays	Only on specific day	Others
N	55	2	0	2	1	0
%	91.7	3.3	0.0	3.3	1.7	0.0

Source: JICA Study Team 2015

The length of bathing time is mostly more than 30 minutes, 55.0 % of people spend more than 1 hour at the Ghat, while 30.0 % spend 30 minutes - one hour. 20.0% answered 15-30 minutes, and 10.0% answered 5-15 minutes. Among people who spend over 5 hours, their average spending hours are 7.8 hours.

Table 6.2.126 The length of daily bathing

	Less than 5 minutes	5-15 minutes	15-30 minutes	30 min -1 hour	More than 1 hour	Total
N	0	3	12	18	27	60
%	0.0	5.0	20.0	30.0	55.0	100.0

Source: JICA Study Team 2015

c) Changing rooms for women

Out of 12 Ghats, two thirds of Ghats have the clothes change facilities of the women. Type of the facilities each has for changing rooms for women are: 45.0% says that there are the temporary changing rooms, 35.0% permanent changing rooms, and 20.0% unknown. It can be concluded that the temporary changing rooms are majority in existence in the surveyed Ghats.

Table 6.2.127 Type of changing rooms found in Surveyed Ghats

	Permanent changing rooms	Temporary changing rooms	Unknown	Total
N	21	27	12	60
%	35.0	45.0	20.0	100.0

Source: JICA Study Team 2015

Table below shows the satisfaction of the changing rooms. 29.2% of the respondent answered that the changing rooms are relatively satisfactory, and also the same number of people (29.2 %) says it is average, followed by very unsatisfactory (27.1%) and very satisfactory (6.3 %).

Table 6.2.128 Satisfaction in changing rooms

	Very satisfactory	Relatively satisfactory	Average	Relatively unsatisfactory	Very unsatisfactory	Unknown	Total
N	3	14	14	0	13	4	48
%	6.3	29.2	29.2	0.0	27.1	8.3	100.0

Source: JICA Study Team

Concerning the questions of the reason for dissatisfaction to be asked to people who answered the present changing rooms are unsatisfactory, they answered that not clean (80.5%), not conveniently placed (53.7%), bad smell (46.3%), fear of molesting (19.5%), not spacious (12.2%), and mosquitos, flies and other bugs (4.9%).

Table 6.2.129 Reasons for dissatisfaction of the changing rooms (multiple answers)

	Not spacious	Not clean	Not conveniently placed	Bad smell	Fear of molesting	Mosquitos, flies, other bugs	Others	Total
N	5	33	22	19	8	2	0	89 (41*)
%	12.2	80.5	53.7	46.3	19.5	4.9	0.0	-

Source: JICA Study Team 2015

Note: The number of people who do not respond "very satisfactory" is forty-one.*

Concerning the questions of the type of improvement to be asked to people who answered the present changing rooms are unsatisfactory, they answered that cleaning should be more frequent (56.1%), make permanent rooms (43.9%), quantity should be more (39.0%), rules should be made (7.3%), and make lockers (2.4%).

Table 6.2.130 Type of improvement to be proposed for the present changing rooms

	Permanent rooms	Quantity should be more	Cleaning should be more frequent	Rules on changing rooms	Make lockers*1	Total
N	18	16	23	3	1	61(41*2)
%	43.9	39.0	56.1	7.3	2.4	100.0

Source: JICA Study Team 2015

*Note*1: The question is originally an open question and the answers include the issues above changing rooms.*
**2: The number of people who do not respond "very satisfactory" is forty-one.*

d) Floor renovations of each Ghat

Regarding the floor renovation for the Ghats, 88.3% of them answered they are very satisfied with the Project efforts, followed by average (5.0 %), relatively satisfactory (3.3%), and very unsatisfactory (1.7%) and unknown (1.7%). High satisfactions for the floor renovation works can be seen from the results.

Table 6.2.131 Satisfaction in floor renovations

	Very satisfactory	Relatively satisfactory	Average	Relatively unsatisfactory	Very unsatisfactory	Unknown	Total
N	53	2	3	0	1	1	60
%	88.3	3.3	5.0	0.0	1.7	1.7	100.0

Source: JICA Study Team

Concerning the questions of the reason for dissatisfaction to be asked to people who answered the present floor renovations are unsatisfactory, they raised no system of maintenance (83.3%), no comfortable material texture (50.0%), not luxurious enough (50.0%), and no system of community awareness (50.0%).

Table 6.2.132 Reasons for dissatisfaction of the floor renovations (multiple answers)

	Not spacious	No comfortable material texture	Not conveniently placed	Not luxurious enough	No system of maintenance	No system of community awareness of cleaning	Total
N	0	3	0	3	5	3	14 (6*)
%	0	50.0	0	50.0	83.3	50.0	-

Source: JICA Study Team 2015

Note: The number of people who do not respond "very satisfactory" is six.*

Concerning the questions of the type of improvement to be asked to people who answered the present floor renovations are unsatisfactory, they answered that cleaning should be regular (22.2%), make maintenance programs (22.2%), make toilets on the renovated floors (22.2%), make awareness programs (11.1%), make changing rooms (11.1%), and install chairs (11.1%).

Table 6.2.133 Type of improvement to be proposed for the present floor renovations

	No regular cleaning	Maintenance Program not existing	Awareness Program *1	Changing rooms *1	Make toilets *1	Install Chairs (benches) *1	Total
N	2	2	1	1	2	1	9 (6 *2)
%	22.2	22.2	11.1	11.1	22.2	11.1	-

Source: JICA Study Team 2015

*Note*1:The question is originally an open question and the answers include the issues above floor renovations.*
**2: The number of people who do not respond "very satisfactory" is six.*

e) Step renovations of each Ghat

Regarding the step renovations for the Ghats, 85.0% of them answered they are very satisfied with the Project efforts, followed by relatively satisfactory (5.0%) and average (5.0%), and relatively unsatisfactory (1.7%) and unknown (3.3%). High satisfactions for the step renovation works can be seen from the results.

Table 6.2.134 Satisfaction in step renovations

	Very satisfactory	Relatively satisfactory	Average	Relatively unsatisfactory	Very unsatisfactory	Unknown	Total
N	51	3	3	1	0	2	60
%	85.0	5.0	5.0	1.7	0.0	3.3	100.0

Source: JICA Study Team

Concerning the questions of the reason for dissatisfaction to be asked to people who answered the present step renovations are unsatisfactory, they raised not luxurious enough (57.1%), no system of maintenance (57.1%), not comfortable height range (28.6%), not conveniently placed (28.6%), and no system of community awareness cleaning (14.3 %).

Table 6.2.135 Reasons for dissatisfaction of the step renovations (Multiple answers)

	Not spacious	Not comfortable height range	Not conveniently placed	Not luxurious enough	No system of maintenance	No system of community awareness of cleaning	Total
N	0	2	2	4	4	1	13 (7*)
%	0.00	28.6	28.6	57.1	57.1	14.3	-

Source: JICA Study Team 2015

Note: The number of people who do not respond "very satisfactory" is seven.*

Concerning the questions of the type of improvement, asked to people who answered the present step renovations are unsatisfactory, they answered that make changing rooms (42.9%), railing for steps

(42.9%), awareness programs should be held (28.6 %), rules for using steps should be made (28.6 %), make toilets on the stairs (28.6%), construct more stairs (28.6%) and make the stairs in better quality (14.3 %).

Table 6.2.136 Type of improvement to be proposed for the present step renovations (Multiple answers)

	Make Changing rooms *1	Make Railing	Awareness programs should be held	Rules should be made	Make toilets *1	Construct stairs	Make better quality	Total
N	3	3	2	2	2	2	1	15 (7*2)
%	42.86	42.86	28.57	28.57	28.57	28.57	14.29	-

Source: JICA Study Team 2015

*Note*1: The question is originally an open question and the answers include the issues above step renovations.*
**2: The number of people who do not respond "very satisfactory" is seven.*

f) Cloak facilities of each Ghat

Regarding the cloak facilities, not many samples are taken as others questions, because these are still under consideration at the GAP project. The cloaks are all private installation and the Ghat which has the private cloaks is Hanuman Ghat which lies in the middle of the Ghat area. Regarding the cloak facilities for the Ghats, only 3 people said that they have seen the cloak facilities and 2 of them feels very satisfactory and 1 feels relatively unsatisfactory.

Table 6.2.137 Satisfaction in cloak facilities

	Very satisfactory	Relatively satisfactory	Average	Relatively unsatisfactory	Very unsatisfactory	Total
N	2	0	0	1	0	3
%	66.7	0	0	33.3	0	100.0

Source: JICA Study Team 2015

Concerning the questions of the reason for dissatisfaction to be asked to people who answered the present cloak facilities are unsatisfactory, they raised the cloak facilities are not conveniently placed (100.0%).

Table 6.2.138 Reasons for dissatisfaction of the cloak facilities

	Not spacious	Not clean	Not conveniently placed	Not luxurious enough	No system of maintenance	No system of community awareness of cleaning	Total
N	0	0	1	0	0	0	1 (1 *)
%	0.00	0.00	100.00	0.00	0.00	0.00	-

Source: JICA Study Team 2015

Note: The number of people who responded not very satisfactory is one.

Concerning the questions of the type of improvement to be asked to people who answered the present cloak renovations are unsatisfactory, they answered that they raised make changing rooms for male **and disabled people (100.0%).**

Table 6.2.139 Type of improvement to be proposed for the present cloak facilities

	Cloak facilities for male or disabled people	Lockers should be made*1	Total
N	1	0	1(*2)
%	100.0	0	100.0

Source: JICA Study Team 2015

*Note*1: The question is originally an open question and the answers include the issues above step renovations.*
**2: The number of people who do not respond "very satisfactory" is one.*

g) Ghat renovation responsibility

Concerning the question that who they think is responsible for the renovations of these Ghats, 85.0% answered it is by municipality (Varanasi municipality), followed by district municipality (3.3%), and other governmental organization (1.7 %). It is concluded that JICA's efforts role are unknown to them.

Table 6.2.140 People thoughts on who is (are) responsible for the Ghat renovations

	N	%
National Government	51	85.0
Unknown	6	10.0
District government	2	3.3
Other	1	1.7
Municipality	0	0
Other governmental organization	0	0
Foreign aid	0	0
Foreign government fund	0	0
Total	60	100.0

Source: JICA Study Team 2015

h) Public Health Activities

Regarding the questions what kind of public activities at the Ghat are known to people, they answered the following activities. The most well-known activities are health and fitness program including yoga (33.3%), cleaning awareness (26.7%), Clean Ganga Plan (20.0%), human rights (13.3%) and women rights and domestic violence matters (6.7%).

Table 6.2.141 Respondents' thoughts on activities for the Ghats

	Health and fitness program (yoga etc.)	Cleaning awareness	Clean Ganga Plan	Human rights	Women rights/Domestic Violence	Total
N	5	4	3	2	1	15
%	33.3	26.7	20.0	13.3	6.7	-

Source: JICA Study Team 2015

The questions asked on what are the major issues in these Ghats, more than half of the respondents answered to the major issues in the Ghats are the lack of cleanliness (55.5%), followed by the lack of public toilets (28.3%), permanent changing rooms (16.7%), cloak rooms (5.0%) and dustbins (3.3%). 1.7% says lack of railings for steps, animal roaming, shortage of lighting, and plastic uses.

Table 6.2.142 Major issues of the Ghats (multiple answers)

Issues	N	%
Cleanliness	33	55.5
Public toilets	17	28.3
Permanent changing rooms	10	16.7
Cloak rooms	3	5.0
Dustbins	2	3.3
Railings	1	1.7
Animals roaming	1	1.7
Lighting	1	1.7
Use of plastics	1	1.7
Total	69 (60*)	-

Source: JICA Study Team 2015

Note: The number of people who do not responded "very satisfactory" is 60.*

Concerning the open questions asked to the respondents about the facilities they would like to have in the Ghats are: permanent changing room (75.0%), public toilets (55.0%), lockers (20.0%), cloak rooms (15.0%), drinking water facilities (15.0%), railings for steps (8.3%), dustbins (6.7%), awareness programs (1.7%), and sewers (1.7%).

Table 6.2.143 Facilities wanted be equipped in the Ghats

	N	%
Permanent changing rooms	45	75.0
Public toilets	33	55.0
Lockers	12	20.0
Cloak rooms	9	15.0
Drinking water facilities	9	15.0
Railings	5	8.3
Dustbins	4	6.7
Awareness programs	1	1.7
Sewers	1	1.7

	119 (60)	

Source: JICA Study Team 2015

Note: The number of people who responded not very satisfactory is 60.*

Questions asked on the suggestions to make the Ghats better, 48.3% answered that make cleaning systems for Ghats, 35.0 % says to make permanent changing rooms, 23.3 % answered make public toilets, 11.7 % answered install dustbins, and each 3.3 % answered more awareness programs and setting up the caution boards. Other suggestions are cloak rooms, railing for the steps, prohibition of animal roaming, and better drainage system (1.7% each).

Table 6.2.144 Suggestions to make the Ghats better

	N	%
Make cleaning system	29	48.3
Make permanent changing rooms	21	35.0
Make public toilets	14	23.3
Install dustbins	7	11.7
More awareness programs	2	3.3
Caution boards	2	3.3
Make cloak rooms	1	1.7
Make railings	1	1.7
Stop animals roaming	1	1.7
Better drainage system	1	1.7
Total		
Make cleaning system	29	48.3

Source: JICA Study Team 2015

2) Summary of the Outcomes

JICA Experts concluded that the following outcomes are extracted through the Ghat surveys. It can be said that floors and steps renovations are considered successful, while changing rooms should need some major changes in future.

Table 6.2.145 Satisfaction of the Ghat renovations at GAP

Type of renovations	N	Satisfactory*1	Unsatisfactory*2
Changing rooms	48	35.4%	27.1%
Floors	60	91.7%	1.7%
Steps	60	90.0%	1.7%
Cloaks	3	66.7%	33.3%

Source: JICA Study Team 2015

Note: Satisfactory includes "Very satisfactory" and "Relatively satisfactory."

Unsatisfactory includes "Very unsatisfactory" and "Relatively unsatisfactory."

The three questions, Table 6.2.142 Major issues of the Ghats (multiple answers), Table 6.2.143 Facilities wanted be equipped in the Ghats, and Table 6.2.144 Suggestions to make the Ghats better, were discussed separately. However, in terms of the interests in each topic, these questions are closely connected each other. The table below summarizes the questions that asked the issues on the Ghats, facilities wanted in the Ghats, suggestions in the Ghats. JICA Study Team identified that these questions shows the interests in Ghats in a comprehensive manner.

Table 6.2.146 Items that include more interests in the Ghats shows the items that the respondents said they are interested in them as the issues, wanted facilities, and suggestions. The most interested item is the permanent changing room facilities, followed by public toilets, cleanliness related matters, dustbins, cloakrooms, lockers.

Table 6.2.146 Items that include more interests in the Ghats by stakeholders

	Issues	Facilities wanted	Suggestions	Total Interests
Cleanliness related	33	0	29	62
Toilets	17	33	14	64
Dustbins	2	4	7	13
Permanent Changing rooms	10	45	21	76
Railings	1	5	1	7
Animal roaming	1	0	1	2
Lighting	1	0	0	1
Lockers	0	12	0	12
Cloak rooms	3	9	1	13
Drainage system	0	1	1	2
Use of Plastics	1	0	0	1
Drinking water facilities	0	9	0	9
Awareness programs	0	1	2	3
Caution boards	0	0	2	2
Total	69	119	79	

Source: JICA Study Team 2015

6.2.9 Cremation Issues

This section describes the issues of cremation in Varanasi areas.

1) Varanasi, the holy place of cremation for Hindi people

According to the Hindu belief, dying and getting burnt in Varanasi offers the opportunity that you can reach moksha, the state of liberation/escape from the cycle of rebirth and death, loss of egoistic self to union with Brahman, and the ultimate aim of every Hindu to achieve this state [5]. Therefore, not only the people near the areas but also the religious people from all over India or overseas came to be cremated here.

2) Outline of the cremation in the Ghats

Annually, less than 2 in 1000 people who die in India, or 25,000 to 30,000 bodies are cremated on various Varanasi Ghats; about an average of 80 per day[6]. In Varanasi, the cremation takes place at two special burning Ghats which are located along the riverbank next to the bathing Ghats in the heart of the city: Manikarnika and Harishchandra Ghat. Harishchandra Ghat is the smaller and is named after a king who was the caretaker of the crematorium. This Ghat can be used by all religions and castes. On the other hand, the primary cremation Ghat, Manikarnika Ghat, is reserved for Hindus and covers two thirds of the total amount of cremations[7].

The way to be cremated are two: electric cremation (about Rs. 250 or free for the poor) and wooden cremation (Rs. 5,000-7,000, depending on the body size). Though there are many sanitation and environmental issues in wooden burning, it has not been discussed openly as the issues are delicate in terms of social, cultural, religious, and political points of views.

3) Issues in cremation

Based on the literature reviews and preliminary interviews with the related people, three main issues for the cremation are identified. These are: the shortage of cremation facilities, O&M problems of the facilities, and environmental pollutions from cremation. The congestion in these cremation facilities is a critical issue, as more and more people travel to Varanasi to be cremated here with the rapid increase in richer population[8]. Also, the facilities for cremation become older and it is often heard that it is under repair[9]. Moreover, soil pollution, water pollution and air pollution caused from cremation are issues, as the more and more dead bodies are coming to the Varanasi Ghats[10]. It can be strictly monitored and some improvements need to be suggested.

4) Recommendations for the future activities

Though the cremation issues are not discussed in present JICA loans and other international aid activities vociferously, some improvements should be made concerning sanitary issues. Therefore, in the next phase, the loan should cover the investigation in quality and quantity of the present

5 India TV News Desk. 2014. Visiting the Ghats of World's Spiritual capital "Varanasi".
6 Ibid.
7 RWTH University. 2011. The burning ghats of Varanasi, Uttar Pradesh. Water and Megacities, October 2011
8 Justin Rowlatt. 2011. Holy cremations boom in richer India. BBC News
9 Interview with concerned people in March 2016
10 Sayantani Basak, Anwesha Sarkar, Ranjita Ghosh, and Adrija Chaudhuri. 2015. Ghats of Varanasi - An Emerging Centre of Pollution

cremation facilities, monitoring the present O&M of the facilities, and measurement of the environmental pollutions of the cremation activities.

Finishing above the mentioned survey, proper recommendations might be: upgrading the quality and quantity of the cremation facilities, presenting more solid system of the O&M of the facilities, and proposing the regular measurement of the environmental pollutions of the cremation activities.

6.2.10 Recommendation for Public Health and Outreach in the Project Area

This section discusses the Preliminary Plan of public toilets and relevant facilities in Varanasi, Mirzapur and Ghazipur.

1) Current Status of Sanitary Facilities

This section mainly discuss the present conditions of the public/community toilets of the three cities.

a) Varanasi

In India, the term 'public toilet' means a toilet placed in public places, such as railway stations and bus parks, while 'community toilet' means a toilet mainly installed in residential areas, where the low income people live, for the benefit of the local people.

In Varanasi, There are 12 public toilets and 96 community toilets (108 in total) constructed by VNN. A zone-wise summary of public/community toilets is shown in Table 6.2.147. Moreover 205 toilets are made by GAP as shown in Section 6.2.2. The location of public toilets in Varanasi is shown in Appendix 4.

Table 6.2.147 Summary of Existing Public and Community Toilets in Varanasi City (2011)

No.	Type of facility	Number
1	Community toilets	96 (Sulabh-72, Refrozen-6, ADS-6, NEDA-12)
2	Public toilets	12 (Around Ghats)
3	Public Urinals	75
4	Open Defection	15% of the city population

Source: City Sanitation Plan for Varanasi, CEPT University, 2011

The O&M works for toilets are currently conducted by a private company, namely Sulabh International Social Service (SISS) Organization. Several public toilets impose toilet charges collected by a bill collector in front of the toilets for maintenance.

b) Mirzapur

Mirzapur only have 10 public toilets and considering their population and household size, which is one fourth of the Varanasi, it is quite small in quantity. The shortage of the public and community toilets is obvious.

Table 6.2.148 Summary of Existing Public and Community Toilets in Mirzapur City (2016)

No.	Type of facility	Number
1	Community toilets	00
2	Public toilets	10
3	Public Urinals	00
4	Open Defection	17%

Source: Nagar Palika Mirzapur 2016

c) Ghazipur

Ghazipur has presently 26 public toilets. Having approximately one tenth of the size in population compared to Varanasi, it is rather quantitative. However, open defecation rate is high and some countermeasures should be taken.

Table 6.2.149 Summary of Existing Public and Community Toilets in Ghazipur City (2016)

Sl. No.	Type of facility	Number
1	Community toilets	00
2	Public toilets	26
3	Public Urinals	Attached with Public Toilets not separately
4	Open Defection	33%

Source: Nagar Palika Ghazipur 2016

2) Locations

Based on the locations of existing public toilets and the results of questionnaires survey, the proposed locations of new public/community toilets should be selected. As the construction of new public/community toilets is currently under progress by JICA Project Loan, the locations should be discussed carefully with officials for the cities of Varanasi, Mirzapur and Ghazipur.

The following five points should be considered on proposed locations:

- Focus on community toilets in low-income group areas.
- Focus on wards without public and community toilets.
- Remote and wide areas, where sewers will be constructed and connected to houses.
- Opinions of residents obtained from the social survey should be reflected on the proposal.
- Areas where municipalities of Varanasi, Mirzapur, and Ghazipur have plans to construct public and community toilets should be excluded.

3) Cost Unit Estimate for New Public Toilets (Tentative)

Table 6.2.150 explains the unit cost of each toilet unit. The unit cost for ten seated toilets is taken from VNN and other municipalities' document for financial year 2011-12. Table 6.2.151 shows the cost of O & M in each complex.

Table 6.2.150 Cost of toilet appliances

	Appliances	Rs
1	WC pan	4,071
2	European	3,981
3	Mirror	1,800
4	Urinal pan	3,991
5	Siric	8,463
6	Wash basin	2,797
		25,103

Source: GAP 2016

Table 6.2.151 Cost of O&M

Water and electricity cost			
Seat size	5	3,000	per month
	10	5,000	per month
	20	10,000	per month
	Summecible fitting	113,000	per month
Employers			
	2 cleaning staff	12,000	per month
	2 care taker	12,000	per month
	1 supervisor	10,000	per month
	bit in charge		
Cleaning devices*			
	5	3,000	per month
	10	5,000	per month
	20	10,000	per month

Source: GAP 2016

Note: Including: soap, bleaching, phenyl, acid, urinal balls, freshener, brush, mop, and wiper*

As shown in above mentioned cost and specialists' interviews[11], the cost of each CTC construction and renovations are decided as below. CTCs with sewers are slightly cheaper than the ones with the septic tanks. GAP project experiences identified that the ratio of the CTCs in size ranges 60-75% for 5 seats, 20-30 % for 10 seats, and 5-10 % for 20 seats. It seems that the less the seats are,

[11] Interviews with local experts, March and April 2016

the more common they are as the CTCs in the areas.

According to the GAP, demolish & build of the CTCs are more common than the renovation of CTCs in India. It is partly because the past CTCs are old and obsolete when used with the sewer system. In fact, all the works by the GAP were demolish & build, and no renovation works.[12] Cost for the CTCs with sewers are less expensive than those with septic tanks.

Table 6.2.152 Unit Cost of CTC construction Unit Cost (Rs. 1,000)

ID	Mode of Construction	# of seat	Ratio (%)	Sewer (Rs. 1,000)	Septic tanks (Rs. 1,000)	Gap (Rs. 1,000)
1	New	5	60-75	1,463	1,529	66
2	New	10	20-30	2,045	2,065	20
3	New	20	5-10	2,348	2,817	469
4	Demolish & Build	5	60-75	1,493	1,559	66
5	Demolish & Build	10	20-30	2,075	2,095	20
6	Demolish & Build	20	5-10	2,378	2,847	469

Source; GAP 2016

4) Proposed Projects

This section discusses the proposed budget for CTCs in three cities. It estimates that all the projects will be located in the range of present sewers and newly planned sewers, and that they will either construct the new CTCs in new sites, or demolish & build at the present CTC sites.

a) Varanasi

Here the number of the CTCs to be built in Varanasi is discussed. There are presently 313 public and community toilets and considering each CTC covers at least 300 people/per day[13], and over 90,000 people are covered by the CTCs. This number is slightly above the people without HH toilets in their premise (5.3% of population). However, the place of CTCs are rather concentrated and the places like remote areas and newly identified squatter areas still need public/community toilets. In addition, there are issues of aging of the facilities.[14]

Take all these things in account, the estimated cost for public/community toilets renovations and constructions are shown as below.

[12] Specialist interviews in May 2016
[13] Fuwa and Kitawaki. 2004. India Yanam River Sewerage Project EIA for post Project.
[14] Specialist interviews in May & April 2016

Table 6.2.153 Cost Estimate for Public/Community Toilets in Varanasi (Tentative) (Rs 1,000)

Item	# of seat	Ratio (%)	Unit Cost (Rs. 1,000)	Proposed number	Total (Rs. 1,000)
Construction of New	5	70	1,463	21	30,723
Construction of New	10	20	2,045	6	12,270
Construction of New	20	10	2,348	3	7,044
Total				30	50,037
Demolish & Build	5	70	1,493	35	52,255
Demolish & Build	10	20	2,075	10	20,750
Demolish & Build	20	10	2,378	5	11,890
Total				50	84,895
					134,932

Source*: JICA Study Team 2016*

b) Mirzapur

In Mirzapur, there are presently only 10 public toilets. Considering 22.2% people who do not have toilets in their HH, approximately it needs to serve around 75,000. Theoretically around 250 toilets are needed in total. For a start, around half of the most needed areas should be covered. In addition, existing CTCs are aging, and their renovations are needed. The estimated cost for public/community toilets renovations and constructions are shown as below.

Table 6.2.154 Cost Estimate for Public/Community Toilets in Mirzapur (Tentative) (Rs. 1,000)

Item	# of seat	Ratio (%)	Unit Cost (Rs. 1,000)	Proposed number	Total (Rs. 1,000)
Construction of New	5	60	1,463	75	109,725
Construction of New	10	24	2,045	30	61,350
Construction of New	20	16	2,348	20	46,960
Total				125	218,035
Demolish & Build	5	70	1,493	35	52,255
Demolish & Build	10	20	2,075	20	41,500
Demolish & Build	20	10	2,378	20	47,560
Total				10	141,315
					359,350

Source: JICA Study Team 2016

c) Ghazipur

In Ghazipur, there are presently 26 public toilets. Considering the 19.4% of people who do not have toilets in their HH, approximately it needs to serve around 30,000. Therefore around 100 CTCs in total are needed. For a start, half are the most needed areas are considered. In addition, renovations of existing older CTCs are needed. The estimated cost for public/community toilets renovations and constructions are shown as below.

Table 6.2.155 Cost Estimate for Public/Community Toilets in Ghazipur (Tentative) (Rs. 1,000)

Item	# of seat	Ratio (%)	Unit Cost (Rs. 1,000)	Proposed number	Total (Rs. 1,000)
Construction of New	5	70	1,463	35	51,205
Construction of New	10	20	2,045	10	20,450
Construction of New	20	10	2,348	5	11,740
Total				50	83,395
Demolish & Build	5	70	1,493	14	20,902
Demolish & Build	10	20	2,075	4	8,300
Demolish & Build	20	10	2,378	2	4,756
Total				20	33,958
					117,353

Source: JICA Study Team 2016

Total budget for the Construction of New and Demolish & Build of the CTCs in three cities are shown as follows. The total is Rs. 611 million and the cities that needs most budget is Mirzapur, which now lacks the total number. The city that need the second-most budget is Varanasi, as it needs more maintenance for the old and the demolish & build.

Table 6.2.156 Budget Proposal for the CTCs in future (Rs. 1,000)

	Construction of New	Demolish & Build	Total Budget (Rs. 1000)
Varanasi	30	50	134,932
Mirzapur	125	10	359,350
Ghazipur	50	20	117,353
Total	205	80	611,635

Source: JICA Study Team 2016

CHAPTER 7 Projection of Sewage Flow Generated and Treated

<Objective of the Survey>

Projected Sewage Flow by Design Year in each DPR (Varanasi, Mirzapur, Ghazipur, Ramnagar, and Chunar) was studied for confirmation

<Result of the Survey>

Population for the cities were confirmed and projection of water supply, sewage flow for 2020, 2030, 2035, 2040 and 2050 was conducted. Although the target year for each towns and cities is deferent from each other because of respective status/situation, future projection was conducted uniformly through the cities/towns, namely 2020, 2030, 2035, 2040, 2050.

7.1 Projected Population,

7.1.1 General

Prior to designing of pipe, pumping station and STP, setting the planned sewage flow is required. Usually, sewage flow is set based on the future planned population in the sewer planning area, and population projection in the area of each DPR is compliant with 2013 CPHEEO manual. Used population projection methods are below:

1) Demographic Method

This method takes into account the prevailing and anticipated birth rates and death rates of the region or city for the period under consideration. An estimate is also made of the emigration from and immigration to the city, growth of the city area wise, and the net increase of population is calculated accordingly considering all these factors, by arithmetical balancing.

2) Arithmetical Increase method

It is generally applicable to large and old cities. This method gives a low value and is suitable for well-settled and established communities.

3) Incremental increase method

It increases the figures obtained by the arithmetical increase method.

4) Geometrical increase method

It gives much higher value and is mostly applicable for growing towns and cities having vast scope for expansion.

5) Graphical Method

In this method population curve of the city (i.e. population v/s past decades) is smoothly extended for getting future value.

6) Decreasing Rate of Growth Method

This method is applicable only in such cases where the rate of growth of population shows a downward trend

7) Logistic Method

The "S" shaped logistic curve for any city gives complete trend of growth of the city right from beginning to saturation limit of population of the city.

8) Density Method

In this approach, trend n rate of density increase of population for each sector of a city is found out and population forecast is done for each sector based on above approach. Addition of sector wise population gives the population of the city.

7.1.2 Projection Results

The projection results are shown below, all planned population of DPR is considered with urban development. Adopted estimation is attached with "O" mark at table, and bold line at graph. Each city adopts medium to high-level estimation. Future increasing rate per year is about 1 to 3% constantly, hence these results are considered reasonable and proper.

1) Varanasi

From the Data / Details in table it has been observed that population projection by Arithmetical, Incremental Increase method, Semi log and Simple Graph method gives population on the lower side. Projection by Geometrical & Exponential method are on higher side. However, it has been observed that these methods do not reflects the realistic figures. Hence, density method is being adopted for the subject project as it is most appropriate method for similar developing area.

Source: Varanasi District III DPR

2) Mirzapur

From the Data / Details in table it has been observed that population projection by Arithmetical, Incremental Increase method, Semi log and Simple Graph method gives population on the lower side. Projection by Geometrical & Exponential method are on higher side. However, it has been observed that these methods do not reflects the realistic figures. Hence, density method is being adopted for the subject project as it is most appropriate method for similar developing area.

Source: Mirzapur DPR

3) Ghazipur

Geometric Increase Method is adopted.

4) Ramnagar

As per the discussion with General Manager UP Jal Nigam, Varanasi, it was decided to adopt Geometric Increase method as high increase in population is anticipated because of upcoming infrastructure and real estate projects (like, construction of a bridge (Sastri Bridge) from Smane Ghat to Ram Nagar as well as development of residential and commercial projects by many builders in the vacant plots in the Ram Nagar Jurisdiction) the population of the town is expected to surge in next few decades.

Source: Ramnagar DPR

5) Chunar

From the Data / Details in table it has been observed that population projection by Arithmetical and Simple Graph method is almost similar. Projection by Semi log, Geometrical & Exponential method is on higher side. However it has been observed that these methods do not reflects the realistic figures. Hence density method is being adopted for the subject project as it is most appropriate method for similar developing area.

Source: Chunar DPR

6) Saidpur

No DPR obtained.

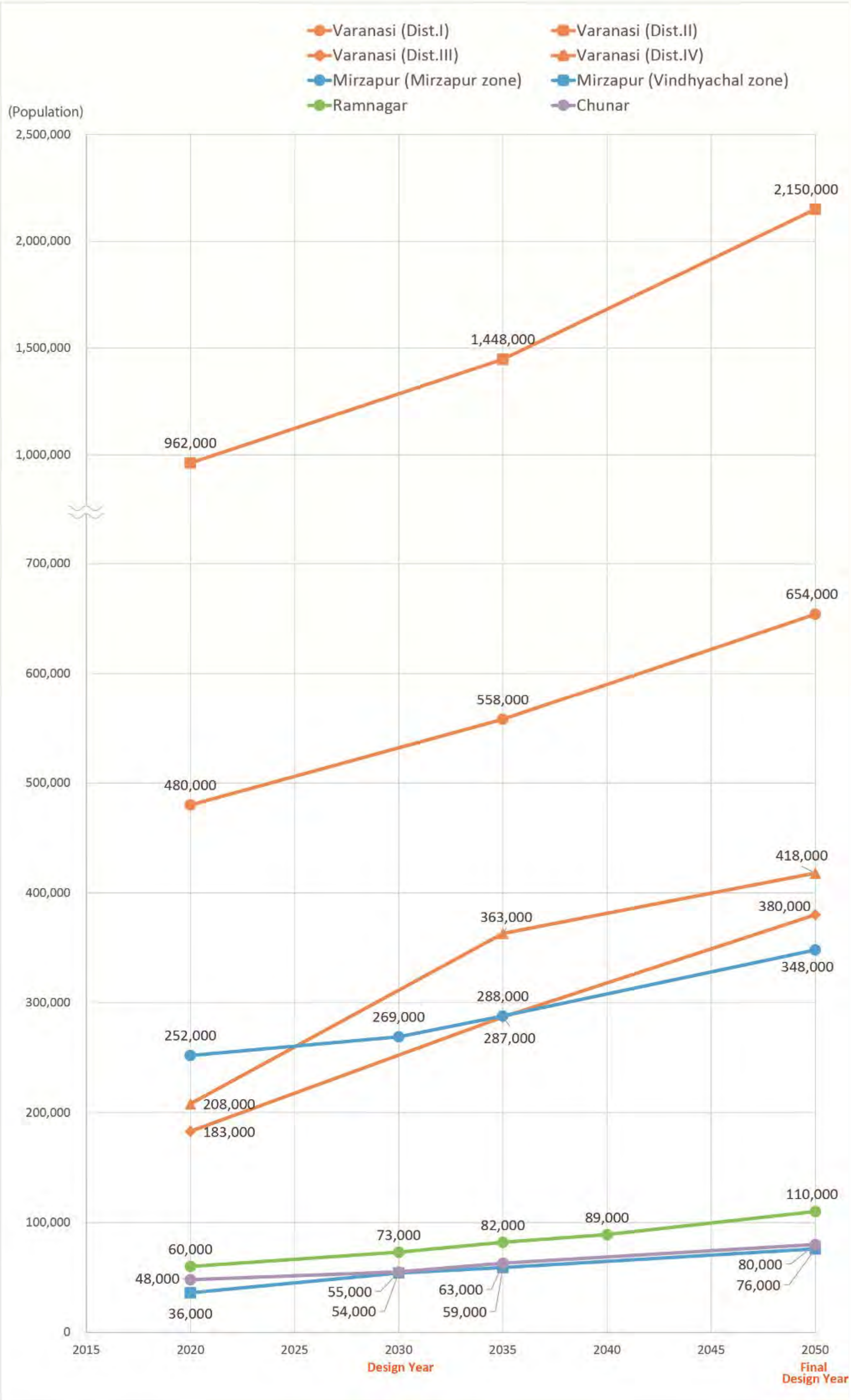


Figure 7.2.1 Population Projections

Table 7.2.1 Population Projections at Varanasi

Year	Varanasi Arithmetical Increase Method	Varanasi Geometric Increase Method	Varanasi Incremental Increase Method	Varanasi Simple Graph Method	Varanasi Semi-log Method	Varanasi Ratio Method	Varanasi Density Method
1971	617,934	617,934	617,934	617,934	617,934	617,934	617,934
1981	773,865	773,865	773,865	773,865	773,865	773,865	773,865
1991	1,030,863	1,030,863	1,030,863	1,030,863	1,030,863	1,030,863	1,030,863
2001	1,202,443	1,202,443	1,202,443	1,202,443	1,202,443	1,202,443	1,202,443
2011	1,435,113	1,435,113	1,435,113	1,435,113	1,435,113	1,435,113	1,435,113
2020	1,618,978	1,729,882	1,642,000	1,600,000	1,625,000	1,620,000	1,700,000
2035	1,925,420	2,361,749	1,986,812	1,892,000	1,810,000	1,900,000	2,400,000
2050	2,231,863	3,224,416	2,331,623	2,155,000	1,900,000	2,300,000	2,650,000
Adopted		O					

Increasing Rate per Year

Year	Varanasi Arithmetical Increase Method	Varanasi Geometric Increase Method	Varanasi Incremental Increase Method	Varanasi Simple Graph Method	Varanasi Semi-log Method	Varanasi Ratio Method	Varanasi Density Method
1971							
1981	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
1991	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
2001	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
2011	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
2020	1.4%	2.3%	1.6%	1.3%	1.5%	1.4%	2.1%
2035	1.3%	2.4%	1.4%	1.2%	0.8%	1.2%	2.7%
2050	1.1%	2.4%	1.2%	0.9%	0.3%	1.4%	0.7%
Adopted		O					

Note: by 2011 data is actual population by Census in India.

Source: Varanasi District III DPR

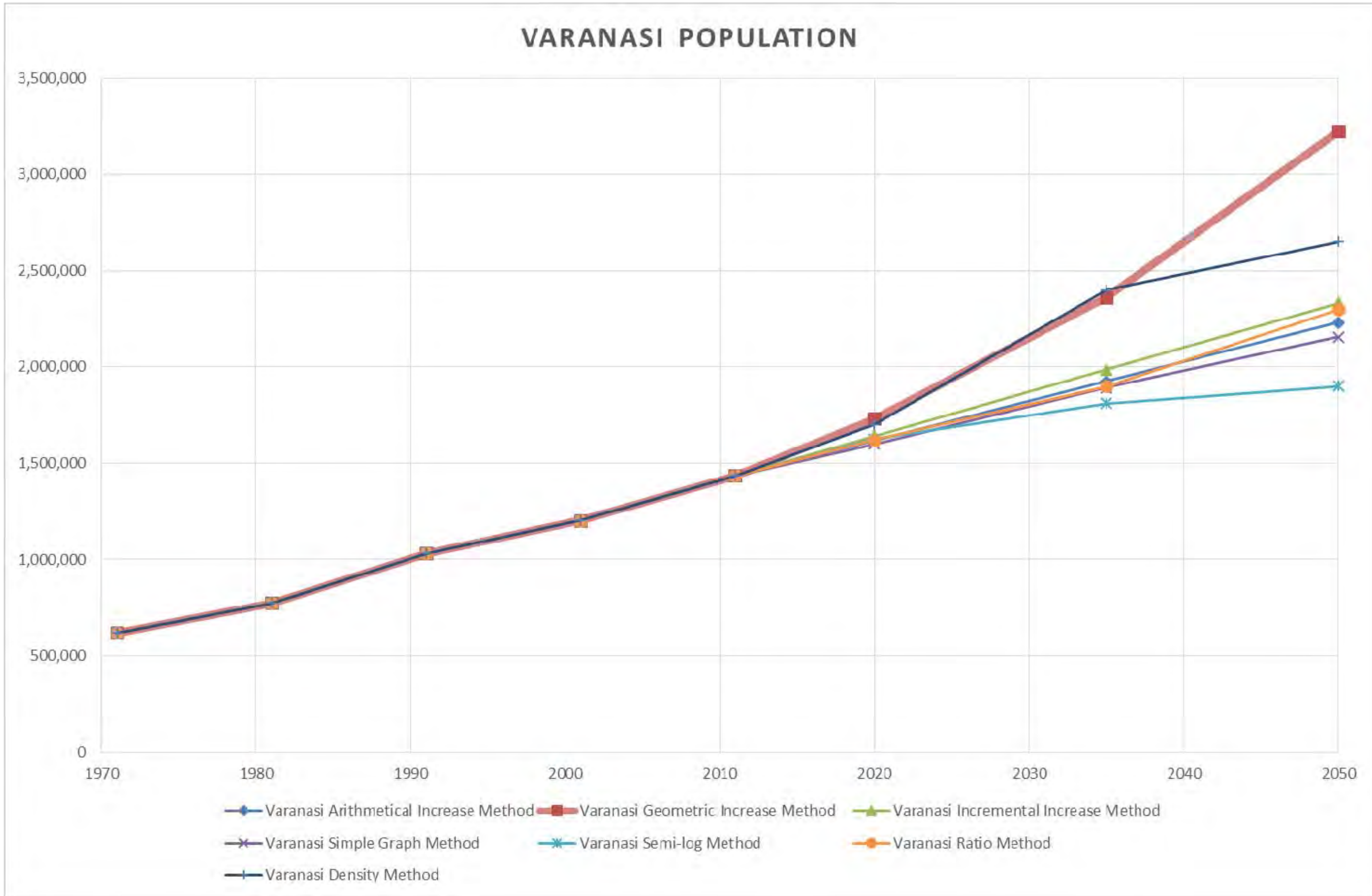


Figure 7.2.2 Population Projections at Varanasi

Table 7.2.2 Total Population within Municipality

Year			2020	2035	2050
Varanasi city			1,729,882	2,361,749	3,224,416
Population within municipality	**District I**		**440,365**	**508,136**	**589,439**
	District II	ZONE 2A	539,635	733,014	974,362
		ZONE 2B	117,379	213,580	374,689
		ZONE 2C	129,622	212,134	332,783
		NSA2	37,883	70,240	123,718
		NSA1	63,255	117,226	204,966
		FSA1	-	-	-
		Sum	**887,774**	**1,346,194**	**2,010,518**
	District III	ZONE 3	104,052	144,863	196,337
		FSA4	-	-	-
		Sum	**104,052**	**144,863**	**196,337**
	District IV	FSA2	12,579	18,525	26,365
		FSA3	-	-	-
		Sum	**12,579**	**18,525**	**26,365**
	Sum		**1,444,771**	**2,017,719**	**2,822,659**

Table 7.2.3 Population outside Municipality

Year		2020	2035	2050
District II	FSA1	26,194	29,936	33,678
District III	FSA4	78,561	141,410	183,309
District IV	FSA2	93,672	107,054	120,436
	FSA3	101,639	237,157	271,036
	Sum	195,311	344,211	391,472
Sum		300,066	515,557	608,459

Table 7.2.4 Floating Population

Year		2020	2035	2050
District I		38,953	49,564	63,836
District II	ZONE 2A	47,734	71,499	105,523
Sum		86,687	121,063	169,359

Table 7.2.5 Total Population within Municipality

Year		2020	2035	2050
District I		**479,318**	**557,700**	**653,275**
District II	ZONE 2A	587,369	804,513	1,079,886
	ZONE 2B	117,379	213,580	374,689
	ZONE 2C	129,622	212,134	332,783
	NSA2	37,883	70,240	123,718
	NSA1	63,255	117,226	204,966
	FSA1	26,194	29,936	33,678
	Sum	**961,702**	**1,447,629**	**2,149,720**
District III	ZONE 3	104,052	144,863	196,337
	FSA4	78,561	141,410	183,309
	Sum	**182,613**	**286,273**	**379,646**
District IV	FSA2	106,252	125,579	146,801
	FSA3	101,639	237,157	271,036
	Sum	**207,891**	**362,736**	**417,837**
Sum		**1,831,523**	**2,654,338**	**3,600,478**

Source: Varanasi District III DPR

Note: Every DPR in Varanasi, such district population is adopted; the other is as a reference value treatment.

Table 7.2.6 Population Projections at Mirzapur

Year	Mirzapur Arithmetical Increase Method	Mirzapur Geometric Increase Method	Mirzapur Incremental Increase Method	Mirzapur Simple Graph Method	Mirzapur Semi-log Method	Mirzapur Exponential Method	Mirzapur Density Method
1921	54,994	54,994	54,994	54,994	54,994	54,994	54,994
1931	61,184	61,184	61,184	61,184	61,184	61,184	61,184
1941	70,944	70,944	70,944	70,944	70,944	70,944	70,944
1951	86,528	86,528	86,528	86,528	86,528	86,528	86,528
1961	100,097	100,097	100,097	100,097	100,097	100,097	100,097
1971	105,939	105,939	105,939	105,939	105,939	105,939	105,939
1981	127,787	127,787	127,787	127,787	127,787	127,787	127,787
1991	138,951	138,951	138,951	138,951	138,951	138,951	138,951
2001	205,464	205,464	205,464	205,464	205,464	205,464	205,464
2011	234,170	234,170	234,170	234,170	234,170	234,170	234,170
2020	252,000	270,000	260,000	255,000	245,000	275,000	268,333
2030	272,000	310,000	280,000	280,000	278,000	315,000	301,667
2035	282,000	332,850	298,000	295,000	285,000	335,000	321,950
2050	312,000	414,670	349,000	335,000	335,000	420,000	394,557
Adopted							O

Increasing Rate per Year

Year	Mirzapur Arithmetical Increase Method	Mirzapur Geometric Increase Method	Mirzapur Incremental Increase Method	Mirzapur Simple Graph Method	Mirzapur Semi-log Method	Mirzapur Exponential Method	Mirzapur Density Method
1921							
1931	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
1941	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
1951	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
1961	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
1971	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
1981	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
1991	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
2001	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
2011	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
2020	0.8%	1.7%	1.2%	1.0%	0.5%	1.9%	1.6%
2030	0.8%	1.5%	0.8%	1.0%	1.3%	1.5%	1.2%
2035	0.7%	1.5%	1.3%	1.1%	0.5%	1.3%	1.3%
2050	0.7%	1.6%	1.1%	0.9%	1.2%	1.7%	1.5%
Adopted							O

Note: by 2011 data is actual population by Census in India.

Source: Mirzapur DPR

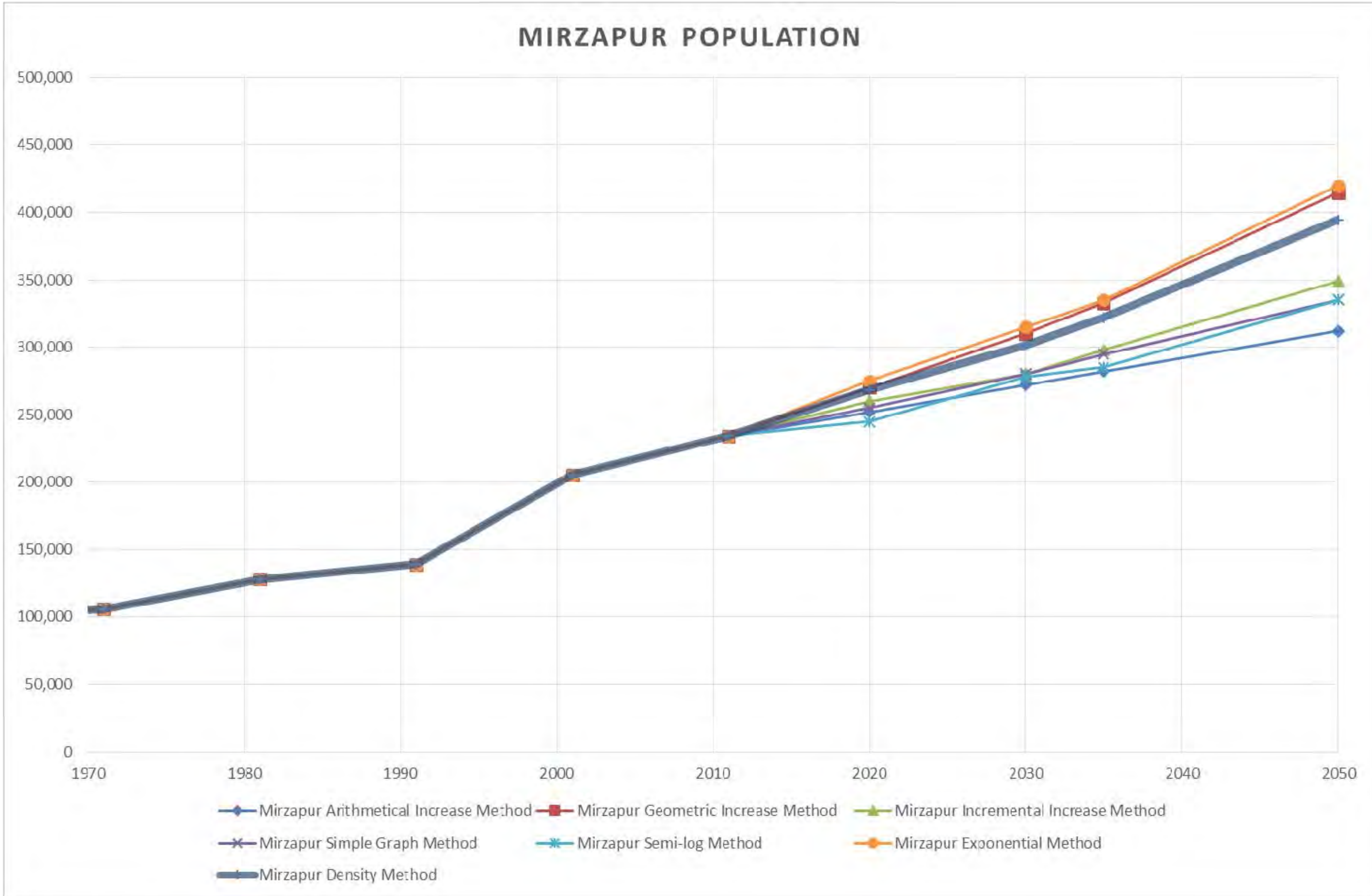


Figure 7.2.3 Population Projections at Mirzapur

Table 7.2.7 Population Projections at Ghazipur

Year	Ghazipur Arithmetical Increase Method	Ghazipur Geometric Increase Method	Ghazipur Incremental Increase Method	Ghazipur Simple Graph Method	Ghazipur Semi-log Method
1911	22,165	22,165	22,165	22,165	22,165
1921	24,708	24,708	24,708	24,708	24,708
1931	27,498	27,498	27,498	27,498	27,498
1941	31,326	31,326	31,326	31,326	31,326
1951	33,498	33,498	33,498	33,498	33,498
1961	37,147	37,147	37,147	37,147	37,147
1971	45,635	45,635	45,635	45,635	45,635
1981	60,725	60,725	60,725	60,725	60,725
1991	76,547	76,547	76,547	76,547	76,547
2001	93,356	93,356	93,356	93,356	93,356
2011	121,020	121,020	121,020	121,020	121,020
2015	124,975	128,768	125,694	130,000	130,000
2030	139,804	162,511	146,881	165,000	190,000
2045	154,633	205,094	173,849	199,500	280,000
Adopted		O			

Increasing Rate per Year

Year	Ghazipur Arithmetical Increase Method	Ghazipur Geometric Increase Method	Ghazipur Incremental Increase Method	Ghazipur Simple Graph Method	Ghazipur Semi-log Method
1911					
1921	1.1%	1.1%	1.1%	1.1%	1.1%
1931	1.1%	1.1%	1.1%	1.1%	1.1%
1941	1.4%	1.4%	1.4%	1.4%	1.4%
1951	0.7%	0.7%	0.7%	0.7%	0.7%
1961	1.1%	1.1%	1.1%	1.1%	1.1%
1971	2.3%	2.3%	2.3%	2.3%	2.3%
1981	3.3%	3.3%	3.3%	3.3%	3.3%
1991	2.6%	2.6%	2.6%	2.6%	2.6%
2001	2.2%	2.2%	2.2%	2.2%	2.2%
2011	3.0%	3.0%	3.0%	3.0%	3.0%
2015	0.8%	1.6%	1.0%	1.9%	1.9%
2030	0.8%	1.7%	1.1%	1.8%	3.1%
2045	0.7%	1.7%	1.2%	1.4%	3.2%
Adopted		O			

Note: by 2011 data is actual population by Census in India.

Source: Ghazipur DPR

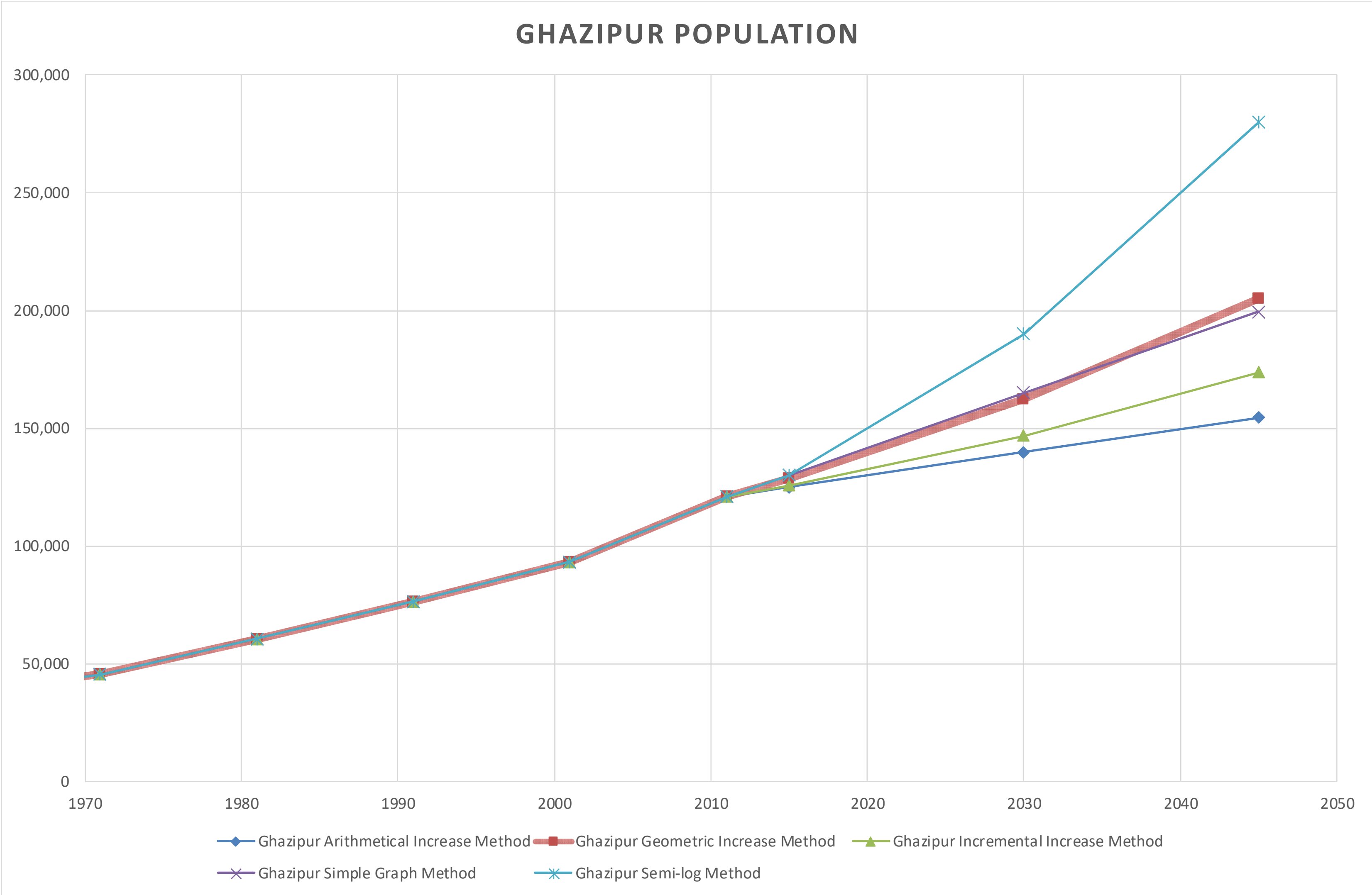


Figure 7.2.4 Population Projections at Ghazipur

Table 7.2.8 Population Projections at Ramnagar

Year	Ramnagar Arithmetical Increase Method	Ramnagar Geometric Increase Method	Ramnagar Incremental Increase Method	Ramnagar Simple Graph Method	Ramnagar Semi-log Method
1961	16,036	16,036	16,036	16,036	16,036
1971	17,241	17,241	17,241	17,241	17,241
1981	23,297	23,297	23,297	23,297	23,297
1991	30,116	30,116	30,116	30,116	30,116
2001	40,619	40,619	40,619	40,619	40,619
2011	49,087	49,087	49,087	49,087	49,087
2020	55,036	59,845	56,589	52,928	61,172
2030	61,646	72,049	66,649	59,848	77,813
2035	64,951	81,021	72,360	63,308	87,761
2040	68,257	88,176	78,525	66,768	98,981
2050	74,867	109,692	92,216	73,688	125,907
Adopted		O			

Increasing Rate per Year

Year	Ramnagar Arithmetical Increase Method	Ramnagar Geometric Increase Method	Ramnagar Incremental Increase Method	Ramnagar Simple Graph Method	Ramnagar Semi-log Method
1961					
1971	0.8%	0.8%	0.8%	0.8%	0.8%
1981	3.5%	3.5%	3.5%	3.5%	3.5%
1991	2.9%	2.9%	2.9%	2.9%	2.9%
2001	3.5%	3.5%	3.5%	3.5%	3.5%
2011	2.1%	2.1%	2.1%	2.1%	2.1%
2020	1.3%	2.4%	1.7%	0.9%	2.7%
2030	1.2%	2.0%	1.8%	1.3%	2.7%
2035	1.1%	2.5%	1.7%	1.2%	2.6%
2040	1.0%	1.8%	1.7%	1.1%	2.6%
2050	1.0%	2.4%	1.7%	1.0%	2.7%
Adopted		O			

Note: by 2011 data is actual population by Census in India.

Source: Ramnagar DPR

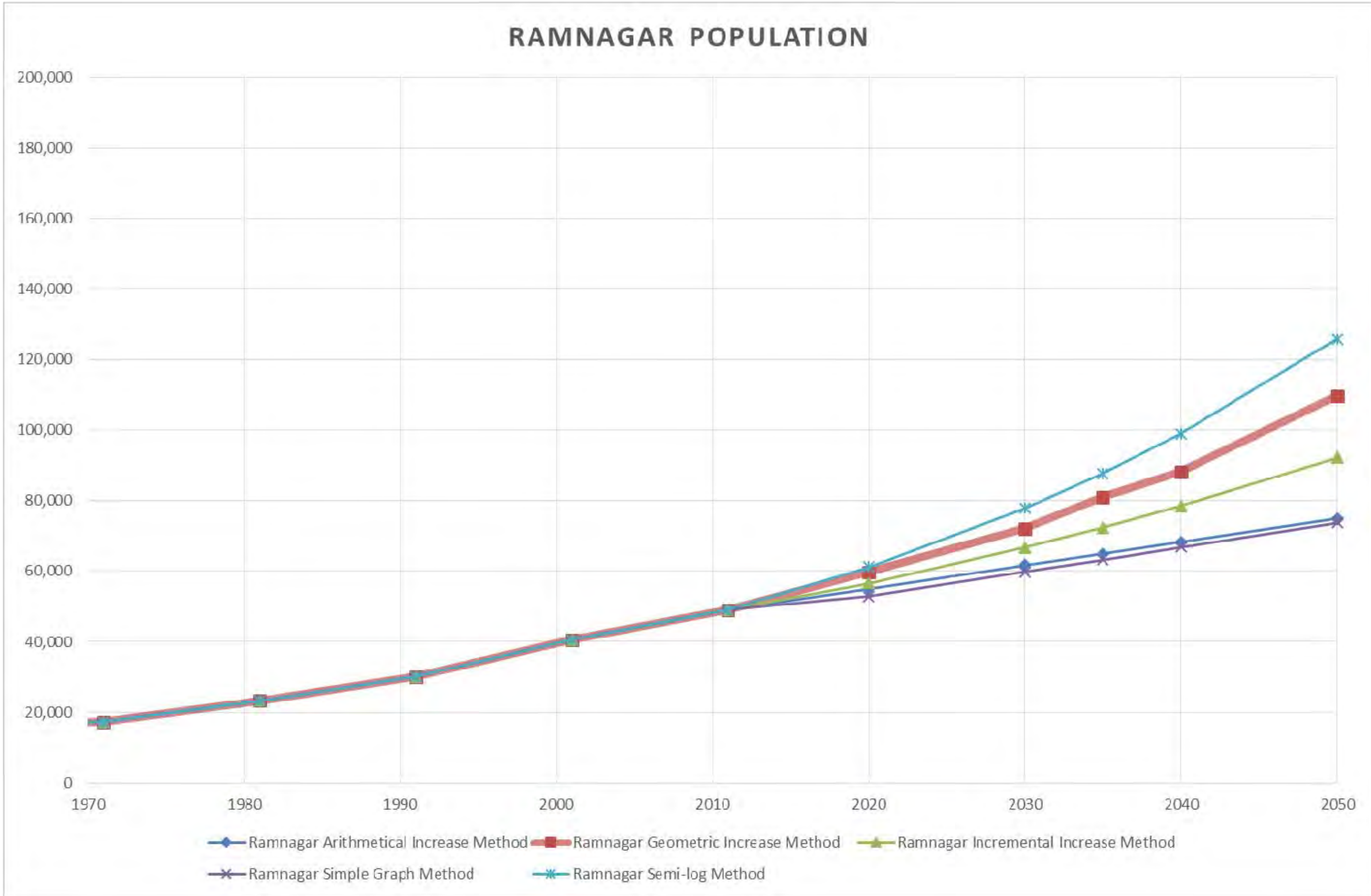


Figure 7.2.5 Population Projections at Ramnagar

Table 7.2.9 Population Projections at Chunar

Year	Chunar Arithmetical Increase Method	Chunar Geometric Increase Method	Chunar Incremental Increase Method	Chunar Simple Graph Method	Chunar Semi-log Method	Chunar Exponential Method	Chunar Density Method
1971	10,264	10,264	10,264	10,264	10,264	10,264	10,264
1981	21,318	21,318	21,318	21,318	21,318	21,318	21,318
1991	28,189	28,189	28,189	28,189	28,189	28,189	28,189
2001	33,919	33,919	33,919	33,919	33,919	33,919	33,919
2011	37,227	37,227	37,227	37,227	37,227	37,227	37,227
2020	43,294	46,757	41,086	44,900	55,719	46,683	48,000
2030	50,035	60,232	42,921	51,550	75,509	63,268	55,000
2035	53,405	68,363	42,871	54,875	87,902	73,654	63,000
2050	63,517	99,952	38,846	64,850	138,676	116,207	80,000
Adopted							O

Increasing Rate per Year

Year	Chunar Arithmetical Increase Method	Chunar Geometric Increase Method	Chunar Incremental Increase Method	Chunar Simple Graph Method	Chunar Semi-log Method	Chunar Exponential Method	Chunar Density Method
1971							
1981	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%
1991	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
2001	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
2011	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
2020	1.8%	2.8%	1.2%	2.3%	5.5%	2.8%	3.2%
2030	1.6%	2.9%	0.4%	1.5%	3.6%	3.6%	1.5%
2035	1.3%	2.7%	0.0%	1.3%	3.3%	3.3%	2.9%
2050	1.3%	3.1%	-0.6%	1.2%	3.9%	3.9%	1.8%
Adopted							O

Note: by 2011 data is actual population by Census in India.

Source: Chunar DPR

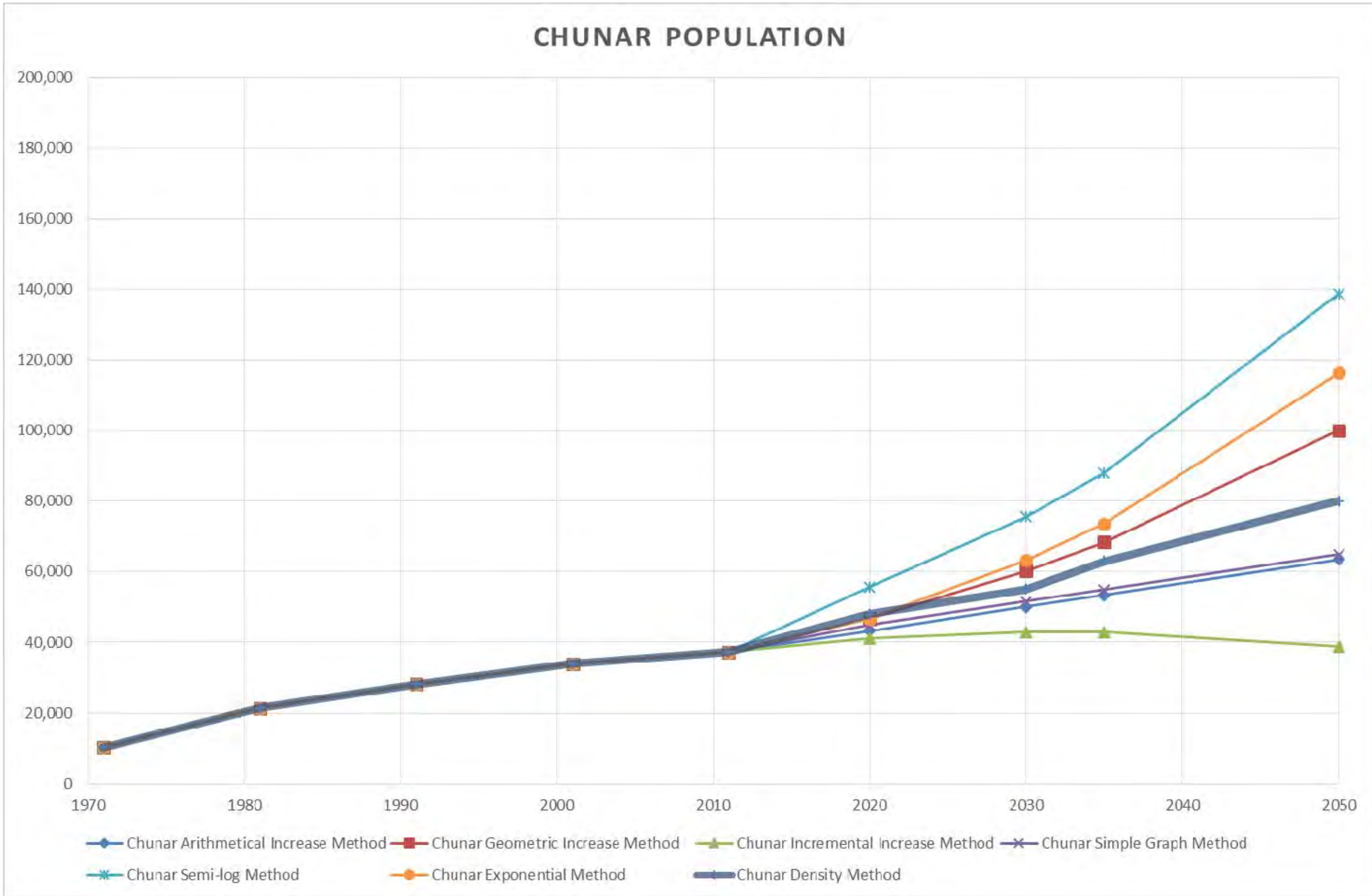


Figure 7.2.6 Population Projections at Chunar

7.2 Projected Sewage Flow

7.2.1 General

Modelling of sewage flow is described as below:

$$Q_1 = \{A \times (B/1{,}000) \times C \times (1 + D)\}/1{,}000$$
$$Q_2 = Q_1 \times E$$

<Symbol>
Q_1: Average Sewage Flow [MLD].
Q_2: Maximum Sewage Flow [MLD].
MLD: Million litter per day. 1 MLD = 1,000 m^3/day

A: Population.
B: Water supply unit [lpcd]. In Varanasi, 150 lpcd is applied, and in other cities, 135 lpcd is applied. 150 lpcd is compliant with "Water Supply component (Distribution System in Cis-Varuna Area) Under JNNURM (2008)", and 135lpcd is compliant with "Manual on Water Supply and Treatment as shown below (Ministry of Urban Development, 1999)":

Table 7.2.1 Recommended per capita water Supply Levels for Designing Schemes

Classification of towns/cities	Recommended Maximum Water Supply Levels (lpcd)
Towns provided with piped water supply without sewerage system	70
Cities provided with piped water supply where sewerage system is existing/contemplated	135
Metropolitan and Mega cities provided with piped water supply where sewerage system is existing,/ contemplated	150

Note:
i) In urban areas, where water is provided through public stand-posts, 40 1pcd should be considered
ii) Figures exclude "Unaccounted for Water (UFW)" which should be limited to 15%
iii) Figures include requirements of water for commercial, institutional and minor industries. However, the bulk supply to such establishments should be assessed separately with proper justification.
iv) lpcd: litters per capita per day.

Source: Manual on Water Supply and Treatment (Ministry of Urban Development, 1999)

C: Conversion factor that means there is a slight loss when flow from water into sewerage. 0.8 is applied.
D: Infiltration water factor that means the infiltrate flow from pipe join or manhole etc. Range 0.15 to 0.25 is applied in Varanasi, and 0.1 is applied in other cities.
E: Peak factor that means the ratio of maximum to average. Refer below table.

Table 7.2.2 Peak factor for Contributory Population

Contributory Population	Peak Factor
Up to 20,000	3.00
Above 20,001 to 50,000	2.50
Above 50,001 to 750,000	2.25
Above 750,001	2.00

Source: 2013 CPHEEO Manual

7.2.2 Sewage Flow Derive from Projected Population

Each city population and each area sewage flow is calculated in below:

Table 7.2.3 Sewage Flow

City	Year	Projected Population		Water Supply Unit [lpcd]	Conversion Factor	Infiltration Water Factor	Peak Factor	Average Sewage Flow [MLD]	Maximum Sewage Flow [MLD]
		Projected	Say (Round Up)						
		-	A*****	B	C	D	E	Q1****,*****	Q2*****
Varanasi	2020	1,729,882							
	2035	2,361,749							
	2050	3,224,416							
(District I)*	2020	479,318	480,000	150	0.8	0.25	2.00	72	144
	2035	557,700	558,000	150	0.8	0.20	2.00	80	160
	2050	653,275	654,000	150	0.8	0.15	2.00	90	180
(District II)*,**,***	2020	961,702	962,000	150	0.8	0.25	2.00	144	288
	2035	1,447,629	1,448,000	150	0.8	0.20	2.00	209	418
	2050	2,149,720	2,150,000	150	0.8	0.15	2.00	297	594
(District III)*,**	2020	182,613	183,000	150	0.8	0.25	2.00	27	54
	2035	286,273	287,000	150	0.8	0.20	2.00	41	82
	2050	379,646	380,000	150	0.8	0.15	2.00	52	104
(District IV)*,**	2020	207,891	208,000	150	0.8	0.25	2.00	31	62
	2035	362,736	363,000	150	0.8	0.20	2.00	52	104
	2050	417,837	418,000	150	0.8	0.15	2.00	58	116
Mirzapur	2020	268,333							
	2030	301,667							
	2035	321,950							
	2050	394,557							
(Mirzapur Zone)**	2020	251,262	252,000	135	0.8	0.10	2.25	30	68
	2030	268,710	269,000	135	0.8	0.10	2.25	32	72
	2035	287,863	288,000	135	0.8	0.10	2.25	34	77
	2050	347,938	348,000	135	0.8	0.10	2.25	41	92
(Vindhyachal Zone)**	2020	35,025	36,000	135	0.8	0.10	2.50	4.3	11
	2030	53,823	54,000	135	0.8	0.10	2.50	6.4	16
	2035	58,823	59,000	135	0.8	0.10	2.50	7.0	18
	2050	75,686	76,000	135	0.8	0.10	2.50	9.0	23
Ghazipur	2015	128,768	129,000	135	0.8	0.10	2.25	15	34
	2030	162,511	163,000	135	0.8	0.10	2.25	19	43
	2045	205,094	206,000	135	0.8	0.10	2.25	24	54
Ramnagar	2020	59,845	60,000	135	0.8	0.10	2.25	7.1	16
	2030	72,049	73,000	135	0.8	0.10	2.25	8.7	20
	2035	81,021	82,000	135	0.8	0.10	2.25	9.7	22
	2040	88,176	89,000	135	0.8	0.10	2.25	10.6	24
	2050	109,692	110,000	135	0.8	0.10	2.25	13.1	29
Chunar	2020	48,000	48,000	135	0.8	0.10	2.50	5.7	14
	2030	55,000	55,000	135	0.8	0.10	2.50	6.5	16
	2035	63,000	63,000	135	0.8	0.10	2.50	7.5	19
	2050	80,000	80,000	135	0.8	0.10	2.50	9.5	24
Saidpur									

*STP capacity in Varanasi is determined separately.
**Including Future Service Area (FSA).
***Including Non Sewerage Area (NSA).
****Adopted for STP Calculation except for STPs in Varanasi.
*****Original setteings in this report.

7.2.3 Sewage Flow Derive from Tourists in Varanasi

Varanasi is popular sightseeing city in India. Below table is shown annual tourist arrival in Varanasi. In recent 5 years, average increasing rate is 6.8%. Almost everyone is Indian, but the rate of foreigner is higher than 10%, so share of foreigner is increasing gradually.

Table 7.2.4 Annual Tourist Arrival in Varanasi

Year	2008	2009	2010	2011	2012	Average
Indian	3,713,809	3,898,557	4,139,785	4,466,972	4,783,012	
(Increasing Rate)	-	5.0%	6.2%	7.9%	7.1%	6.6%
Foreign	178,396	188,853	219,088	245,660	278,573	
(Increasing Rate)	-	5.9%	16.0%	12.1%	13.4%	11.9%
Total	3,892,205	4,087,410	4,358,873	4,712,632	5,061,585	
(Increasing Rate)	-	5.0%	6.6%	8.1%	7.4%	6.8%

Source: UP tourism.com

If existing increasing rate is continued, future annual tourist arrival is calculated in below:

Table 7.2.5 Trial Calculation of Annual Tourist Arrival in Varanasi

Year	Result		Trial Calculation			
	2012	Increasing Rate(2008-2012)	2020	2025	2030	2035
Indian	4,783,012	6.6%	7,975,522	10,978,554	15,112,320	20,802,579
Foreign	278,573	11.9%	684,825	1,201,518	2,108,048	3,698,546
Total	5,061,585	6.8%	8,567,548	11,904,546	16,541,279	22,983,986

Source: JICA study team

But in fact, so more hotels or guesthouses are not provided in recent years and in future. Hence, it may peak out numbers of tourist same level in 2012.

- Tourist Arrival in Varanasi: 5,061,585/365 = 13,867no. /day, say 14,000no. /day
- Peak factor (in winter): 14,000 x 2 = 28,000no. /day

According to the below figure, consumption rate of water by tourist is calculated 54%.

- Water supply unit [vs living population %]: 28 (Bathing) + 20 (Toilet) + 4 (Drinking) +2 (Others) = 54

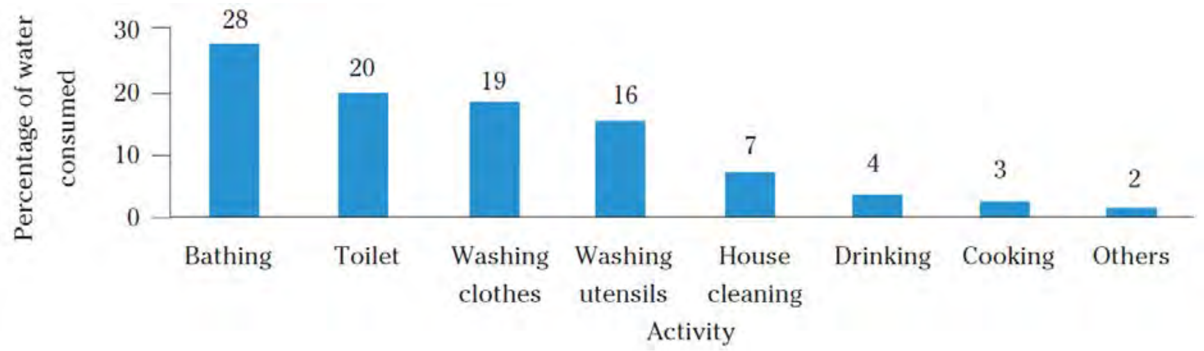


Figure 7.2.1 Average Domestic Water Consumption for Various Activities

Source: Buildings: Earthscrapers - Environment Impact Assessment of Buildings, CSE, 2011

Assumed all tourists are staying, maximum sewage flow from tourists are calculated below:

- 28,000 x {((150 /1,000) x 0.54) x 0.8 x (1 + 0.25)}/ 1,000 =2.3 MLD (in 2020)
- 28,000 x {((150 /1,000) x 0.54) x 0.8 x (1 + 0.20)}/ 1,000 =2.2 MLD (in 2035)
- 28,000 x {((150 /1,000) x 0.54) x 0.8 x (1 + 0.15)}/ 1,000 =2.1 MLD (in 2050)

*Assumed that peak factor is included in setting of population.

Almost tourists visit Ganga and old Varanasi; hence, this flow is mainly derived from District I or II and inflow to Dinapur STP. Proposed Dinapur STP treatment ability is 140MLD, so the influence of sewage flow derive from tourists is less1.64% (2.3/140 in 2020), that is unaffected. Hence, it is not necessary to set the flow as planning.

7.2.4 Sewage Flow Derive from Industry

Existing industrial wastewater is shown in below table. All of them are discharged to the Ganga finally and there is no accepted plan of industrial wastewater in DPR. Especially in Ramnagar, most of wastewater derive from pulp & paper factory. In general, this wastewater is high polluted, hence installing private STP on factory site is desirable.

Table 7.2.6 Wastewater from Existing Factory

S. No.	Name and Address of the Unit	Type of Industry	Water Consumption (industrial) [m3/day]	Wastewater Generation [m3/day]	Canal/Drain /Suhtributary	Name of River /tributary	Remarks
19	M/s Government Opium and Alkaloid Works, Ghazipur	Chemical (Opium and Alkaloid)	200	170	River Ganga	Ganga	
56	M/s Lords Distillery Limited, Nandgunj, Ghazipur	Distillery	727	365	-	Ganga	Out of sewer planning area
62	M/s O Bee Tee Limited, Gopepur, Gopigunj,Sant Ravidas Nagar	Dying, Textile & Bleach	900	630	Natural Drain	Ganga	Out of sewer planning area
144	M/s Dugdh Utpadak Sahkari Sangh Limited, Industrial Area; Ramnagar, Chandauli	Food, Dairy & Beverage (Dairy)	120	120	UPSIDC Drain	Ganga	
145	M/s Hindustan Cocl Cola Beverages(P)Ltd, Mehndigunj, Raja Talab.Varanasi	Food, Dairy & Beverage (Soft Drinks)	1,080	540	Natural Drain	Ganga	Out of sewer planning area
146	M/s Diesel Locomotive Works,Manduadih, Varanasi	Other (Diesel Locomotive)	21,000	2,100	Assi river	Ganga	Treated at DLW STP
247	M/s Newel Calcutta(P)Ltd,D-16, Industrial Area Ramnagar,Chandauli	Pulp & Paper	3,200	800	Ghuraha Nallah	Ganga	
248	M/s Shri Omkar Paper & Board Mills(P)Ltd,D-6, 7 Industrial Area.Ramnagar,Chandauli	Pulp & Paper	500	300	Ghuraha Nallah	Ganga	
249	M/s Ganga Pulp & Paper (P)Ltd,A-6, Industrial Area, Ramnagar. Chandauli	Pulp & Paper	3,200	800	Ghuraha Nallah	Ganga	

Source: Pollution Assessment: River Ganga (CPCB, 2013), partially added

Table 7.2.7 Wastewater from Existing Factory in Sewer Planning Area

City	S. No. of Table 7.2.6	Wastewater generation [m^3/day]
Ghazipur	19	170
Ramnagar	144, 247, 248, 249	120+800+300+800=2,020

7.2.5 Total Projected Sewage Flow

The result of recalculation flow based on the above and sewage flow in DPR is shown in the below table. Both are generally consistent, hence planning sewage flow in every DPR is reasonable.

Table 7.2.8 Total Projected Sewage Flow

City	STP	Existing STP (Capacity[MLD])	Year	Average Sewage Flow [MLD]	Comrehensive		Interception Diversion	
				Q1*	Sewage Flow at DPR [MLD]	Planned STP Capacity at DPR [MLD]	Sewage Flow at DPR {MLD]	Planned STP Capacity at DPR [MLD]
Varanasi	Dinapur	O (80)	2025	-	-	140		
	Bhagwanpur	O (8)	2025	-	-	9.8		
	Ramna		2035	-	-	50		
Mirzapur	Mirzapur	O (14)	2020	30	30	-	30	-
			2030	32	32	32	32	32
			2035	34	34	-	34	-
			2050	41	41	-	41	-
	Vindhyachal	O (4)	2020	4.3	4	-	4	-
			2030	6.4	6	6	6	6
			2035	7.0	7	-	7	-
			2050	9.0	9	-	9	-
Ghazipur	Ghazipur		2015	15	15.44	15		
			2025	-	17.88	18		
			2030	19	19.60	18		
			2045	24	24.36	18		
Ramnagar	Ramnagar		2020	7.1	7.6	-	7.11	-
			2030	8.7	-	-	-	-
			2035	9.7	10.36	-	10.00	10
			2040	10.6	-	-	-	-
			2050	13.1	14.06	13to14	13.00	-
Chunar	Chunar		2020	5.7	5.68	-	5.68	-
			2030	6.5	6.51	6.5	6.51	6.5
			2035	7.5	7.46	-	7.46	-
			2050	9.5	9.48	-	9.48	-
Saidpur	Saidpur							

*Original setteings in this report.

CHAPTER 8 Scope of Work for Ganga Rejuvenation Project

<Objective of the Study>

Scope of work was confirmed based on existing DPR. Confirmation of projects, drawings, calculation sheets, description of details were done in the work.

<Result of the Study>

For the sewers, both cases of ID/T and Comprehensive were reviewed for Mirzapur, Chunar, and Ramnagar without decision of selection of the type of sewer network. Saidpur was excluded due to no submission of DPR. Ghazipur submitted only comprehensive plan although NMCG instructed to submit ID/T plan.

For the STPs, since NMCG instructed to submit DPR which is compliant with new effluent standard in CPHEEO, DPRs according to the instruction were dealt in this study.

8.1 Plan of Sewers

Refer to Chapter 7 regarding to the sewage flow. Refer to Appendices for review of DPR drawings and calculation sheets.

8.1.1 Proposed Sewer Works in Varanasi City District-I

Table 8.1.1 shows the bill of quantities for sewer works in Varanasi District-I proposed in the DPR for the same district. Three septic tanks and one lift pumping station were proposed in draft DPR for District-I but there are no available lands for those facilities. Hence sewerage system was remodelled without those facilities.

Figure 8.1.1 shows the general sewerage map and **Figure 8.1.2** shows the locations of micro-tunnelling sections, septic tanks and lift pumping station in District-I.

Table 8.1.1 Proposed Sewer Works in Varanasi District-I

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	193,294	840
RCC	250	9,862	309
RCC	300	4,808	0
RCC	350	2,010	18
RCC	400	2,069	268
RCC	450	1,609	30
RCC	500	2,081	99
RCC	600	1,638	192
RCC	700	84	30
RCC	800	317	90
RCC	900	0	0
Sub-total		**217,772**	**1,876**
Total		**219,648**	

(2) Manhole

Dia. (mm)	Nos.
900	10,898
1200	27
Total	**10,925**

(3) House Connection

Transfer of Exist. (nos.)	New Pipe (nos.)	New Chamber (nos.)
38,288	**9,804**	4,902

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
400	265	(30% of 883m)
600	218	(30% of 728m)
Total	**483**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
88

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
300	795
600	664
Total	**1,459**

Source: Draft DPR Varanasi District-I revised by JICA Survey Team

8.1.2 Proposed Sewer Works in Varanasi City District-II

The draft DPR for Varanasi District-II included an issue of too deep and wide open excavation in a narrow main road with heavy traffic that may cause much impact to traffic circumstance due to closed road. After the discussion between DPR consultant, UPJN, and JICA Study Team it was agreed that the micro-tunnelling method for laying the sewer will be applied for the section. Consequently the DPR was completed and finally submitted to UPJN.

The following table shows the bill of quantities for sewer works in Varanasi District-II proposed in the DPR for the same district. The number of house connections was estimated based on projected population 570,252 for year 2020 in District-II Zone 2A, 5 persons/household, and 70% existing house connections in the area. The existing house connections will be transferred to new sewer after proper repairs of existing connection chambers and reconnections to new manholes. Any pumping station is not proposed in DPR for District-II.

Table 8.1.2 shows the proposed sewer works in the DPR. Figure 8.1.3 shows the general sewerage map and Figure 8.1.4 shows the detail on micro-tunnelling locations.

Table 8.1.2 Proposed Sewer Works in Varanasi District-II

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	236,690	332
RCC	250	11,062	0
RCC	300	6,018	269
RCC	350	3,788	145
RCC	400	4,132	499
RCC	450	2,427	311
RCC	500	2,875	540
RCC	600	1,366	368
RCC	700	1,924	90
RCC	800	570	439
RCC	900	1,244	918
Sub-total		**272,096**	**3,911**
Total		**276,007**	

(2) Manhole

Dia. (mm)	Nos.
900	12,983
1200	145
Total	**13,128**

(3) House Connection

Exist. (nos.)	New (nos.)	New Chamber (nos.)
79,836	**34,216**	17,108

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
450	256	(30% of 852m)
600	145	(30% of 484m)
900	309	(30% of 1,031m)
Total	**710**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
24

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
250	3,850
300	3,451
400	567
600	813
Total	**8,681**

Source: Draft DPR Varanasi District-II compiled by JICA Survey Team

8.1.3 Proposed Sewer Works in Varanasi City District-III

The following table shows the bill of quantities for sewer works in Varanasi District-III proposed in the DPR for the same district. The sewer network is shown in **Figure 8.1.5**.

Table 8.1.3 Proposed Sewer Works in Varanasi District-III

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	109,441	0
RCC	250	1,993	0
RCC	300	1,333	0
RCC	350	572	0
RCC	400	298	0
RCC	450	1,411	554
RCC	500	288	39
RCC	600	729	49
RCC	700	2,603	165
RCC	800	867	0
Sub-total		**119,535**	**807**
Total		**120,342**	

(2) Manhole

Dia. (mm)	Nos.
900	5,159
1200	149
Total	**5,308**

(3) House Connection

Nos.
5,987

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)
225-300	22,700
Total	**22,700**

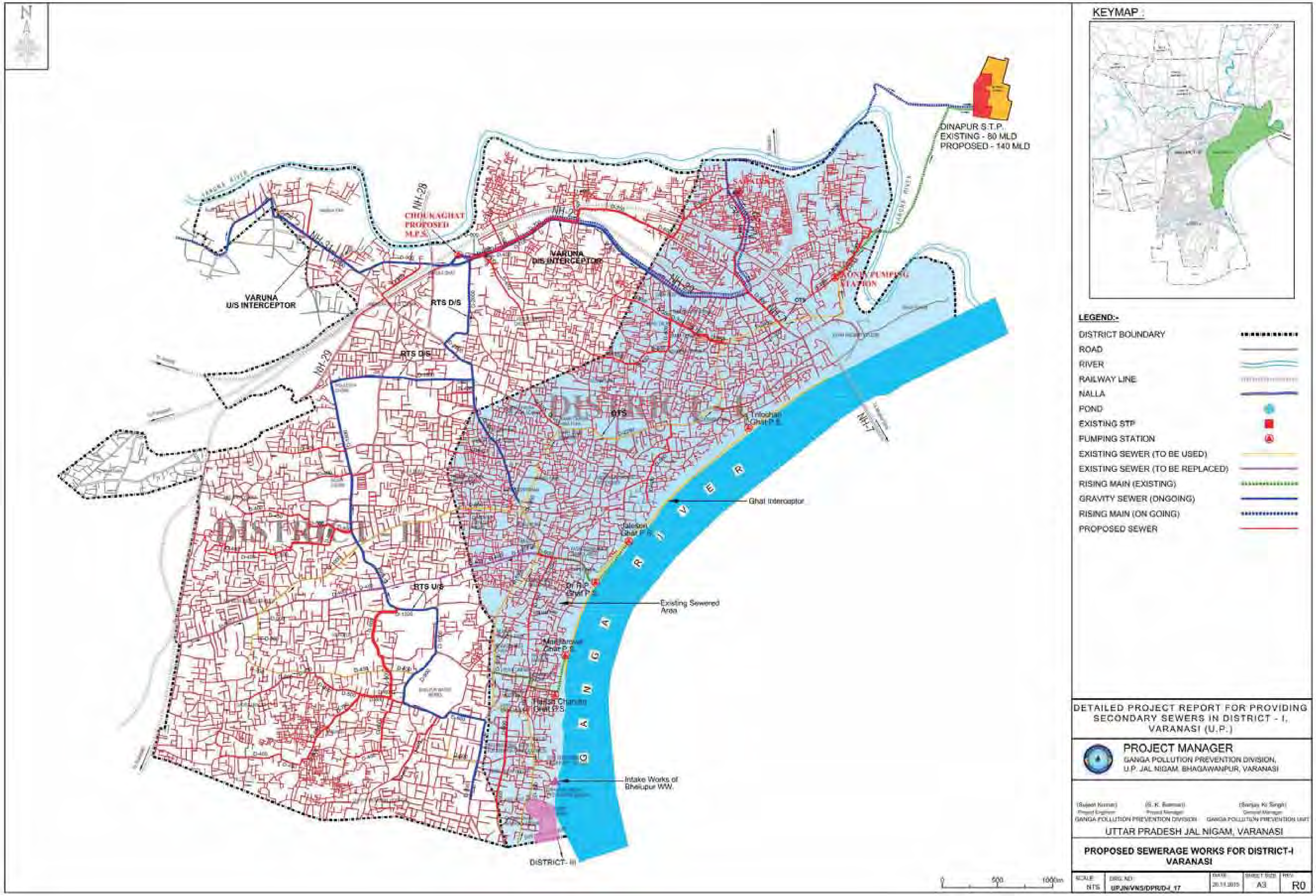
(5) Repairs/Rehabilitation of Existing Manhole

Nos.
500

(6) Dismantling of Existing Sewers

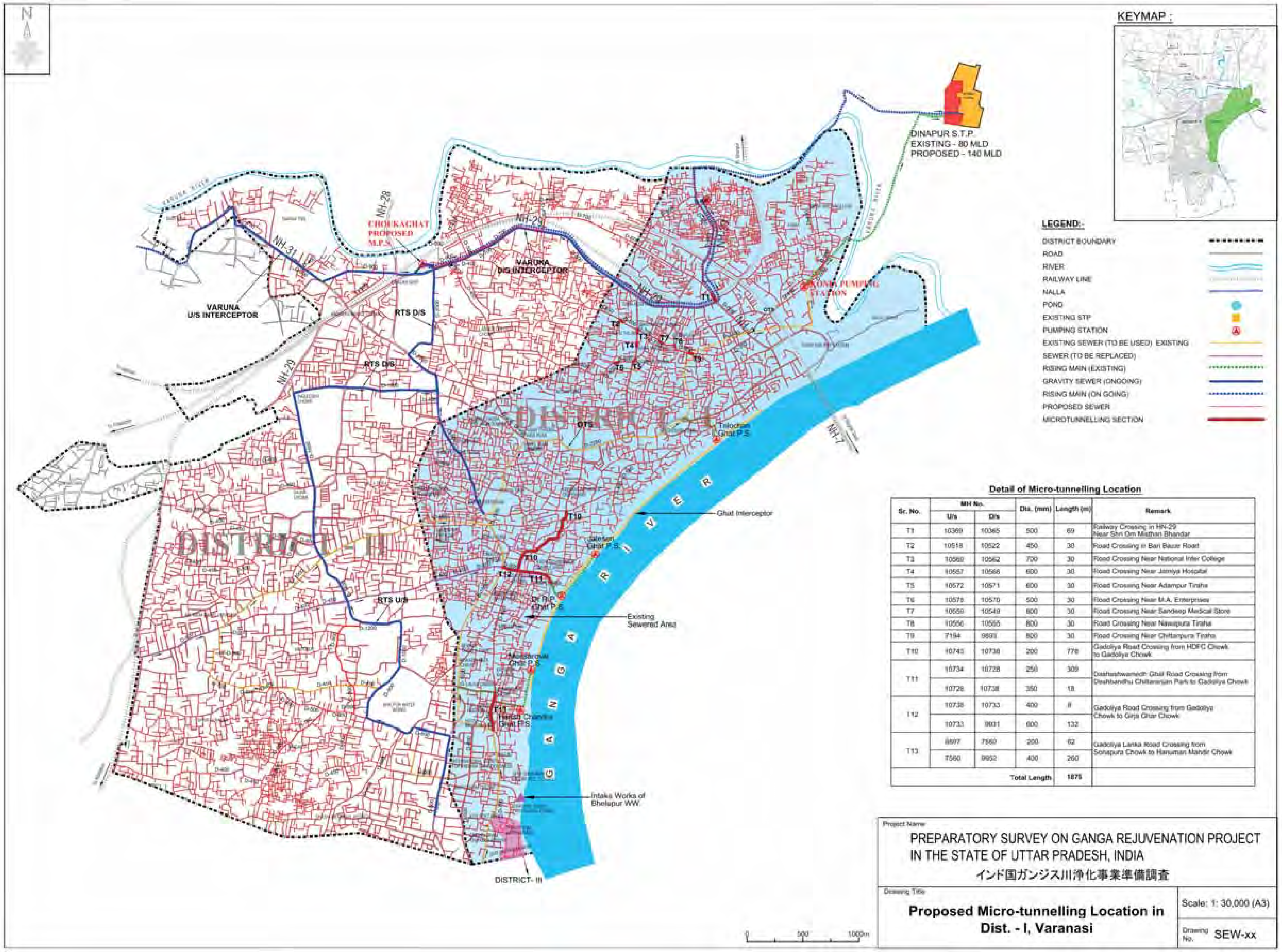
Dia. (mm)	Length (Rm)
150	10,000
200	10,000
Total	**20,000**

Source: DPR Varanasi District-III revised by JICA Survey Team



Source: DPR Varanasi District-I compiled by JICA Survey Team

Figure 8.1.1 Proposed Sewer Network in Varanasi City District-I

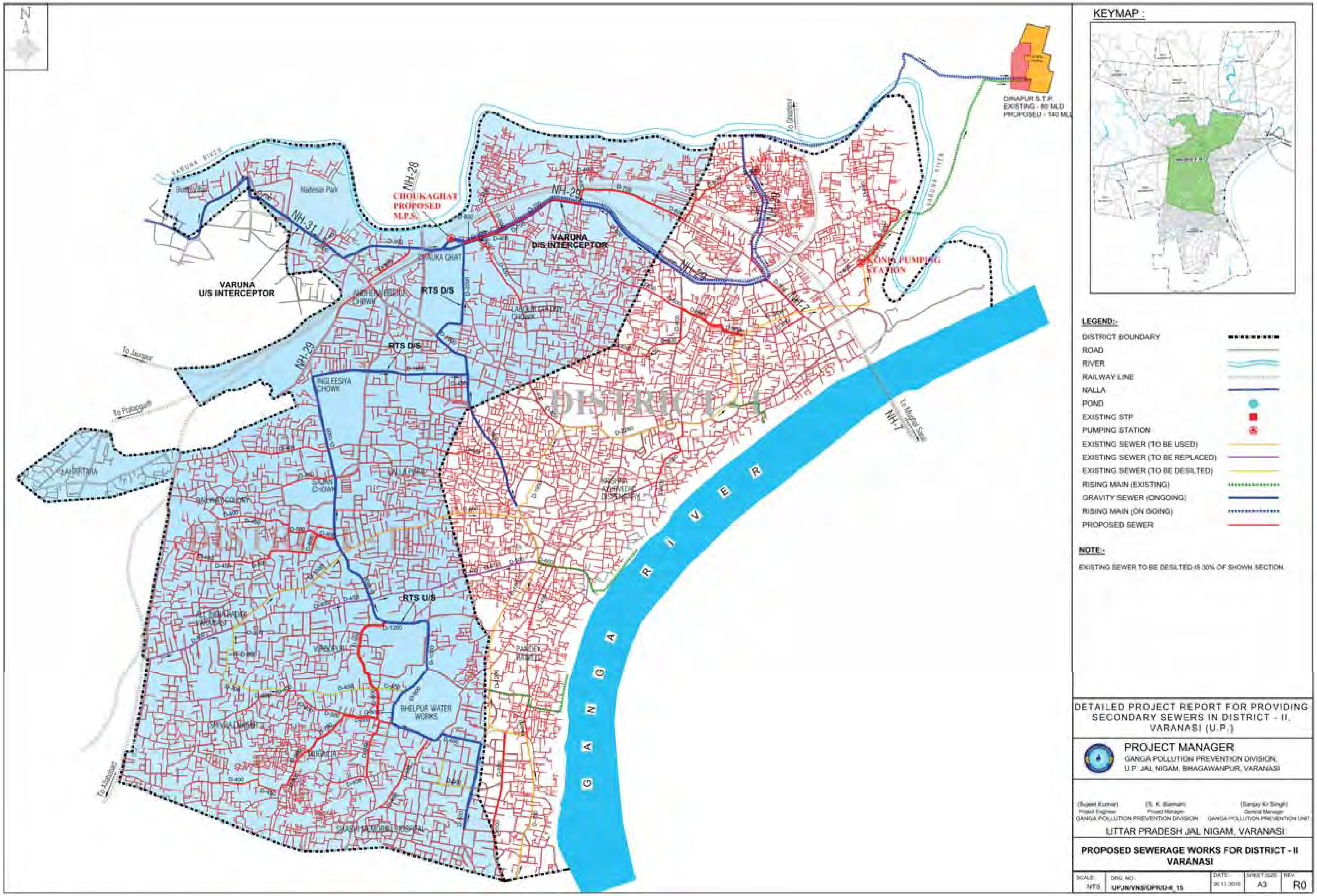


Detail of Micro-tunnelling Location

Sr. No.	MH No. U/s	MH No. D/s	Dia. (mm)	Length (m)	Remark
T1	10369	10365	500	69	Railway Crossing in HN-29 Near Shri Om Misthan Bhandar
T2	10518	10522	450	30	Road Crossing in Bari Bazar Road
T3	10569	10562	700	30	Road Crossing Near National Inter College
T4	10567	10566	600	30	Road Crossing Near Jaimiya Hospital
T5	10572	10571	600	30	Road Crossing Near Adampur Tiraha
T6	10578	10570	500	30	Road Crossing Near M.A. Enterprises
T7	10559	10549	800	30	Road Crossing Near Sandeep Medical Store
T8	10556	10555	800	30	Road Crossing Near Nawapura Tiraha
T9	7194	9893	800	30	Road Crossing Near Chittanpura Tiraha
T10	10743	10738	200	778	Gadoliya Road Crossing from HDFC Chowk to Gadoliya Chowk
T11	10734	10728	250	309	Dashashwamedh Ghat Road Crossing from Deshbandhu Chittaranjan Park to Gadoliya Chowk
	10728	10738	350	18	
T12	10738	10733	400	8	Gadoliya Road Crossing from Gadoliya Chowk to Girja Ghar Chowk
	10733	9831	600	132	
T13	8597	7560	200	62	Gadoliya Lanka Road Crossing from Sonapura Chowk to Hanuman Mandir Chowk
	7560	9852	400	260	
			Total Length	1876	

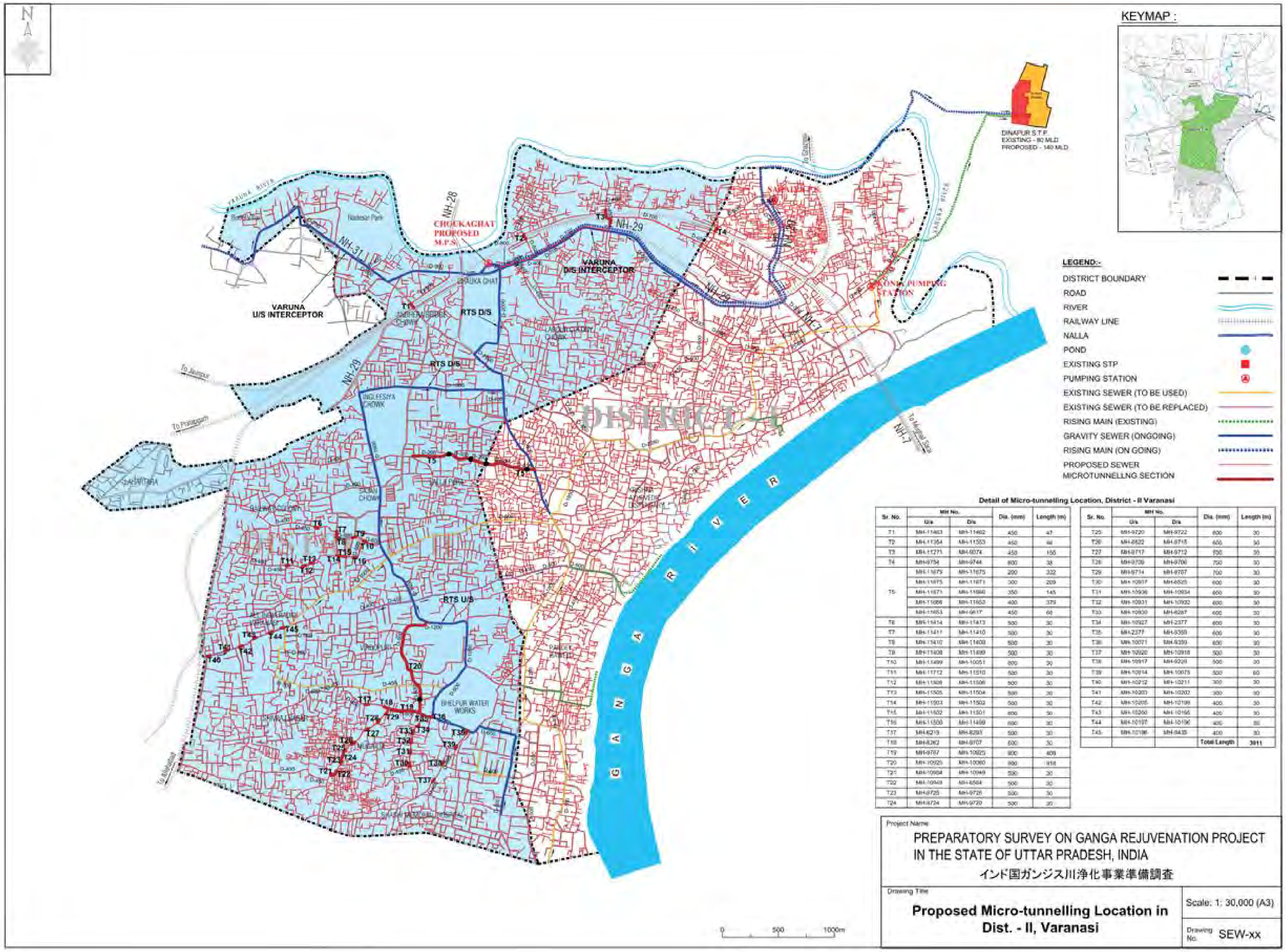
Source: JICA Survey Team based on DPR Varanasi District-I

Figure 8.1.2 Proposed Micro-tunneling Locations in Varanasi City District-I



Source: DPR Varanasi District-II compiled by JICA Survey Team

Figure 8.1.3 Proposed Sewer Network in Varanasi City District-II

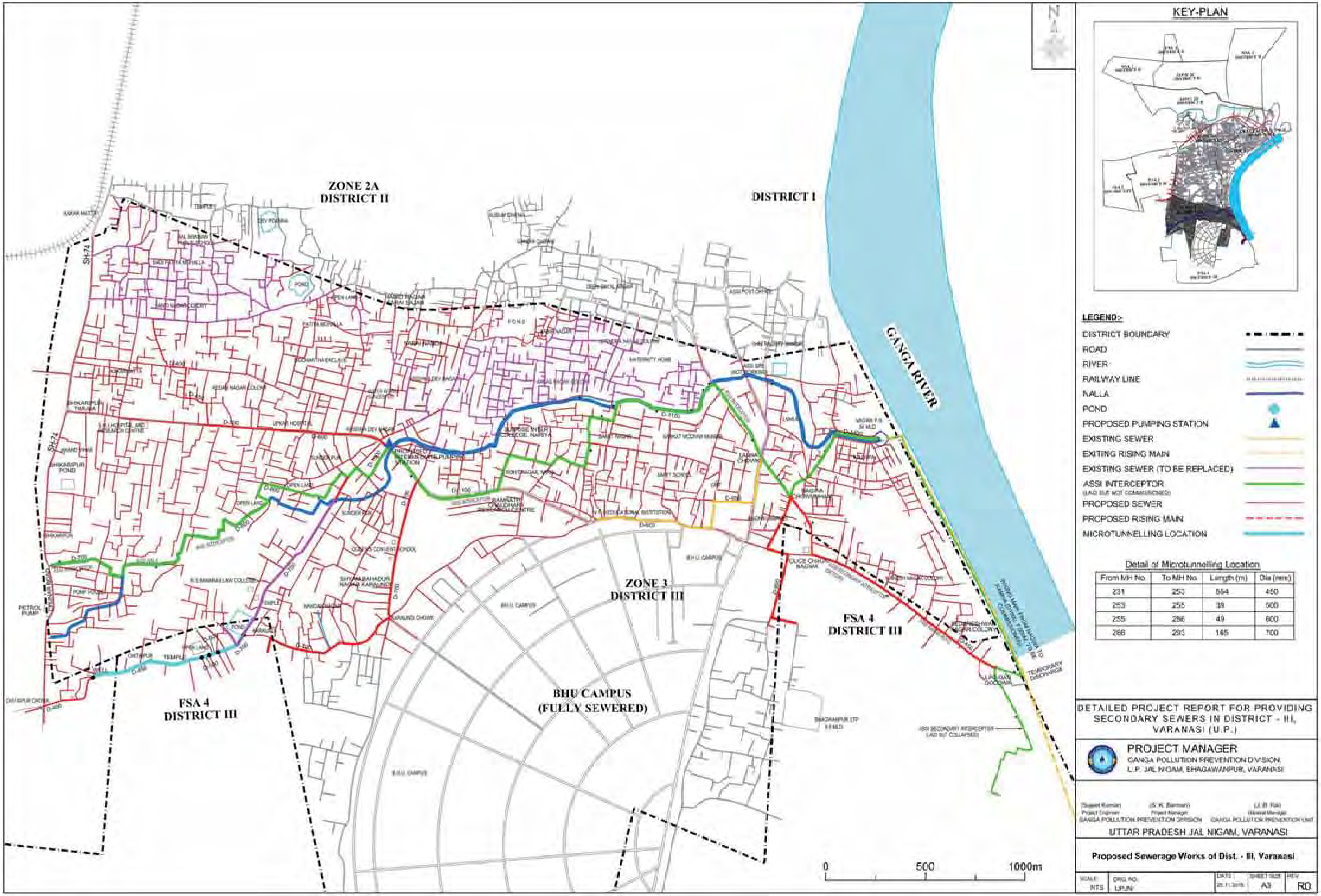


Detail of Micro-tunnelling Location, District - II Varanasi

Sr. No.	MH No. U/s	MH No. D/s	Dia. (mm)	Length (m)
T1	MH-11403	MH-11402	450	47
T2	MH-11354	MH-11353	450	46
T3	MH-11271	MH-9074	450	150
T4	MH-9756	MH-9744	600	38
T5	MH-11679	MH-11675	200	332
	MH-11675	MH-11671	300	209
	MH-11671	MH-11666	350	145
	MH-11666	MH-11653	400	379
	MH-11653	MH-9617	450	68
T6	MH-11414	MH-11413	500	30
T7	MH-11411	MH-11410	500	30
T8	MH-11410	MH-11409	500	30
T9	MH-11409	MH-11499	500	30
T10	MH-11499	MH-10051	500	30
T11	MH-11712	MH-11510	500	30
T12	MH-11509	MH-11506	500	30
T13	MH-11505	MH-11504	500	30
T14	MH-11503	MH-11502	500	30
T15	MH-11502	MH-11501	600	30
T16	MH-11500	MH-11499	600	30
T17	MH-6219	MH-8293	500	30
T18	MH-8262	MH-9707	600	30
T19	MH-9707	MH-10925	800	409
T20	MH-10925	MH-10060	800	958
T21	MH-10904	MH-10949	500	30
T22	MH-10949	MH-6504	500	30
T23	MH-9725	MH-9726	500	30
T24	MH-9724	MH-9720	500	30
T25	MH-9720	MH-9722	600	30
T26	MH-8522	MH-9715	600	30
T27	MH-9717	MH-9712	700	30
T28	MH-9709	MH-9706	750	30
T29	MH-9714	MH-9707	700	30
T30	MH-10917	MH-6525	600	30
T31	MH-10936	MH-10934	600	30
T32	MH-10931	MH-10932	600	30
T33	MH-10930	MH-6267	600	30
T34	MH-10927	MH-2377	600	30
T35	MH-2377	MH-9359	600	30
T36	MH-10071	MH-9359	600	30
T37	MH-10920	MH-10918	500	30
T38	MH-10917	MH-9229	500	30
T39	MH-10914	MH-10073	500	60
T40	MH-10212	MH-10211	300	30
T41	MH-10203	MH-10202	300	30
T42	MH-10205	MH-10199	400	30
T43	MH-10200	MH-10195	400	30
T44	MH-10197	MH-10196	400	30
T45	MH-10196	MH-9435	400	30
			Total Length	3011

Source: JICA Survey Team based on DPR Varanasi District-II

Figure 8.1.4 Proposed Micro-tunnelling Locations in Varanasi City District-II



Source: DPR Varanasi District-III compiled by JICA Survey Team

Figure 8.1.5 Proposed Sewer Network in Varanasi City District-III

8.1.4 Proposed Sewer Works in Ramnagar City

In common with the cases of Mirzapur and Chunar mentioned later, two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga for sewer have been prepared for Ramnagar City in Varanasi District. From the scale of Ramnagar City of which the population is less than 100,000 the ID&T method will be adopted for this city and sewer network would not be developed in future.

1) Comprehensive Case

The proposed BOQ of sewer related works in Ramnagar City with comprehensive method is tabulated as follows. The proposed sewer network is shown in **Figure 8.1.6**.

Table 8.1.4 Proposed Sewer Works in Ramnagar City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)				
1) Gravity Sewer			Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
RCC	NP3	200	6,901	3,428	4,930	6,327	21,586
RCC	NP3	250	1,410	797	655	889	3,751
RCC	NP3	300	531	514	116	173	1,335
RCC	NP3	350	96		202	0	298
RCC	NP3	400	155		203	356	713
RCC	NP3	450	0		347	204	551
RCC	NP3	500	0			276	276
RCC	NP3	600	0				0
RCC	NP3	700	0	782			782
RCC	NP3	800	2,200				2,200
RCC	NP3	900	0				0
Sub-total			**11,292**	**5,522**	**6,452**	**8,224**	**31,489**
2) Rising Main							
DI	K9	100					3,700
DI	K9	150					0
DI	K9	200					0
DI	K9	250					0
DI	K9	300					0
DI	K9	350					150
DI	K9	400					50
Sub-total							3,900
Total							**35,389**

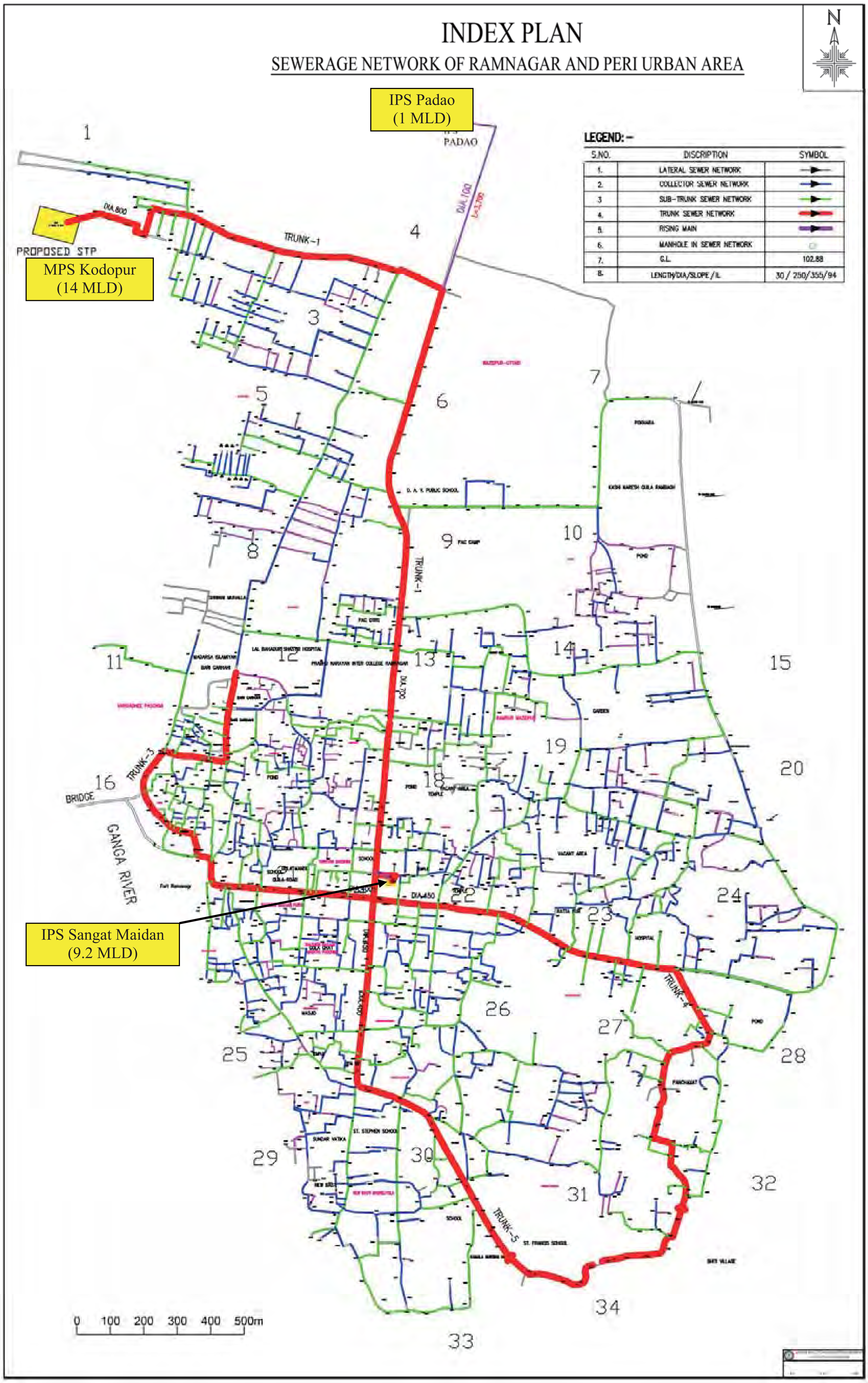
(2) Manhole

Dia. (mm)	Nos. Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
900	261	195	416	412	1,284
1200	112	91	100	118	421
1500	296	170	183	264	913
1200x900	29	22	47	46	144
1500x1500	13	4	4	13	34
Total	**711**	**482**	**750**	**853**	**2,796**

(3) House Connection

Nos. Trunk-1	Trunk-2	Trunk-3	Trunk-4&5	Total
1,396	957	1,493	1,679	**5,525**

Source: DPR Ramnagar Comprehensive compiled by JICA Survey Team



Source: DPR Ramnagar Comprehensive compiled by JICA Survey Team

Figure 8.1.6 Proposed Sewerage System in Ramnagar City (Comprehensive)

2) ID&T Case

Table 8.1.5 shows the list of existing drains in Ramnagar City with projected population and wastewater generations for 2020 (base year) and 2050 (ultimate year) in DPR ID&T. Out of 5 existing drains only Hanuman Ghat Drain was excluded from interception since it flows in remote area and there is no wastewater flow in dry season.

Table 8.1.5 List of Drains with Projected Population and Wastewater Generation in Ramnagar City (ID&T)

No.	Name of Drain	Population		Average Flow (MLD)		IC No.
		2020	2050	2020	2050	
1	Balua Ghat Drain	2,319	4,251	0.28	0.50	BGD
2	Salotri Ghat Drain	334	612	0.04	0.07	SLD
3	Shakti Ghat Drain	1,992	3,651	0.24	0.43	SHD
4	Ram Bagh Drain	54,698	100,257	6.50	11.91	RBD
5	Hanuman Ghat Drain	502	920	0.06	0.11	Not intercepted
Total		59,845	109,692	7.11	13.03	
Intercepted & Treated		59,343	108,771	7.05	12.92	

Source: DPR Ramnagar ID&T compiled by JICA Survey Team

The proposed BOQ of sewer related works in Ramnagar City with ID&T method is tabulated in Table 8.1.6 and the alignment of interceptor is shown in **Figure 8.1.7**. Any drawing with rising main alignment to STP was not prepared in DPR.

The longitudinal profile (L-section) of interceptor in the DPR is shown in Appendix 8.1.1 and proposed interception structure is shown in Appendix 8.1.2.

Table 8.1.6 Proposed Sewer Works in Ramnagar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)
1) Gravity Sewer			Total
RCC	NP3	200	0
RCC	NP3	250	0
RCC	NP3	300	0
RCC	NP3	350	80
RCC	NP3	400	150
RCC	NP3	450	0
RCC	NP3	500	120
RCC	NP3	600	0
RCC	NP3	700	0
RCC	NP3	800	0
RCC	NP3	900	30
Sub-total			**380**
2) Rising Main			
DI	K9	400	**2,700**
Sub-total			**2,700**
Total			**3,080**

(2) Manhole

1200x900	0
1500x1500	10
Total	**10**

(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Ramnagar ID&T compiled by JICA Survey Team

Source: DPR Ramnagar ID&T

Figure 8.1.7 Proposed Interceptor in Ramnagar City (ID&T)

8.1.5 Proposed Sewer Works in Mirzapur City

Two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga have been prepared for Mirzapur City.

1) Comprehensive Case

The proposed BOQ of sewer related works in Mirzapur City with comprehensive method is tabulated in as below. The proposed sewerage system is shown in **Figure 8.1.8** and the locations of sewer installations with micro tunnelling method is shown in **Figure 8.1.9**.

Table 8.1.7 Proposed Sewer Works in Mirzapur City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length		
			Replacement (Rm)	Open (Rm)	Micro Tunneling (Rm)
1) Sewer Line					
RCC	NP3	200		217,181	110
RCC	NP3	250		3,814	0
RCC	NP3	300		9,141	25
RCC	NP3	350		1,716	0
RCC	NP3	400		4,219	30
RCC	NP3	450		1,275	25
RCC	NP3	500		1,908	0
RCC	NP3	600		586	20
RCC	NP3	700		1,899	0
RCC	NP3	800		1,199	0
RCC	NP3	900		970	0
RCC	NP3	1000		1,537	20
RCC	NP3	1200		0	30
Sub-total			**4,500**	**245,445**	**260**
2) Rising Main					
DI	K9	150		333.7	
DI	K9	200		730	
DI	K9	250		334	
DI	K9	300		66	
DI	K9	350		1,700	
DI	K9	600		-	
DI	K9	700		1,370	
DI	K9	800		30	
DI	K9				
Sub-total				4,563	
Total			**4,500**	**250,008**	**260**
Grand total				**250,268**	

(2) Manhole

Dia. (mm)	Nos.
900	2,729
1200	162
Total	**2,891**

(3) House Connection

Nos.
5,726

(4) Septic Tank Soak Pit

Nos.
8

Source: DPR Mirzapur Comprehensive revised by JICA Survey Team

2) ID&T Case

The population projection in catchments of existing drains and the wastewater flow projection to be intercepted from each drain are shown in the following table. The flow calculations of interceptor and connecting sewers from interception chambers (ICs) were made based on these flows and peak factors.

Table 8.1.8 List of Drains with Projected Population and Wastewater Generation to be intercepted in Mirzapur City (ID&T)

No.	Drain Name	Population		Flow (MLD)		Note
		2020	2050	2020	2050	
Mirzapur Zone						
1	Bisundarpur Drain	14,703	21,947	1.747	2.607	IC1
2	Hanumanghat Drain	9,110	13,339	1.082	1.585	IC2
3	Public Club Drain	5,617	8,490	0.667	1.009	IC3
4	Barahmiliah Drain	3,744	5,660	0.445	0.672	IC4
5	District Judge Drain	3,052	4,378	0.363	0.520	IC5
6	Lift Canal Drain	3,052	4,378	0.363	0.520	IC6
7	Irrigation Colony Drain	690	990	0.082	0.118	IC7
8	Morcha Ghar Drain	15,268	20,131	1.814	2.392	IC8
9	Ghoreshahid Drain	66,252	89,480	7.871	10.630	IC9
10	Kachari Drain	14,408	21,272	1.712	2.527	Existing IC
11	Oliyar Drain	24,345	31,089	2.892	3.693	Existing IC
12	Sundar Drain	5,180	6,795	0.615	0.807	Existing IC
13	Bandali Drain	11,247	15,707	1.336	1.866	Existing IC
14	Konia Drain	2,238	3,172	0.266	0.377	IC10
15	Narghat Drain	10,899	14,029	1.295	1.667	Existing IC
16	Balaji Temple Drain	21,260	29,526	2.526	3.508	IC11
17	Khandawa Drain	37,796	53,922	4.490	6.406	IC13
18	Chorawa Drain	2,403	3,632	0.285	0.432	IC12
	Sub-total	**251,262**	**347,938**	**29.850**	**41.335**	
Vindhyanchal Zone						
19	Basvariya Drain	8,359	23,490	0.993	2.791	IC15
20	Diwan Ghat new Drain	277	598	0.033	0.071	IC16
21	Diwan Ghat old Drain	923	1,993	0.110	0.237	Existing IC
22	Balughat Kacha Drain	92	199	0.011	0.024	IC17
23	Balughat Pakka Drain	1,569	3,387	0.186	0.402	Existing IC
24	Parasuram Drain	9,586	20,484	1.139	2.434	Existing IC
25	Gudara Drain	1,845	3,985	0.219	0.473	Existing IC
26	Malhaya Drain	2,532	5,360	0.301	0.637	IC14
27	Patengra (Manasarovar) Drain	9,842	16,190	1.169	1.923	IC14
	Sub-total	**35,025**	**75,686**	**4.161**	**8.991**	
Total		**286,287**	**423,624**	**34.011**	**50.326**	

Source: DPR Mirzapur ID&T arranged by JICA Survey Team

The proposed BOQ of sewer related works in Mirzapur City with ID&T method is tabulated as below. The proposed sewerage system is shown in **Figure 8.1.10.**

Table 8.1.9 Proposed Sewer Works in Mirzapur City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length	
			Open (Rm)	Micro Tunneling (Rm)
1) Interceptor				
RCC	NP3	200	750	0
RCC	NP3	250	400	0
RCC	NP3	300	800	0
RCC	NP3	350	0	0
RCC	NP3	400	555	0
RCC	NP3	450	550	0
RCC	NP3	500	1,659	0
RCC	NP3	600	2,211	0
RCC	NP3	700	0	0
RCC	NP3	800	210	0
RCC	NP3	900	1,700	0
RCC	NP3	1000	0	0
RCC	NP3	1200	0	0
Sub-total			**8,835**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	**370**	
DI	K9	250	-	
DI	K9	300	**3,550**	
DI	K9	350		
DI	K9	600	**80**	
DI	K9	700	**1,370**	
Sub-total			**5,370**	
3) Treated Effluent Reuse Line				
RCC	NP3	800	**7,000**	
Total			**21,205**	

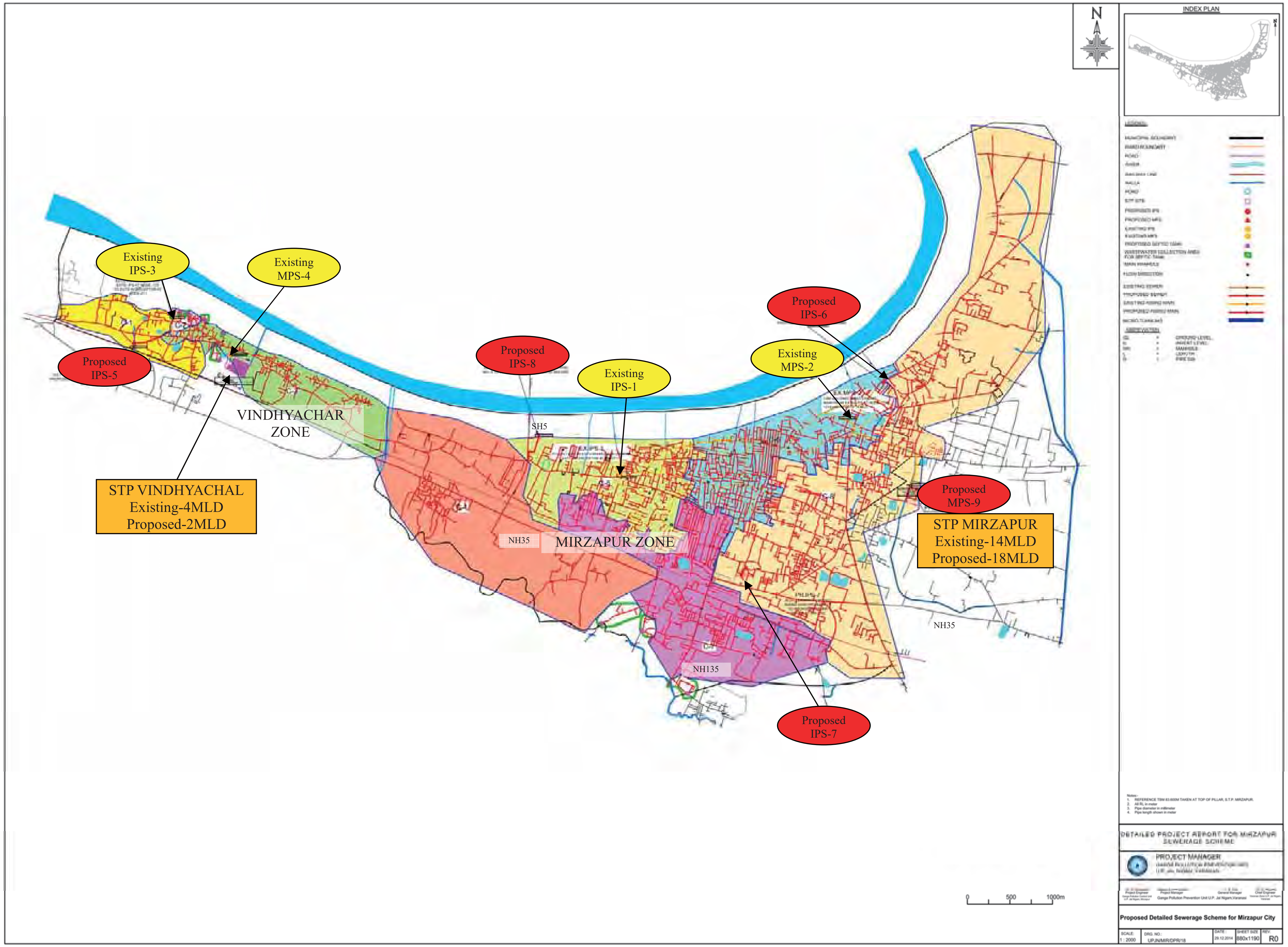
(2) Manhole

1) Interceptor	
900	241
1200	65
Sub-total	306
2) Treated Effluent Reuse Line	
900	38
Total	**344**

(3) Interception Structure (Nala Tapping Structure)

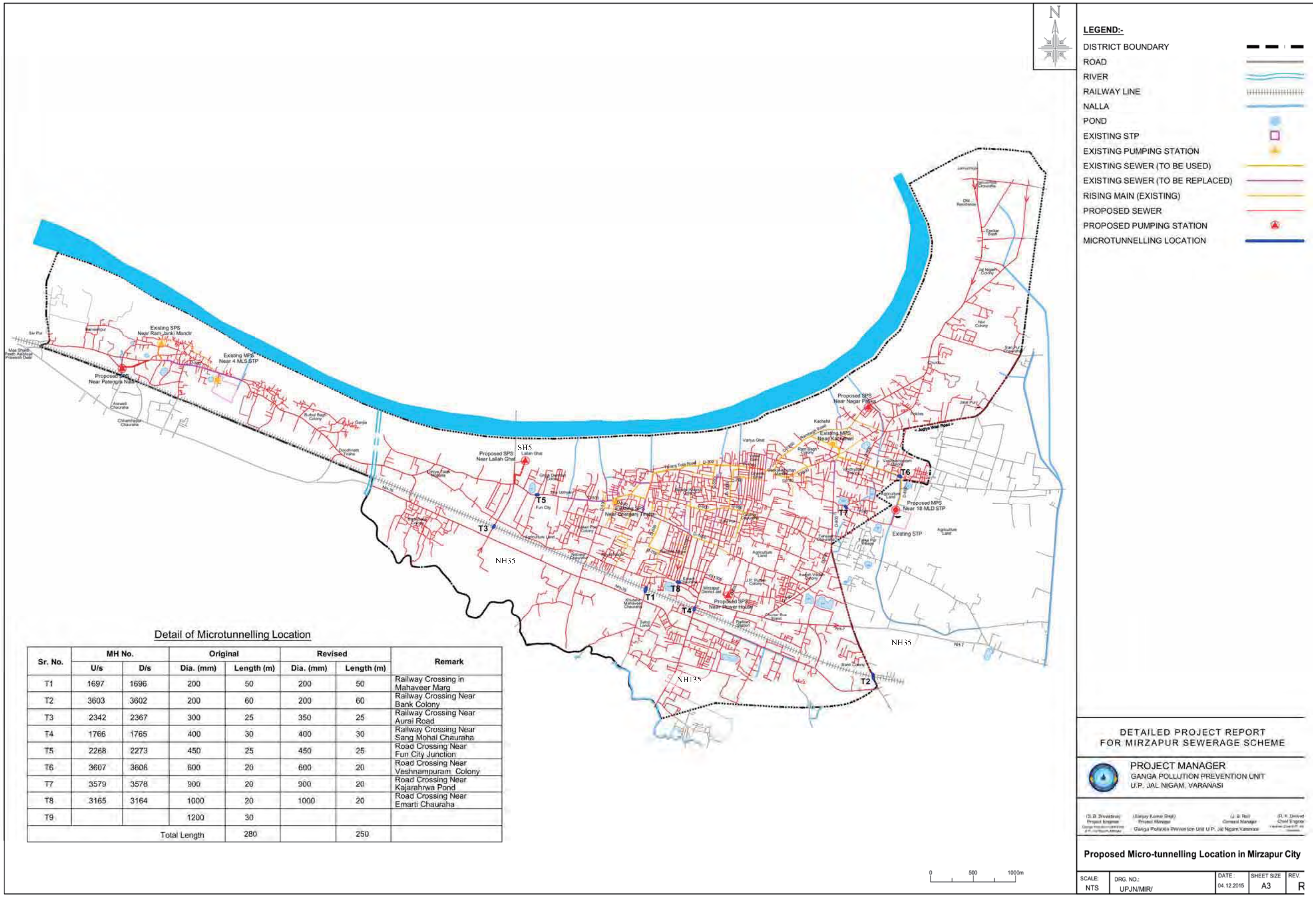
Zone	Nos.	
	New	Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

Source: DPR Mirzapur ID&T revised by JICA Survey Team



Source: DPR Mirzapur Comprehensive revised by JICA Survey Team

Figure 8.1.8 Proposed Sewer Network in Mirzapur City (Comprehensive)

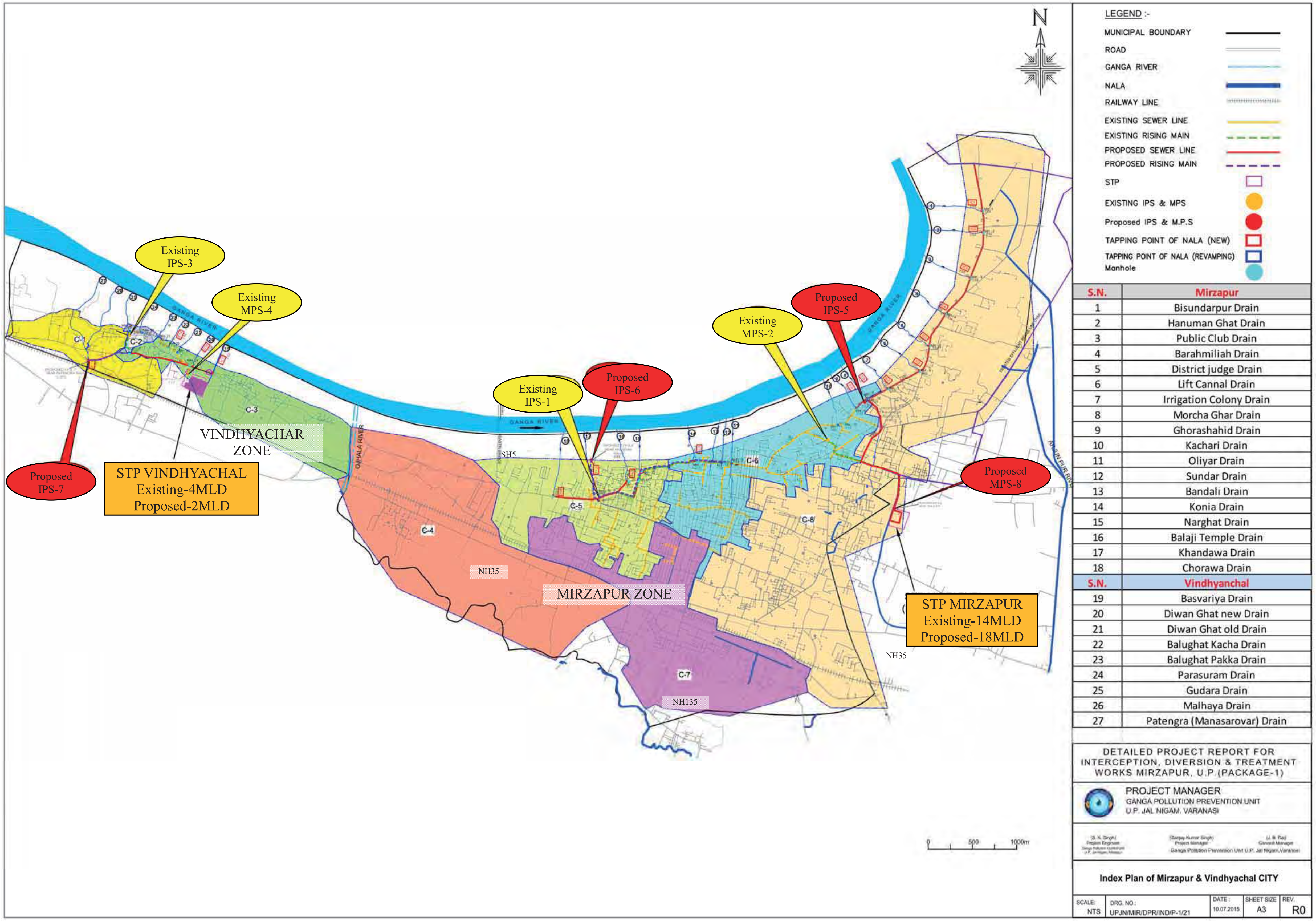


Detail of Microtunnelling Location

Sr. No.	MH No.		Original		Revised		Remark
	U/s	D/s	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	
T1	1697	1696	200	50	200	50	Railway Crossing in Mahaveer Marg
T2	3603	3602	200	60	200	60	Railway Crossing Near Bank Colony
T3	2342	2367	300	25	350	25	Railway Crossing Near Aurai Road
T4	1766	1765	400	30	400	30	Railway Crossing Near Sang Mohal Chauraha
T5	2268	2273	450	25	450	25	Road Crossing Near Fun City Junction
T6	3607	3606	600	20	600	20	Road Crossing Near Veshnampuram Colony
T7	3579	3578	900	20	900	20	Road Crossing Near Kajarahrwa Pond
T8	3165	3164	1000	20	1000	20	Road Crossing Near Emarti Chauraha
T9			1200	30			
Total Length				280		250	

Source: JICA Survey Team based on DPR Mirzapur Comprehensive

Figure 8.1.9 Proposed Micro Tunnelling Locations in Mirzapur City (Comprehensive)



Source: DPR Mirzapur ID&T revised by JICA Survey Team

Figure 8.1.10 Proposed Sewer Network in Mirzapur City (ID&T)

8.1.6 Proposed Sewer Works in Chunar City

In common with the case of Mirzapur, two DPRs namely 1) comprehensive case which includes area wise development with trunk and branch sewers and house connections in the city area, 2) interception, diversion and Treatment (ID&T) case which includes only interception structures in drains and interceptors beside River Ganga have been prepared for Chunar City.

1) Comprehensive Case

The proposed BOQ of sewer related works in Chunar City with comprehensive method is tabulated as follows and the sewerage map is shown in **Figure 8.1.11**. The proposed micro tunneling locations are shown in **Figure 8.1.12**.

Table 8.1.10 Proposed Sewer Works in Chunar City (Comprehensive)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)	Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200	49,017	70
RCC	NP3	250	2,033	27
RCC	NP3	300	3,399	15
RCC	NP3	350	1,069	470
RCC	NP3	400	1,252	0
RCC	NP3	450	126	50
RCC	NP3	500	1,377	0
RCC	NP3	600	615	0
RCC	NP3	700	1,916	0
Sub-total			**60,804**	**632**
2) Rising Main				
DI	K9	150	1,670	
DI	K9	200	900	
DI	K9	250		
DI	K9	300		
DI	K9	350	1,250	
Sub-total			3,820	
Total			**65,256**	

(2) Manhole

Dia. (mm)	Nos.
900	2,582
1200	73
Total	**2,655**

(3) House Connection

Nos.
2,285

Source: DPR Chunar Comprehensive revised by JICA Survey Team

2) ID&T Case

Table 8.1.11 shows the list of existing drains in Chunar City with projected population and wastewater generations for 2020 (base year) and 2050 (ultimate year) in DPR ID&T. The wastewater from colonies around No. 2, 3, 5, and 6 drains were designed with primary treatment in septic tanks because of the low lands where are difficult to connect to interceptor and ones around No. 17 to 22 drains towards Jargo River were left since water in Jargo River has been utilized for farm land and no wastewater does not flow into Ganga River at present.

Table 8.1.11 List of Drains with Projected Population and Wastewater Generation in Chunar City

No.	Name of Drain	Population		Flow (MLD)		IC No.	Treatment
		2020	2050	2020	2050		
Towards Ganga River							
1	Tambal Ganj	8,151	20,771	0.97	2.47	IC1	STP
2	Bhairam Ganj East	944	2,193	0.11	0.26	IC2	Septic Tank
3	Bhairam Ganj West	734	1,706	0.09	0.20	IC3	Septic Tank
4	Dargah Sharif	6,354	12,963	0.75	1.54	IC4	STP
5	Tekaur Basti North	2,946	4,779	0.35	0.57	IC5	Septic Tank
6	Tekaur Basti South	1,158	2,180	0.14	0.26	IC6	Septic Tank
7	Santoshi Mata Mandir	657	906	0.08	0.11	IC7	STP
8	Post Office South	3,217	4,093	0.38	0.49	IC8	STP
9	Post Office North	2,268	2,583	0.27	0.31	IC9	STP
10	Gangeshwar (Nishad Park)	1,337	1,265	0.16	0.15	IC10	STP
11	Balu Ghat	1,322	2,992	0.16	0.36	IC11	STP
12	Belbeer Ghat	331	748	0.04	0.09	IC12	STP
13	Choura Mata Mandir (Ramghat)	331	748	0.04	0.09	IC13	STP
14	Kasi Ram Awas	1,322	2,992	0.16	0.36	IC14	STP
Towards Jargo River							STP
15	Parade Ground	1,965	1,901	0.23	0.23	IC15	STP
16	Nagar Palika	1,334	1,265	0.16	0.15	IC16	STP
17	Nagarpur	1,408	2,300	0.17	0.27		Used for farm land
18	Tekaur Nagarpur (Chunar Fort)	1,318	1,757	0.16	0.21		Used for farm land
19	Bharatpur Kabristan	1,621	1,699	0.19	0.20		Used for farm land
20	Bharatpur Trimohani	986	1,179	0.12	0.14		Used for farm land
21	Saddupur Naipurwa (Ganda)	6,861	7,619	0.80	0.88		Used for farm land
22	Pashu Chikitsalaya	1,436	1,361	0.17	0.16		Used for farm land
Total		**48,000**	**80,000**	**5.68**	**9.48**		
Intercepted		**34,370**	**64,085**	**4.08**	**7.61**		
Treated in STP		**28,588**	**53,226**	**3.40**	**6.32**		

Source: DPR Chunar ID&T Flow-I Main Report compiled by JICA Survey Team

The proposed BOQ of sewer related works in Chunar City with ID&T method is tabulated in Table 8.1.12 and the sewerage map is shown in **Figure 8.1.13**. Since the longitudinal profile (L-section) for interceptor was not prepared in DPR the JICA Survey Team prepared the drawing based on flow calculation sheet as shown in Appendix 8.1.3.

Table 8.1.12 Proposed Sewer Works in Chunar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)	Length Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200		
RCC	NP3	250	700	
RCC	NP3	300		
RCC	NP3	350	250	
RCC	NP3	400		
RCC	NP3	450		
RCC	NP3	500		
RCC	NP3	600	1,550	
RCC	NP3	700	1,808	
Sub-total			**4,308**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	2,130	
DI	K9	250	-	
DI	K9	300	-	
DI	K9	350	30	
Sub-total			**2,160**	
3) Treated Effluent Reuse Line				
RCC	NP3	350	**3,695**	
Total			**10,163**	

(2) Manhole

Dia. (mm)	Nos.
900	86
1200	63
Total	**149**

(3) Interception Structure

Nos.
16

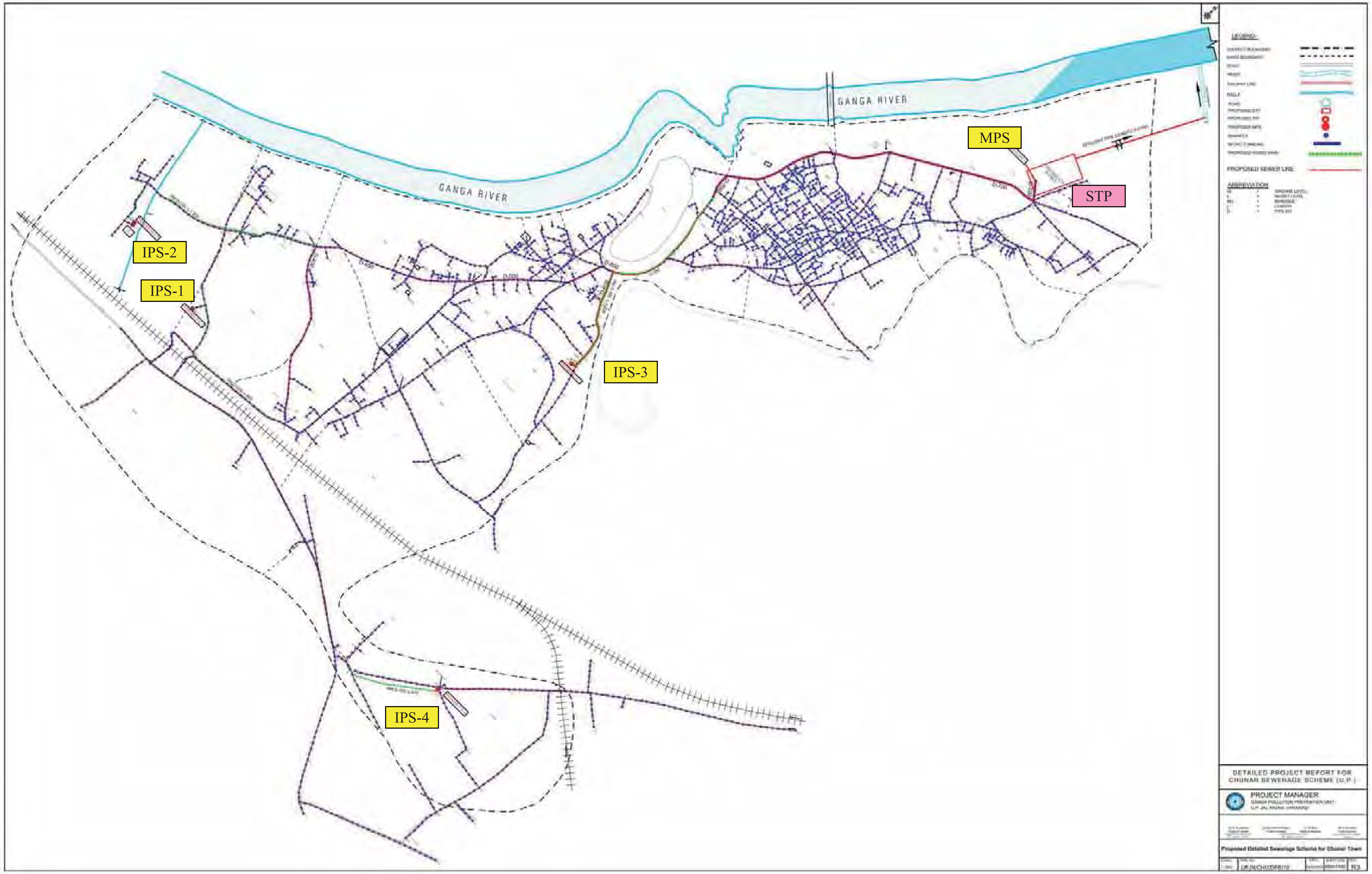
(4) Septic Tank Soak Pit

Nos.
4

(5) House Connection

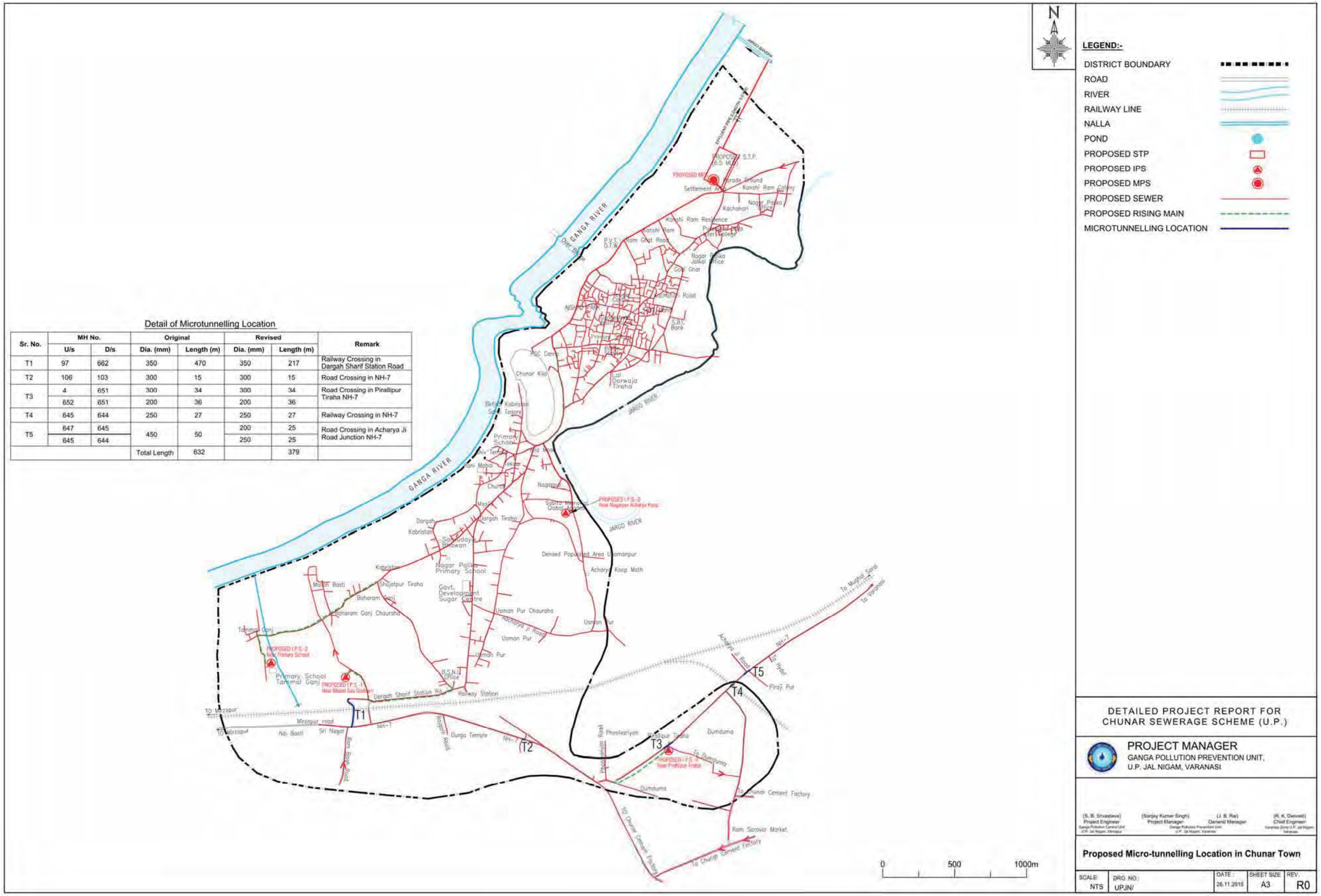
Nos.
0

Source: DPR Chunar ID&T revised by JICA Survey Team



Source: DPR Chunar Comprehensive compiled by JICA Survey Team

Figure 8.1.11 Proposed Sewer Network in Chunar City (Comprehensive)

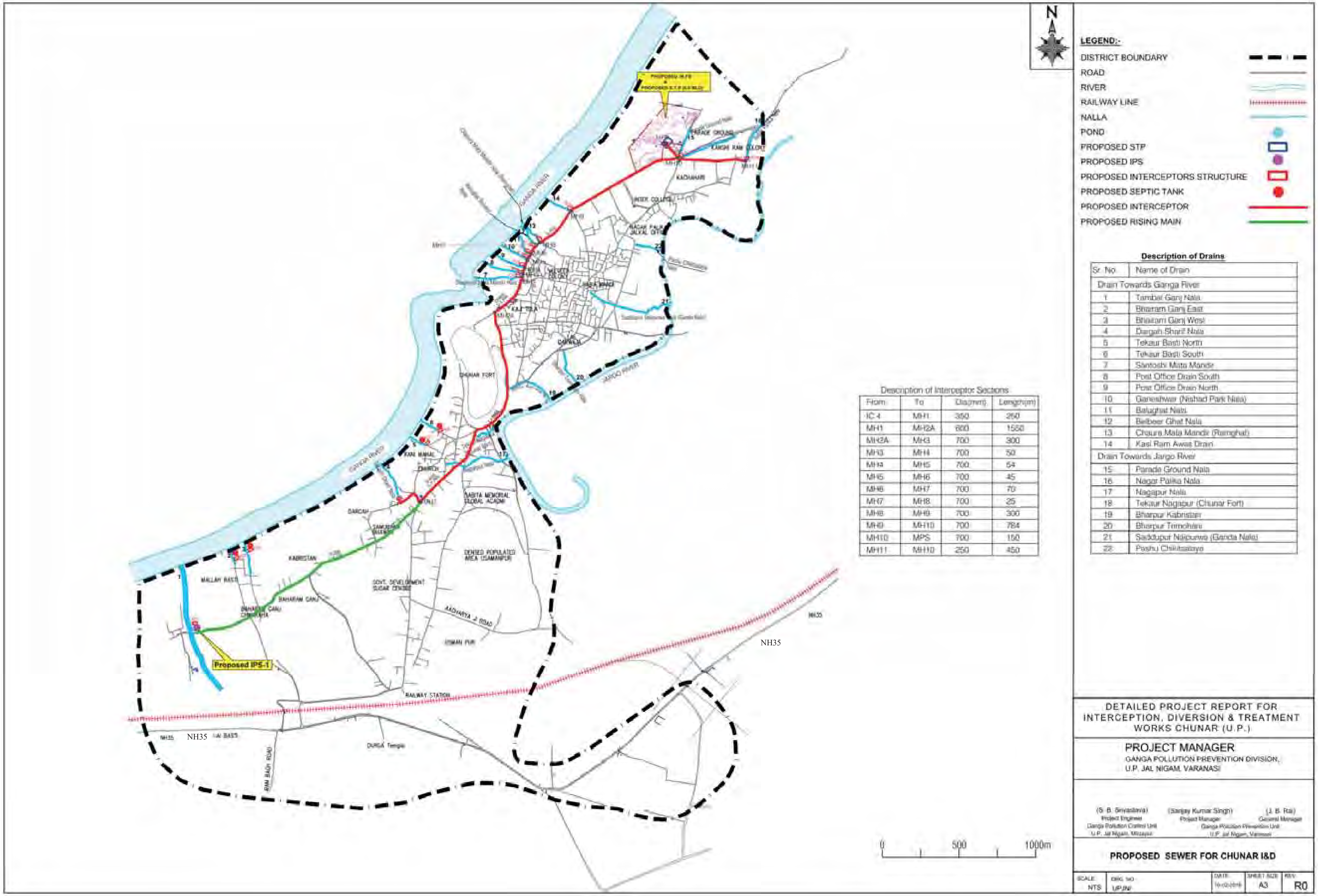


Detail of Microtunnelling Location

Sr. No.	MH No.		Original		Revised		Remark
	U/s	D/s	Dia. (mm)	Length (m)	Dia. (mm)	Length (m)	
T1	97	662	350	470	350	217	Railway Crossing in Dargah Sharif Station Road
T2	106	103	300	15	300	15	Road Crossing in NH-7
T3	4	651	300	34	300	34	Road Crossing in Pirallipur Tiraha NH-7
	652	651	200	36	200	36	
T4	645	644	250	27	250	27	Railway Crossing in NH-7
T5	647	645	450	50	200	25	Road Crossing in Acharya Ji Road Junction NH-7
	645	644			250	25	
			Total Length	632		379	

Source: JICA Survey Team based on DPR Chunar Comprehensive

Figure 8.1.12 Proposed Micro Tunnelling Locations in Chunar City (Comprehensive)



Description of Interceptor Sections

From	To	Dia(mm)	Length(m)
IC 4	MH1	350	250
MH1	MH2A	600	1550
MH2A	MH3	700	300
MH3	MH4	700	50
MH4	MH5	700	54
MH5	MH6	700	45
MH6	MH7	700	70
MH7	MH8	700	25
MH8	MH9	700	300
MH9	MH10	700	784
MH10	MPS	700	150
MH11	MH10	250	450

Description of Drains

Sr. No	Name of Drain
Drain Towards Ganga River	
1	Tambal Ganj Nala
2	Bharam Ganj East
3	Bharam Ganj West
4	Dargah Sharif Nala
5	Tekaur Basti North
6	Tekaur Basti South
7	Santoshi Mata Mandir
8	Post Office Drain South
9	Post Office Drain North
10	Ganeshwar (Nishad Park Nala)
11	Balughat Nala
12	Belbeer Ghat Nala
13	Choura Mata Mandir (Ramghat)
14	Kasi Ram Awas Drain
Drain Towards Jargo River	
15	Parade Ground Nala
16	Nagar Palika Nala
17	Nagapur Nala
18	Tekaur Nagapur (Chunar Fort)
19	Bharpur Kabristan
20	Bharpur Timohani
21	Saddupur Naipurwa (Ganda Nala)
22	Pashu Chikitsalaya

Source: DPR Chunar ID&T compiled by JICA Survey Team

Figure 8.1.13 Proposed Sewer Network in Chunar City (ID&T)

8.1.7 Proposed Sewer Works in Ghazipur City

1) Comprehensive Case

The DPR for Ghazipur City was prepared with comprehensive method as shown in **Figure 8.1.14**. Since the original file of sewerage map has not been submitted to UPJN from the DPR consultant, JICA Survey Team recreated the map based on the image file. The following table shows the bill of quantity of sewer works in DPR comprehensive for Ghazipur City.

Table 8.1.13 Proposed Sewer Works in Ghazipur City

(1) Sewer Pipe

Material	Class of Pipe	Dia. (mm)	Length Open (Rm)				Length Micro Tunneling (Rm)
			Zone-I	Zone-II	Zone-III	Total	
1) Gravity							
RCC	NP3	150	5,502	5,681	24,559	35,742	
RCC	NP3	200	5,107	3,504	13,621	22,232	
RCC	NP3	250	1,170	751	3,653	5,574	
RCC	NP3	300	176	1,032	2,456	3,664	
RCC	NP3	350	74	249	2,927	3,250	
RCC	NP3	400	492	379	733	1,604	
RCC	NP3	450	0	0	1,169	1,169	
RCC	NP3	500	261	538	1,943	2,742	
RCC	NP3	600	521	487	133	1,141	
RCC	NP3	700			525	525	
RCC	NP3	800			0	0	
RCC	NP3	900			2,415	2,415	
RCC	NP3	1000			264	264	
RCC	NP3	1100			188	188	
RCC	NP3	1200			0	0	
Sub-total			**13,303**	**12,621**	**54,586**	**80,510**	**0**
2) Rising Main							
DI	K-7	200				250	
DI	K-9	350				1,440	
DI	K-9	700				25	
Sub-total						1,715	
Total						**82,225**	

(2) Manhole

Total Nos.	1,721

(3) House Connection

Nos.
3,900

Source: DPR Ghazipur Comprehensive compiled by JICA Survey Team

2) ID&T Case

UPJN says that DPR with ID&T method would be prepared separately from comprehensive as urgent work required by NMCG. However, there are many rivers which flows much groundwater and it makes difficult to intercept only wastewater. UPJN has not started the preparation of DPR ID&T as of end of February 2016.

Source: JICA Survey Team based on DPR Ghazipur Comprehensive

Figure 8.1.14 Proposed Sewerage System in Ghazipur City (Comprehensive)

8.1.8 Proposed Sewer Works in Saidpur City

1) Comprehensive Case

The DPR for Saidpur City in Ghazipur District was prepared with comprehensive method. However, DPR with ID&T method is under preparation by UPJN in accordance with the requirement by UPJN.

The following table shows the bill of quantity of sewer works in the said DPR comprehensive for Saidpur City:

Table 8.1.14 Proposed Sewer Works in Saidpur City

(1) Sewer Pipe

Material	Dia. (mm)	Open (Rm)	Micro Tunneling (Rm)
1) Gravity			
RCC	150	18,885	
RCC	200	18,854	
RCC	250	1,340	
RCC	300	1,270	
RCC	350	50	
RCC	400	1,545	
RCC	450	494	
RCC	500	0	
RCC	600	200	
Sub-total		**42,638**	**0**
2) Rising Main			
DI	N/A	N/A	
DI (Class K-9)	350	30	
Total		**42,668**	

(2) Manhole

Dia. (mm)	Nos.
Sewer connecting chamber	1,091
Ventilating columns	10
Others	349
Total	**1,450**

(3) House Connection

Nos.
N/A

Source: DPR Saidpur Comprehensive compiled by JICA Survey Team

2) ID&T Case

DPR ID&T is under preparation by UPJN as of February 2016. In the course of the preparation UPJN refers to the old DPR ID&T for Saidpur which was prepared in 1997. **Table 8.1.15** shows the bill of quantity of sewer works in the old DPR ID&T for Saidpur City for reference. Obviously the diameter of the interceptor and the number of interception structure (target nalas) will be increased. However, observed from 1) locations of all the nalas in the city, 2) narrow and carving road for candidate interceptor route, 3) no enough space for constructing interception structure, and 4) congested houses between the road and River Ganga which causes difficulty to intercept all the wastewater near the road, it can be said that ID&T method in this city is quite difficult and JICA survey team recommended the comprehensive method in this city. However, since this city is small with the population of less than 100,000 this city will be developed with ID&T method in accordance with NMCG's requirement.

Figure 8.1.15 shows the tentative sewerage map for ID&T which was prepared based on route survey and interview to UPJN.

Table 8.1.15 Sewer Works in Old DPR ID&T Saidpur City (Reference)

(1) Sewer Pipe

Material	Dia. (mm)	Open (Rm)	Micro Tunneling (Rm)
1) Gravity			
RCC	200	560	
RCC	250	180	
RCC	300	190	
RCC	350	160	
RCC	400	145	
Sub-total		**1,235**	**0**
2) Rising Main			
CI	200	500	
Total		**1,735**	

(2) Manhole

Dia. (mm)	Nos.
1.0x1.5x3.0m	29
Total	**29**

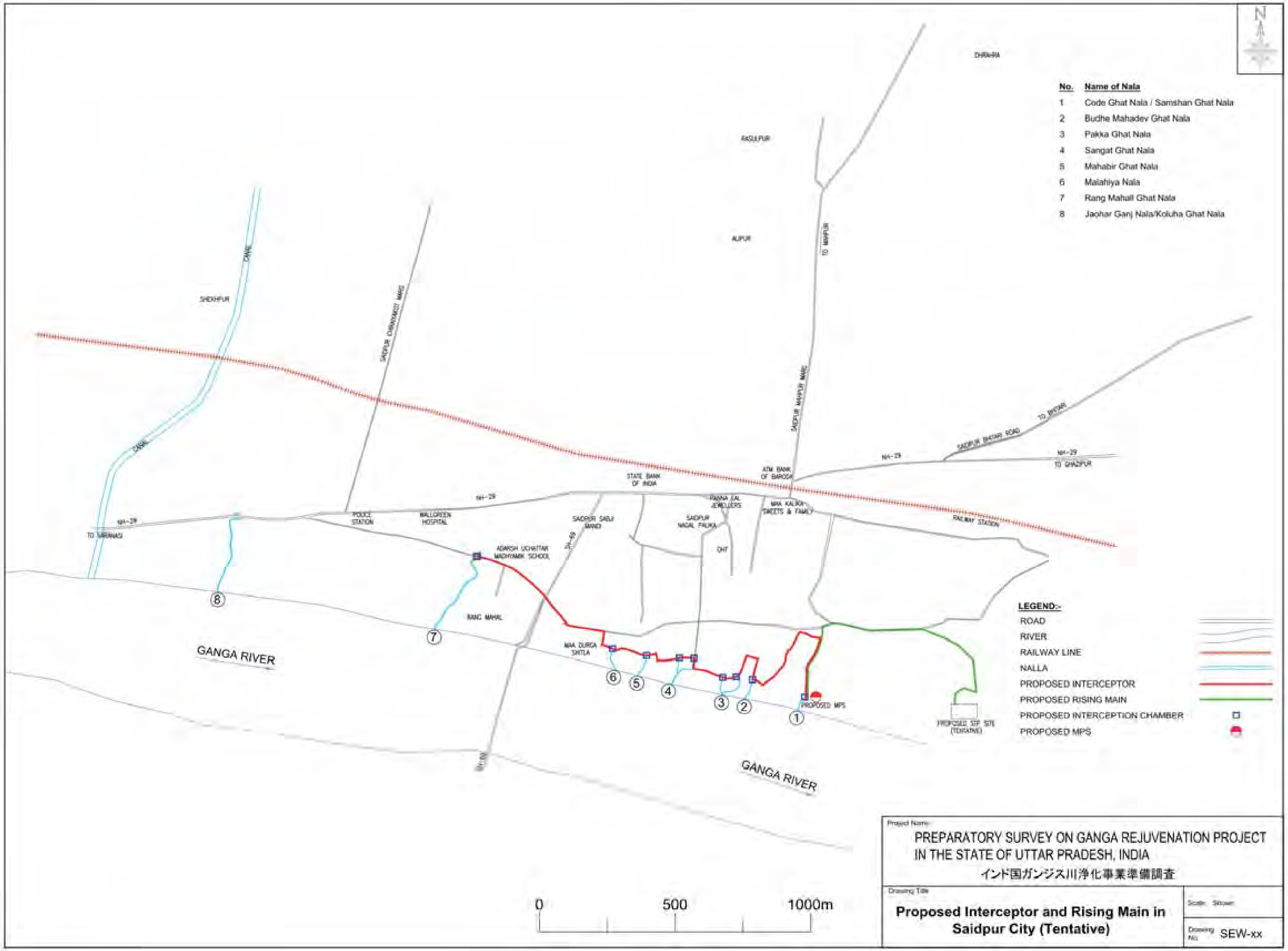
(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Saidpur ID&T compiled by JICA Survey Team



Source: JICA Survey Team based on Interview to UPJN

Figure 8.1.15 Proposed Interceptor in Saidpur City (ID&T): Tentative

8.1.9 Abstract of Proposed Sewer Works in Target Cities

Table 8.1.16 shows the list of proposed sewer works in target cities.

Table 8.1.16 Abstract of Proposed Sewer Works in Target Cities in Existing DPRs

No.	Item	Material	Dia. (mm)																								
			District	Varanasi										Mirzapur								Ghazipur					
			City/Town	Varanasi						Ramnagar				Mirzapur				Chunar				Ghazipur		Saidpur			
			Sewerage District	District-I		District-II		District-III		-		-		-		-		-		-		-		-		-	
			Comprehensive/I&D	Comprehensive		Comprehensive		Comprehensive		Comprehensive		I&D		Comprehensive		I&D		Comprehensive		I&D		Comprehensive		Comprehensive		I&D (old)	
	Item	Material	Dia. (mm)	Open (m)	Trenchless (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																										
	1) Gravity	RCC	150																			35,742	0	18,885	0		
		HDPE	160							24,148	0																
		RCC	200	193,294	840	236,690	332	109,441	0	21,586	0	0	0	217,181	110	750	0	49,017	70	0	0	22,232	0	18,854	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	3,751	0	0	0	3,814	0	400	0	2,033	27	700	0	5,574	0	1,340	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	1,335	0	0	0	9,141	25	800	0	3,399	15	0	0	3,664	0	1,270	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	298	0	80	0	1,716	0	0	0	1,069	470	250	0	3,250	0	50	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	713	0	150	0	4,219	30	555	0	1,252	0	0	0	1,604	0	1,545	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	551	0	0	0	1,275	25	550	0	126	50	0	0	1,169	0	494	0		
		RCC	500	2,081	99	2,875	540	288	39	276	0	120	0	1,908	0	1,659	0	1,377	0	0	0	2,742	0	0	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	0	0	586	20	2,211	0	615	0	1,550	0	1,141	0	200	0		
		RCC	700	84	30	1,924	90	2,603	165	782	0	0	0	1,899	0	0	0	1,916	0	1,808	0	525	0				
		RCC	800	317	90	570	439	867	0	2,200	0	0	0	1,199	0	210	0					0	0				
		RCC	900	0	0	1,244	918	0	0			30	0	970	20	1,700	0					2,415	0				
		RCC	1000											1,537	20	0	0					264	0				
		RCC	1200											0	30	0	0					188	0				
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	55,637	0	380	0	245,445	280	8,835	0	60,804	632	4,308	0	80,510	0	42,638	0	1,235	0
			Total	219,648		276,007		120,342		55,637		380		245,725		8,835		61,436		4,308		80,510		42,638		1,235	
	2) Rising Main	DI	100							3,700																	
		DI	150							0				334		0		1,670		0							
		DI	200					30		0				730		370		900		2,130		250					
		CI	200																							500	
		DI	250							0				334		0		0		0							
		DI	300							0				66		3,550		0		0							
		DI	350							150				1,700		0		1,250		30		1,440		30			
		DI	400							50		2,700															
		DI	600													80											
		DI	700											1,370		1,370						25					
		DI	800											30													
			Total	0	-	0	-	30	-	3,900	-	2,700	-	4,563	-	5,370	-	3,820	-	2,160	-	1,715		30	-	500	-
	3) Treated Effluent Reuse Line																										
		RCC	350	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-		
		RCC	800	-	-	-	-	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-	-	-		
	Total of pipe laying work			219,648		276,007		120,372		59,537		3,080		250,288		21,205		65,256		10,163		82,225		42,668		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159		1,284				10,210		279		2,582		86							
			1200	27		145		149		421				162		65		73		63							
			1500							913																	
			1200x900							144																	
			1000x1500																							29	
			1500x1500							34		10															
			Total	10,925	-	13,128	-	5,308	-	2,796	-	10	-	10,372	-	344	-	2,655	-	149	-	1,721	-	1,450	-	29	
3	Desilting of Existing Sewer Pipe			-	483	-	710	-	22,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Interception Structure		Zone											Mirzapur	Vindhyachal	Mirzapur	Vindhyachal										
	1) New		nos.	-	-	-	-	-	-	-	-	4	-	-	-	13	4	-	-	16	-	-	-	-	-	4	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	-	-	4	-	-	-	18	8	-	-	16	-	-	-	-	-	4	-
4	House Connection																										
	1) New		nos.	9,804	-	34,216	-	18,261	-	5,525	-	-	-	28,629	-	-	-	2,285	-	-	-	3,900	-	N/A	-	-	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Septic tank soak pit		nos.	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	4	-	-	-	-	-	-	-
6	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) Rehabilitation		nos.	-	-	-	-	-	-	-	-	-	-	2	2	2	2	-	-	-	-	-	-	-	-		
	2) New		nos.	-	-	-	-	1	-	2	1	0	1	4	1	3	1	4	1	1	1	3	1	1	1	0	1
	Total		nos.	0		0		1		3		1		9		8		5		2		4		2		1	

Source: JICA Survey Team compiled from DPRs for target cities

8.2 Intermediate Pump Stations (IPSs)

8.2.1 Proposed Pumping Stations in Varanasi City District-I

No IPS and MPS works were confirmed in proposed DPR.

8.2.2 Proposed Pumping Stations in Varanasi City District-II

No IPS and MPS works were confirmed in proposed DPR.

8.2.3 Proposed Pumping Stations in Varanasi City District-III

One lift pumping station to transfer the wastewater from the secondary sewer and flow into Assi Interceptor was confirmed. The general specification is shown in the table below. The plan and section confirmed in DPR is shown in Appendix 8.2.1.

Table 8.2.1 General Specification of Proposed IPS in Varanasi District-III

<table>
<tr><th rowspan="4">No.</th><th colspan="14">LPS (New)</th></tr>
<tr><th rowspan="3">Location</th><th colspan="2">Flow</th><th colspan="8">Pumps</th><th colspan="3">Rising Main</th></tr>
<tr><th colspan="2">(MLD)</th><th rowspan="2">Total</th><th rowspan="2">Duty</th><th rowspan="2">Standby</th><th>Capacity</th><th colspan="2">Total Capacity (Duty)</th><th>Head</th><th rowspan="2">HP</th><th rowspan="2">Material</th><th>Dia.</th><th>Length</th></tr>
<tr><th>2035</th><th>2050</th><th>(m3/hr)</th><th>(m3/hr)</th><th>(MLD)</th><th>(m)</th><th>(mm)</th><th>(m)</th></tr>
<tr><td>1</td><td>near Sarai Nandan (MH No. 1295)</td><td>3.92</td><td>6.45</td><td>6</td><td>4</td><td>2</td><td>100</td><td>400</td><td>9.6</td><td>15</td><td>10</td><td>DI</td><td>200</td><td>30</td></tr>
</table>

Source: JICA Survey Team confirmed from DPR Varanasi District III

8.2.4 Proposed Pumping Stations in Ramnagar City

1) Comprehensive Case

Two IPSs and a MPS were proposed in DPR Ramnagar Comprehensive as specified in following table.

Table 8.2.2 General Specification of Proposed Pumping Stations in Ramnagar City (Comp.)

No.	PS	Location	PS Capacity (MLD)	Required Area (m2)	Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
							Nos.	Duty	Standby						
1	IPS	Padao	1	625	Peak	Submersible	3	2	1	0.75	65	30	DI-K9	100	3,700
					Non-peak	Submersible	2	1	1	0.25	65	15			
2	IPS	Sangat Maidan	9.2	625	Peak	Submersible	3	2	1	5.3	20	60	DI-K9	350	150
					Non-peak	Submersible	2	1	1	3.2	20	35			
3	MPS	Kodopur	14	10000	Peak	Submersible	3	2	1	5.3	15	65	DI-K9	400	50
					Non-peak	Submersible	2	1	1	3.2	15	40			

Source: JICA Survey Team confirmed from DPR Ramnagar Comprehensive

2) ID&T Case

Only a MPS is proposed in DPR Ramnagar ID&T as specified in the table below. The proposed layout is shown in Appendix 8.2.2.

Table 8.2.3 General Specification of Proposed Pumping Stations in Ramnagar City (ID&T)

No.	PS	Location	PS Capacity (MLD)		Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
			Average	Peak			Nos.	Duty	Standby						
1	MPS	Ram Bagh Nala, Mallahi	**13**	29.25	Peak	Submersible non clog	3	2	1	7.84	55	180	DI-K9	400	2,700
					Non-peak	Submersible non clog	2	1	1	3.94	55	100			

Source: JICA Survey Team confirmed from DPR Ramnagar ID&T

8.2.5 Proposed Pumping Stations in Mirzapur City

1) Comprehensive Case

a) IPS

Two existing IPS will be rehabilitated and four new IPS will be constructed as shown in following tables.

Table 8.2.4 General Specification of Rehabilitated IPS in Mirzapur City (Comprehensive)

No.	Rehabilitation of Existing PS												
	Name	Location	Pump							Rising Main			
			Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
				Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur													
1	IPS-1	Imambara	450	3	2	1	17	900	21.6	Existing	DI	350	1700
			220	2	1	1	10	220	5.28	**Proposed**	**DI-K9**	**350**	**1700**
Vindhyachal													
2	IPS-3	Ram Janki Mandir	35	3	2	1	8	70	1.68	Existing	DI	80	250
			15	2	1	1	8	15	0.36	**Proposed**	**DI-K9**	**150**	**333.7**

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

Table 8.2.5 General Specification of New IPS in Mirzapur City (Comprehensive)

No.	Proposed									
	Name	Location	Pump					Rising Main		
			Capacity (cum/hr)	Nos.	Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
						(cum/hr)	(MLD)			
Mirzapur										
1	IPS-6	Sadar Post Office	125	3	13	375	9	DI-K9	200	39
			50	2	13	100	2.4			
2	IPS-7	district jail Mirzapur	280	3	13	840	20.16	DI-K9	300	36
			150	2	13	300	7.2			
3	IPS-8	lalah ghat	160	3	21	480	11.52	DI-K9	200	356
			65	2	17	130	3.12			
Vindhyachal										
4	IPS-5	Patengra Nala	145	3	14	435	10.44	DI-K9	200	335
			60	2	11	120	2.88			

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-9 in Mirzapur Zone.

Table 8.2.6 General Specification of Rehabilitated MPS in Mirzapur City (Comprehensive)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump							Rising Main			
			Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
				Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur													
1	MPS-2	Kutchary	850	3	2	1	10	1700	40.8	Existing	DI	700	1370
			445	2	1	1	9	445	10.68	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal													
2	MPS-4	near Vidyachal STP	150	6	4	2	7	600	14.4	Existing	DI	300	100
										Proposed	**DI-K9**	**300**	**30**

Table 8.2.7 General Specification of New MPS in Mirzapur City (Comprehensive)

No.	Proposed									
			Pump					Rising Main		
	Name	Location	Capacity (cum/hr)	Nos.	Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
						(cum/hr)	(MLD)			
Mirzapur										
1	MPS-9	near Existing STP	830	6	14	4980	119.52	DI-K9	800	30

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

2) ID&T Case

a) IPS

Two existing IPS will be rehabilitated and three new IPS will be constructed as shown in following tables. The proposed plans and sections for the new IPSs in DPR are shown in Appendix 8.2.3 to 8.2.5.

Table 8.2.8 General Specification of Rehabilitated IPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS														
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**
Vindhyachal														
2	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**

Table 8.2.9 General Specification of New IPS in Mirzapur City (ID&T)

No.	Proposed											
	Name	Location	Pump							Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur												
1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal													
3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	50	2	1	1	12	50	1.2			

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed as listed in tables below. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-8 in Mirzapur Zone. The plans and sections for proposed MPS-8 is shown in Appendix 8.2.6.

Table 8.2.10 General Specification of Rehabilitated MPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity (Duty)		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	MPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal														
2	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100
											Proposed	**DI-K9**	**300**	**30**

Table 8.2.11 General Specification of New MPS in Mirzapur City (ID&T)

No.	Proposed											
	Name	Location	Pump							Rising Main		
			Flow	Capacity (m3/hr)	Pump Nos.			Head (m)	Total Capacity	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	600	30

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

8.2.6 Proposed Pumping Stations in Chunar City

1) Comprehensive Case

Four IPSs and a MPS are proposed in DPR Chunar Comprehensive as specified in following table.

Table 8.2.12 General Specification of Proposed Pumping Stations in Chunar City (Comp.)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Bhart Gas Godown	Peak	Submersible	3	2	1	105	23	DI-K9	200	900
			Non-peak	Submersible	2	1	1	45	19			
2	IPS-II	Tambal Ganj	Peak	Submersible	3	2	1	60	21	DI-K9	150	1,200
			Non-peak	Submersible	2	1	1	25	14			
3	IPS-III	Nagarpur	Peak	Submersible	3	2	1	300	21	DI-K9	350	1,220
			Non-peak	Submersible	2	1	1	160	19			
4	IPS-IV	Pirallipura Tiraha	Peak	Submersible	3	2	1	30	18	DI-K9	150	470
			Non-peak	Submersible	2	1	1	10	17			
5	MPS	Settlement Area	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar Comprehensive

2) ID&T Case

One IPSs and a MPS are proposed in DPR Chunar ID&T as specified in following table. The layout of proposed IPS-I and MPS are shown in Appendixes 8.2.7 and 8.2.8.

Table 8.2.13 General Specification of Proposed Pumping Stations in Chunar City (ID&T)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Tambal Ganj	Peak	Submersible	3	2	1	105	23	DI-K9	200	2,130
			Non-peak	Submersible	2	1	1	45	19			
					5	3	2					
2	MPS	Near STP	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar ID&T

8.2.7 Proposed Pumping Stations in Ghazipur City

a) IPS

Three IPSs were proposed in DPR Ghazipur Comprehensive as specified in following table. The plans and sections for the proposed IPSs are shown in Appendix 8.2.9 to 8.2.11. As can be confirmed from the 3 drawings, contents for 3 IPSs including even levels in texts are completely same.

Table 8.2.14 General Specification of Proposed IPSs in Ghazipur City (Comp.)

No.	Name	Location	Capacity (mld)	Pumps						Rising Main		
				Nos.	Capacity		Total Capacity	Head (m)	HP	Material	Dia. (mm)	Length (m)
					(lps)	(m3/min)	(mld)					
1	IPS-I	Steamer Ghat	14.374	5	50	3.00	21.60	20	25.0	DI (K-9)	350	450
2	IPS-II	Dadri Ghat	13.334	5	50	3.00	21.60	20	25.0	DI (K-9)	350	990
3	IPS-III	Foxganj	3.171	5	15	0.90	6.48	20	7.5	DI (K-7)	200	250

Source: JICA Survey Team confirmed from DPR Ghazipur Comprehensive

b) MPS

One MPS was proposed in DPR Ghazipur Comprehensive as specified in following table. The plans and sections for the proposed MPS is shown in Appendix 8.2.12.

Table 8.2.15 General Specification of Proposed MPS in Ghazipur City (Comp.)

No.	Name	Location	Capacity (mld)	Pumps						Rising Main		
				Nos.	Capacity		Total Capacity	Head (m)	HP	Material	Dia. (mm)	Length (m)
					(lps)	(m3/min)	(mld)					
1	MPS	near proposed STP	49.815	5	200	12.00	86.40	22	100	DI (K-9)	700	25

Source: JICA Survey Team confirmed from DPR Ghazipur Comprehensive

8.2.8 Proposed Pumping Stations in Saidpur City

1) Comprehensive Case

Only a MPS could be confirmed from the limited photos of pages in the DPR comprehensive as specified in the following table.

Table 8.2.16 General Specification of Proposed Pumping Station in Saidpur City (Comp.)

No.	Name	Location	Area (m2)	Pump						Rising Main		
				Flow	Capacity			Nos.	Head (m)	Material	Dia.(mm)	Length (m)
					(kL/hr)	(LPS)	(m3/min)					
1	MPS	near proposed STP	50.24	Peak	577.13	165	9.6	6	15		350	30
				Average	256.5	75	4.3					
				Non-peak	153.9	45	2.6					

2) ID&T Case - OLD

Only a MPS was proposed in old DPR ID&T as specified in the following table.

Table 8.2.17 General Specification of Proposed Pumping Station in Saidpur City (ID&T-old)

No.	Name	Location	Pump							Rising Main		
			Flow	Nos.	Capacity (lpm)	Total Capacity (lpm)	Discharge (m3/sec)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	MPS	nearby the Pucca Ghat	Peak	2	1350	3375	0.0563	27	13.5	CI	200	500
				1	675			27	7.5			
			Average	1	1350	1350	0.0225	27	13.5			
			Non-peak	1	675	675	0.0113	27	7.5			

Source: JICA Survey Team confirmed from old DPR Saidpur ID&T

8.3 Sewage Treatment Plants (STPs)

8.3.1 Dinapur and Bhagwanpur STPs

Dinapur STP

Existing STPs were designed to achieve BOD:TSS less than 30:50 mg/L respectively. In order to achieve the new treated effluent standards of BOD<10 mg/L TSS<10 mg/l and Total Nitrogen<10 mg/L, it is recommended to demolish the existing 80 MLD Dinapur STP and construct the new STP with the same capacity by single stage circulated nitrification-denitrification (CND) process in the revised DPR on August 20, 2016.

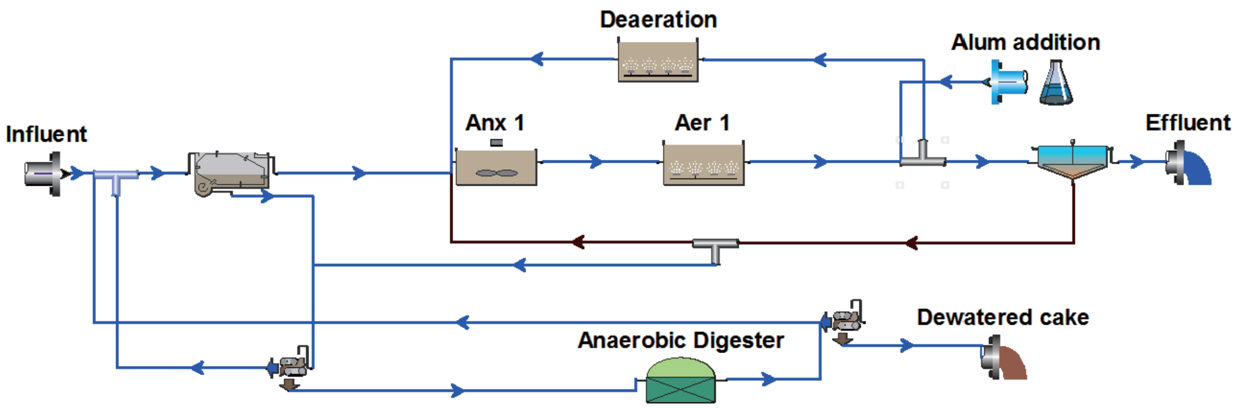


Figure 8.3.1 Flowchart of CND Process for Dinapur STP

Table 8.3.1 Outline of Major Facilities at 8 MLD Bhagwanpur STP

Sr. No.	Process Unit	Flow	Dimensions, in m				
			No	L	W/ Dia	SWD	Total
1	Inlet Chamber	160	1	1.21	7.3	4.2	4.7
2	Screen channel for fine screens	80	3	6	2.00	1.1	1.90
3	Screen channel for Manual screen	80	1	6	1.30	1.10	1.90
4	Grit Distribution Channel	160	1	12	1.23	1.00	1.50
5	Grit Chamber Vortex Type	80	3		6	5	5.5
6	Grit effluent channel including Parshall Flume	160	1	12	1.23	1	1.5
7	Primary Clarifiers		2		34	3.5	4
8	Primary Sludge Pump House		1	6.5	5		
9	Bio-Reactors		2	100	35	7.5	8
10	Blower room for Bio- reactors		1	15	10		5
11	Secondary Clarifiers		2		50	3.5	4
12	Return Sludge Pump House		1	10.5	10		
13	Tertiary System						
14	Sludge Thickener		2		20	4.5	
15	Thickened Sludge Pump House		1				
16	Anaerobic Digesters		2		26	11.2	
17	Thickened Sludge Pump House		1	13	15		5
18	Gas Holders		2		17	4	
19	Centrifuge Building		1	20	12		5

Bhagwanpur STP

Existing STPs were designed to achieve BOD:TSS less than 30:50 mg/L respectively. In order to achieve the new treated effluent standards of BOD<10 mg/L TSS<10 mg/l and Total Nitrogen<10 mg/L, it is recommended to demolish the existing 8 MLD Bhagwanpur STP and construct the new STP with the same capacity by Sequential Batch Reactor (SBR) process in the revised DPR on August 20, 2016.

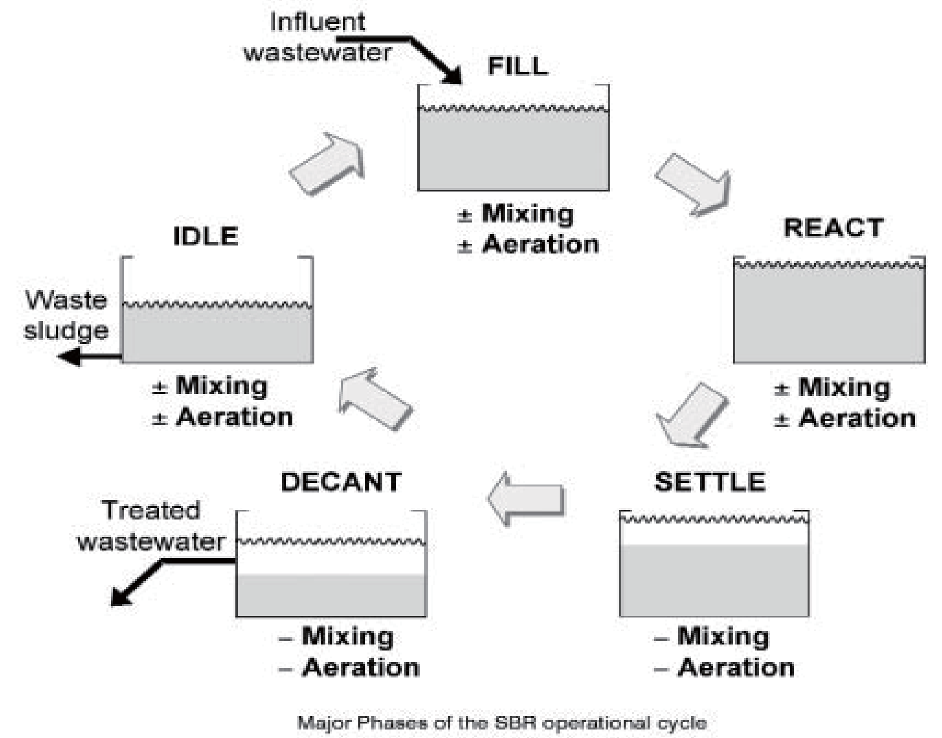


Figure 8.3.2 SBR Process for Bhagwanpur STP

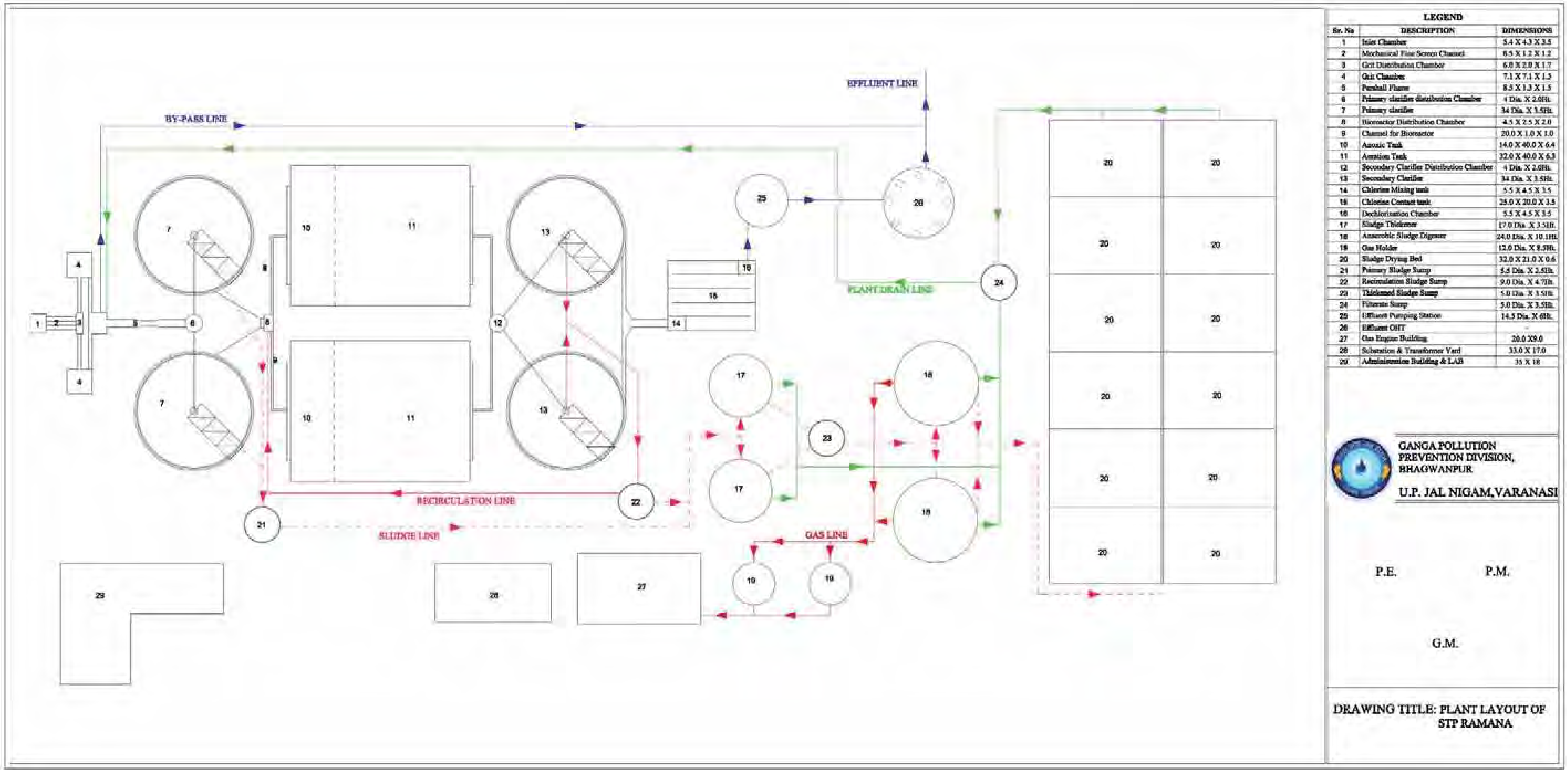
Table 8.3.2 Outline of Major Facilities at 8 MLD Bhagwanpur STP

Sr. No.	Process Unit	Flow	Dimensions, in m				
			No	L	W/ Dia	SWD	Total depth
1	Inlet Chamber	8 MLD	1	2	2	3	
2	Mechanical Fine Bar Screen	8 MLD	2	6	1	0.8	
3	Manual Fine Bar Screen	8 MLD	1	6	1	0.8	
4	Grit Chamber	0.21 m3/s	2		5		
5	Distribution Box	18 MLD	1	3	1.5	2	
6	SBR Basin Feed Channel	0.21m3/s	1	3	2	2	
7	SBR Reactor	8 MLD	1	34	17	5	
8	Chlorine Cintactor	8 MLD	1	6	1	0.8	
9	Sludge Sump	175 m3/d	1		4	2.5	
10	Slufge Thickener	175 m3/d	1		6	3	
11	Centrifuge	30.29 m3/d	2				

8.3.2 Ramna STP

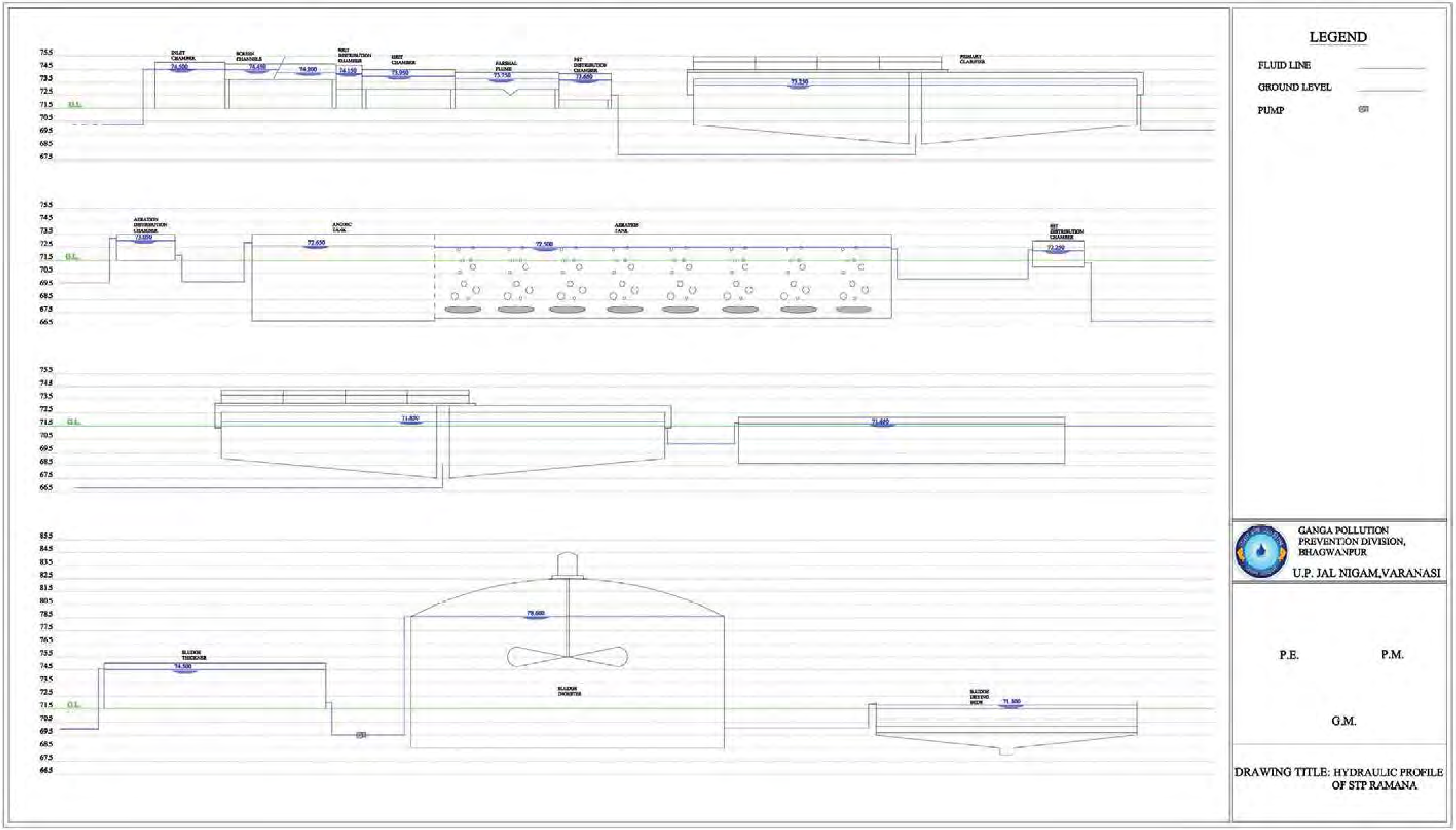
The following is the overview of the DPR.

- New construction of 50MLD STP.
- Water treatment process is based on circulated nitrification / denitrification process (CND) which is modified process of activated sludge process (ASP).
- After CND, new Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener, digester and sludge drying bed.



Source: Ramna STP DPR

Figure 8.3.3 Layout of Proposed Ramna STP



Source: Ramna STP DPR

Figure 8.3.4 Flowsheet of Proposed Ramna STP

8.3.3 Mirzapur STP

The following is an overview of the DPR.

1) Comprehensive Case

- As planned sewage flow is 32MLD, new construction of 18MLD STP based on SBR is required.
- Existing 14MLD STP based on UASB is not concerned.
- Vortex type Grit Chamber will be installed in terms of grit removal.
- MBBR will be installed in terms of BOD removal.
- Dissolved air floatation will be installed in terms of TSS removal.
- New Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- Mechanical dewatering will be installed to produce stabilized sludge.
- Existing oxidation pond will be demolished and this area will be used for some of new construction.
- No attached calculation sheets correspond to 32MLD STP.

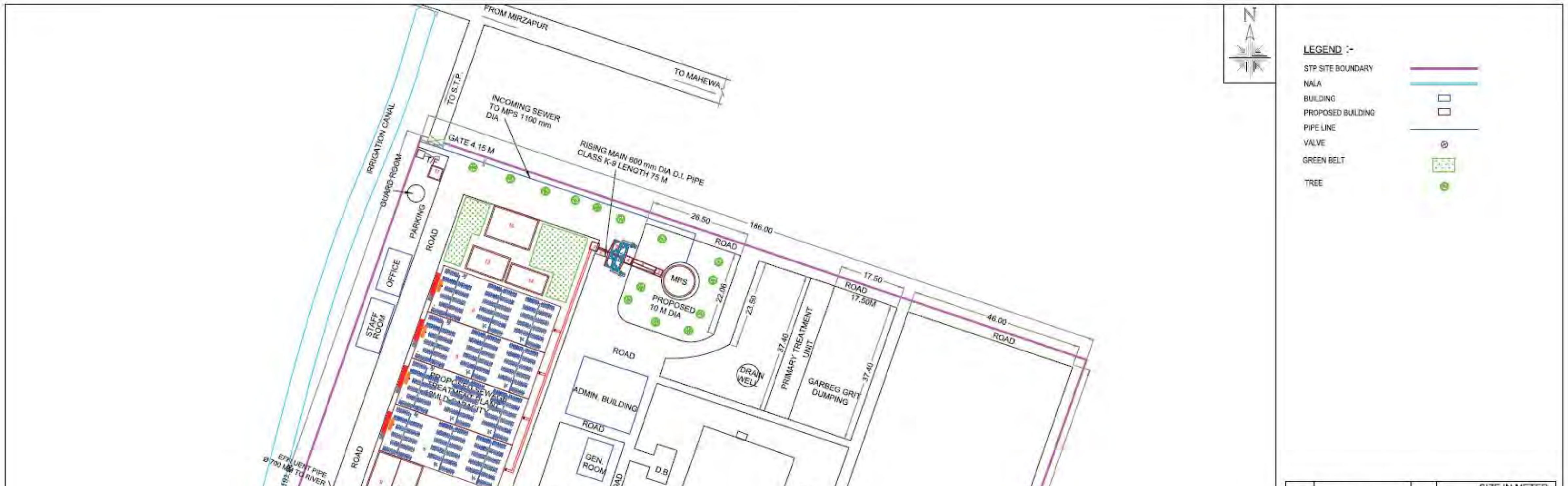
2) ID&T Case

- Two “Alternative plan” are proposed.
- “Alternative 1” is to rehabilitate the existing structures, replace E&M equipment and providing disinfection facility.
- “Alternative 2” is to rehabilitate the existing STP and upgrade the existing STP as per NRGBA/ NMCG directions. That is to say, new 14MLD SBR will be installed at oxidation pond area.
- Attached drawings are correspond to Comp. and “Alternative 2”.
- Attached brief calculation sheets are correspond to 14MLD STP based on “Alternative 2”.
- Both “Alternative plan” isn't mentioned the reason why new 18MLD STP is not necessary in case of ID&T. That is to say, this STP based on “Alternative plan” is not equipped same treatment capacity as comprehensive plan.

Table 8.3.3 Proposed works /Modification of Mirzapur STP by DPR

	Units	Design flow	Existing Spec					Proposed works /Modification			
			Nos.	Process Unit (m)				Civil	Mechanical	Electrical	Instrumentation
				Length	Width	Dia.	SWD				
1	Head Works- Inlet Chamber	-	1	5.5	4.0	-	4.0	Local repairs, painting	Motorised CI Sluice gates for each screen channel (3 Nos)	-	-
2	Head Works-Fine Screens	-	1	5.0	2.0	-	2.0	Local repairs, painting	One numbers of Mechanical Fine screens (6 mm spacing) alongwith conveyor to be provided 1 One numbers of Manual Fine screens to be provided	All I cabling and starters/ panel for the proposed screens mechanism to be provided	Level switches and overload protection switches to be provided
3	Head Works-Grit Removal Mechanism	-	1	9.0	2.0	-	2.0	Present grit removal facility at STP to be demolished and replaced with new grit chambers of Vortex type.	2 Nos Vortex Type Grit removal mechanism (each for 50% of peak flow) including grit classifier/washer, air lift pumps etc to be installed	All I cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
4	Outlet Chamber	-	1	4.0	2.0	-	4.0	-	-	-	-
5	Diversion Box	-	4	1.0	1.6	-	4.0	Local repairs, painting	Motorised CI Sluice gates for each channel (4 Nos)	-	-
6	Distribution Box	-	4	2.5	2.5	-	4.0	Local repairs, painting	-	-	-
7	UASB Reactor	Average Flow :14MLD	2	28.0	17.0	-	5.0	Local repairs, painting	Sluice valves (20 Nos) to be replaced	-	-
8	SBR (Alternative 2 only)	Average Flow :14MLD	(new)2	15.0	30.0	-	5.5	New SBR structure to be constructed	All mechanical items related to SBR to be installed which includes decanters, valves etc	All I cabling and starters/ panel for the proposed SBR mechanism to be provided	Level switches and overload protection switches to be provided
9	Blower Room for SBR (Alternative 2 only)	-	(new)1	10.0	6.0	-	-	New blower room to accommodate blowers to be constructed	6 nos Blowers (4W+2S)with 1500Nm3/hr capacity to be installed. Acoustic enclosures to be provided	All I cabling and starters/ panel for blower room to be provided	-
10	Polishing pond (Alternative 2 only)	-	1	178.0	70.0	-	2.0	To be filled up partially for construction of new structures	-	-	-
11	CCT Feed Sump	Peak Flow :31.5MLD	(new)					New CCT feed sump structure to be constructed	All mechanical items related to CCT feed pump to be installed	All I cabling and starters/ panel for CCT feed sump to be provided	Level switches and overload protection switches to be provided
12	Chlorine contact Tank	Peak Flow :31.5MLD	(new)					New CCT structure to be constructed	All mechanical items related to CCT to be installed.	All I cabling and starters/ panel for the proposed CCT to be provided	Level switches and overload protection switches to be provided
13	Treated Effluent Channel	-	1	240.0	1.5	-	1.0	-	-	-	-
14	Sludge Sump	-	1	-	-	4.0	4.0	-	Replacement of pumps	All I cabling and panel for the proposed primary sludge pumps to be replaced.	1 No Level switch with cables
15	Generator Room	-	1	5.0	5.0	-	4.0	-	-	-	-
16	Gas Holder	-	1	6.0	4.7	-	5.0	Local repairs, painting	Safety equipment to be installed	-	1 No Gas flow meter
17	Sludge Drying Beds	-	12	20.0	20.0	-	1.5	Civil Rehab work for SBD area for 25% of sludge volume	Installation of piping and valves.	<- Note: Same as Dinapur, maybe miswritten.	
18	Mechanical Sludge Dewatering (Centrifuge sump and Building) (Alternative 2 only)	-	(new)					New building to accommodate centrifuges and polydosing system to be constructed	2 nos (1W+1S) centrifuges to be installed 2 nos. (1W+1S) centrifuge feed pumps to be installed	Panel, Cable	-
19	Gas Burner	-	1	3.0	3.0		-	-	-	-	Required automation for flair
20	Miscellaneous	-						Repairs, painting and roads	2 No Air Conditioners for laboratory 1 No Air Conditioner for Control Room 1 No Microscope, 1 No water cooler	-	Lightening Arrester for gas digester and gas holder

Source: JICA Survey Team



S.NO	UNITS	Nos	SIZE IN METER				
			L	W	DIA	SWD	FB
1	Wet Well	1	2.0	2.0		2.0	0.5
2	Inlet Chamber	1	2.0	2.0		2.0	0.5
3	Screen Chamber	1	6.0	2.0		1.2	0.5
4	Distribution Chamber	1	1.5	1.5		1.5	0.5
5	Grit Chamber	2			3.5	3.6	0.5
6	Parshall Flume	1	1.5	0.4			0.5
7	Distribution Chamber for SBR	1	2.0	2.0		1.5	0.5
8	SBR	4	32.9	13.5		5.5	0.5
9	CCT	2	15.0	6.0		3.0	0.5
10	Sludge Thickner	1			10.0	3.5	0.5
11	Sludge Sump cum Pump House	1			4.0	1.5	0.5
12	BFP /Chemical Building	1	12.0	8.0			
13	Blower Room	1	10.0	6.0			
14	Electrical Room	1	10.0	5.0			
15	Administration /Lab Building	1	12.0	8.0			
16	Clorination Building	1	8.0	6.0			
17	Guard Room	1	3.0	3.0			

NOTES :-
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. THE TBM IS SITUATED AT TOP OF PILLAR STP MIRZAPUR AND RL=83.600m
3. THE CONTOUR INTERVAL IS 0.2m
4. STP AREA = 37443.60sqm = 3.74ha

DETAILED PROJECT REPORT FOR
MIRZAPUR SEWERAGE SCHEME (U.P.)

PROJECT MANAGER
GANGA POLLUTION PREVENTION UNIT
U.P. JAL NIGAM, VARANASI

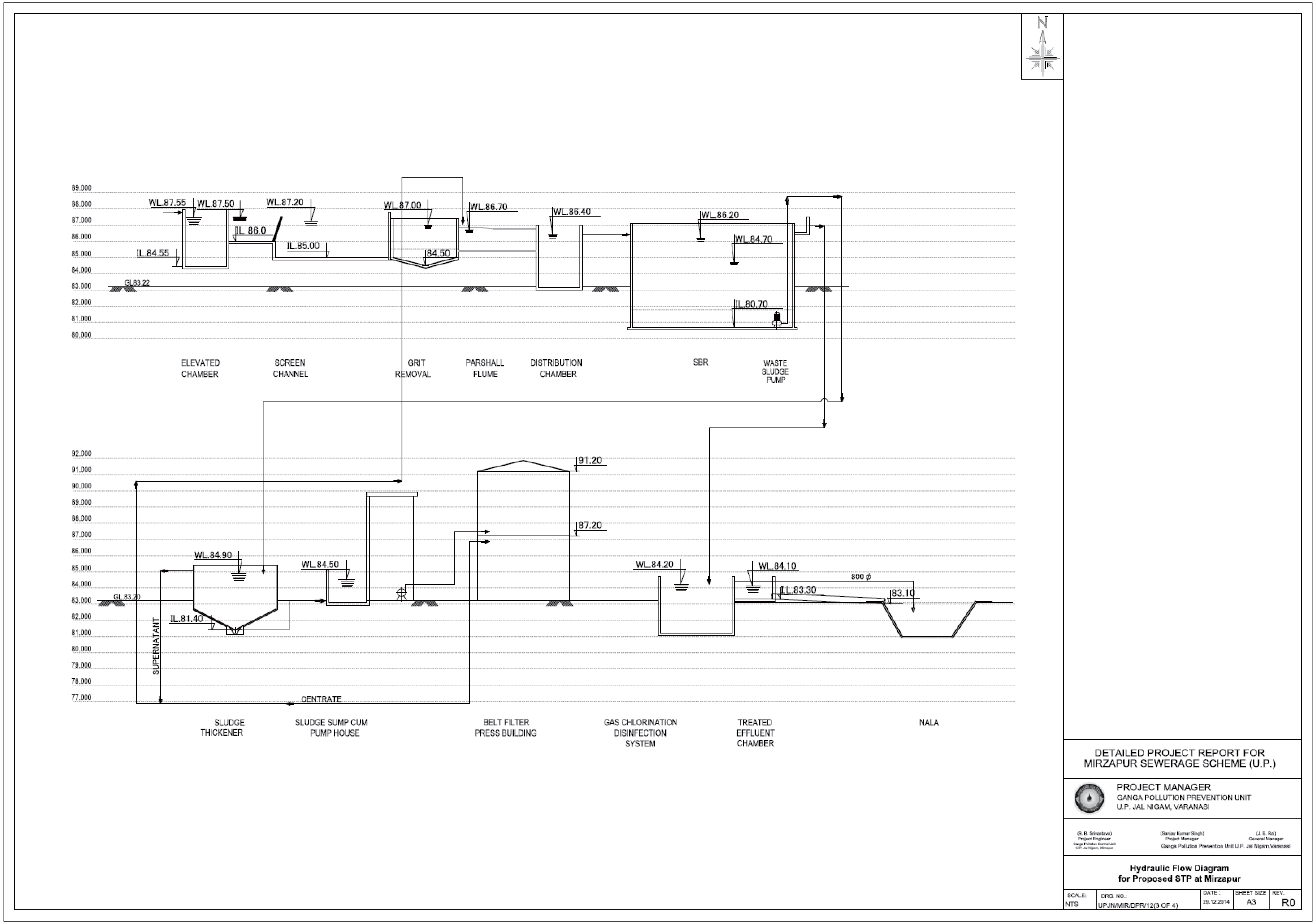
(S. B. Srivastava) Project Engineer
(Sanjay Kumar Singh) Project Manager
(J. B. Rai) General Manager
Ganga Pollution Prevention Unit U.P. Jal Nigam, Varanasi

LAYOUT SHOWING PROPOSED 18 MLD STP AT MIRZAPUR

SCALE:	DRG. NO.:	DATE :	SHEET SIZE	REV.
NTS	UPJN/MIR/DPR/12(1 OF 4)	29.12.2014	A3	R0

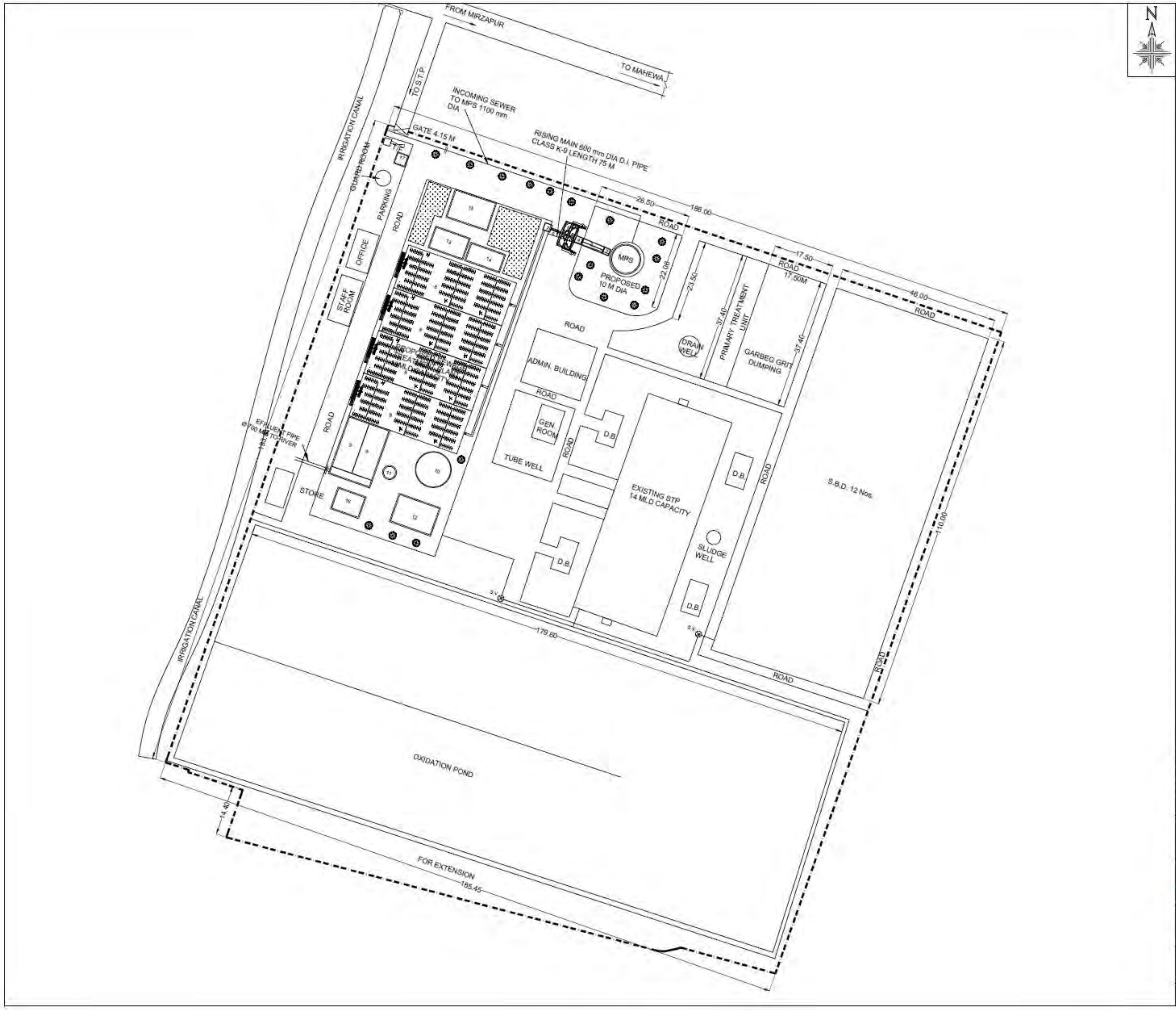
Source: Mirzapur DPR (Comprehensive)

Figure 8.3.5 Layout of Proposed Mirzapur STP (Comprehensive)



Source: Mirzapur DPR (Comprehensive)

Figure 8.3.6 Flowsheet of Proposed Mirzapur STP (Comprehensive)



S.NO	UNITS	Nos.	SIZE IN METER				
			L	W	DIA	SWD	FB
1	Wet Well	1	2.0	2.0		2.0	0.5
2	Inlet Chamber	1	2.0	2.0		2.0	0.5
3	Screen Chamber	1	6.0	2.0		1.2	0.5
4	Distribution Chamber	1	1.5	1.5		1.5	0.5
5	Grit Chamber	2			3.5	3.6	0.5
6	Parshall Flume	1	1.5	0.4			0.5
7	Distribution Chamber for SBR	1	2.0	2.0		1.5	0.5
8	SBR	4	32.9	13.5		5.5	0.5
9	CCT	2	15.0	6.0		3.0	0.5
10	Sludge Thickner	1			10.0	3.5	0.5
11	Sludge Sump cum Pump House	1			4.0	1.5	0.5
12	BFP /Chemical Building	1	12.0	8.0			
13	Blower Room	1	10.0	6.0			
14	Electrical Room	1	10.0	5.0			
15	Administration /Lab Building	1	12.0	8.0			
16	Clorination Building	1	8.0	6.0			
17	Guard Room	1	3.0	3.0			

NOTES :-
1. ALL DIMENSIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. THE TBM IS SITUATED AT TOP OF PILLAR STP MIRZAPUR AND RL=83.600m
3. THE CONTOUR INTERVAL IS 0.2m
4. STP AREA = 37443.60sqm = 3.74ha

DETAILED PROJECT REPORT FOR INTERCEPTION, DIVERSION & TREATMENT WORKS MIRZAPUR, U.P.(PACKAGE-1)

PROJECT MANAGER
GANGA POLLUTION PREVENTION UNIT
U.P. JAL NIGAM, VARANASI

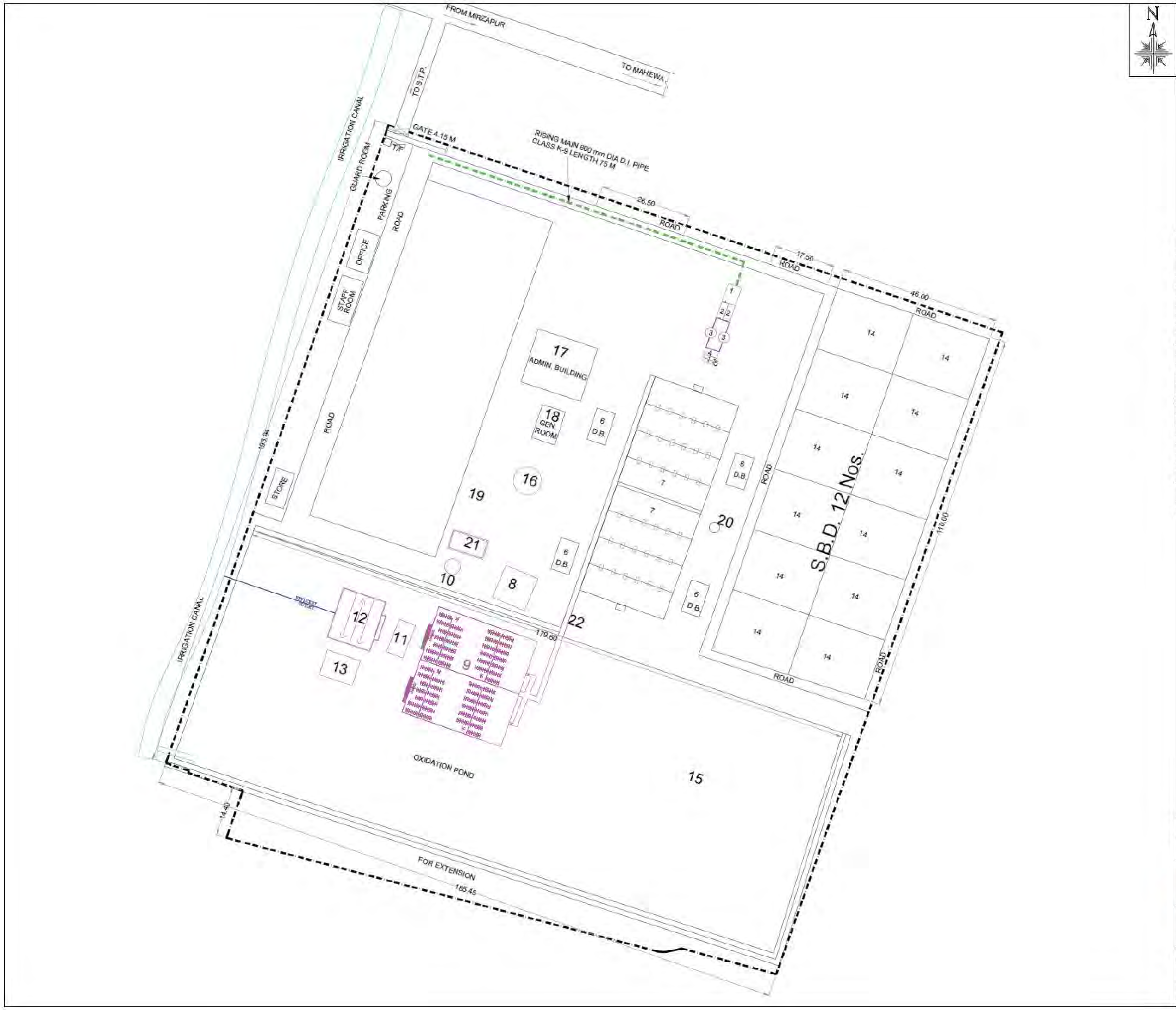
Ganga Pollution Prevention Unit U.P. Jal Nigam,Varanasi

LAYOUT SHOWING PROPOSED 18 MLD STP AT MIRZAPUR

SCALE:	DRG. NO.:	DATE :	SHEET SIZE	REV.
NTS	UPJN/MIR/DPR/IND/P-1/11(1 OF 4)	10.07.2015	A3	R0

Source: Mirzapur DPR (ID&T)

Figure 8.3.7 Layout of Proposed Mirzapur STP (1/2, ID&T)



Sr. No.	Unit	No.	Process Unit, All dimensions are in meter			
			Length	Width	Dia	SWD
1	Inlet Chamber	1	5.5	4		4
2	Screen Channel	1	5	2		2
3	Grit Chamber	1			3	2
4	Outlet Chamber	1	4	2		4
5	Division Box	4	1	1.6		4
6	Distribution Box	4	2.5	2.5		4
7	UASB Reactor	2	28	17		5.5
8	Blower Room	1	10	15		0
9	SBR	1	30	30		5.5
10	Gravity Thickener	1			4.5	3.5
11	CCT Feed sump	1	5	5		3.5
12	Chlorine Contact Tank	1	35	9		3
13	Chlorination Building	1	10	7.5		5
14	Sludge Drying Beds	4	20	20		1.5
15	Pond	1	178	70		2
16	Gas Holder	1	6	4.7		5
17	Admin Building	1	10	15.0		5
18	Generator Room	1	5	5		4
19	Gas Burner	1				0
20	Sludge Sump	1			4	4
21	Mechanical Dewatering Room	1	12	12		5
22	Effluent Channel	1	240	1.5		1

DETAILED PROJECT REPORT (DPR)
FOR REHABILITAION & PROCESS UPGRADATION
OF EXISTING STPs IN MIRZAPUR(PACKAGE-2)

PROJECT MANAGER
GANGA POLLUTION PREVENTION UNIT
U.P. JAL NIGAM, VARANASI

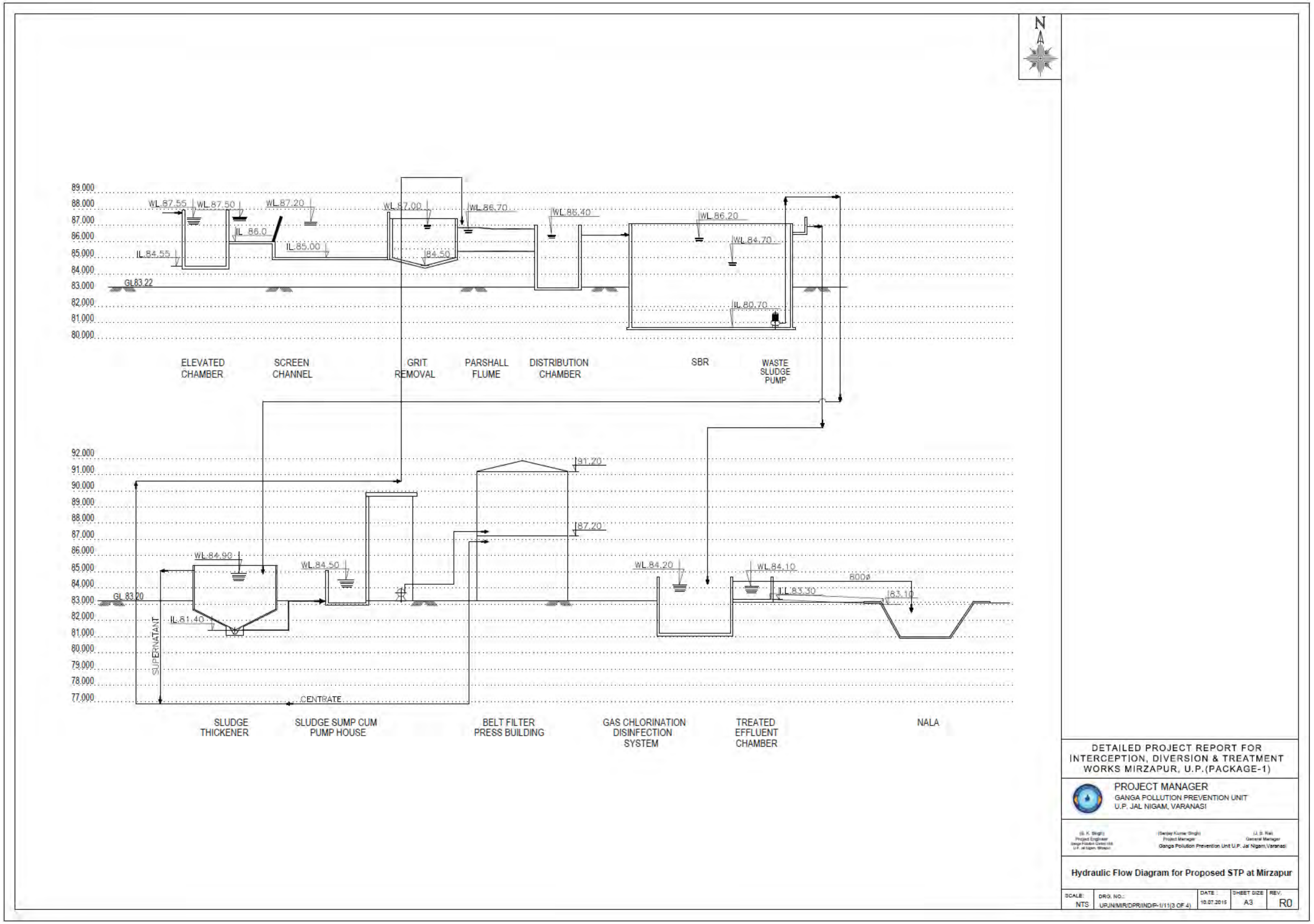
Ganga Pollution Prevention Unit U.P. Jal Nigam Varanasi

Layout Showing Proposed Modifications in Existing 14 MLD STP at Mirzapur

SCALE:	DRG. NO.:	DATE :	SHEET SIZE	REV.
NTS	UPJN/MIR/DPR/IND/P-2/06	24.06.2015	A3	R0

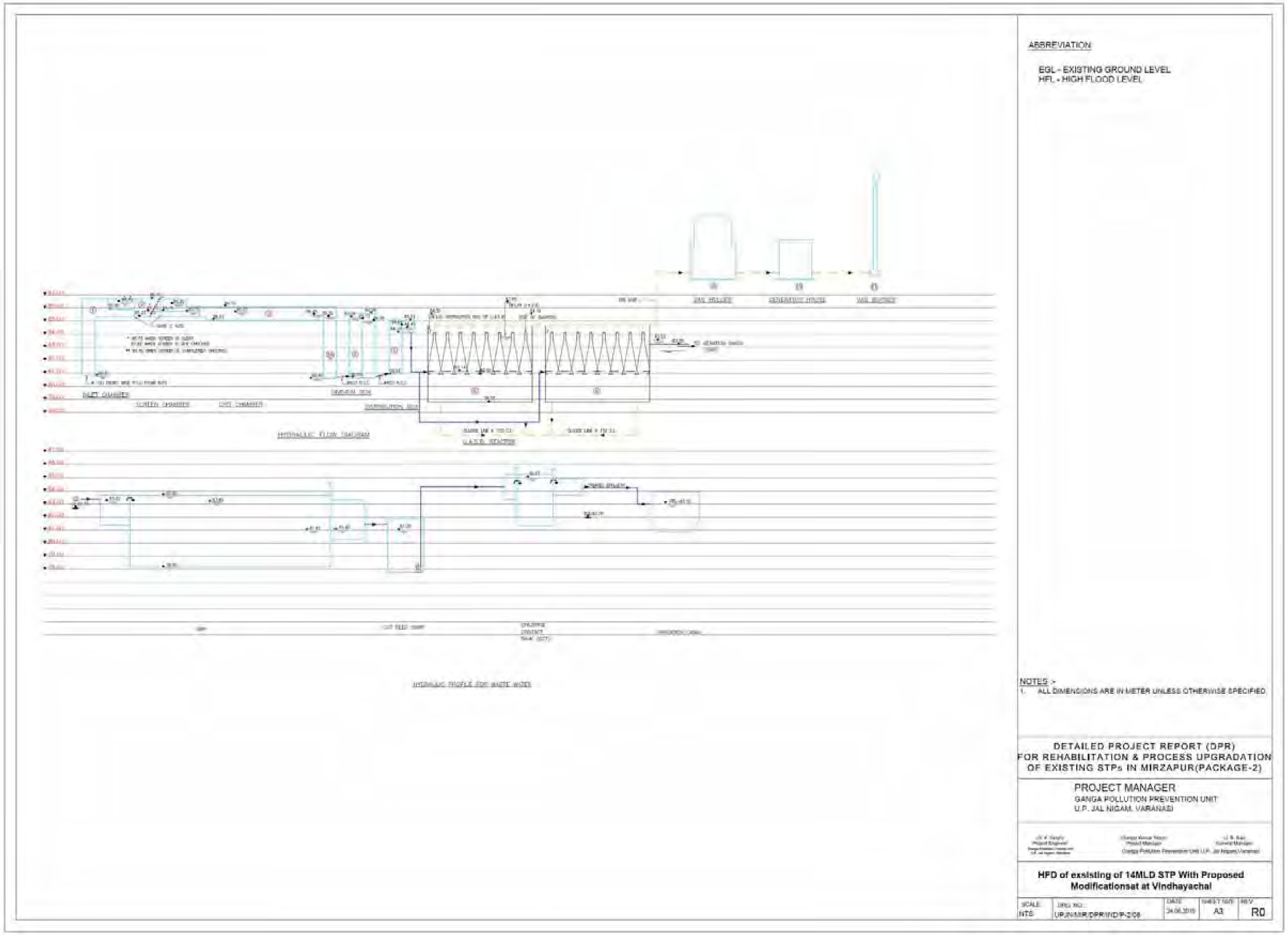
Source: Mirzapur DPR (ID&T)

Figure 8.3.8 Layout of Proposed Mirzapur STP (2/2, ID&T)



Source: Mirzapur DPR (ID&T)

Figure 8.3.9 Flowsheet of Proposed Mirzapur STP (1/2, ID&T)



Source: Mirzapur DPR (ID&T)

Note: "Vindhyachal" of title box is miswritten.

Figure 8.3.10 Flowsheet of Proposed Mirzapur STP (2/2, ID&T)

8.3.4 Vindhyachal STP

The following is the overview of the DPR.

1) Comprehensive Case

- Rehabilitation of 4MLD existing STP.
- As planned sewage flow is 6MLD, augmentation of 2MLD STP is required.
- For this purpose, new construction of SBR and installation of surface aerator are planned.
- New Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- No drawings attached.

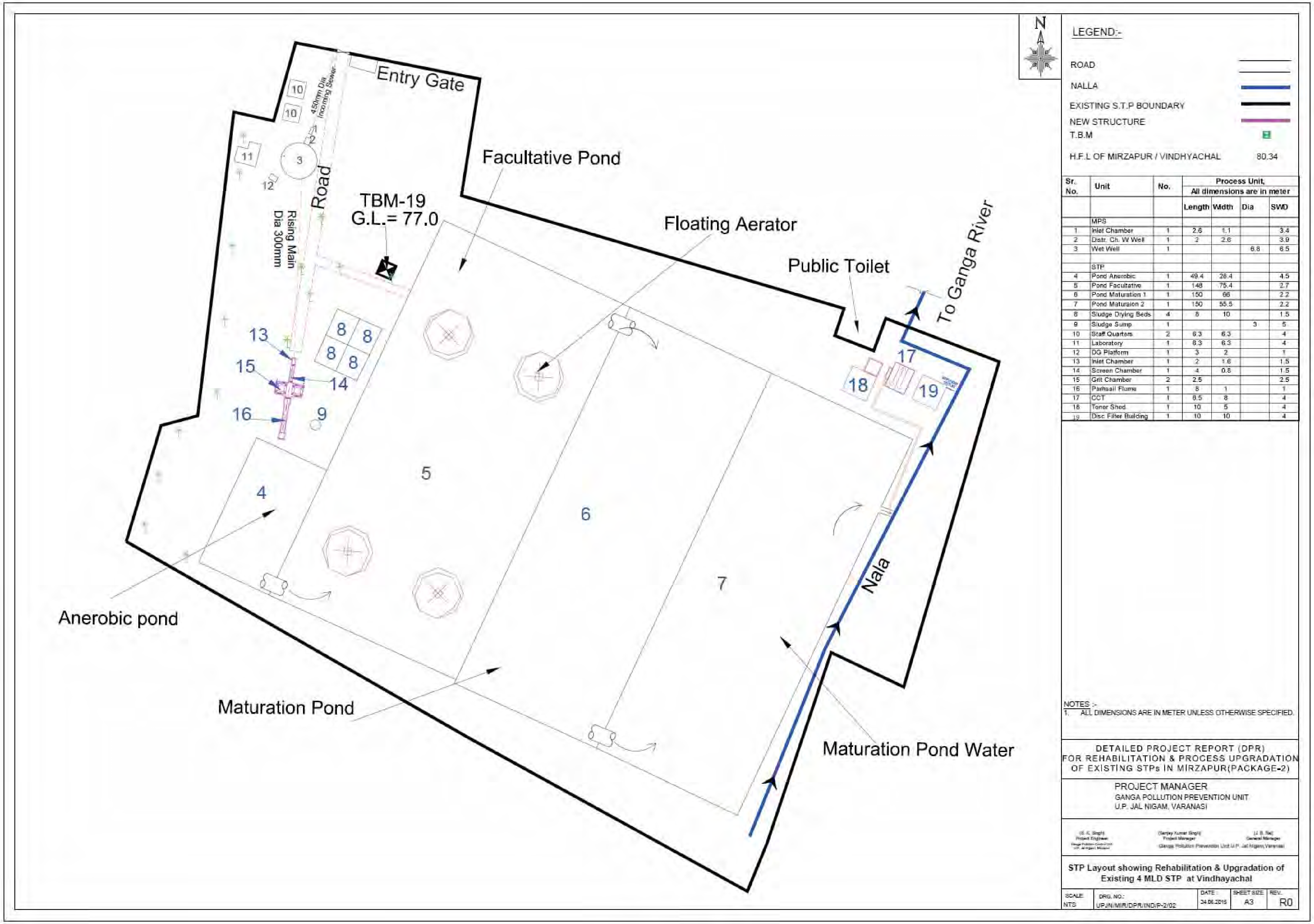
2) ID&T Case

- Main policy is same as Comp. plan.

Table 8.3.4 Proposed works /Modification of Vindhyachal STP by DPR

No.	Units	Design flow	Spec after rehabilitated					Proposed works /Modification			
			Nos.	Process Unit (m)				Civil	Mechanical	Electrical	Instrumentation
				Length	Width	Dia.	SWD				
1	Inlet Chamber	Peak Flow :10MLD	(new for improvement)1	2.0	1.6	-	1.5	**Existing to be demolished and replaced by new**	-	-	-
2	Fine Screens	Peak Flow :10MLD	(new for improvement)1	4.0	0.8	-	1.5	**Existing to be demolished and replaced by new**	2 Nos Mechanical Fine screen to be installed	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
3	Grit Chamber	Peak Flow :10MLD	(new for improvement)2	2.5	-	-	2.5	At present there is no grit removal facility at STP. **New grit chambers** of Vortex type to be constructed.	2 Nos Vortex Type Grit removal mechanism (each for 50% of peak flow) including grit classifier/washer, air lift pumps etc to be installed	All cabling and starters/ panel for the proposed grit removal mechanism to be provided	Level switches and overload protection switches to be provided
4	Parhsall Flume	Peak Flow :10MLD	(new for improvement)1	8.0	1.0	-	1.0	**Existing to be demolished and replaced by new**	-	-	Flow measurement devices to be installed
5	Distribution Box		(new for improvement)1	-	-	-	-	**Existing to be demolished and replaced by new**	-	-	-
6	Anaerobic Pond	Average Flow :4MLD	1	49.4	28.4	-	4.5	Local repairs	-	-	-
7	Facultative pond	Average Flow :4MLD	(remodeling for improvement)1	148.0	75.4	-	2.7	Local repairs	**Surface Aerator To be installed**	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	-
8	Maturation Pond1		1	150.0	66.0	-	2.2	Local repairs	-	-	-
9	Maturation Pond2		1	150.0	55.5	-	2.2	Local repairs	-	-	-
10	Chlorine Contact Tank	Peak Flow :10MLD	(new for improvement)1	6.5	8.0	-	4.0	**New Structure**	Chlorination unit to be installed	All l cabling and starters/ panel for the proposed grit removal mechanism to be provided	-
11	Chlorination Building	-	(new for improvement)1	10.0	5.0	-	4.0	**Toner shed to be installed**	-	-	-
12	Sludge Sump	-	1	-	-	3.0	5.0	Local repairs,Painting	-	-	-
13	Sludge Drying Beds	-	4	8.0	10.0	-	1.5	-	-	-	-
14	Disc Filtration system	Peak Flow :10MLD	(new for improvement)1	10.0	10.0	-	4.0	-	**New Disc filtration system to be installed**	-	-
15	Miscellaneous	Staff Quarters	2	6.3	6.3	-	4.0	Repairs, painting and roads	1 No Air Conditioners for laboratory	-	-
		Laboratory	1	6.3	6.3	-	4.0				
		DG Platform	1	3.0	2.0	-	1.0				

Source: JICA Survey Team



Sr. No.	Unit	No.	Process Unit, All dimensions are in meter			
			Length	Width	Dia	SWD
	MPS					
1	Inlet Chamber	1	2.6	1.1		3.4
2	Distr. Ch. W Well	1	2	2.6		3.9
3	Wet Well	1			6.8	6.5
	STP					
4	Pond Anerobic	1	49.4	26.4		4.5
5	Pond Facultative	1	148	75.4		2.7
6	Pond Maturation 1	1	150	66		2.2
7	Pond Maturaion 2	1	150	55.5		2.2
8	Sludge Drying Beds	4	8	10		1.5
9	Sludge Sump	1			3	5
10	Staff Quarters	2	6.3	6.3		4
11	Laboratory	1	6.3	6.3		4
12	DG Platform	1	3	2		1
13	Inlet Chamber	1	2	1.6		1.5
14	Screen Chamber	1	4	0.8		1.5
15	Grit Chamber	2	2.5			2.5
16	Parhsall Flume	1	8	1		1
17	CCT	1	6.5	8		4
18	Toner Shed	1	10	5		4
19	Disc Filter Building	1	10	10		4

Source: Mirzapur DPR (ID&T)

Figure 8.3.11 Layout of Proposed Vindhyachal STP (ID&T)

Source: Mirzapur DPR (ID&T)

Figure 8.3.12 Flowsheet of Proposed Vindhyachal STP (ID&T)

8.3.5 Ghazipur STP

The following is the overview of the DPR.

1) Comprehensive Case

- New construction of 18MLD STP based on cyclic activated sludge process (C-TECH) is required. This process is a type of SBR.
- Chlorine disinfection will be installed in terms of Faecal Coliform reduction.
- Centrifuge dewatering will be installed to produce stabilized sludge.

2) ID&T Case

・DPR is not yet available.

PROCESS UNIT

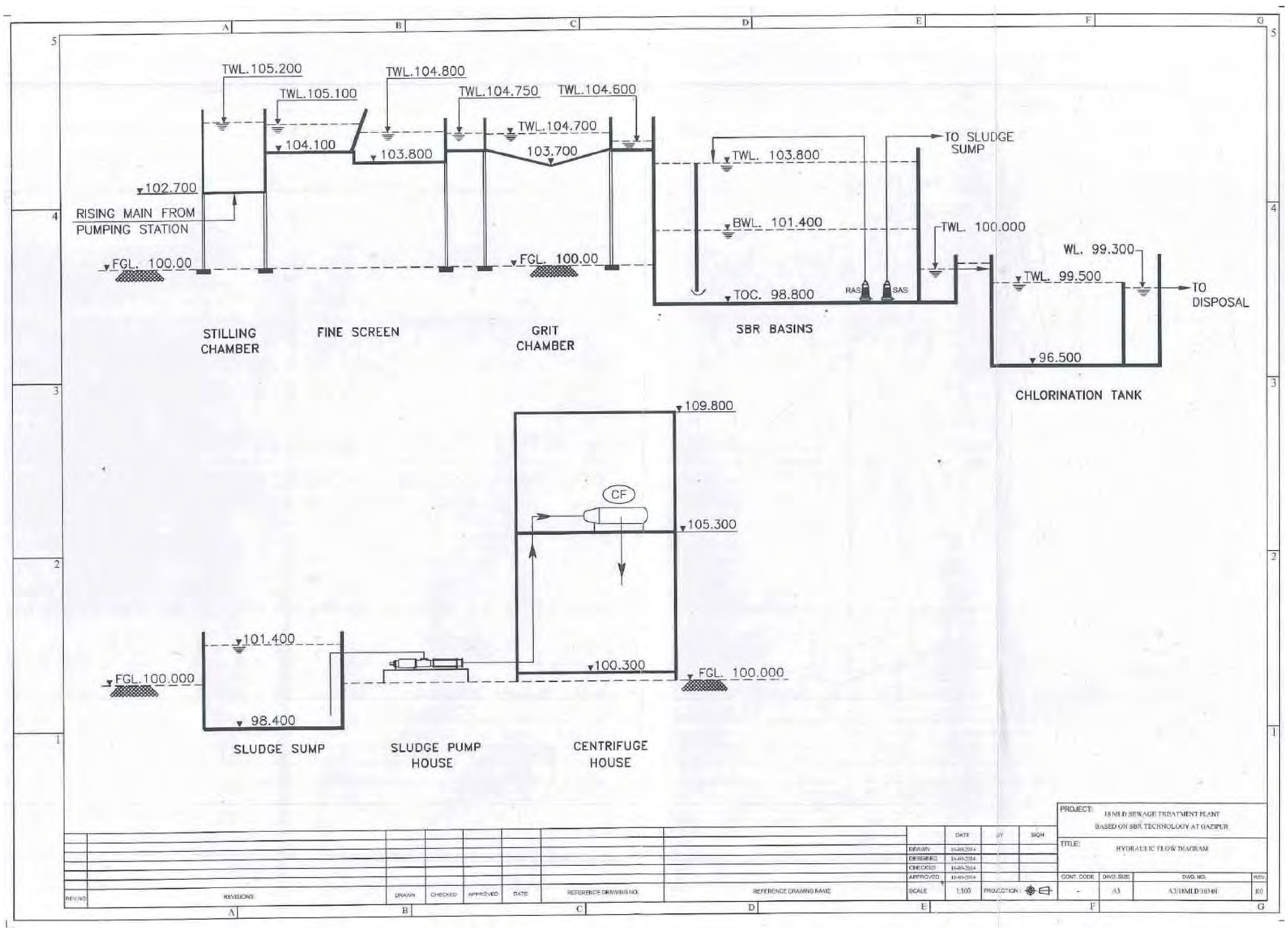
SL.NO.	DESCRIPTION	SIZE/CAPACITY	QTY.	MOC.
01	STILLING CHAMBER	2500 x 2500 x 2500 SWD.	01	RCC
02	FINE SCREEN CHANNEL– MANUAL	7000 x 1000 x 1000 SWD.	01	RCC
03	FINE SCREEN CHANNEL– MECHANICAL	7000 x 1000 x 1000 SWD.	01	RCC
04	GRIT CHAMBER	6500 x 6500 x 1000 SWD.	01	RCC
05	SBR BASINS – 1/2	46000 x 23000 x 5000 SWD.	02	RCC
06	CHLORINATION TANK	23000 x 11000 x 3000 SWD.	01	RCC
07	SLUDGE SUMP	7500 x 4000 x 3000 SWD.	01	RCC
08	DWPE DOSING TANK	1500 x 1500 x 1200 SWD.	02	RCC

BUILDINGS

SL.NO.	DESCRIPTION	SIZE/CAPACITY	QTY.	MOC.
09	HT SUBSTATION	15000 x 10000 x 4500 HT.	01	
10	DG SET HOUSE	10000 x 5000 x 4500 HT.	01	
11	SBR AIR BLOWER/MCC CONTROL BUILDING	15000 x 10000 x 10000 HT	01	G+1
12	CHLORINATION CUM CHLORINE TOONER HOUSE	11000 x 5000 x 4500 HT.	01	
13	CENTRIFUGE FEED PUMP HOUSE	7500 x 5000 x 4500 HT.	01	
14	CENTRIFUGE HOUSE	7500 x 6000 x 9500 HT.	01	G(STILT)+1

Source: Ghazipur DPR (Comprehensive)

Figure 8.3.13 Layout of Proposed Ghazipur STP (Comprehensive)



Source: Ghazipur DPR (Comprehensive)

Figure 8.3.14 Flowsheet of Proposed Ghazipur STP (Comprehensive)

8.3.6 Ramnagar STP

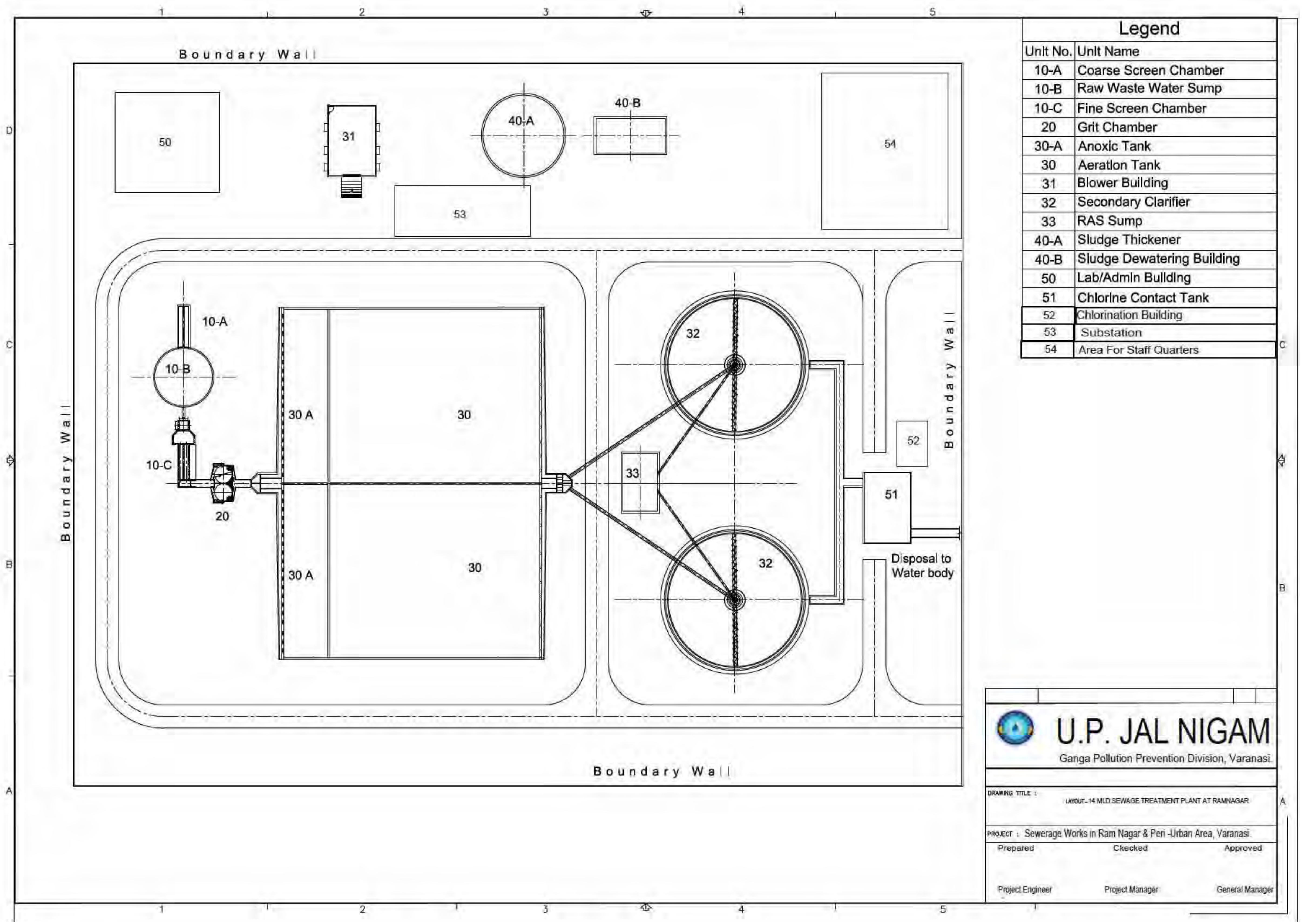
The following is an overview of the DPR.

1) Comprehensive Case

- New construction of 13MLD STP.
- Water treatment process is based on "the extended aeration with an anoxic tank (modified Ludzack Ettinger)" which is same as CND adopted at DPR of Ramna STP.
- After water treatment process, Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener and mechanical dewatering.

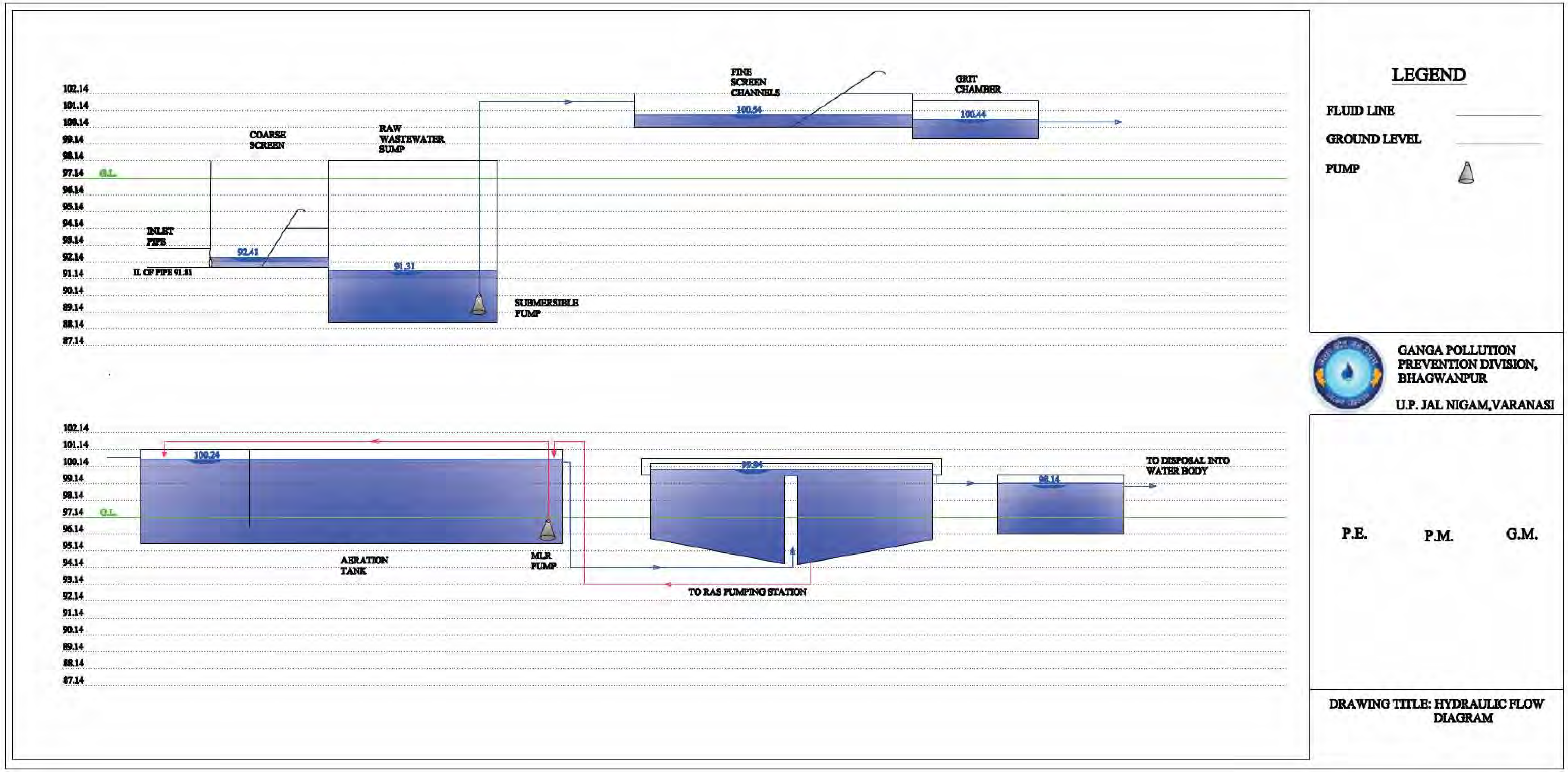
2) ID&T Case

- Plan of STP is same with the comprehensive case in the DPR.



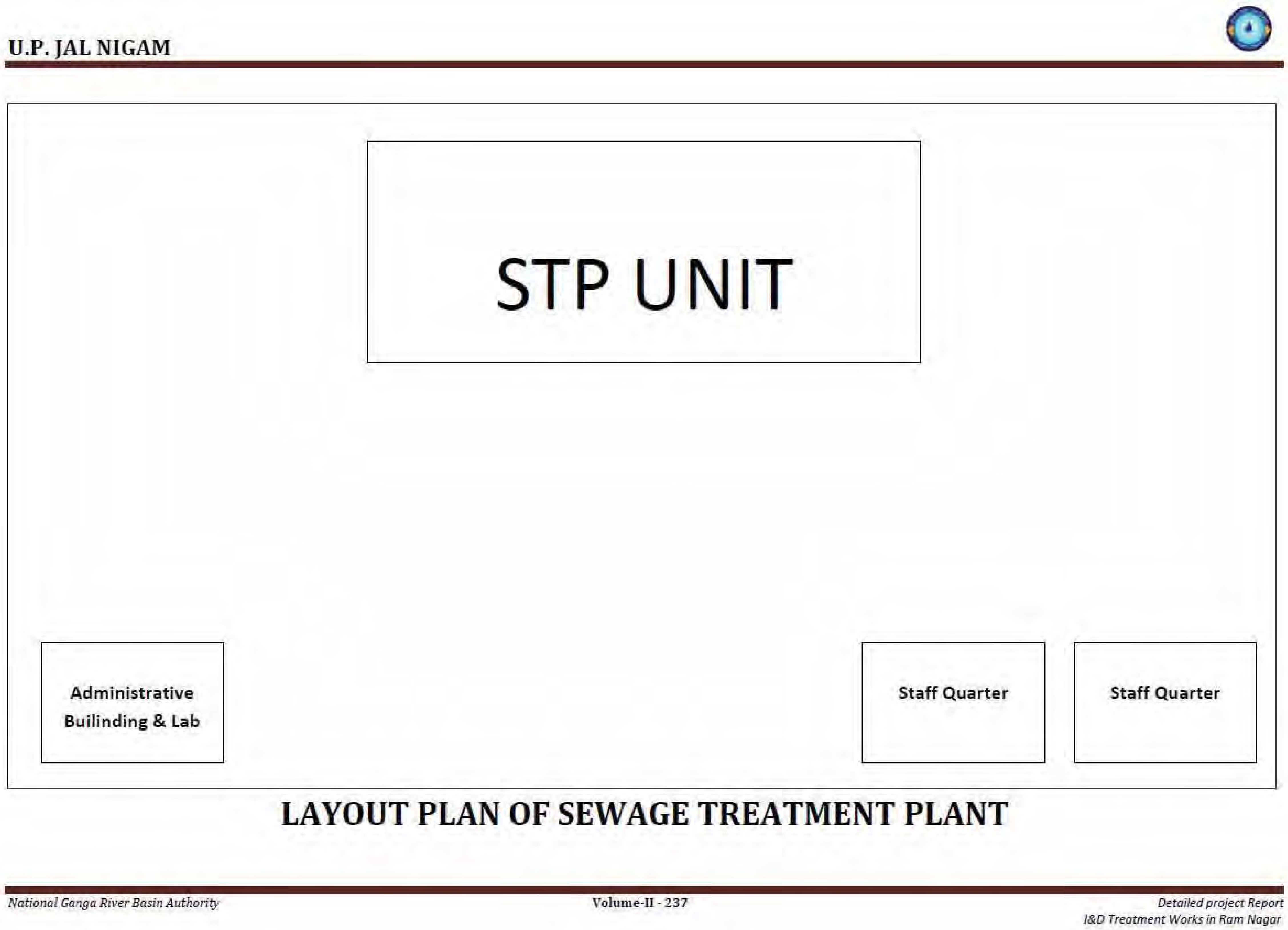
Source: Ramnagarr DPR (Comprehensive)

Figure 8.3.15 Layout of Proposed Ramnagar STP (Comprehensive)



Source: Ramnagar DPR (Comprehensive)

Figure 8.3.16 Flowsheet of Proposed Ramnagar STP (Comprehensive)



Source: Ramnagar DPR (ID&T)

Figure 8.3.17 Layout of Proposed Ramnagar STP (ID&T)

8.3.7 Chunar STP

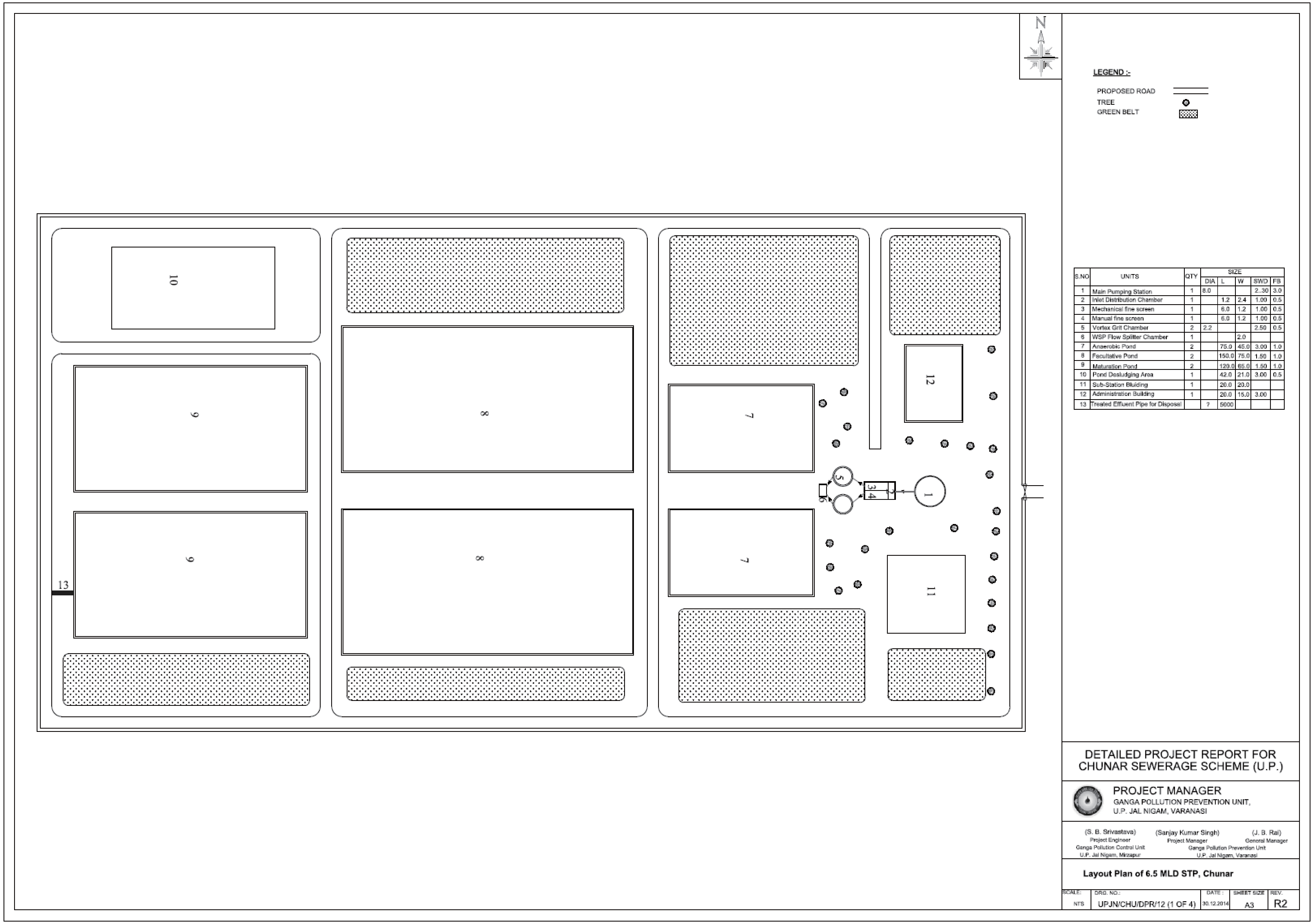
The following is an overview of the DPR.

1) Comprehensive Case

- New construction of 6.5MLD STP based on waste stabilization pond (WSP) is required.
- Installation of disinfection equipment and sludge treatment system is not written clearly.

2) ID&T Case

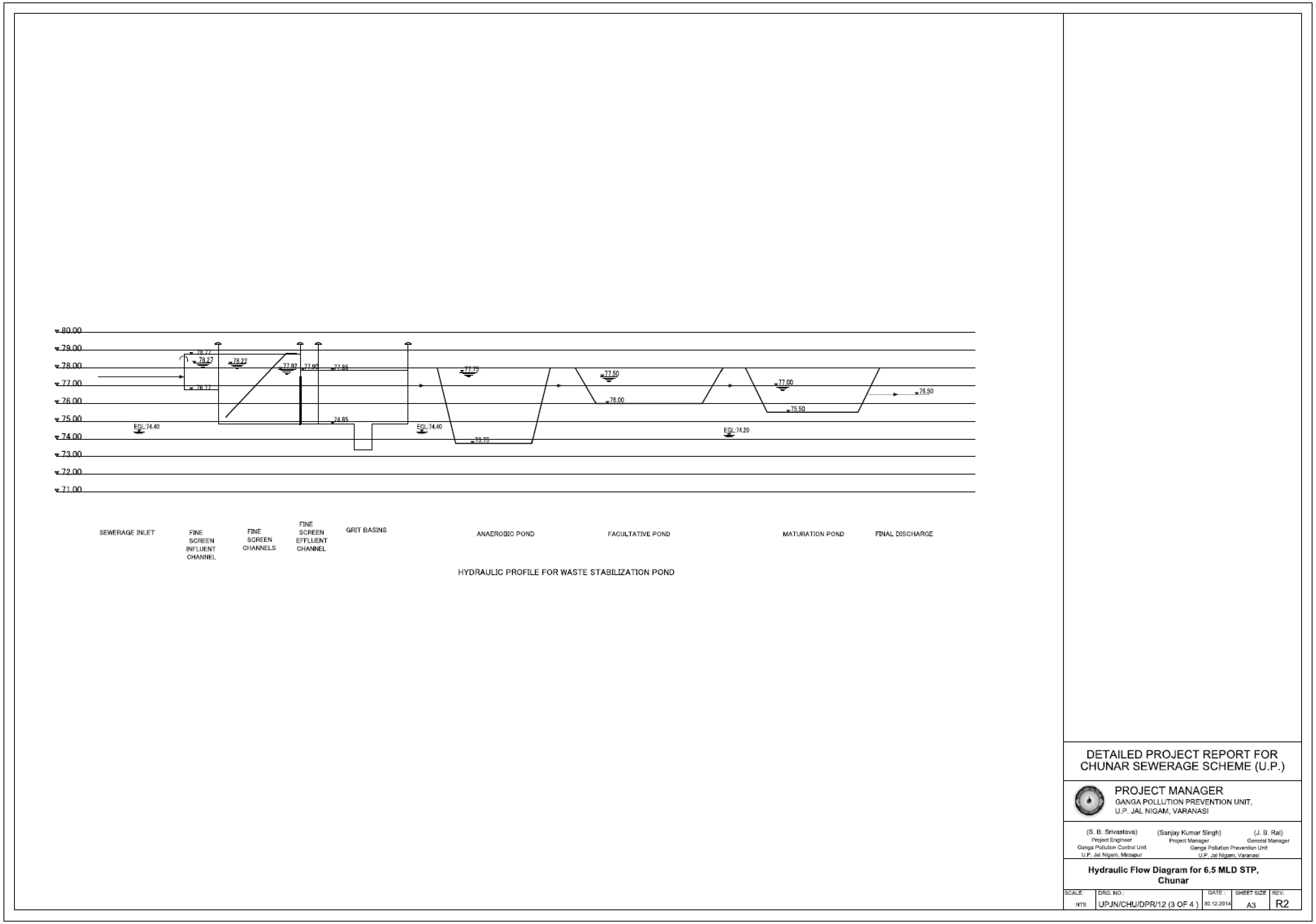
- New construction of 6.5MLD STP based on SBR is required.
- After water treatment process, Chlorine disinfection is planned.
- Sludge treatment process is consisted of sludge thickener and centrifuge.



S.NO	UNITS	QTY	SIZE				
			DIA	L	W	SWD	FB
1	Main Pumping Station	1	8.0			2..30	3.0
2	Inlet Distribution Chamber	1		1.2	2.4	1.00	0.5
3	Mechanical fine screen	1		6.0	1.2	1.00	0.5
4	Manual fine screen	1		6.0	1.2	1.00	0.5
5	Vortex Grit Chamber	2	2.2			2.50	0.5
6	WSP Flow Splitter Chamber	1			2.0		
7	Anaerobic Pond	2		75.0	45.0	3.00	1.0
8	Facultative Pond	2		150.0	75.0	1.50	1.0
9	Maturation Pond	2		120.0	65.0	1.50	1.0
10	Pond Desludging Area	1		42.0	21.0	3.00	0.5
11	Sub-Station Bluiding	1		20.0	20.0		
12	Administration Building	1		20.0	15.0	3.00	
13	Treated Effluent Pipe for Disposal		?	5000			

Source: Chunar DPR (Comprehensive)

Figure 8.3.18 Layout of Proposed Chunar STP (Comprehensive)



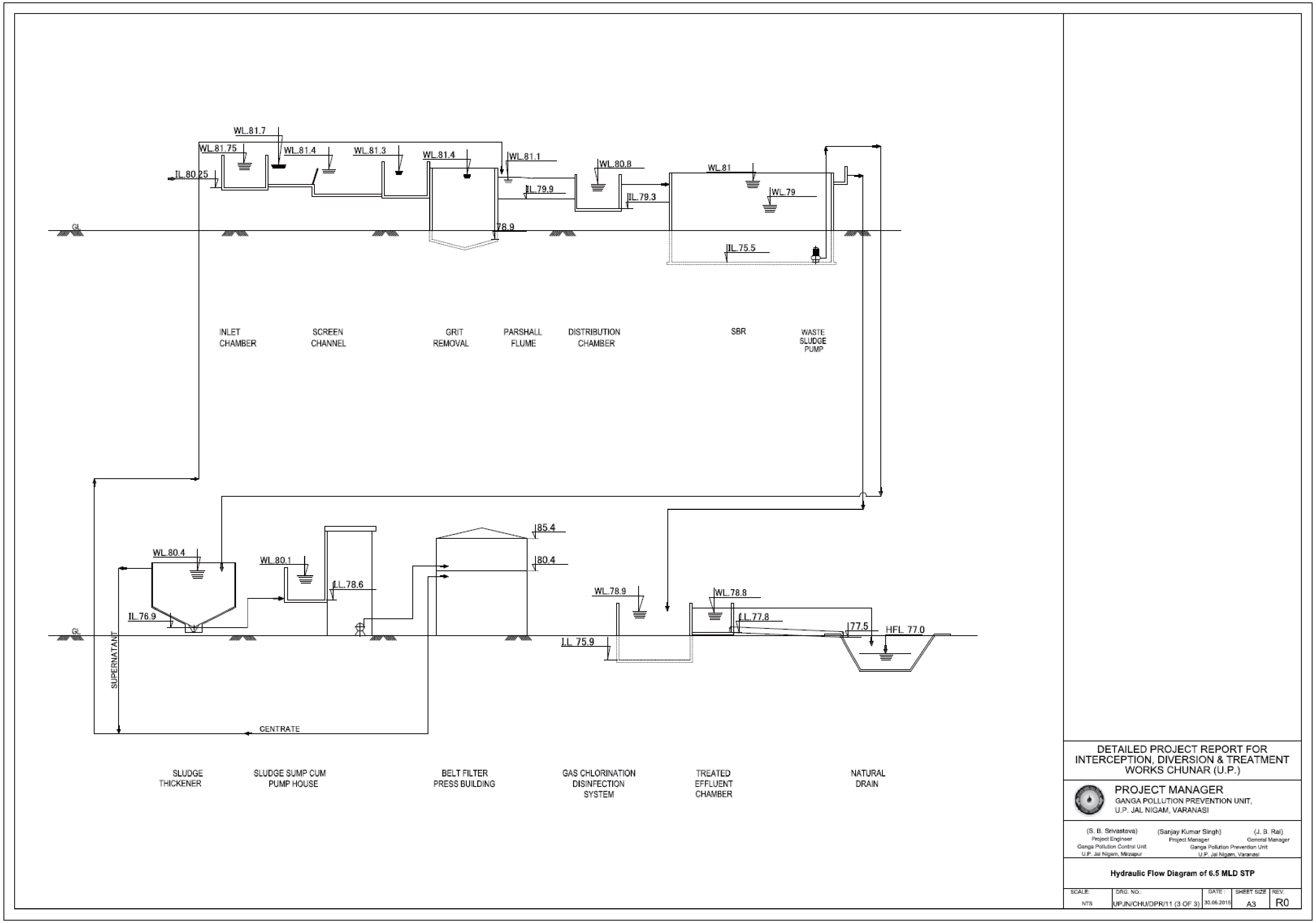
Source: Chunar DPR (Comprehensive)

Figure 8.3.19 Flowsheet of Proposed Chunar STP (Comprehensive)

S.NO	UNITS	Nos	SIZE IN METER				
			L	W	DIA	SWD	FB
1	Inlet Chamber	1	2.0	2.0		2.0	0.5
2	Screen Channel	1	4.0	2.0			0.5
3	Sump cum Pump House	1			8.0	3.0	0.5
1	Inlet chamber	1	2.4	1.6		1.5	0.5
2	Screen Chamber	1	4	1.6		1.0	0.5
3	Distribution Chamber	1	1.5	1.5		1.5	0.5
4	Grit Chamber	2			3	3.6	0.5
5	Parshall Flume	1	1.5	0.4			0.5
6	Distribution Chamber for SBR	1	1.5	1.5		1.5	0.5
7	SBR	2	20	15		5.5	0.5
8	CCT	2	10	15		3.0	0.5
9	Sludge Thickner	1			4	3.5	0.5
10	Sludge Sump cum Pump House	1			4.0	1.5	0.5
11	BFP /Chemical Building	1	10	8.0			
12	Blower Room	1	8.0	6.0			
13	Electrical Room	1	5.0	5.0			
14	Administration /Lab Building	1	12.0	8.0			
15	Clorination Building	1	8.0	6.0			
16	Guard Room	1	3.0	3.0			

Source: Chunar DPR (ID&T)

Figure 8.3.20 Layout of Proposed Chunar STP (ID&T)



Source: Chunar DPR (ID&T)

Figure 8.3.21 Flowsheet of Proposed Chunar STP (ID&T)

8.3.8 Saidpur STP

- DPR is not available yet as of March 2016.

8.3.9 Other Common Topics

- Each STP site location is indicated at figure at section 8.1.
- Effluent quality of BOD and SS from each STP is set in the range of 10-30 mg/l respectively.
- Comprehensive plan and ID&T plan is finalized separately.

8.3.10 Abstract of Proposed STP in Target Cities

Table 8.3.5 shows the list of proposed sewer works in target cities.

Table 8.3.5 Abstract of Proposed STP in Target Cities

<table>
<tr><th colspan="2" rowspan="2">STP</th><th rowspan="2">Target Year*</th><th colspan="2">Capacity of target STP (MLD)</th><th rowspan="2">Treatment Process</th></tr>
<tr><th>Existing</th><th>Target Year</th></tr>
<tr><td colspan="2">Dinapur**</td><td>2025</td><td>80</td><td>80</td><td>ASP +MBBR</td></tr>
<tr><td colspan="2">Bhagwanpur</td><td>2025</td><td>8</td><td>8</td><td>ASP</td></tr>
<tr><td colspan="2">Ramna</td><td>2035</td><td>-</td><td>50</td><td>CND</td></tr>
<tr><td rowspan="2">Mirzapur</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">14</td><td>32</td><td rowspan="2">UASB +SBR</td></tr>
<tr><td>ID&T</td><td>14</td></tr>
<tr><td rowspan="2">Vindhyachal</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">4</td><td rowspan="2">6</td><td rowspan="2">WSP+SBR</td></tr>
<tr><td>ID&T</td></tr>
<tr><td>Ghazipur</td><td>Comp.</td><td>2025</td><td>-</td><td>18</td><td>SBR</td></tr>
<tr><td rowspan="2">Ramnagar</td><td>Comp.</td><td>2050</td><td>-</td><td>13</td><td>CND</td></tr>
<tr><td>ID&T</td><td>2035</td><td>-</td><td>13</td><td>CND</td></tr>
<tr><td rowspan="2">Chunar</td><td>Comp.</td><td rowspan="2">2030</td><td rowspan="2">-</td><td rowspan="2">6.5</td><td>WSP</td></tr>
<tr><td>ID&T</td><td>SBR</td></tr>
</table>

Note: *Design year of capacity of target STP shown at DPR.

**New construction of 60MLD STP is under designing and construction by GAP-II another scheme.

CHAPTER 9 Preliminary Design of Sewerage Facilities

<Objective of the study>

The survey team has made some modifications of existing DPRs as alternative according to the necessity of revision of the plans.

<Methodologies

According to the description/rules in 9.1, verification of requirement of revision was confirmed for respective sewer plans, pumping stations and STPs. Given that different cities had different Design years of facilities as shown in Table 9.3.2 which were depicted from DPRs, the study was conducted by setting final target year for all the cities and towns as 2050 to confirm future allowance/room of the proposed sewage treatment plants by the unified comparison method among the subject cities and towns.

9.1 Verification of Existing DPRs Sewers

The verification of the existing DPRs and the modification of the designs if required were conducted in following manners:

(1). Verification of Sewer Planning Methodologies in Existing DPRs

With respect to sewer planning methodologies in existing DPRs, the items below were confirmed in order;

1) Descriptions on design methodologies and/or criteria for sewer networks including target year in existing DPRs,
2) Sewerage catchment areas and the boundaries from the sewerage maps including river crossings,
3) Sewerage system, namely separate/combined, or comprehensive/interception & diversion (I&D) in each target city in this project,
4) Locations and the scales of existing drains in target areas where the flows will be intercepted and the interception points in case of I&D. Those were confirmed carefully with route survey conducted during this study,
5) Locations of existing sewered areas and ongoing/planned sewerage works (Varanasi, Mirzapur),
6) STPs where the generated and collected sewage will be conveyed and the capacities,
7) Design population in districts and wards/colonies,
8) Allocation methods of population into flows of each drains to be intercepted in target year in case of I&D in comparison of ward/colony boundaries and drain alignments,
9) Methods of interceptions from existing drains based on proposed interception structures,
10) General ground levels in target areas and locations of intermediate pumping stations, sections of

rising mains from sewerage maps,

11) Areas where are difficult to connect to trunk lines or interceptors and the generated sewage are proposed to be treated with septic tanks due to the ground levels and scales,
12) Proposed trunk sewer sections and the widths, traffic conditions of the roads on grounds for excavation works,
13) Proposed sections (locations, lengths) of sewer installations with trenchless method and the reasons (river crossings/railway crossings/congested roads etc.).

The ways of planning confirmed from the points above are acceptable in terms of Indian standards (CPHEEO Manual and NMCG norms) and generally adopted ones in Japan and the other countries. Therefore planning methodology itself are not required to be changed in general.

However, in light of 2) and 5) above, District-III in Varanasi City had some issues and JICA Study Team proposed the following change of designs.

- Many sewers crossed Assi River without any proposal of trenchless installation that would be cause problem in construction stage. Since trenchless sections have issue of too deep sewer that makes difficult to connect to existing trunk sewer (Assi Interceptor) or alternate siphon makes difficult for O&M work, JICA Study Team concluded that the sewerage system should be remodelled without river crossings except for the upstream part of Assi River where the depth is not significant to be crossed by sewers.
- Assi Secondary Interceptor would be rerouted to inland route under GAP-II due to collapse of laid sewer beside River Ganga. However, it was not taken into account to the design. Therefore, the proposed sewerage system were revised with the rerouted Assi Secondary Interceptor.

In addition, in light of 11) above, there is no enough space for septic tank in congested District-I and also NMCG does not accept the utilization of septic tanks. Therefore, a small area near District-III was remodelled to connect to sewer in District-III rather than constructing the septic tank after discussion with UPJN. It was confirmed that the remodelling does not cause the change of STP capacities due to the small flow and allowance of the STP capacity. Since Interceptor system in Chunar also included some septic tanks, the sewer planning was revised in the city.

In light of 12) on road and traffic conditions, District-II had an issue for installation of trunk sewer. A continuous sections with heavy traffic on the ground was proposed to be installed with trenchless method in discussion and site visit with UPJN.

(2). Verification of Design Inflows and Flow Capacities of Sewers

1) Verification of Existing Design Standards in India

With respect to sewer design methodology in India, JICA Study Team verified “Chapter 3: Design and

Construction of Sewers" in "Manual on Sewerage and Sewage Treatment Systems, Part A: Engineering, Third Edition – Revised and Updated, MOUD & CPHEEO in collaboration with JICA, November 2013". The concepts of design are in general acceptable to be adopted for this project.

2) Verification of Design Parameters in DPRs in Comparison with Design Standard

The design parameters of sewers in main texts and flow calculation sheets of existing DPRs were verified in comparison with the aforementioned existing design standard in India. The example of verified parameters are as follows;

i. Inflow of domestic wastewater
ii. Groundwater infiltration
iii. Pipe material and Manning's coefficient of roughness of each material
iv. Slope, minimum and maximum flow velocities
v. Design depth of sewer (allowance)
vi. Minimum earth cover of sewer
vii. Size and interval of manholes

The parameters in DPRs followed the standard in general and it is acceptable.

(3) Verification of Sewer Capacities in DPRs

The capacities of proposed sewers in DPRs were verified with the design parameters verified as above in flow calculation sheets. The design invert and crown levels of sewers also were confirmed in balance with the levels of existing sewers and ones of ongoing works in Varanasi and Mirzapur.

JICA Study Team confirmed that there is no significant errors of setup and calculations itself in flow calculation sheets. Therefore, the flow calculation sheets were revised based on the revision of planning concepts in Varanasi District-I, II, III and Chunar without specific change of design parameters.

The more details of revised parts, locations and the methodologies in each target city are explained in sections for sewerage system in each city in Chapter 8 and 9.

9.1.1 General Concept

Table 9.1.1 shows the category of development method for each target city. Varanasi City has been and will be developed with comprehensive method as a large city more than 1 million population and Mirzapur and Ghazipur Cities should be developed with combination of ID&T method under implementation by NMCG as the urgent action and following sewer network development under implementation by MoUD as the cities more than 100,000 populations as of Census 2011. Chunar, Ramnagar and Saidpur Cities will be developed with ID&T method as the cities less than 100,000 populations. However, since it is difficult to intercept the wastewater from existing nallahs due to no road for interceptor in parallel with and close to Ganga River and also many large nalas with not only wastewater but also much groundwater in dry weather flow, the preparation of DPR ID&T for Ghazipur City has been facing the problem in UPJN and the initiation of the preparation is delayed.

Table 9.1.1 Category of Development Method for Target Cities in Accordance with MOUD Rule

City	Varanasi	Mirzapur	Ghazipur	Ramnagar	Chunar	Saidpur
District	Varanasi	Mirzapur	Ghazipur	Varanasi	Mirzapur	Ghazipur
Population (Census2011)	1,435,113	234,170	121,020	49,087	37,227	24,338
Scale of City	More than 1 million	More than 1 lakh	More than 1 lakh	Less than 1 lakh	Less than 1 lakh	Less than 1 lakh
Development Method	Comp.	ID&T Sewer	(ID&T) Sewer	ID&T	ID&T	ID&T

Source: JICA Survey Team

9.1.2 Proposed Sewerage Work for Varanasi City District-I

All the project components for sewers are same with what was stated in sub-section 8.1.1 as comprehensive method.

The map showing the proposed sewerage system based on the DPR is shown in Figure 9.1.1 and abstract of proposed sewerage system is shown in Table 9.1.2.

9.1.3 Proposed Sewerage Work for Varanasi City District-II

Any significant issue was found in DPR Varanasi District-II after the confirmations such as matching of invert levels between proposed sewers and RTS which has been constructed in GAP-II and will be connected with the branch sewers under this project as shown in L-Section in Appendix 9.1.2. Therefore, all the project components for sewers are same with what was stated in sub-section 8.1.2 as comprehensive method.

Table 9.1.3 shows the proposed sewer works in the DPR. The map showing the proposed sewerage system is shown in Figure 9.1.2.

Table 9.1.2 Proposed Sewer Works in Varanasi District-I

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	193,294	840
RCC	250	9,862	309
RCC	300	4,808	0
RCC	350	2,010	18
RCC	400	2,069	268
RCC	450	1,609	30
RCC	500	2,081	99
RCC	600	1,638	192
RCC	700	84	30
RCC	800	317	90
RCC	900	0	0
Sub-total		**217,772**	**1,876**
Total		**219,648**	

(2) Manhole

Dia. (mm)	Nos.
900	10,898
1200	27
Total	**10,925**

(3) House Connection

Transfer of Exist. (nos.)	New Pipe (nos.)	New Chamber (nos.)
38,288	**9,804**	4,902

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
400	265	(30% of 883m)
600	218	(30% of 728m)
Total	**483**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
88

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
300	795
600	664
Total	**1,459**

Source: DPR Varanasi District-I compiled by JICA Survey Team

Table 9.1.3 Proposed Sewer Works in Varanasi District-II

(1) Sewer Pipe

Material	Dia. (mm)	Length	
		Open (Rm)	Micro Tunneling (Rm)
RCC	200	236,690	332
RCC	250	11,062	0
RCC	300	6,018	269
RCC	350	3,788	145
RCC	400	4,132	499
RCC	450	2,427	311
RCC	500	2,875	540
RCC	600	1,366	368
RCC	700	1,924	90
RCC	800	570	439
RCC	900	1,244	918
Sub-total		**272,096**	**3,911**
Total		**276,007**	

(2) Manhole

Dia. (mm)	Nos.
900	12,983
1200	145
Total	**13,128**

(3) House Connection

Exist. (nos.)	New (nos.)	New Chamber (nos.)
79,836	**34,216**	17,108

(4) Desilting of Existing Sewer Pipe

Dia. (mm)	Length (Rm)	
450	256	(30% of 852m)
600	145	(30% of 484m)
900	309	(30% of 1,031m)
Total	**710**	

(5) Repairs/Rehabilitation of Existing Manhole

Nos.
24

(6) Dismantling of Existing Sewers

Dia. (mm)	Length (Rm)
250	3,850
300	3,451
400	567
600	813
Total	**8,681**

Source: DPR Varanasi District-II compiled by JICA Survey Team

9.1.4 Proposed Sewerage Work for Varanasi City District-III

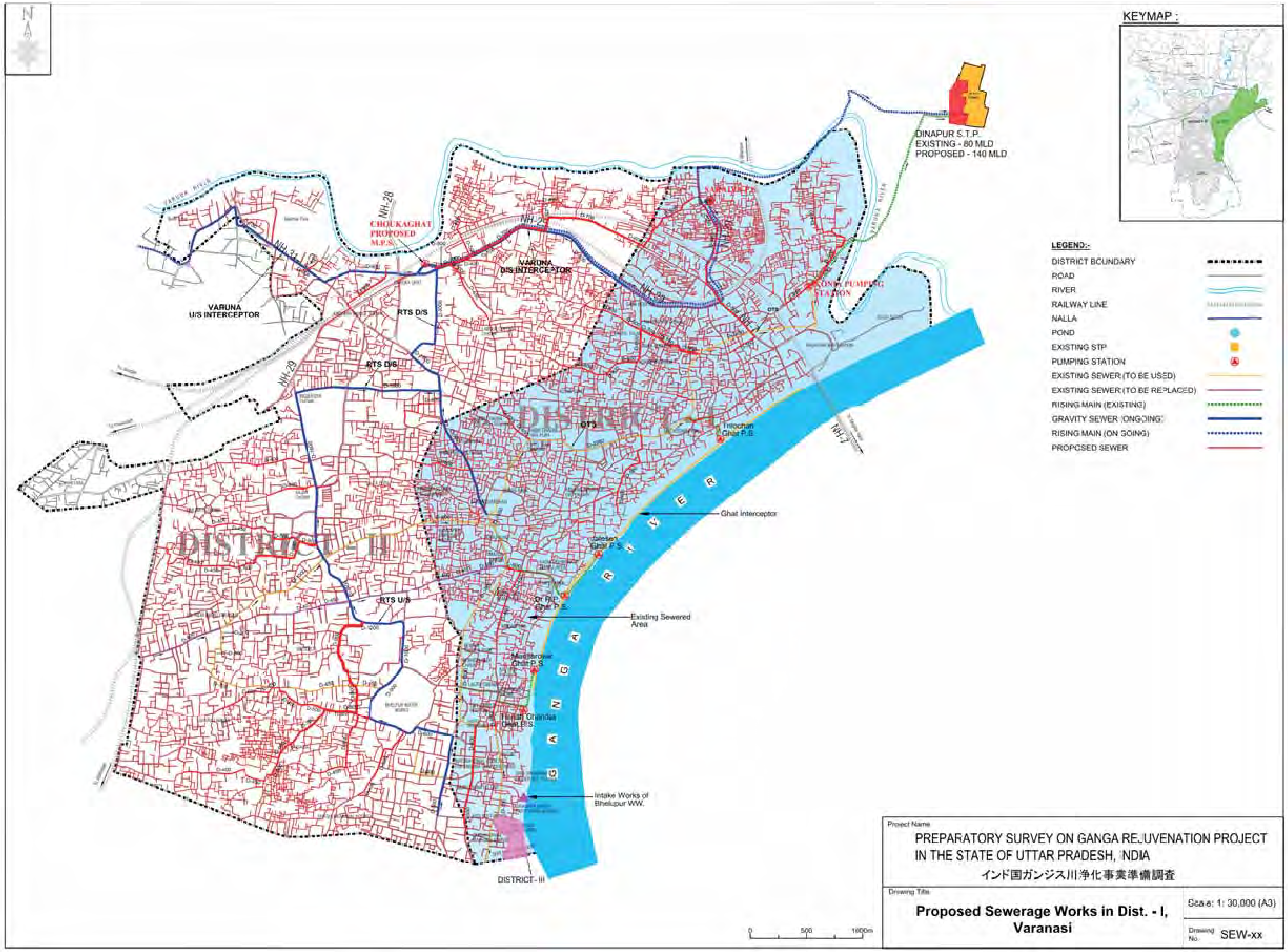
The project components for sewers which was stated in sub-section 8.1.3 with comprehensive method had the following significant issues:

1) Included many river crossings on Assi Nala alignment without any proposal of siphons under the river constructed by micro-tunnelling method. The alignment of sewers would interfere the flow of Assi Nala which may cause the flooding and/or accumulation of garbage.

2) The collaboration with latest plan in the nearby area of proposed route for Assi Secondary Interceptor of which the laid sewer was collapsed by land slide at bank of Ganga River and will be re-laid under GAP-II project was not found.

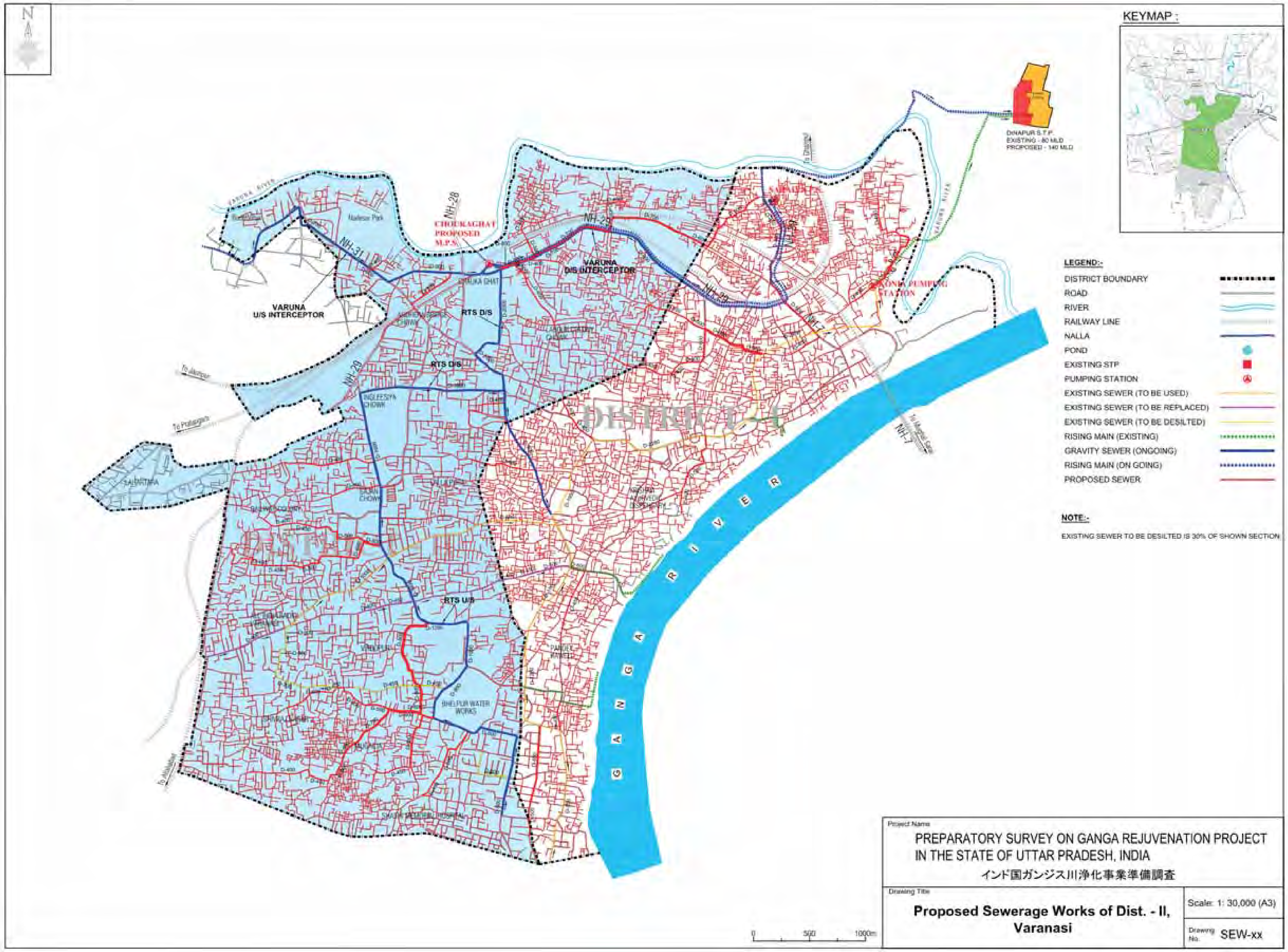
Therefore, JICA Survey Team proposed the remodelling of sewer network in nearby area of Assi Nala and proposed Assi Secondary Interceptor.

The map showing the proposed sewerage system is shown in Figure 9.1.3.



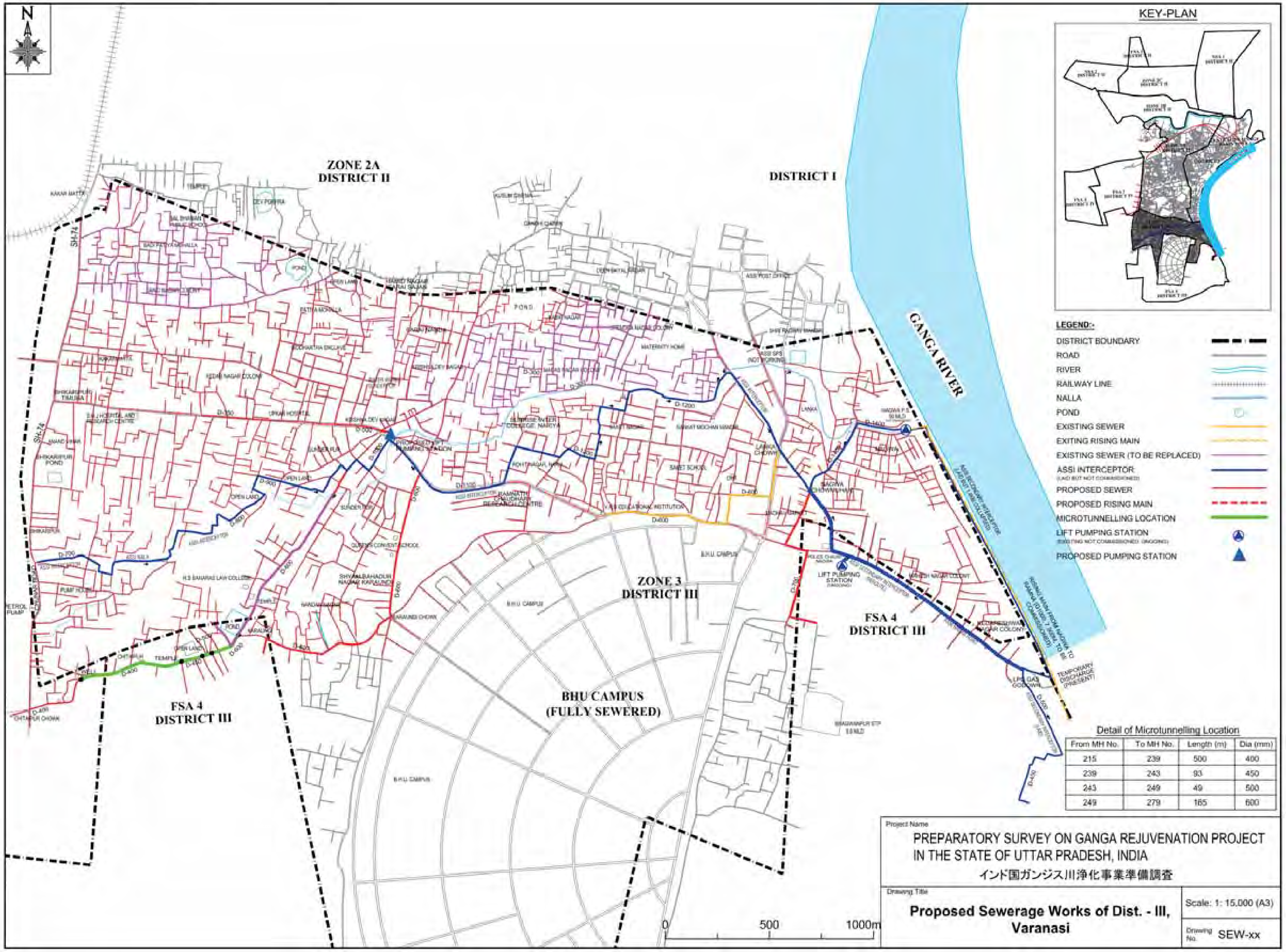
Source: DPR Varanasi District-I compiled by JICA Survey Team

Figure 9.1.1 Proposed Sewerage System in Varanasi City District-I



Source: DPR Varanasi District-II compiled by JICA Survey Team

Figure 9.1.2 Proposed Sewerage System in Varanasi City District-II



Source: JICA Survey Team

Figure 9.1.3 Proposed Sewerage System in Varanasi City District-III

9.1.5 Proposed Sewerage Work for Ramnagar City

The separate DPRs with comprehensive method and ID&T method were prepared for Ramnagar City. However, due to the scale of city with less than 100,000 population, only ID&T method will be adopted and sewer network to connect with interceptor will not be developed.

Since DPR ID&T for Ramnagar does not include the general sewerage map showing rising main route to STP, JICA Survey Team prepared the sewerage map in accordance with interview to UPJN on the base map of DPR Ramnagar comprehensive as shown in Figure 9.1.4.

The original DPR included the following issues from the review by JICA Survey Team.

1) The ground levels at interceptor alignment was not consistent with existing ones confirmed from route survey. However, the invert levels of drains of which the wastewater flows will be intercepted were almost correct. It lead to much less excavation depth than actually required ones in BOQ and cost.

2) The velocity of sewer did not exceed 0.8 m/sec which is required for combined sewer to flush the sands and silts in DPR's flow calculation even in ultimate year 2050.

3) An interception structure for Ram Bagh Drain as a largest drain to be intercepted was not estimated in BOQ for sewer works and it was not found in the BOQ for MPS beside Ram Bagh Drain.

Therefore, JICA Survey Team revised the flow calculation and BOQ based on accurate ground levels obtained from route survey. The proposed longitudinal profile (L-Section) for the interceptor designed from the revised flow calculation is shown in Appendix 9.1.3. In addition, JICA Survey Team revised the proposed interception structures as shown in Appendix 9.1.4 since the original drawing included many discrepancies from dimensions of interceptors in flow calculation sheet and BOQ.

Table 9.1.4 shows the BOQ of proposed sewer works. Although the excavation volume for interceptor and estimated number of interception structures are proposed to be increased due to aforementioned reasons, the dimensions in the table is consistent with original DPR.

Table 9.1.4 Proposed Sewer Works in Ramnagar City (ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)
1) Gravity Sewer			Total
RCC	NP3	200	0
RCC	NP3	250	0
RCC	NP3	300	0
RCC	NP3	350	80
RCC	NP3	400	150
RCC	NP3	450	0
RCC	NP3	500	120
RCC	NP3	600	0
RCC	NP3	700	0
RCC	NP3	800	0
RCC	NP3	900	30
Sub-total			**380**
2) Rising Main			
DI	K9	400	**2,700**
Sub-total			**2,700**
Total			**3,080**

(2) Manhole

1200x900	0
1500x1500	10
Total	**10**

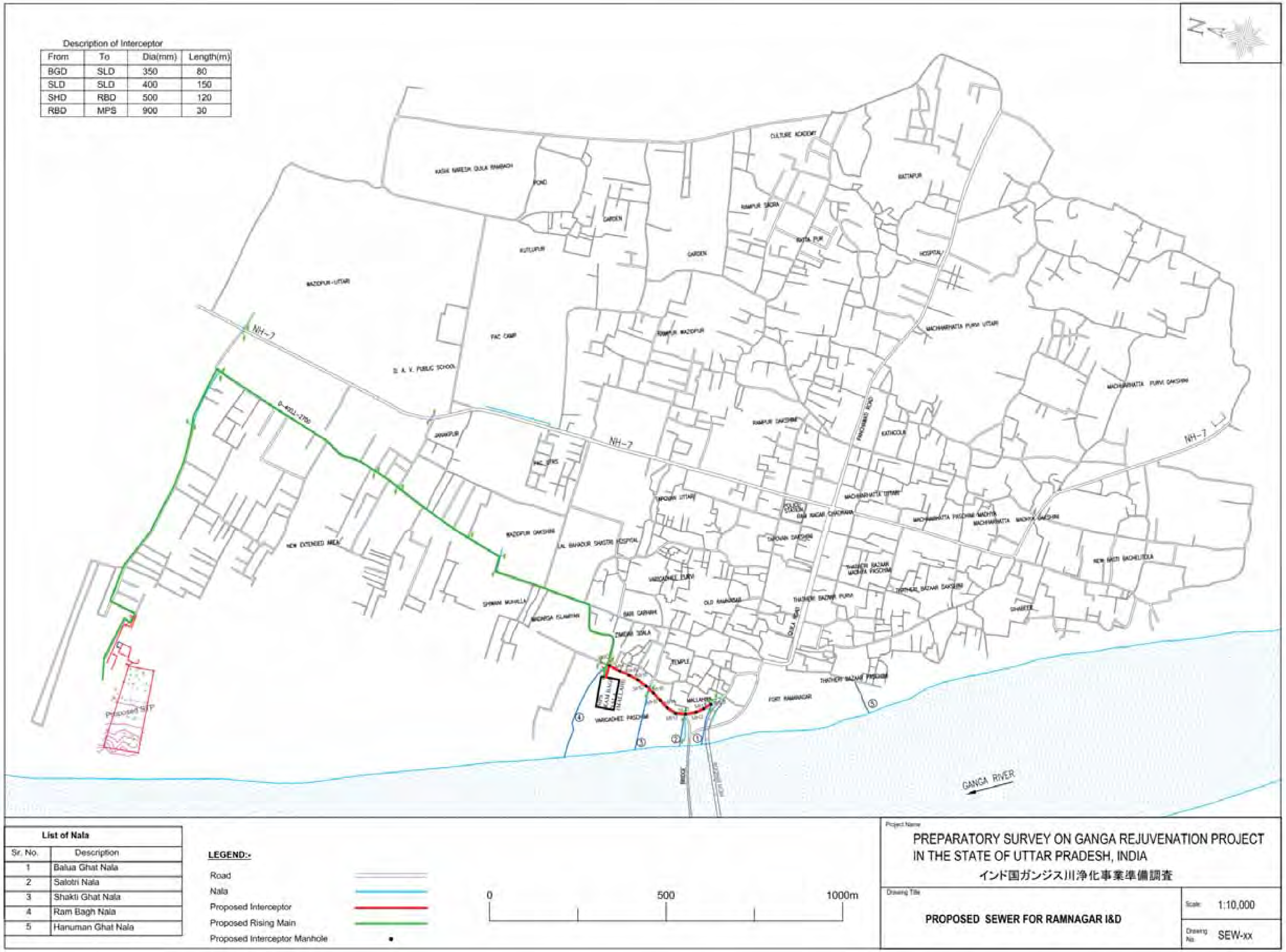
(3) Interception Structure

Nos.
4

(4) House Connection

Nos.
0

Source: DPR Ramnagar ID&T compiled by JICA Survey Team



Source: JICA Survey Team revised on DPR Ramnagar Comprehensive

Figure 9.1.4 Proposed Sewer Network in Ramnagar City (ID&T)

9.1.6 Proposed Sewerage Work for Mirzapur City

The separate DPRs with comprehensive method and ID&T method explained in Chapter 8 should be incorporated as Phase-I work for ID&T and Phase-II work for the successive sewer networks development to connect the branch sewers to interceptor without parallel lines except for rising mains as much as possible.

Figure 9.1.5 shows the proposed sewerage system for ID&T work (Phase-I) as urgent development and the longitudinal profile (L-Section) of proposed interceptor is shown in Appendix 9.1.x. Table 9.1.5 shows the abstract of ID&T work. The lengths of small diameters as connection pipes from interception structures to interceptor sewers would be revised due to the move of interception structures.

Figure 9.1.6 shows the integrated image of the works. For the easiness of future secondary sewer connection to interceptor, manholes in the road crossings should be constructed in Phase-I for future. To reduce the number of lift pumping stations on the secondary sewer alignments as much as possible for connecting to interceptor, the depth of interceptor should be enough deep considering the depth in end points of secondary sewers. (Local consultants of UPJN will revise DPR under that concept.)

Under this concept 10 pumping stations consisting of 1) existing four pumping stations for rehabilitation in Phase-1, 2) proposed four pumping stations in Phase-1, and 3) proposed two intermediate pumping stations in Phase-2 will be developed.

Table 9.1.5 Proposed Sewer Works in Mirzapur City (Phase-I: ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)	Length Micro Tunneling (Rm)
1) Interceptor				
RCC	NP3	200	750	0
RCC	NP3	250	400	0
RCC	NP3	300	800	0
RCC	NP3	350	0	0
RCC	NP3	400	555	0
RCC	NP3	450	550	0
RCC	NP3	500	1,659	0
RCC	NP3	600	2,211	0
RCC	NP3	700	0	0
RCC	NP3	800	210	0
RCC	NP3	900	1,700	0
RCC	NP3	1000	0	0
RCC	NP3	1200	0	0
Sub-total			**8,835**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	**370**	
DI	K9	250	-	
DI	K9	300	**3,550**	
DI	K9	350		
DI	K9	600	**80**	
DI	K9	700	**1,370**	
Sub-total			**5,370**	
3) Treated Effluent Reuse Line				
RCC	NP3	800	**7,000**	
Total			**21,205**	

(2) Manhole

Dia. (mm)	Nos.
1) Interceptor	
900	241
1200	65
Sub-total	306

900	38
Total	**344**

(3) Interception Structure (Nala Tapping Structure)

Zone	Nos. New	Nos. Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

Source: JICA Survey Team revised from DPR Mirzapur ID&T

Table 9.1.6 Proposed Sewer Works in Mirzapur City (ID&T and Sewer Network)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length (Rm)				
			Open	Micro Tunneling	Replacement	Open	Micro Tunneling
			ID&T (NMCG)		Sewer Network (MoUD)		
1) Interceptor/Gravity Sewer							
RCC	NP3	200	750	0		217,181	110
RCC	NP3	250	400	0		3,814	0
RCC	NP3	300	800	0		9,141	25
RCC	NP3	350	0	0		1,716	0
RCC	NP3	400	555	0		4,219	30
RCC	NP3	450	550	0		1,275	25
RCC	NP3	500	1,659	0		1,908	0
RCC	NP3	600	2,211	0		586	20
RCC	NP3	700	0	0		1,899	0
RCC	NP3	800	210	0		1,199	0
RCC	NP3	900	1,700	0		970	20
RCC	NP3	1000	0	0		1,537	20
RCC	NP3	1200	0	0		0	30
					4,500		
Sub-total			**8,835**	**0**	**4,500**	**245,445**	**280**
2) Rising Main							
DI	K9	150	-	-	-	-	-
DI	K9	200	**370**	-	-	**356**	-
DI	K9	250	-	-	-	-	-
DI	K9	300	**3,550**	-	-	**36**	-
DI	K9	350	-	-	-	-	-
DI	K9	600	**50**	-	-	-	-
DI	K9	700	**1,370**	-	-	-	-
DI	K9	800	**30**				
Sub-total			**5,340**	**0**	-	**392**	-
3) Treated Effluent Reuse Line							
RCC	NP3	800	**7,000**	**0**	-	**0**	-
Total			**21,175**	**0**		**245,837**	**280**

(2) Manhole

Dia. (mm)	NMCG (Nos.)	MOUD (Nos.)
1) Interceptor		
900	241	10,210
1200	65	162
Sub-total	306	10,372
2) Treated Effluent Reuse Line		
900	38	0
Total	**344**	**10,372**

(3) Interception Structure (Nala Tapping Structure)

Zone	NMCG (Nos.)	
	New	Revamping
Mirzapur	13	5
Vindhyachal	4	4
Total	**17**	**9**

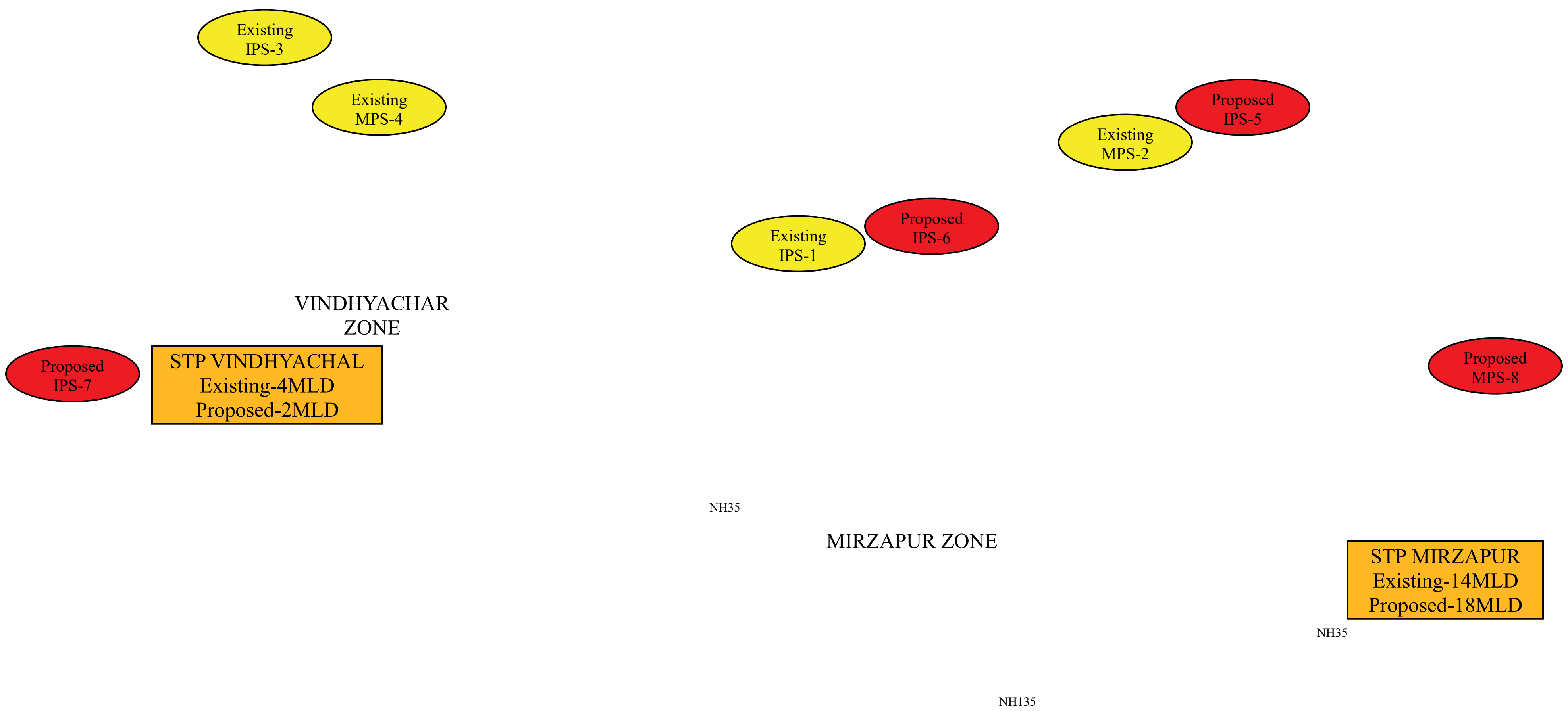
(4) House Connection (Nos.)

NMCG	MOUD
0	**5,726**

(5) Septic Tank Soak Pit (Nos.)

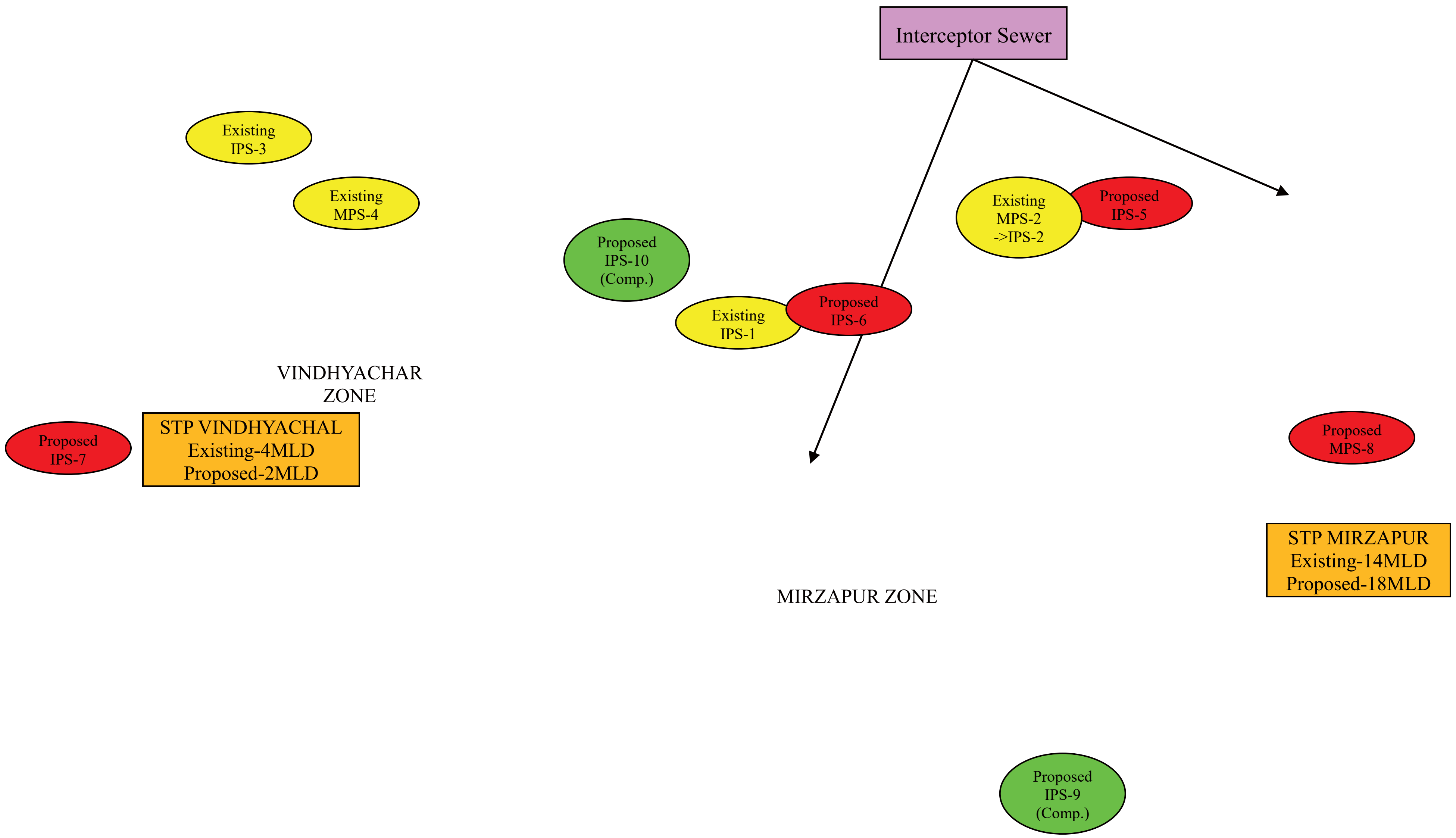
NMCG	MOUD
0	**8**

Source: JICA Survey Team revised from DPR Mirzapur Comprehensive and ID&T



Source: DPR Mirzapur ID&T revised by JICA Survey Team

Figure 9.1.5 Proposed Sewerage System in Mirzapur City ID&T (Phase-I)



Source: DPR Mirzapur Comprehensive and ID&T revised by JICA Survey Team

Figure 9.1.6 Proposed Sewerage System in Mirzapur City (Phase-I: ID&T and Phase-II: Sewer Network)

Table 9.1.7 General Specification of Pumping Stations in Proposed Sewerage Works in Mirzapur City (ID&T and Sewer Network)

1) NMCG (ID&T)

IPS

No.	Rehabilitation of Existing PS														No.	Proposed												
	Name	Location	Pump								Rising Main					Name	Location	Pump								Rising Main		
			Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length				Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
Mirzapur															Mirzapur													
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700	1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**														
2	MPS-2 -> IPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370	2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**				Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal															Vindhyachal													
3	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250	3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**				Non-peak	50	2	1	1	12	50	1.2			
Sub-Total	3														Sub-Total	3												
Total	**6**																											

MPS

No.	Rehabilitation of Existing PS														No.	Proposed												
	Name	Location	Pump								Rising Main					Name	Location	Pump								Rising Main		
			Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length				Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
Mirzapur															Mirzapur													
-	Existing MPS-2 in Kutchary should be renamed to IPS-2														1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	800	30
Vindhyachal																												
1	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100														
											Proposed	**DI-K9**	**300**	**30**														
Sub-total	1														Sub-Total	1												
Total	**2**																											

8

2) MOUD (Sewer Network)

IPS

Rehabilitation of Existing PS															Proposed													
No.	Name	Location	Pump								Rising Main				No.	Name	Location	Pump								Rising Main		
			Flow	Capacity	Pump Nos.			Head	Total Capacity		Status	Material	Dia.	Length				Flow	Capacity	Pump Nos.			Head	Total Capacity		Material	Dia.	Length
				(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)			(mm)	(m)					(cum/hr)	Total	Duty	Standby	(m)	(cum/hr)	(MLD)		(mm)	(m)
															Mirzapur													
															1	IPS-7-> IPS-9	district jail Mirzapur	Peak	280	3	2	1	13	13	13	DI-K9	300	36
																		Non-peak	150	2	1	1	13	13	13			
															2	IPS-8-> IPS-10	lalah ghat	Peak	160	3	2	1	21	21	21	DI-K9	200	356
																		Non-peak	65	2	1	1	17	17	17			
Sub-Total	0														Sub-total	2												
Total	**2**																											

Source: DPR Mirzapur Comprehensive and ID&T revised by JICA Survey Team

9.1.7 Proposed Sewerage Work for Chunar City

The separate DPRs with comprehensive method and ID&T method were prepared for Chunar City. However, due to the scale of city with less than 100,000 population, only ID&T method will be adopted and sewer network to connect with interceptor will not be developed. Table 9.1.8 shows the BOQ of proposed sewer works and Figure 9.1.7 shows the sewerage map. Since the longitudinal profile (L-section) for interceptor has not been prepared for DPR, JICA Survey Team prepared the L-section as shown in Appendix 9.1.6.

Since NMCG commented for submitted DPR that 1) the use of septic tanks are not permitted, 2) the drains towards Jargo River also should be intercepted since the wastewater would inflow to Ganges River in future due to decrease of water use in nearby farm land, now DPR should be revised as follows;

1) The wastewater from septic tank areas should be collected into interceptor by lowering the interceptor depth or adding/moving the pump stations,

2) The drains towards Jargo River are to be intercepted with additional interceptor line.

Once the sewerage map will be finalized based on the actions above, the figures will be replaced.

Table 9.1.8 Proposed Sewer Works in Chunar City (ID&T) Tentative

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length Open (Rm)	Length Micro Tunneling (Rm)
1) Gravity Sewer				
RCC	NP3	200		
RCC	NP3	250	700	
RCC	NP3	300		
RCC	NP3	350	250	
RCC	NP3	400		
RCC	NP3	450		
RCC	NP3	500		
RCC	NP3	600	1,550	
RCC	NP3	700	1,808	
Sub-total			**4,308**	**0**
2) Rising Main				
DI	K9	150	-	
DI	K9	200	2,130	
DI	K9	250	-	
DI	K9	300	-	
DI	K9	350	30	
Sub-total			**2,160**	
3) Treated Effluent Reuse Line				
RCC	NP3	350	**3,695**	
Total			**10,163**	

(2) Manhole

Dia. (mm)	Nos.
900	86
1200	63
Total	**149**

(3) Interception Structure

Nos.
22

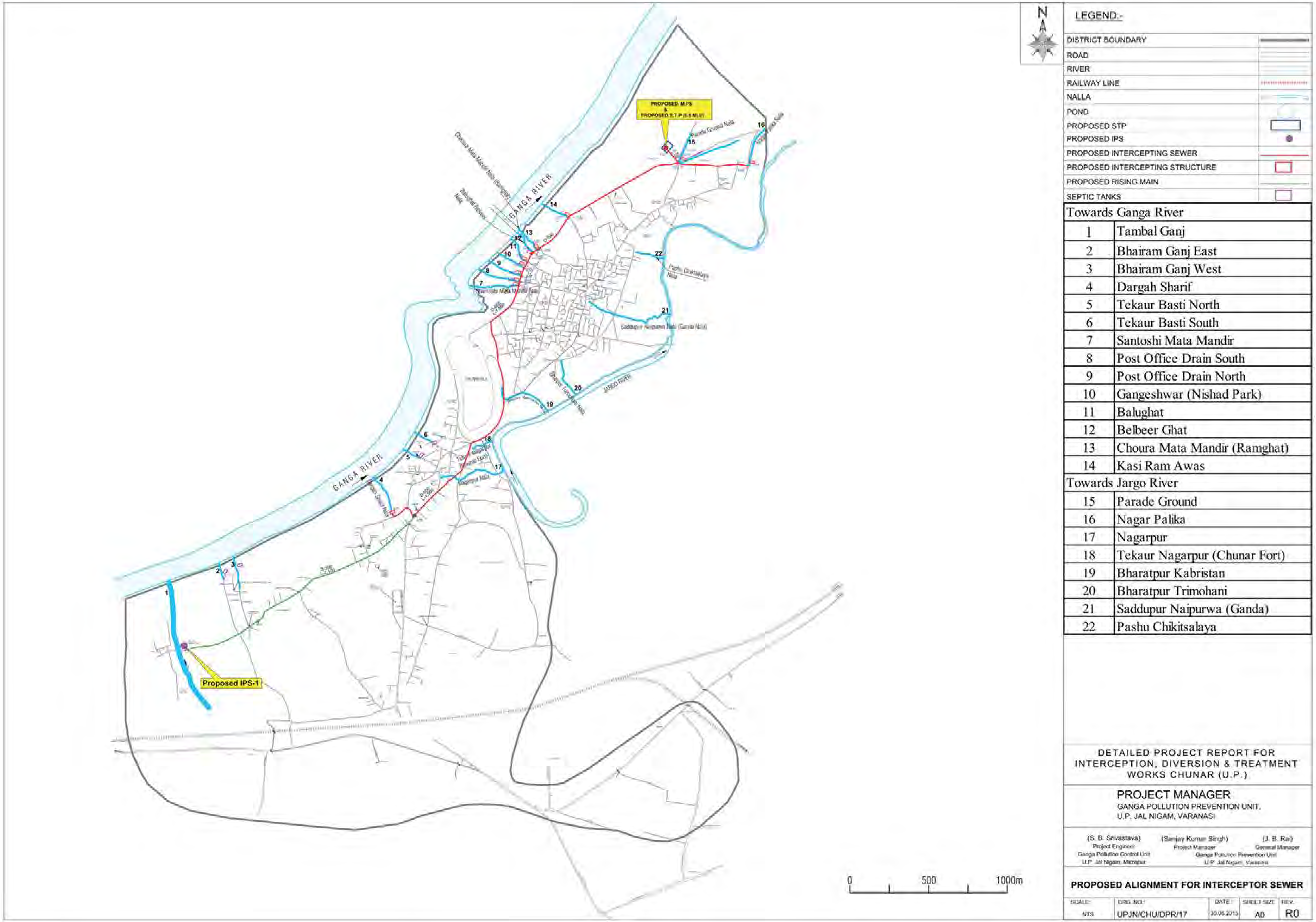
(4) Septic Tank Soak Pit

Nos.
0

(5) House Connection

Nos.
0

Source: DPR Chunar ID&T revised by JICA Survey Team



Source: DPR Chunar ID&T compiled by JICA Survey Team

Figure 9.1.7 Proposed Sewer Network in Chunar City (ID&T)

9.1.8 Proposed Sewerage Work for Ghazipur City

As a city where the population is more than 1 lakh Ghazipur City will be developed with the sewer networks. However, for urgent development of sewerage system UPJN has to prepare the DPR ID&T separate from the existing DPR comprehensive due to the instruction by NMCG., but UPJN still seeks for the development with only existing DPR comprehensive since interception of drains are difficult in this city which has large drains (rather those should be called as "rivers") and no good road for laying interceptor in parallel with Ganga River. In case UPJN would prepare DPR ID&T the JICA Survey Team would propose the necessary revisions for the DPR comprehensive and ID&T.

Due to the delay of starting the preparation of DPR Ghazipur ID&T by UPJN the JICA Survey Team prepared the image of interceptions from 13 existing drains as shown in **Figure 9.1.8**. The abstract of quantities are shown in Table 9.1.9. The intermediate pumping stations (IPS-1 and 2) are not necessary from the preliminary consideration of interceptor invert level but it is continued to be checked for matching with invert levels of future branch sewers to be connected.

Figure 9.1.9 shows the integrated image of 1) ID&T work as urgent measure and 2) future sewer network which will be developed with MoUD fund. The abstract of quantities is shown in Table 9.1.10. The quantities of future sewer network are under revision for deducting the overlapped sections between interceptor and future sewer network.

Table 9.1.9 Proposed Sewer Works in Ghazipur City (Phase-I: ID&T)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length		
			Open (Rm)	Micro Tunneling (Rm)	
1) Gravity Sewer					
RCC	NP3	350	770	0	
RCC	NP3	400	1,661	0	
RCC	NP3	450	0	0	
RCC	NP3	500	0	0	
RCC	NP3	600	1,018	0	
RCC	NP3	700	1,360	0	
RCC	NP3	800	1,414	0	
RCC	NP3	900	967	0	
RCC	NP3	1000	651	0	
RCC	NP3	1100	494	0	
Sub-total			**8,335**	**0**	
2) Rising Main					
DI	K9	700	25		MPS
Sub-total			**25**	**0**	
Total			**8,360**		

(2) Manhole

Dia. (mm)	Nos.
900	118
1200	127
1500	39
Total	**284**

(3) Interception Structure

Nos.
13

Source: JICA Survey Team

Note: red color parts will be changed after further consideration

Table 9.1.10 Proposed Sewer Works in Ghazipur City (ID&T and Sewer Network)

(1) Sewer Pipe

Material	Type	Dia. (mm)	Length (Rm)				
			Open	Micro Tunneling	Open	Micro Tunneling	
			ID&T (NMCG)		Sewer Network (MoUD)		
1) Interceptor/Gravity Sewer							
RCC	NP3	200	0	0	57,974	0	
RCC	NP3	250	0	0	5,574	0	
RCC	NP3	300	0	0	3,664	0	
RCC	NP3	350	770	0	3,250	0	
RCC	NP3	400	1,661	0	1,604	0	
RCC	NP3	450	0	0	1,169	0	
RCC	NP3	500	0	0	2,742	0	
RCC	NP3	600	1,018	0	1,141	0	
RCC	NP3	700	1,360	0	525	0	
RCC	NP3	800	1,414	0	0	0	
RCC	NP3	900	967	0	2,415	0	
RCC	NP3	1000	651	0	264	0	
RCC	NP3	1200	494	0	188	0	
Sub-total			**8,335**	**0**	**80,510**	**0**	
2) Rising Main							
DI	K9	200	**-**	**-**	**250**	**-**	IPS-3
DI	K9	700	**25**	**-**			MPS
Sub-total			**25**	**0**	**250**	**-**	
Total			**8,360**	**0**	**80,760**	**0**	

(2) Manhole

Dia. (mm)	NMCG (Nos.)	MOUD (Nos.)
900	118	
1200	127	
1500	39	
Total	**284**	**1,721**

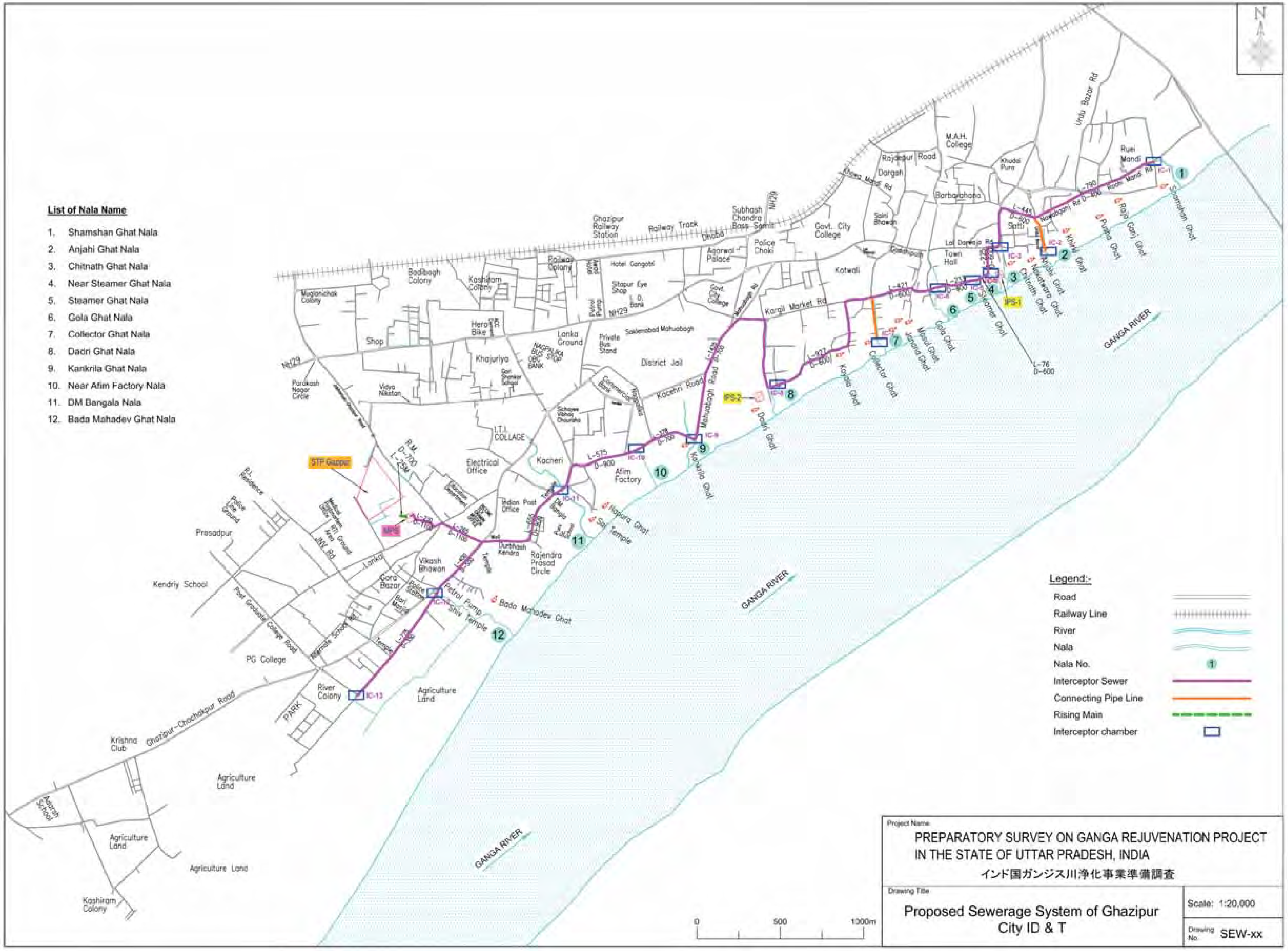
(3) Interception Structure (Nala Tapping Structure)

NMCG (Nos.)	MOUD (Nos.)
13	**0**

(4) House Connection (Nos.)

NMCG	MOUD
0	**3,900**

Source: JICA Survey Team, DPR Ghazipur Comprehensive
Note: red color parts will be changed after further consideration



Source: JICA Survey Team

Figure 9.1.8 Proposed Sewerage System in Ghazipur City ID&T

Source: JICA Survey Team based on DPR Ghazipur ID&T and Comprehensive

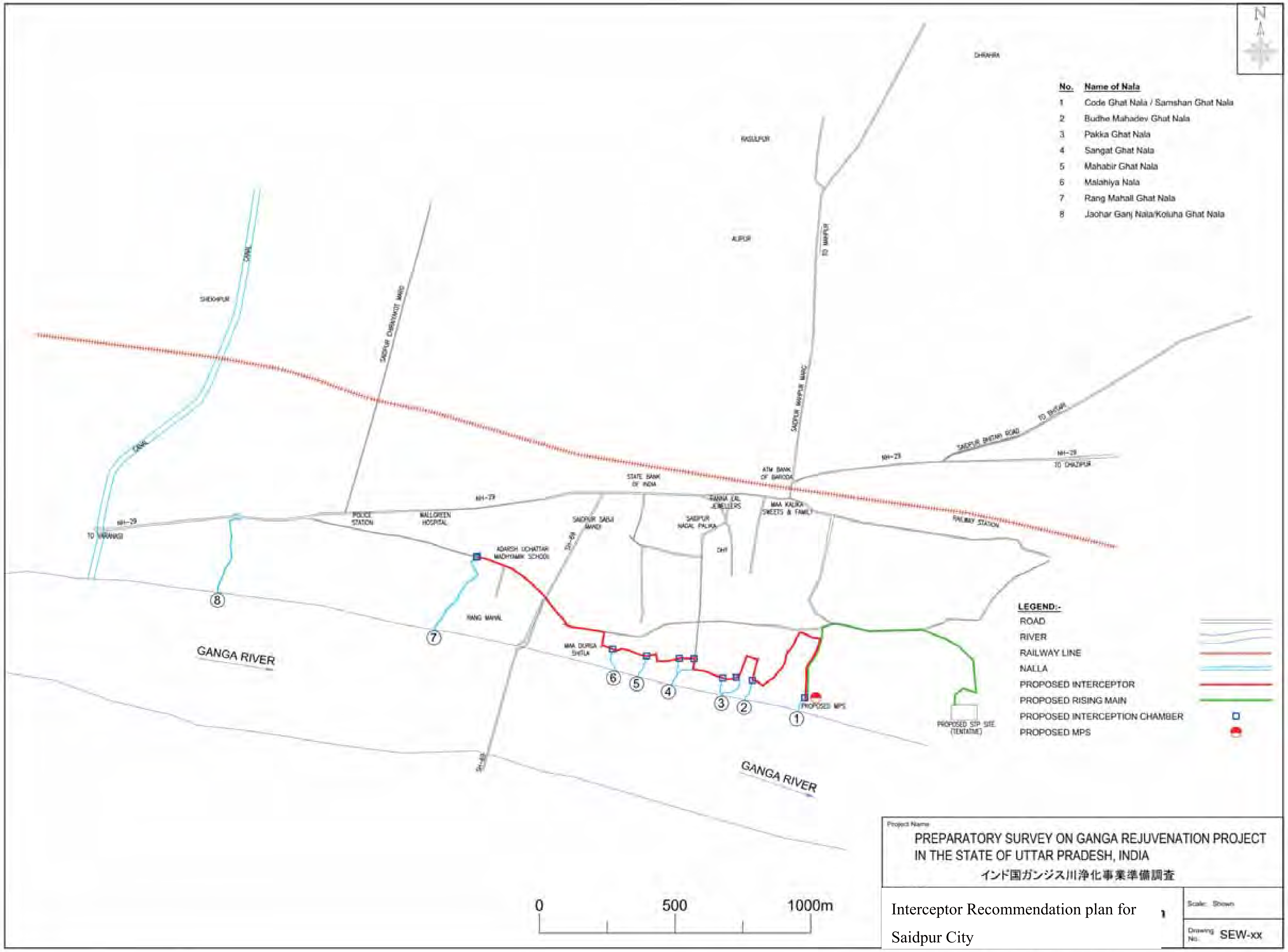
Figure 9.1.9 Proposed Sewerage System in Ghazipur City (Phase-I: ID&T and Phase-II: Sewer Network)

9.1.9 Proposed Sewerage Work for Saidpur City

DPR of ID&T was thought to be prepared by UPJN based on survey results of drains for interception. However, ID&T plan was not submitted and the land for the STP was not available at last. Based on the interview to UPJN, the possible route and tapping points under consideration are shown in **Figure 9.1.10**. This information will be useful when the land for the STP becomes available.

9.1.10 Abstract of Proposed Sewer Works for Target Cities

Table 9.1.11 shows the list of proposed sewer works (interceptor and/or sewer networks and rising mains) and number of pumping stations as urgent works which were revised from current DPRs by JICA Survey Team. Table 9.1.12 shows the list of future sewer works in target cities with combination of comprehensive and ID&T methods.



Source: JICA Survey Team based on Interview to UPJN

Figure 9.1.10 Interceptor Route in Saidpur City (Recommended Plan)

Table 9.1.11 Abstract of Proposed Sewer Works in Target Cities (Urgent Works):

No.			District	Varanasi								Mirzapur				Ghazipur			
			City/Town	Varanasi						Ramnagar		Mirzapur		Chunar		Ghazipur		Saidpur	
			Sewerage District	District-I		District-II		District-III		-		-		-		-		-	
			Development	Comprehensive		Comprehensive		Comprehensive		ID&T		ID&T		ID&T		ID&T		ID&T	
			Central Government	NMCG		NMCG		NMCG		NMCG		NMCG		NMCG		NMCG		NMCG	
	Item	Material	Dia. (mm)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																		
	1) Gravity	RCC	200	193,294	840	236,690	332	109,441	0	0	0	750	0	0	0	0	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	0	0	400	0	700	0	0	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	0	0	800	0	0	0	0	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	80	0	0	0	250	0	770	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	150	0	555	0	0	0	1,661	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	0	0	550	0	0	0	0	0		
		RCC	500	2,081	99	2,875	540	288	39	120	0	1,659	0	0	0	0	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	2,211	0	1,550	0	1,018	0		
		RCC	700	84	30	1,924	90	2,603	165	0	0	0	0	1,808	0	1,360	0		
		RCC	800	317	90	570	439	867	0	0	0	210	0			1,414	0		
		RCC	900	0	0	1,244	918	0	0	30	0	1,700	0			967	0		
		RCC	1000													651	0		
		RCC	1200													494	0		
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	380	0	8,835	0	4,308	0	8,335	0	1,235	0
			Total	219,648		276,007		120,342		380		8,835		4,308		8,335		1,235	
	2) Rising Main	DI	200					30				370		2,130				500	
		DI	300									3,550							
		DI	350											30					
		DI	400							2,700									
		DI	600									80							
		DI	700									1,370							
			Total	0	-	0	-	30	-	2,700	-	5,370	-	2,160	-	0	-	500	-
	3) Treated Effluent Reuse Line																		
		RCC	350	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-
		RCC	800	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-
			Total of pipe laying work	219,648		276,007		120,372		3,080		21,205		10,163		8,335		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159				279		86		118			
			1200	27		145		149				65		63		127			
			1500													39			
			1000x1500															29	
			1500x1500							10									
			Total	10,925	-	13,128	-	5,308	-	10	-	344	-	149	-	284	-	29	-
3	Interception Structure		Zone									Mirzapur	Vindhyachal						
	1) New		nos.	-	-	-	-	-	-	4	-	13	4	22	-	13	-	9	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	4	-	18	8	22	-	13	-	9	-
4	House Connection																		
	1) New		nos.	9,804	-	34,216	-	18,261	-	0	-	0	-	0	-	0	-	0	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	-	-	-	-	-	-
5	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) New		nos.	-	-	-	-	1	-	0	1	3	1	1	1	0	1	0	1
	2) Rehabilitation		nos.	-	-	-	-	-	-	-	-	2	2	-	-	-	-		
	Total		nos.	0		0		1		1		8		2		1		1	

Remarks: Saidpur was dropped due to Land issue for the STP

Source: JICA Survey Team based on DPRs and Proposals of Revisions for Target Cities

Table 9.1.12 Abstract of Proposed Sewer Works in Target Cities (ID&T and Sewer Networks):

No.			District	Varanasi								Mirzapur						Ghazipur					
			City/Town	Varanasi						Ramnagar		Mirzapur				Chunar		Ghazipur				Saidpur	
			Sewerage District	District-I		District-II		District-III		-		-				-		-				-	
			Development	Comprehensive		Comprehensive		Comprehensive		ID&T		ID&T		Sewer Network		ID&T		ID&T		Sewer Network		ID&T	
			Central Government	NMCG		NMCG		NMCG		NMCG		NMCG		MOUD		NMCG		NMCG		MOUD		NMCG	
	Item	Material	Dia. (mm)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)	Open (m)	Micro Tunneling (m)
1	Sewer																						
	1) Gravity	RCC	200	193,294	840	236,690	332	109,441	0	0	0	750	0	217,181	110	0	0	0	0	57,974	0	560	0
		RCC	250	9,862	309	11,062	0	1,993	0	0	0	400	0	3,814	0	700	0	0	0	5,574	0	180	0
		RCC	300	4,808	0	6,018	269	1,333	0	0	0	800	0	9,141	25	0	0	0	0	3,664	0	190	0
		RCC	350	2,010	18	3,788	145	572	0	80	0	0	0	1,716	0	250	0	770	0	3,250	0	160	0
		RCC	400	2,069	268	4,132	499	298	0	150	0	555	0	4,219	30	0	0	1,661	0	1,604	0	145	0
		RCC	450	1,609	30	2,427	311	1,411	554	0	0	550	0	1,275	25	0	0	0	0	1,169	0		
		RCC	500	2,081	99	2,875	540	288	39	120	0	1,659	0	1,908	0	0	0	0	0	2,742	0		
		RCC	600	1,638	192	1,366	368	729	49	0	0	2,211	0	586	20	1,550	0	1,018	0	1,141	0		
		RCC	700	84	30	1,924	90	2,603	165	0	0	0	0	1,899	0	1,808	0	1,360	0	525	0		
		RCC	800	317	90	570	439	867	0	0	0	210	0	1,199	0			1,414	0	0	0		
		RCC	900	0	0	1,244	918	0	0	30	0	1,700	0	970	20			967	0	2,415	0		
		RCC	1000											1,537	20			651	0	264	0		
		RCC	1200											0	30			494	0	188	0		
			Sub-total	217,772	1,876	272,096	3,911	119,535	807	380	0	8,835	0	245,445	280	4,308	0	8,335	0	80,510	0	1,235	0
			Total	219,648		276,007		120,342		380		8,835		245,725		4,308		8,335		80,510		1,235	
	2) Rising Main	DI	200					30				370		356		2,130				250			
		CI	200																			500	
		DI	300									3,550		36									
		DI	350													30				1,440			
		DI	400							2,700													
		DI	600									80											
		DI	700									1,370								25			
			Total	0	-	0	-	30	-	2,700	-	5,370	-	392	-	2,160	-	0	-	1,715		500	-
	3) Treated Effluent Reuse Line																						
		RCC	350	-	-	-	-	-	-	-	-	-	-	-	-	3,695	-	-	-	-	-	-	-
		RCC	800	-	-	-	-	-	-	-	-	7,000	-	-	-	-	-	-	-	-	-	-	-
	Total of pipe laying work			219,648		276,007		120,372		3,080		21,205		246,117		10,163		8,335		82,225		1,735	
2	Manhole	nos.	900	10,898		12,983		5,159				279		10,210		86		118					
			1200	27		145		149				65		162		63		127					
			1500															39					
			1000x1500																			29	
			1500x1500							10													
			Total	10,925	-	13,128	-	5,308	-	10	-	344	-	10,372	-	149	-	284	-	1,721	-	29	-
3	Interception Structure		Zone									Mirzapur	Vindhyachal	Mirzapur	Vindhyachal								
	1) New		nos.	-	-	-	-	-	-	4	-	13	4	-	-	22	-	13	-	-	-	9	-
	2) Revamping		nos.	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-	-	-	-	-	-
	Total		nos.	-	-	-	-	-	-	4	-	18	8	-	-	22	-	13	-	-	-	9	-
4	House Connection																						
	1) New		nos.	9,804	-	34,216	-	18,261	-	0	-	0	-	28,629	-	0	-	0	-	3,900	-	0	-
	2) Transfer		nos.	38,288	-	79,836	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Septic tank soak pit		nos.	-	-	-	-	-	-	-	-	-		8		0	-	-	-	-	-	-	-
6	Pump Station			IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS	IPS	MPS
	1) New		nos.	-	-	-	-	1	-	0	1	3	1	2	-	1	1	0	1	1	0	0	1
	2) Rehabilitation		nos.	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-		
	Total		nos.	0		0		1		1		8		2		2		1		1		1	

Remarks: Saidpur was dropped due to land issue for the STP

Source: JICA Survey Team based on DPRs and Proposals of Revisions for Target Cities

9.1.11 Permission for Road Cutting

The outline of obtaining permissions for road cuttings for laying of pipes can be categorized into permission by (1) PWD and (2) ULBs according to interviews to concerned agencies such as NHAI Varanasi Office, PWD, UPJN and construction supervision consultant for GAP-II project.

(1) Permission by Public Works Department (PWD)

PWD handles the permission for road cuttings on the following roads;

1) National highway (NH)

2) State highway (SH)

3) Major district road (MDR)

4) Other district road (ODR)

5) Village road (VR): roads connecting to villages (not minor roads in villages)

6) Major municipal road

In many cases in city areas the managements of national highways are transferred from National Highway Authority of India (NHAI) to PWD NH Divisions. Therefore, permissions for all the road cutting works on national highways are to be obtained from PWD NH Division and ones on the other major roads above are to be obtained from PWD office. The steps from application to permission proceeds as follows in general;

1. Application document with drawings are prepared by contractor and submitted to UPJN. In special or urgent case UPJN alone prepares the document.
2. UPJN submits the documents to PWD local office (Varanasi, Mirzapur, Ghazipur). The copies are also sent to urban local body (ULB) office.
3. PWD local office checks the existing utilities such as water supply pipelines, electric cables, and communication cables and any event to use the road which is planned during construction period in the section. If there is not a significant issue requiring adjustment between concerned departments on such as power supply and communication, the permission document will be issued quickly by PWD office alone. PWD NH Division sends the information to NHAI also in case of national highway.
4. If there is any issue, the administration authority such as District Magistrate (DM) as district level, or Divisional Commissioner as division level, or Principal Secretary of PWD as state level hold the meeting between concerned organizations (only government organizations such as Jal Kal and departments of power, communication) and adjust the schedule.
5. After such a meeting “No Objection Certificate (NOC)” is issued from the administration authority who held the meeting to PWD office.
6. PWD office issues the permission document. The required period is normally 1 to 2 months

but it depends on situation of each road and scale of cutting work. The period might be longer as 6 months in case of national highway and insufficient information in attached drawings to application and meanwhile, the period might be rather shortened to several days in the urgent and relatively minor road case according to UPJN.

Table 9.1.13 shows the list of pipe laying on highways which may take long time for obtaining permissions of road cutting. The ID&T works in Mirzapur, Chunar, and Ghazipur are stated as "N/A" but since some sections of the interceptors will be installed under major municipal roads it does not mean all the permission for pipe installation works will be obtained from only ULBs (NPP, NP).

Dia. 900 mm pipe in NH29 in Varanasi District-II would be a biggest issue among all the locations. There have been ongoing work for rising mains under GAP-II in the same road but since the pipe laying in this case is deeper and requires more width for cutting, the permission matter should be taken care enough and the application to PWD should be submitted early enough during the detailed design stage after checking of existing public utilities on the alignment.

Table 9.1.13 Pipe Laying on Major Roads in Target Cities

Project	Development	Major Road	Largest Pipe	Application
Varanasi Dist-I	Comp.	NH7, NH29 Luxa Road Bhadani Road	500mm 500mm 450mm	PWD Varanasi (NH Division) PWD Varanasi
Varanasi Dist-II	Comp.	NH29 Rathyatra Mahmurganj Road	900mm 450mm	PWD Varanasi (NH Division) PWD Varanasi
Varanasi Dist-III	Comp.	SH74 University Road	200mm 600mm	PWD Varanasi
Ramnagar	ID&T	NH7	N/A	PWD Varanasi (NH Division)
Mirzapur	ID&T	NH35, NH135, SH5	N/A	N/A
	Comp.	NH35, NH135 SH5	300mm 400mm	PWD Mirzapur (NH Division) PWD Mirzapur
Chunar	ID&T	NH35	N/A	N/A
Ghazipur	ID&T	NH29 Mahuabagh Road Ghazipur – Chochakpur Road	N/A To be confirmed ditto	N/A PWD Ghazipur
	Comp.	NH29 Kacehri Road	500mm 500mm	PWD Ghazipur (NH Division) PWD Ghazipur
Saidpur	ID&T	NH29 SH69 MDR166E	To be confirmed N/A N/A	(PWD Ghazipur NH Division) N/A N/A

Note:
Comp.: comprehensive, NH: national highway, SH: state highway, N/A: no plan of installing pipe
Source: JICA Survey Team

(2) Permission by Urban Local Bodies (ULBs)

The permissions for road cutting works on all the municipal roads except for roads maintained by PWD are to be obtained from ULB offices. The period for permission is in general less than the case of major roads handled by PWD.

(3) Reference

1) The road cutting length in one application should be 1 to 5 km and the applicant cannot submit for many sections at the same time. The case for 5 km application as maximum length is only the case if the road is not congested.

2) Basically PWD, not contractor for pipe laying work, recovers the pavement on the major roads mentioned above. The exception is only the less important road among the roads handled by PWD. UPJN will pay for the cost called "cutting/road maintenance charges" within the state governments.

3) The documents to be attached to application document are;

a) Longitudinal section of pipe laying work

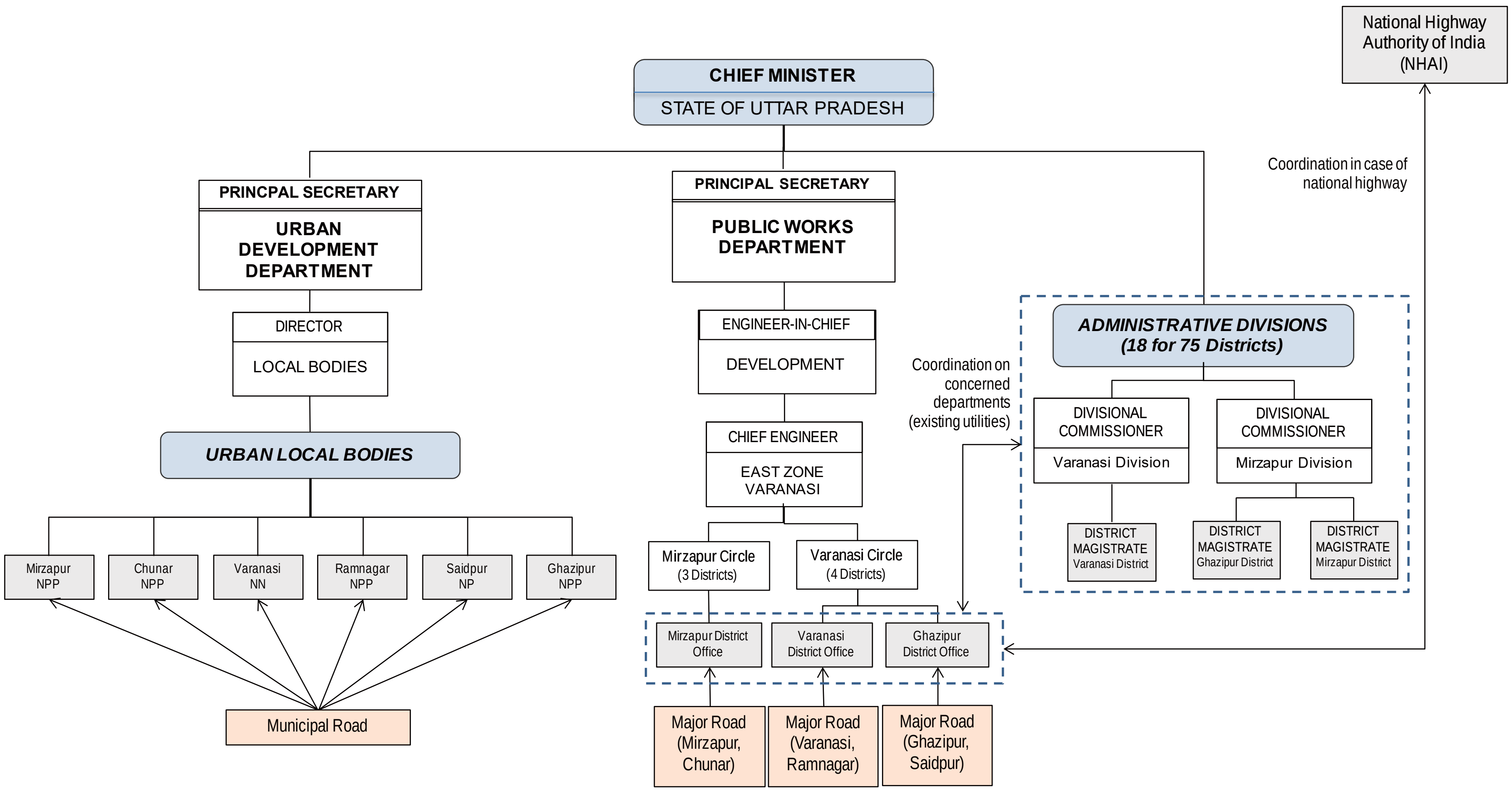
b) Cross section of the work

c) Brief specification

d) Key map of the project

e) Project brief

The concerned government agencies for road cutting permission explained in 1) and 2) above are shown in **Figure 9.1.11**.



Source: JICA Survey Team

Figure 9.1.11 Concerned Government Agency for Road Cutting Permission

9.2 Intermediate Pumping Stations

9.2.1 Varanasi City District-I

No pumping station is proposed for Varanasi City District-I.

9.2.2 Varanasi City District-II

No pumping station is proposed for Varanasi City District-II.

9.2.3 Varanasi City District-III

One lift pumping station (LPS) were proposed near Sarai Nandan beside Assi Interceptor in DPR. The required dimension is shown in following table. The plan and section for the proposed interceptor is shown in Appendix 9.2.1.

Since the sewerage design in District-III is under revision from original DPR, the design of this pumping station such as depth would be revised further.

Table 9.2.1 Proposed Dimension for LPS near Sarai Nandan in Varanasi District-III

No.	LPS (New)													
	Location	Flow (MLD)		Pumps								Rising Main		
		2035	2050	Total	Duty	Standby	Capacity (m3/hr)	Total Capacity (Duty) (m3/hr)	Total Capacity (Duty) (MLD)	Head (m)	HP	Material	Dia. (mm)	Length (m)
1	near Sarai Nandan (MH No. 1295)	3.92	6.45	6	4	2	100	400	9.6	15	10	DI	200	30

Source: DPR Varanasi District-III

9.2.4 Ramnagar City

1) General

A master pumping station (MPS) was proposed by UPJN in DPR Ramnagar ID&T as the design period is shown in **Table 9.2.2** and the general specification is shown in **Table 9.2.3**. The design ground level is TP 74.50m which was determined from high water level of Ganga River 73.90m + 0.45m allowance as per CPHEEO manual.

Since many discrepancies from BOQ in DPR were found in layout drawing, JICA Survey Team has revised the civil structures and buildings to match the contents between drawing and BOQ. The general layout is shown in Appendix 9.2.2.

Table 9.2.2 Design Period for MPS at Ram Bagh Drain, Mallahi in Ramnagar City

No.	Item	Design Period
1	Civil Structure (Wet Well, Screen Chamber etc.)	30 years (2050)
2	E&M (Pumps etc.)	15 years (2035)

Source: DPR Ramnagar ID&T

Table 9.2.3 General Specification of Proposed Pumping Stations in Ramnagar City (ID&T)

No.	PS	Location	PS Capacity (MLD)		Pump								Rising Main		
					Flow	Type	No. of pump			Capacity (m3/min)	Head (m)	HP	Material	Dia. (mm)	Length (m)
			Average	Peak			Nos.	Duty	Standby						
1	MPS	Ram Bagh Nala, Mallahi	**13**	29.25	Peak	Submersible non clog	3	2	1	7.84	55	180	DI-K9	400	2,700
					Non-peak	Submersible non clog	2	1	1	3.94	55	100			

Source: JICA Survey Team confirmed from DPR Ramnagar ID&T

2) Civil Work

The dimensions of civil works are listed in the following table. The dimensions of some structures were adjusted from figures in original DPR (such as H6.9m in inlet chamber) based on the actual layout and revised interceptor design which was revised based on topo survey result of ground and drain levels. Since original heights of civil structures seemed to have some extra free board compared to the required water depths, the heights were reduced.

Table 9.2.4 Dimension of Civil Works for MPS Mallahi in Ramnagar

No.	Structure	Dimension	Water Depth	Note
A	Civil			
1	Inlet Chamber	W4.0m x L3.0m x H5.15m	1.02m	Height reduced based on revised interceptor design
2	Mechanical Screen Channel	W1.1m x L7.0m x H5.15m x 2 nos.	0.55m	Width and length adjusted from DPR
3	Manual Screen Channel	W1.1m x L7.0m x H5.15m	0.55m	Width and length adjusted from DPR
4	Silt Catching Basin	W1.8m x L9.7m x H5.15m x 2 nos.	0.55m	Width adjusted from DPR
5	Wet Well	Internal Dia. 7.5m x H8.65m	1.75m	Height reduced based on inlet chamber level
B	Building			
1	Pump House	W8.5m x L6.0m x H6.0m	-	Width adjusted from DPR
2	HT Room/Metering Room	W12.0m x L6.0m x H6.0m	-	As per DPR
3	LT Room	W6.0m x L6.0m x H6.0m	-	As per DPR
4	Staff Quarter	W8.5m x L5.7m x H6.0m	-	As per DPR

Source: JICA Survey Team

9.2.5 Mirzapur City

1) Phase-I: ID&T Work

a) IPS

Two existing IPS will be rehabilitated and three new IPS will be constructed as shown in following tables. The plans and sections for IPS-5 to 7 after the revisions for matching with flow calculations and BOQs are shown in Appendixes 9.2.3 to 9.2.5.

Table 9.2.5 General Specification of Rehabilitated IPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	IPS-1	near Chetganj Teraha	Peak	255	3	2	1	20	510	12.24	Existing	DI	350	1700
			Non-peak	155	2	1	1	16	155	3.72	**Proposed**	**DI K9**	**300**	**1700**
Vindhyachal														
2	IPS-3	Ram Janki Mandir	Peak	110	3	2	1	10	220	5.28	Existing	DI	80	250
			Non-peak	55	2	1	1	9	55	1.32	**Proposed**	**DI K9**	**200**	**250**

Table 9.2.6 General Specification of New IPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	IPS-5	near Sadar Post Office	Peak	460	6	4	2	13	1840	44.16	DI-K9	600	50
2	IPS-6	near Khandawa Nala	Peak	260	3	2	1	20	520	12.48	DI-K9	300	1750
			Non-peak	140	2	1	1	15	140	3.36			
Vindhyachal													
3	IPS-7	near Patengra Nala	Peak	100	3	2	1	12	200	4.8	DI-K9	200	120
			Non-peak	50	2	1	1	12	50	1.2			

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

b) MPS

Two existing MPS will be rehabilitated and one new MPS will be constructed. Hence, existing MPS-2 in Mirzapur Zone will become IPS after construction of new MPS-8 in Mirzapur Zone. The general specifications of the MPSs are listed in the following tables. The plan and sections for new MPS-8 is shown in Appendix 9.2.6.

Table 9.2.7 General Specification of Rehabilitated MPS in Mirzapur City (ID&T)

No.	Rehabilitation of Existing PS													
	Name	Location	Pump								Rising Main			
			Flow	Capacity (cum/hr)	Pump Nos.			Head (m)	Total Capacity (Duty)		Status	Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)				
Mirzapur														
1	MPS-2	Kutchary	Peak	765	3	2	1	13	1530	36.72	Existing	DI	700	1370
			Non-peak	410	2	1	1	12	410	9.84	**Proposed**	**DI-K9**	**700**	**1370**
Vindhyachal														
2	MPS-4	near Viddyachal STP		175	6	4	2	11	700	16.8	Existing	DI	300	100
											Proposed	**DI-K9**	**300**	**30**

Table 9.2.8 General Specification of New MPS in Mirzapur City (ID&T)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (m3/hr)	Pump Nos.			Head (m)	Total Capacity		Material	Dia. (mm)	Length (m)
					Total	Duty	Standby		(cum/hr)	(MLD)			
Mirzapur													
1	MPS-8	near Existing STP	Peak	460	6	4	2	11	1840	44.16	DI-K9	600	30

Source: JICA Survey Team confirmed from DPR Mirzapur ID&T

2) Phase-II: Sewer Network

Two additional IPS will be constructed for development of sewer network as shown in following table.

Table 9.2.9 General Specification of New IPS in Mirzapur City (Sewer Network)

No.	Proposed												
	Name	Location	Pump								Rising Main		
			Flow	Capacity (cum/hr)	Pump Nos. Total	Duty	Standby	Head (m)	Total Capacity (cum/hr)	(MLD)	Material	Dia. (mm)	Length (m)
Mirzapur													
1	IPS-7-> IPS-9	district jail Mirzapur	Peak	280	3	2	1	13	13	13	DI-K9	300	36
			Non-peak	150	2	1	1	13	13	13			
2	IPS-8-> IPS-10	lalah ghat	Peak	160	3	2	1	21	21	21	DI-K9	200	356
			Non-peak	65	2	1	1	17	17	17			

Source: JICA Survey Team confirmed from DPR Mirzapur Comprehensive

9.2.6 Chunar City

IPS-1 and MPS were proposed in DPR Chunar ID&T as listed in the following table. JICA Survey Team is reviewing the design. The layout of proposed MPS are shown in Appendixes 9.2.7. Since the discrepancies in depth and water levels from flow calculation and BOQ were found those figures were corrected. However, such as pump head would be revised further since the sewerage design for Chunar are under revision.

Table 9.2.10 General Specification of Proposed Pumping Stations in Chunar City (ID&T)

No.	PS	Location	Pump							Rising Main		
			Flow	Type	No. of pump			Capacity (m3/hr)	Head (m)	Material	Dia. (mm)	Length (m)
					Nos.	Duty	Standby					
1	IPS-I	Tambal Ganj	Peak	Submersible	3	2	1	105	23	DI-K9	200	2,130
			Non-peak	Submersible	2	1	1	45	19			
					5	3	2					
2	MPS	Near STP	Peak	Submersible	6	4	2	180	10	DI-K9	350	30

Source: JICA Survey Team confirmed from DPR Chunar ID&T

9.2.7 Ghazipur City

Comprehensive plan was submitted and UPJN is still preparing the DPR for Ghazipur ID&T. JICA Survey Team reviewed comprehensive plan and the design of master pumping station (MPS) in STP site and any other IPSs.

9.2.8 Saidpur City

UPJN has been preparing the DPR for Saidpur ID&T. However, since STP site was not secured in the period of DPR review, Saidpur was dropped from the review work.

9.3 . STPs

9.3.1 Considerations in STP plan

1) Outline

In India, when finalizing a sewer DPR, the engineer mainly refers to “Guidelines for Preparation of Project Reports” by the National River Conservation Plan and the National Ganga River Basin Authority” (MoEF, NRCD, 2010) and “Manual on Sewerage and Sewage Treatment Systems” (MoUD, CPHEEO, JICA, 2013). However strict application has not been made, so the ideas on about individual items, have been left to the discretion of each engineer (UPJN and consultants in the case of these plans) and approver (NGRBA in the case of these plans).

Based on these manuals and other DPR etc., the survey team reviewed STP plans of each DPR. Main considerations are shown in **Table 9.3.1.**

Table 9.3.1 Main considerations in STP plan

1) Design condition	a) design year
	b) design population
	c) design sewage flow
	d) design influent sewage quality
	e) design effluent water quantity
	f) site boundary on map
	g) design ground level (GL) and design effluent water level
	h) other condition
2) Design concept	a) sewage treatment process
	b) disinfection process
	c) sludge treatment process
	d) sludge disposal
	e) necessity of spare machine
3) Design output	a) spec table of main structure and equipment
	b) design calculation sheets
	c) layout plan drawing
	d) hydraulic calculation sheets
	e) hydraulic flow diagram
	f) construction schedule
	g) matching at another components (Between comprehensive and ID&T, pipe planning)

Source: JICA Survey Team

2) Design Year

The description of the design year for the whole DPRs is certain, but in the actual STP construction plan, they were set as shown in **Table 9.3.2**. It is mostly set at approximately 10 to 20 years after the current year (2016). Since the design year setting depends on the construction plan of each local governments, it will be different from each other respectively. The subsequent year will be added in the future if necessary, and it is desirable to refer to a future planned site. Survey Team conducted future projection uniformly for setting the year as 2020, 2030, 2035, 2040, 2050 as presented. Given that different cities had different Design years of facilities as shown in Table 9.3.2 which were depicted from DPRs, the study was conducted by setting final target year for all the cities and towns as 2050 to confirm future allowance/room of the proposed sewage treatment plants by the unified comparison method among the subject cities and towns.

Table 9.3.2 Design Year of Proposed STP

STP		Design Year	Current Year	Term (years)	Remarks
Dinapur		2030	2016	14	
Bhagwanpur		2030		14	
Ramna		2035		19	
Mirzapur	Comp.	2030		14	
	ID&T				
Vindhyachal	Comp.	2030		14	
	ID&T				
Ghazipur	Comp.	2025		9	
Ramnagar	Comp.	2050		34	
	ID&T	2035		19	Detail plan is not shown.
Chunar	Comp.	2030		14	
	ID&T				

Source: JICA Survey Team

3) Design Population

As identified in **Chapter 7**, there is no problem in the design population.

4) Design Sewage Flow

As the design sewage flow, both average and maximum flows are required. As identified in **Chapter 7**, the average design flow has no problem. And in the CPHEEO manual, the design maximum flow is set by multiplying the peak factor in **Table 9.3.3**. Basically, the design maximum flow is applied to an inlet chamber to primary and secondary clarifiers.

Table 9.3.3 Peak Factor for Contributory Population

Contributory Population	Peak Factor
Up to 20,000	3.00
Above 20,001 to 50,000	2.50
Above 50,001 to 750,000	2.25
Above 750,001	2.00

Source: CPHEEO manual, 2013

5) Design Influent Sewage Quality

At the existing STP, records of actual influent sewage value can be of some help for the design. In this survey, as shown in **Chapter 6**, the water quality survey was conducted for design as well as for confirmation of the current status.

6) Design Effluent Water Quality

The transition in recent years of effluent quality regulation values is shown in the following. In 2016, there has been a movement of further strengthening of regulations. And DPRs were finalized before the amendment announcement, thus most current design values for DPRs is not consistent with them. DPR review was made in consideration of these new standards in the work. **Table 9.3.4** indicates the transition and the new standard as of June 2016.

Table 9.3.4 History of Effluent Standards from STP in India

Water Quality Item		NGRBA Guidelines (2010)	CPHEEO Manual (2013)	**CPCB New Standards (27th April 2016)**
		Effluent Standards for discharge into water bodies	Recommended Guidelines for Treated Sewage	**Parameters Limit Not Authorized**
pH	-	5.5-9.0	-	**6.5-9.0**
BOD_5	mg/l	20	Less than 10	**Not more than 10**
COD	mg/l	-	-	**Not more than 50**
TSS	mg/l	30	Less than 10	**Not more than 10**
NH_4-N	mg/l	-	-	**Not more than 5**
T-N	mg/l	-	Less than 10	**Not more than 10**
T-P	mg/l	-	Less than 2	**Less than 2**
Faecal Coliforms	MPN/100mL	Desirable– 1,000 Permissible– 10,000	Less than 230	**Less than 230**

Source: JICA Survey Team

This report basically accepts the new effluent discharged standards for sewage treatment plant in the draft notification gazetted on November 24, 2015.

Compared with the old 2013 CPHEEO manual, the new standard is definitely exhaustive. However the values are almost same as the 2013 standard. UPJN got the notification of the new water quality standard on 27th April 2016 from CPCB.

Since all the existing STPs were constructed according to the old standards, the effluent from them is not compliant with the new standards. They must be reconstructed following the new standards after their lives. However, new construction shall be conducted prior to remodelling/reconstruction of the old facilities in terms of securing the treatment capacity during the construction work, difficulties of reconstruction work within the existing plant yard and budget issue for the construction work. After the operation of new facilities, old facilities can be reconstructed

7) Site Boundary on Map

It is easy to grasp the site boundary of existing STPs. On the other hand, it is hard for New STPs in the drawings of DPRs. In this survey, our team surveyed boundaries of all proposed sites (See appendix). Based on these results, the layout plan should be prepared inside the confirmed site boundary.

8) Design Ground Level (GL) and Design Effluent Water Level

As results of ground elevation survey, the actual GL ware rather different in those of some DPRs. And around Varanasi, large-scale flood occurs in 1978 and 2013. Hence, the planned GL and planned effluent water level should be set on the basis of these past water levels.

2016/1/25 UP IRRIGATION

IRRIGATION DEPARTMENT, UTTAR PRADESH

Login for Departmental Users Instruction for Flood Entry

The water level in major rivers of Uttar Pradesh Date: 01/25/2016

date 25/01/2016 Click To Change Date Reaching Danger Level Above Danger Level

Departmental CWC Both Reservoir

serial number	River	Gauge Site	District	The maximum water level (m 0)	Year	Danger levels (m 0)	date	time	Water level (m 0)	Rain (m 0 m 0)	Trend
1	Nalar	Mrora	Pauri	556.00	1993	556.60	01/25/2016	-NA-	0.00	0.00	-NA-
2	Ganges	Haridwar	Haridwar	296.23	1978	294.00	01/25/2016	-NA-	0.00	0.00	-NA-
3	Ganges	Naraura D 0 S 0	Bulandshahr	180.01	1988	178.42	01/25/2016	-NA-	0.00	0.00	-NA-
4	Ganges	Fatehgarh	Frukabad	138.06	1972	137.60	01/25/2016	-NA-	0.00	0.00	-NA-
5	Ganges	Gumta	Kannauj	126.24	1998	125.97	01/25/2016	-NA-	0.00	0.00	-NA-
6	Ganges	Ankinghat	Kanpur	124.30	1978	124.00	01/25/2016	-NA-	0.00	0.00	-NA-
7	Ganges	Kanpur	Kanpur	113.46	1967	114.00	01/25/2016	-NA-	0.00	0.00	-NA-
8	Ganges	Dlmu	Rae	99.84	1973	99.36	01/25/2016	-NA-	0.00	0.00	-NA-
9	Ganges	Phaphamau	Allahabad	87.98	1978	84.73	01/25/2016	-NA-	0.00	0.00	-NA-
10	Ganges	Chhag	Allahabad	88.03	1978	84.73	01/25/2016	-NA-	0.00	0.00	-NA-
11	Ganges	Mirzapur	Mirzapur	80.34	1978	77.72	01/25/2016	-NA-	0.00	0.00	-NA-
12	Ganges	Varanasi	Varanasi	73.90	1978	71.26	01/25/2016	-NA-	0.00	0.00	-NA-
13	Ganges	Gazipur	Gazipur	65.22	1978	63.10	01/25/2016	-NA-	0.00	0.00	-NA-
14	Ganges	Ballya	Ballya								
15	Ramganga	Kalagdr	Bijnor								
16	Ramganga	Muradabd	Moradabad								
17	Ramganga	Bareilly	Bareilly								
18	Ramganga	Dabri	Shahjahanpur								

http://www.lucknowinfo.com/idup/home.aspx?s=CWC

Figure 9.3.1 Maximum Water Level in Major Rivers

Source: JICA Survey Team

9) Other Condition

a) Soil

In the case of soft ground, pile foundation or ground improvement is required. These costs should be included in the estimation.

b) Material

Compliance with the Indian Standard (IS) or the British Standard (BS) is required.

c) Mechanical Model

On the basis of the manufacturer catalogues and adopt performance, mechanical model should be chosen.

d) Noise and Odour Regulation

See Chapter 11.

e) Architectural Standard

Compliance with the National Building Code of India 2005 (NBC 2005) is required. In addition, additional equipment such as lighting, firefighting equipment, hand washing etc. are required mainly at the administration building. These costs should be included in the estimation.

f) Temporary Works

If the excavation depth is deep or the groundwater level is high, unlined excavation may wreak ground collapse. Hence, appropriate temporary works are required.

g) Entrance Road

If an existing road is narrow as an approach road to STP, construction vehicles may not go through. In that case, the road widening is required.

h) Site Maintenance and Ancillary Works

In spite of no direct effect on plant performance, hall road, boundary wall and planting work are required as parts of civil works. These costs should be included in the estimation.

i) Monitoring System

The selection of resident monitoring or remote monitoring is required. In addition, the necessity of a SCADA system should be considered.

10) Sewage Treatment Process

The sewage treatment process mentioned in this report is proposed by the consultants and does not represent at this stage an actual or presumed endorsement, preference, or acceptance by JICA.

a) Performance in India

In India, when selecting a sewage treatment process, the engineer mainly refers to foregoing references and “Compendium of Sewage Treatment Technologies” (NRCD, 2009). According to this, the outline of the existing STPs in India is described below.

- 32 STPs (728 MLD treatment capacity) were constructed and II existing STPs (151MLD treatment capacity) were renovated under the Ganga Action Plan Phase I (GAP-I). Activated sludge process (ASP) and its modifications were the most preferred technology accounting for almost 62% of the total capacity.

- 26 STPs (722 MLD treatment capacity) were set up under the Yamuna Action Plan, Phase-I (YAP-I). Upflow Anaerobic Sludge Blanket (UASB) process was the most preferred treatment technology, accounting for 83 percent of the total installed treatment capacity.

- Concurrently with YAP, 30 STPs having a treatment capacity of 2325 MLD were added in Delhi under the river conservation programme of the Government of NCT Delhi. Most of these STPs are based on the ASP technology or its minor variants. A big STP (182 MLD capacity) has been constructed at Rithala using the BIOFOR-F technology.

In addition to the technological options discussed above, several other technologies have been used with success in various parts of India. These include the Sequential Batch Reactor (SBR) technology and its minor modification which has been employed in several STPs in western and southern India. Another technological option is the Moving Biological Bed Reactor (MBBR), which is very similar to the FAB* system. Further in many places in western and southern India, the UASB process has been used in conjunction with the FAL and Final Polishing Unit (FPU) or in combination with the ASP to provide higher quality treatment.

*fluidized aerated bed

Source: Compendium of Sewage Treatment Technologies (NRCD, 2009)

b) Candidates considered with new standards

As mentioned above, the effluent quality regulations is strengthened. However, planned effluent water quality in these existing STPs are higher than the value shown at 2016 CPCB standard. Therefore, when adopting these processing methods, not only to ensure the HRT, but it is necessary to ensure that has sufficient treating capacity by process calculation.

On the other hand, STPs in Japan that is achieved the effluent quality standards of India are described below.

Table 9.3.5 STPs in Japan achieved the effluent quality standards of India (2013)

Sewage Process Method	Nos.	Actual Elimination Rate		
		BOD	SS	T-N
Oxidation Ditch	140	98.6%	97.6%	83.1%
Activated Sludge Process	127	98.5%	98.0%	84.1%
Step Flow Multistage Nitrification Denitrification	13	97.1%	96.8%	84.5%
Sequencing Batch Reactor	11	98.6%	98.4%	86.5%
Anaerobic Aerobic Activated Sludge Process	10	98.8%	95.2%	82.8%
Extended Aeration Method	8	98.2%	99.0%	88.1%
Advanced Oxidation Ditch	7	99.1%	98.9%	91.5%
Circulated Nitrification / Denitrification Process	6	99.0%	99.1%	89.4%
Anaerobic Anoxic Oxic Process	6	98.7%	98.9%	80.8%

Note: Based on "Statistics of Sewerage in Japan 2013" (JSWA, 2015), process which past adopted records are more than 5 nos. are made up.

Source: JICA Survey Team

Based on these facts, the candidates which will be satisfied with the standards are shown below.

- Sequencing Batch Reactor (SBR)
- Activated Sludge Process (ASP)
- Oxidation Ditch Process (OD)
- Anaerobic Aerobic Process (AO)
- Circulated Nitrification / Denitrification Process (CND)
- Anaerobic Anoxic Oxic Process (A2O)
- Membrane Biological Reactor (MBR)

c) Sequencing Batch Reactor (SBR)

The sequencing batch reactor (SBR) is a type of activate sludge treatment system which treats wastewater by aeration and sedimentation in a single tank. The detention time of each process can be adjusted flexibly in this process.

Since the anaerobic, anoxic and oxic conditions can be also flexibly controlled, nitrogen and phosphorus removal corresponding to loading variation is possible according to the operation condition.

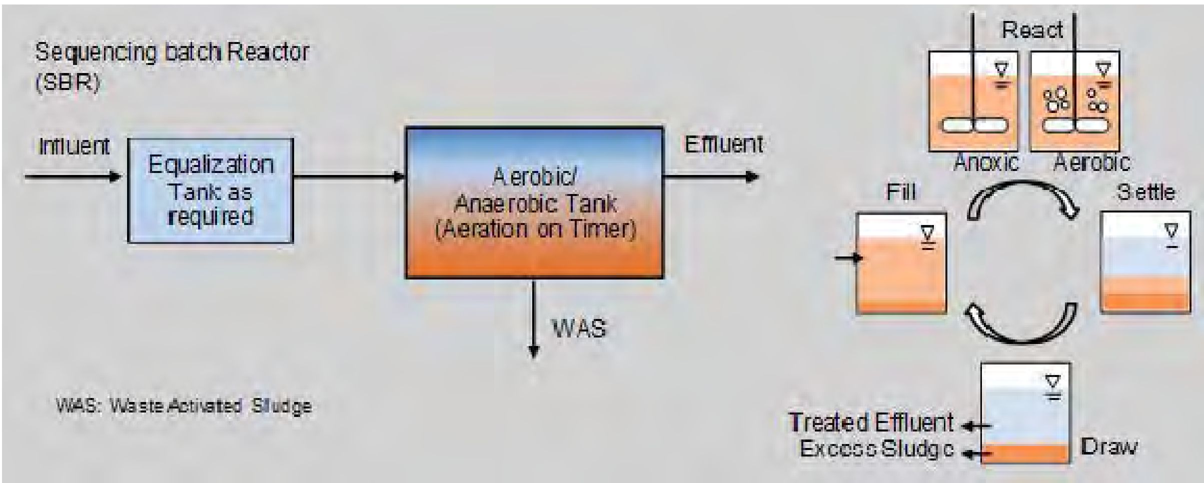


Figure 9.3.2 Process Flow of SBR

Source: JICA Survey Team

It should be noted that an advanced type which is a kind of SBR, has been attracting attention in recent India. It performs multi-processes in a single reactor like SBR, and has a proprietary technology for automatic control by DO monitoring, a blower and a decanter etc. This allows for shorter cycle times as well as the omission of a separate denitrification cycle. Hence, no mixers for denitrification are necessary.

d) Activated Sludge Process (ASP)

This is the most conventional process for wastewater treatment worldwide. As shown in Figure, at first the raw wastewater flows into the primary sedimentation tank for removal of suspended solids. Dissolved organic pollutant is then removed by biological oxidation under aerated condition. Supernatant from final sedimentation tank is discharged as final effluent after chlorination process.

Effluent quality, especially BOD, is low enough in this process, while nitrogen and phosphorus removal is unexpected. Skilled engineers are required for operation and maintenance to avoid troubles (e.g. Sludge bulking, Biological foam).

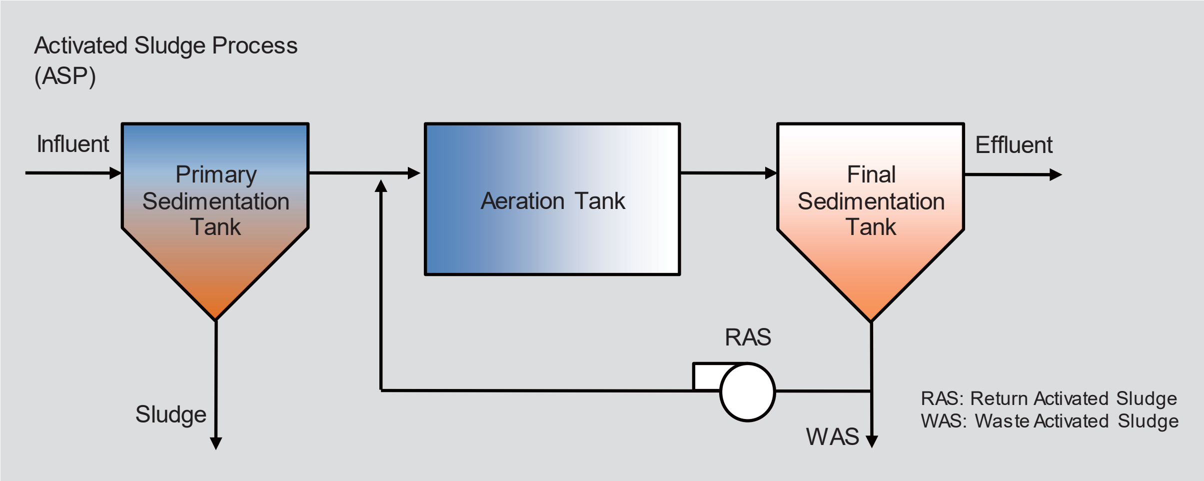


Figure 9.3.3 Process Flow of ASP

Source: JICA Survey Team

e) Oxidation Ditch Process (OD)

Oxidation ditch is one form of an extended aeration system having certain special features like an endless oval ditch for the aeration tank with rotors/aerators. The channel can be earthen with lined sloping sides and lined floor or it may be built in concrete or brick with vertical walls. Sewage is aerated by a surface rotor/aerators placed along the channel. The rotor/aerators not only aerate the sewage but also provide a horizontal velocity to the mixed liquor preventing the sludge from settling in the ditch.

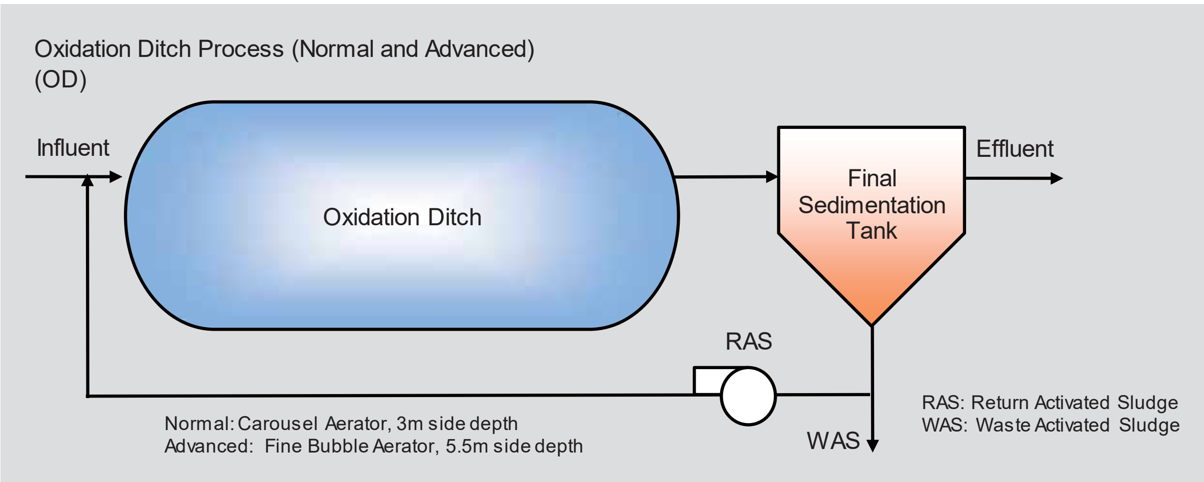


Figure 9.3.4 Process Flow of OD

Source: JICA Survey Team

f) Anaerobic Aerobic Process (AO)

This process is similar to ASP. By dividing an aeration tank into the anaerobic zone and aerobic zones with a wall, it is possible to remove phosphorus effectively.

Organic substrates are supplied from incoming sewage into the anaerobic zone and the return sludge comes into contact with the carbon source only in the anaerobic zone. The faster uptake of organic substrates in the anaerobic zone is the key for bacteria to win in the microbial selection in the enhanced biological phosphorus removal process.

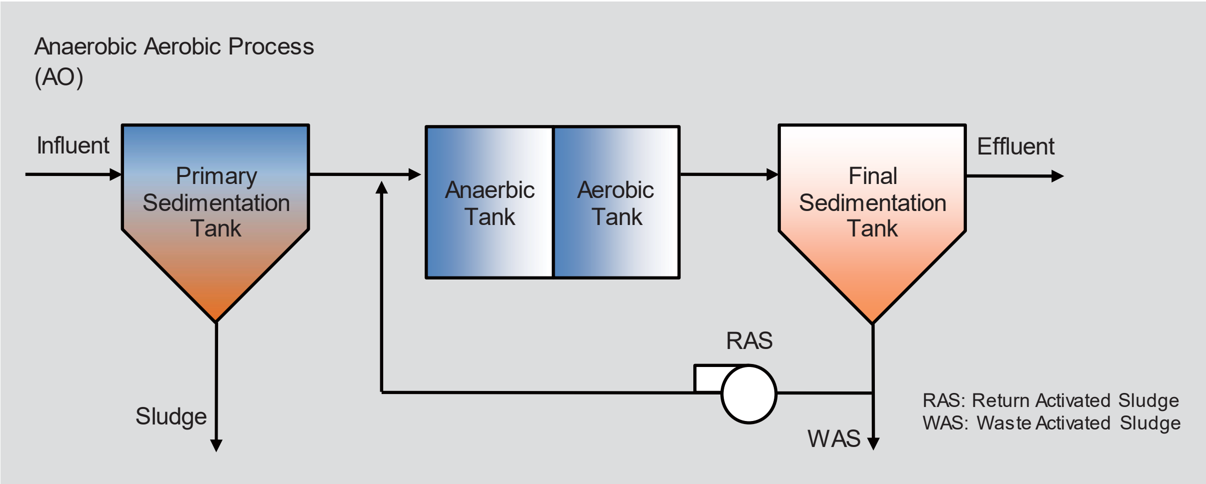


Figure 9.3.5 Process Flow of AO

Source: JICA Survey Team

g) Circulated Nitrification / Denitrification Process (CND)

Single-stage systems are those in which nutrient removal is achieved in a single basin and clarifier. The removal of nitrogen is achieved by combined nitrification (under aerobic conditions) and denitrification (under anoxic conditions). A single-stage system using one anoxic zone can achieve 65 to 70% removal efficiency of T-N for normal influent.

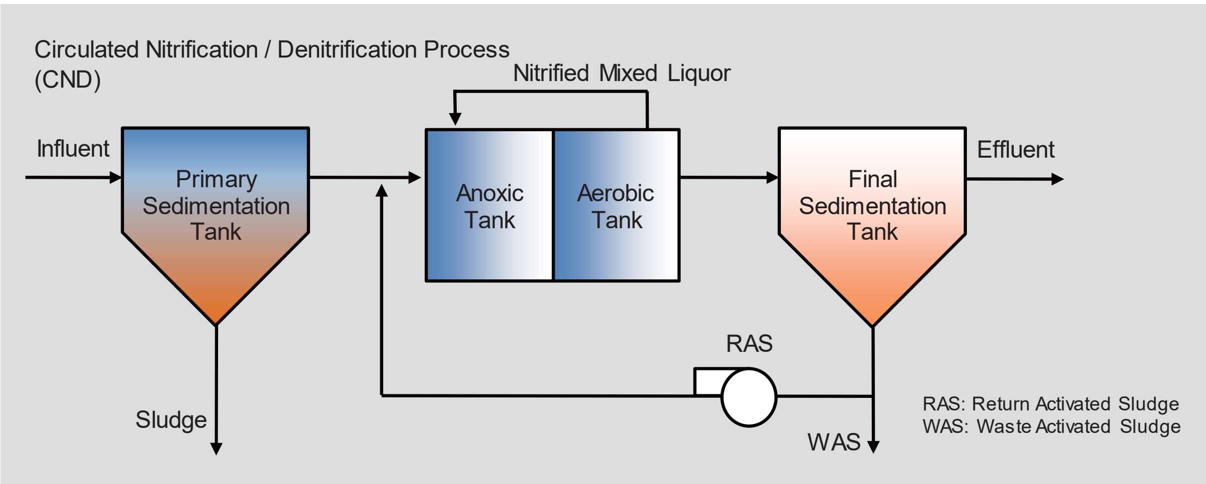


Figure 9.3.6 Process Flow of CND

Source: JICA Survey Team

h) Anaerobic Anoxic Oxic Process (A2O)

In this process, sludge is returned to a reactor in a series of anaerobic, anoxic and oxic tanks, with circulation from oxic tank to anoxic tank as shown in **Figure 9.3.7**. This enables simultaneous removal of nitrogen and phosphorus as an advanced wastewater treatment.

Compared to ASP, since the anaerobic tank and anoxic tank are needed for this system, it needs the construction area wider.

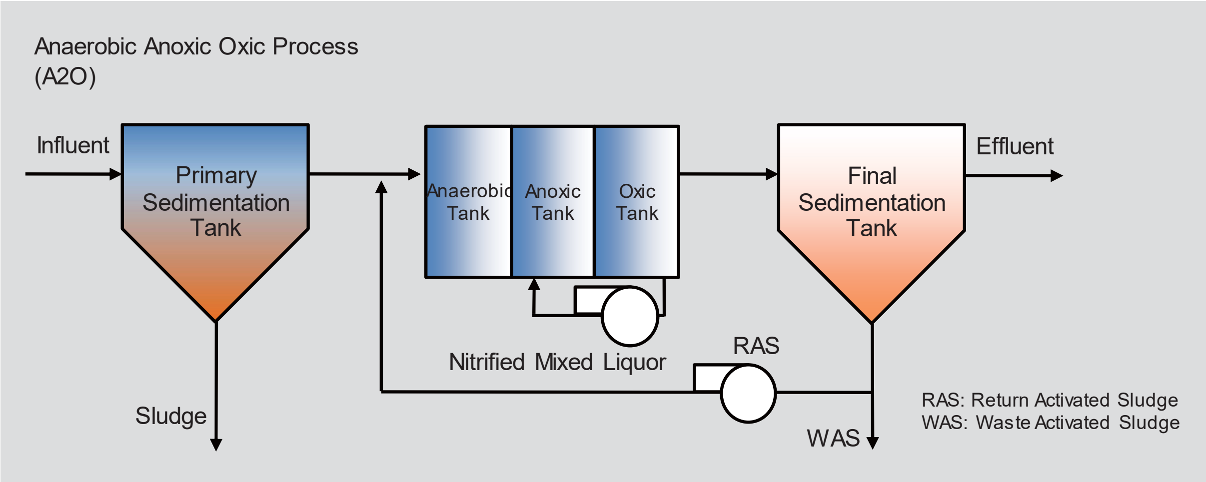


Figure 9.3.7 Process Flow of A2O

Source: JICA Survey Team

i) Membrane Biological Reactor (MBR)

MBR is an activated sludge process similar to ASP. The difference is in the method of separation of liquid and solid. In the MBR process, the bio-solids are separated by membranes.

MBR does not require final sedimentation tanks and the reactor tank volume can be smaller than that of ASP due to high MLSS concentration. Disinfection is not needed because coliform is removed by the membrane. However, the flow equalization tanks are usually equipped because the flux of membrane is not so flexible to flow variation. When the site is small, MBR has advantages.

Much air supply is required to protect the fouling on the membrane surface which causes the high power cost. Chemical cost for periodical cleaning of membrane and membrane replacement cost is necessary. O&M cost for MBR is higher than that of ASP.

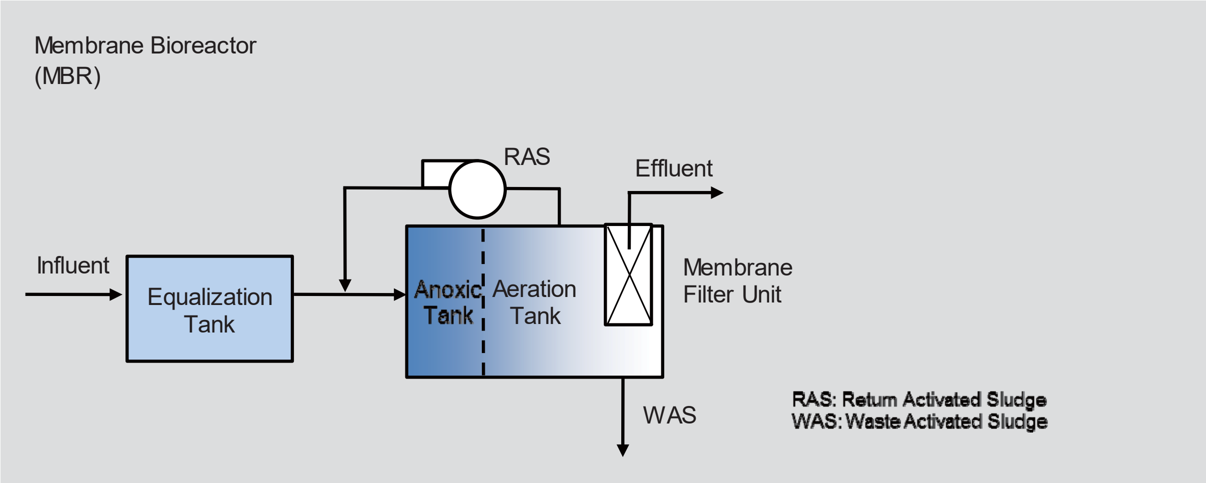


Figure 9.3.8 Process Flow of MBR

Source: JICA Survey Team

j) Comparison of Sewage Treatment Processes

The comparison of sewage treatment processes is shown in **Table 9.3.6**. Circulated Nitrification / Denitrification Process (CND), advanced type SBR and Moving Bed Biofilm Reactor (MBBR) are selected as appropriate processes. Since similar type of the CND is selected in Ramna and Ramnagar DPRs, it seems easy for accepting the new standard for the two STPs. Advanced type SBR has been accepted as the DPR process in the past, (DPR for Pune, in 2014) It is considered to be appropriate for the new standard as well.

At all existing STPs (Dinapur, Bhagwanpur, Mirzapur, Vindhyachal), the upgrading to CND process or advanced type SBR will be needed in the future. Dinapur STP will employ MBBR for replacing existing old trickling filters for keeping good water quality till the life of the lanes come. The MBBR will be removed at the same time when the life for the treatment lane comes.

k) Phosphorus removal

The new standard of T-P concentration of effluent is 2 mg/l as stipulated in **Table 9.3.4**. As shown in **Table 6.1.5**, T-P concentration in the raw sewage of Bhagwanpur STP and Dinapur STP were 3.00 mg/l 2.28mg/l.

Since all the processes listed above are capable of removing approximately 50% of T-P, the effluent quality will be compliant with the new standard.

Table 9.3.6 Comparison of Sewage Treatment Processes

Item	Process incapable of Nitrogen removal				Process for Nitrogen removal					
Name	Sequencing Batch Reactor	Activated Sludge Process	Oxidation Ditch Process	Anaerobic Aerobic Process	Advanced Oxidation Ditch Process	Sequencing Batch Reactor	Circulation Type Nitrification Denitrification Process	Moving Bed Biofilm Reactor	Anaerobic Anoxic Aerobic Process	Membrane Bioreactor
	SBR	ASP	OD	AO	Advanced OD	Advanced type SBR	CND	MBBR	A2O	MBR
DPR		Bhagwanpur (Existing)				Chunar	Ramnagar	Dinapur		
						Vindhyachal (Extension)	Ramna			
						Mirzapur (Extension)				
						Ghazipur				
Nitrogen removal	N/A	N/A	N/A	N/A	5	5	5	5	5	5
Treated Water Quality	3	3	3	3	4	4	4	4	4	5
Lot for Treatment Process	3	3	2	3	3	3	3	3	3	3
CAPEX	3	3	3	3	3	3	3	3	2	2
Easiness of Maintenance	3	3	4	3	3	3	3	4	2	2
OPEX	3	3	3	3	4	3	3	3	3	3
Past Record in India	4	3	2	1	1	4	4	2	1	1
Total	(19)	(18)	(17)	(16)	23	25	25	24	20	21
Adoption	N/A	N/A	N/A	N/A	Better	Best	Best	Better	Fair	Fair

Legend 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A (Not Applicable)

Source: JICA Survey Team

11) Disinfection Process

As methods of disinfection for Faecal Coliforms, mainly one of the 3 methods is used in STP from Chlorination, Ozone disinfection, and UV disinfection. Especially in India, Chlorination is the most common method.

As long as the detention time in the chlorination tank is secured as 30 minutes, the effluent standard for Coli will be kept in the range of the standard as stipulated in the design manual,

12) Sludge Treatment Process

By purifying sewage, since sludge is generated around the solid matter, it must also consider the processing method. For example, the sludge generated in the primary and secondary clarifiers is termed raw sludge, the moisture content is about 99%, thus must be concentrated. The method of concentration consists of sludge thickening and mechanical dewatering. Further, also in the means of power generation by biogas, sludge reduction by sludge digestion is efficient.

13) Sludge Disposal

As the sludge disposal process in the urban area in Japan, dewatered sludge is often treated furthermore for volume reduction to landfill or re-use by incineration. But this time target STPs are located near farmland, thus green farmland reduction of dewatered sludge is realizable.

14) Necessity of Spare Machine

In view of the trouble or maintenance, pumps, blowers and dewatering machines are desirable to have spare units.

15) Spec Table of Main Structure and Equipment

For major facilities, it should be organized in a list and subjected to a check of other organized content.

16) Design Calculation Sheets

The STP consists of two big fields, that is, “civil engineering and architecture” and “mechanical and electrical engineering”. About former, the part about hydraulic design and water tank capacity should be determined by calculation sheets. About latter, specifications should be determined by calculation or manufacturer catalogue, etc.

17) Layout Plan Drawing

Major facilities have to be layout inside boundaries without interference to other structures. In addition, expansion after the design year should be considered. In other words, consideration of allocation of sewage flow and tank is required.

18) Hydraulic Calculation Sheets

19) Hydraulic Flow Diagram

From an inlet chamber to a discharge point, confirmation of flow down without hydraulic problems is required. All target STPs, at first pump-up in or before STP, then ensure the height meters above ground. After that, it has a natural flow to the discharge point.

20) Construction schedule

Any of the DPRs, there is no description of the specific construction process. Without construction time schedule, estimation of annual estimated cost and procurement planning are supposed to be difficult.

Also, defining operation start point and confirming excess process capacity from the inflow sewage amount, should be required.by using a staircase graph, such as shown in the figure below.

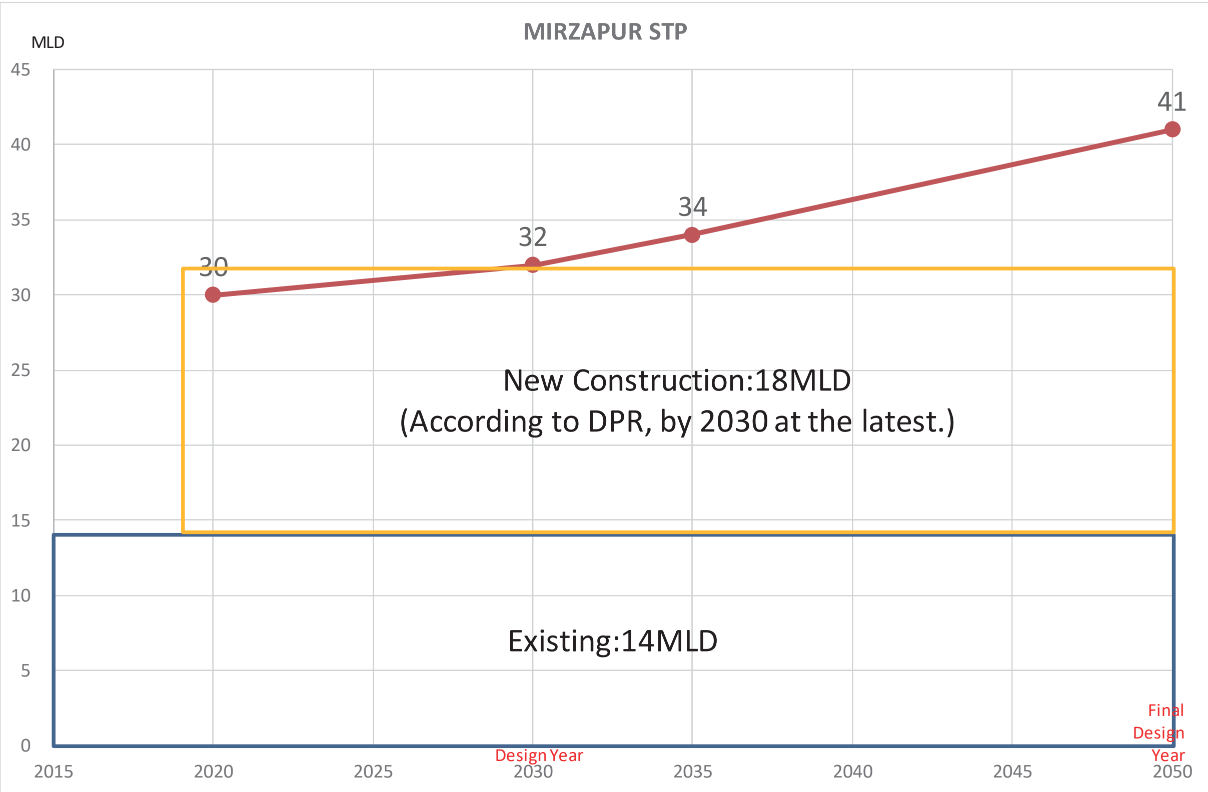


Figure 9.3.9 Construction plan of Mirzapur STP based on DPR

Source: JICA Survey Team

Note: About 3 STPs (Dinapur, Bhagwanpur and Ramna) in Varanasi City, not graphed for no year transition flow plan in DPR.

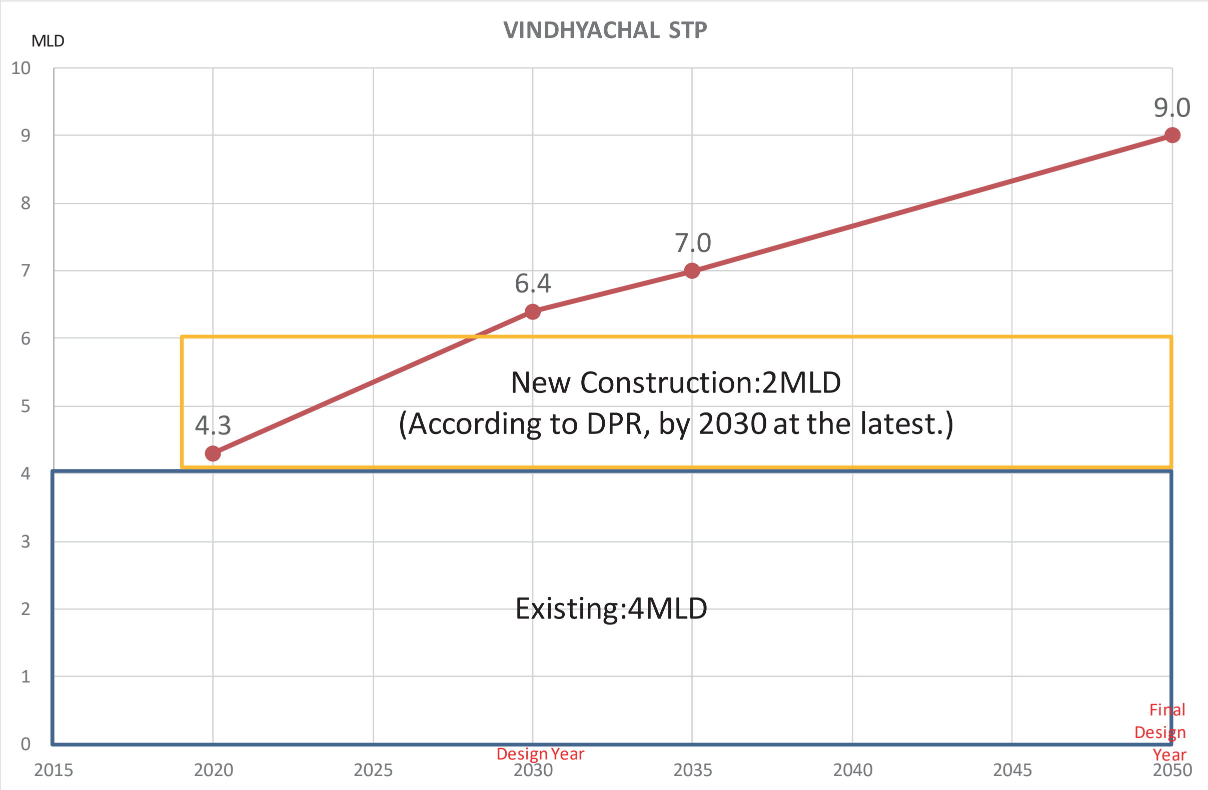


Figure 9.3.10 Construction plan of Vindhyachal STP based on DPR

Source: JICA Survey Team

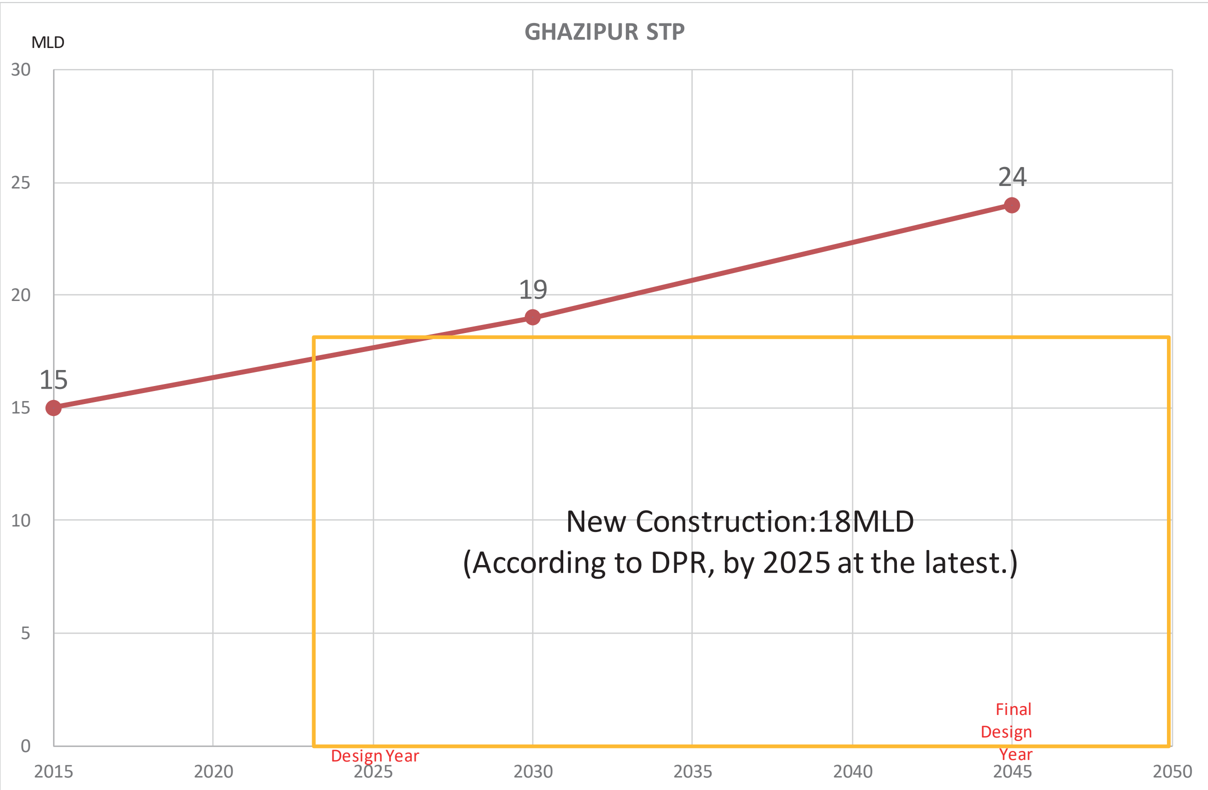


Figure 9.3.11 Construction plan of Ghazipur STP based on DPR

Source: JICA Survey Team

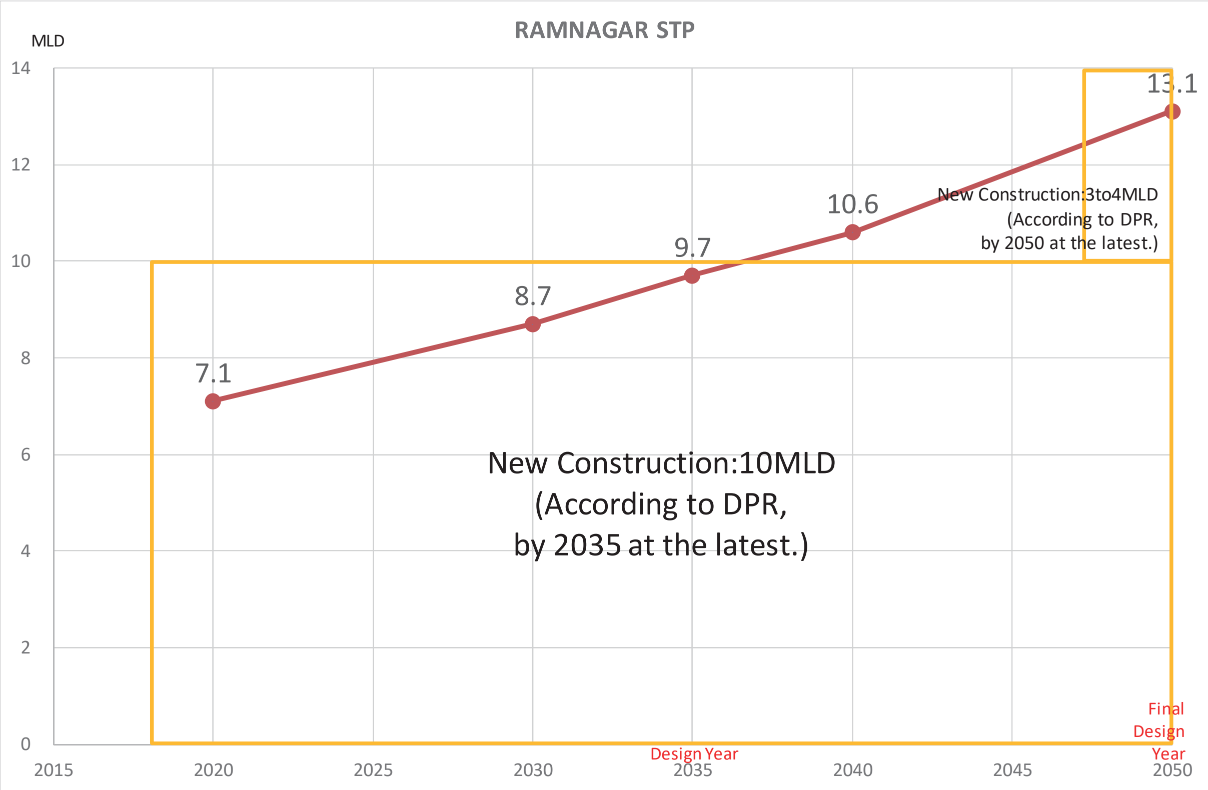


Figure 9.3.12 Construction plan of Ramnagar STP based on DPR

Source: JICA Survey Team

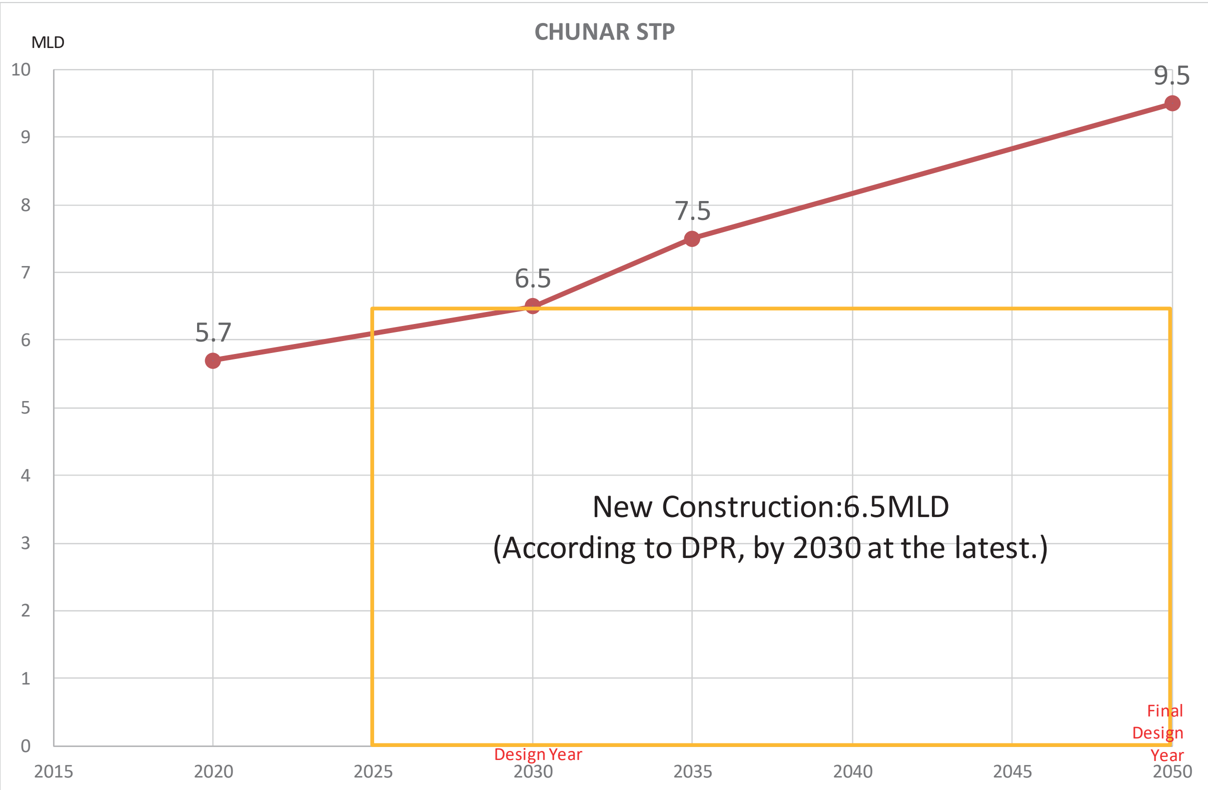


Figure 9.3.13 Construction plan of Chunar STP based on DPR

Source: JICA Survey Team

21) Matching at Another Components (Between comprehensive and ID&T, pipe planning)
In case of project implementation on two stages of ID&T and comprehensive plan, project components shall be properly arranged between the both plans.

9.3.2 Dinapur STP

(1) Consideration of biological treatment process

1) Point to review

As mentioned in 5.2.2, the existing STP is proposed upgrade. At the DPR, many demolitions of existing structures are planned for a reason that biological reactors need larger footprint for meeting the new effluent standards, which have changed to more strict water quality and added nitrogen and phosphorus. However, those existing structures made of reinforced concrete are not as old as being demolished, which are commissioned in 1994, and most of them can be used sufficiently by rehabilitation, therefore, they should be utilized as many as possible not to waste assets. To review the mentioned above, the DPR plan, Single-stage CND, is compared to two alternative plans, Moving Bed Biofilm Reactor (MBBR) and Double-stage CND by Step Feed, by JICA Survey team.

2) Description of DPR's plan and alternatives

a) Single-stage CND plan (DPR)

As shown on Figure 9.3.6, CND comprises anoxic tanks, aerobic tanks, and final clarifiers. Nitrogen can be removed by circulating mixed-liquor from aerobic tank, where organic/ ammonium nitrogen are oxidized by nitrification, to anoxic tank, where denitrification occurs by utilizing BOD of influent wastewater for carbon source; this method is termed MLE technology. As advantage of Single-CND, it is the simplest system and the least equipment in the three plans. However, as disadvantage, the largest footprint is required, which causes much demolition and renewal of the existing facilities, not only liquid treatment facilities but also some sludge treatment facilities. Furthermore, the side water depth, 7.5m, is higher than generally reactor, which makes maintenance of diffusers difficult.

b) MBBR plan (Alternative 1)

The schematic process diagram and layout plan of MBBR plan are shown in Figure 9.3.15, Figure 9.3.16 respectively.

This plan accomplishes to reduce volume by putting biofilm carriers into aerobic tank, where more nitrifiers are kept in it. As advantage of this plan, three existing aerobic tanks can be utilized with modification of water depth from 3.75m to 4.5m; because the freeboard has enough room, it is possible by raising outlet weir level. Existing trickling filter basins are demolished as other plans, and three anoxic tanks added there. As disadvantage, the most electrical power consumes because biofilm carriers need high DO concentration to keep nitrification in it.

c) Double-stage CND plan (Alternative 2)
The schematic Process diagram and layout plan of Double-stage CND plan are shown in

Figure 9.3.**17**, Figure 9.3.18 respectively.

In this plan, the facility has three series of biological reactor, which comprises two sets of anoxic/ aerobic tanks each series. In Double-stage CND, influent wastewater dividedly flows to the two anoxic tanks, which makes MLSS concentration in first anoxic/aerobic tanks higher than that in second anoxic/aerobic tanks; namely first anoxic/ aerobic tanks can keep more bacteria that work for wastewater treatment. Therefore, entire volume of reactor can be more compact than Single-stage CND, if MLSS concentration at inlet of secondary clarifier is same value. As other advantage of this process, circulation rate of nitrified mixed-liquor can be less than Single-stage CND, because the mixed-liquor nitrified at first aerobic can be removed at second anoxic tank without circulation.

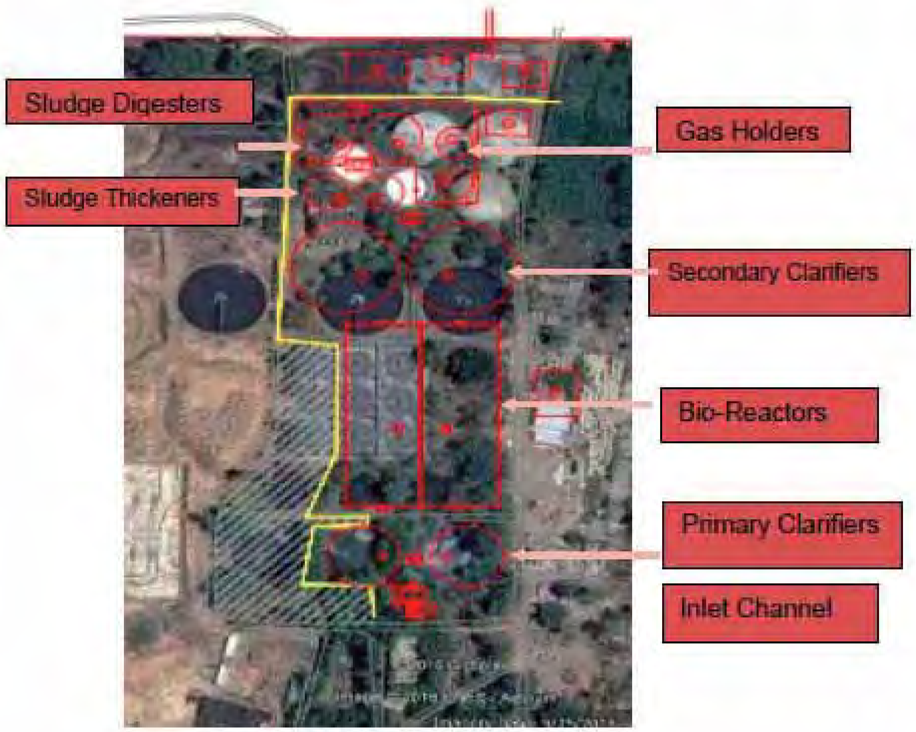


Figure 9.3.14 Layout plan of Dinapur STP (DPR plan)

Source: DPR

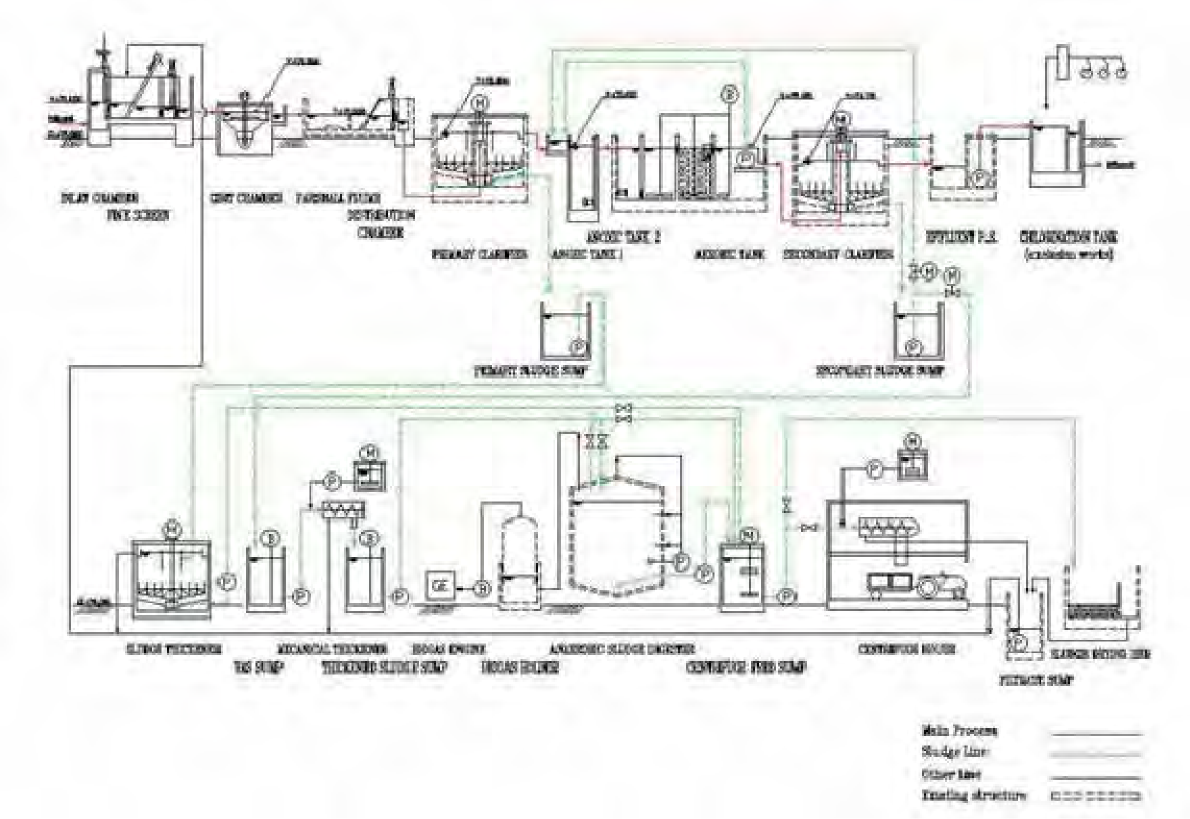
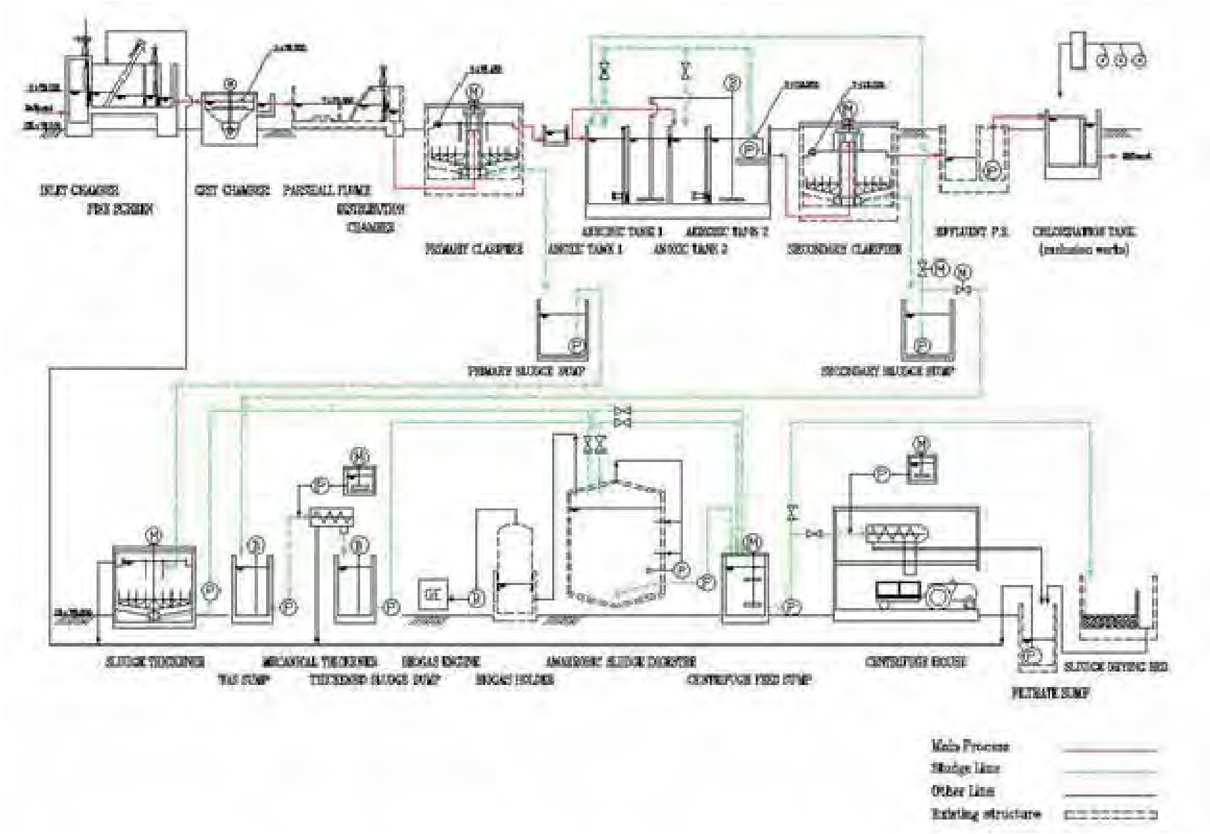


Figure 9.3.15 Schematic Process diagram of Dinapur STP (Alternative 1)

Source: JICA Survey Team

Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	$5.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	****W	****L	****SWD
06	Distribution Chamber	1	****W	****L	****SDW
07	Primary Clarifier	3	$31.2^{Dia.}$		3.5^{SWD}
08	Anoxic Tank 1	3	20.0^{W}	15.0^{L}	5.5^{SWD}
09	Anoxic Tank 2	3	20.0^{W}	19.5^{L}	4.5^{SWD}
10	Aerobic Tank	3	20.0^{W}	40.0^{L}	4.5^{SWD}
11	Secondary Clarifier	3	$40.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	$11.5^{Dia.}$		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	$29.0^{Dia.}$		7.0^{SWD}
19	Biogas Holder	2	$21.0^{Dia.}$		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	****W	****L	****H
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	****H
23	Air Blower Room	1	12.0^{W}	25.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	****H
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	10.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	****H
30	Power House	1	29.5^{W}	31.6^{L}	****H
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	****H
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Figure 9.3.16 Layout plan of Dinapur STP (Alternative 1)



Team

Figure 9.3.17 Schematic Process diagram of Dinapur STP (Alternative 2)

Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	5.5^{W}	4.5^{L}	2.5^{SWD}
02	Main Screen Channel	3	1.5^{W}	7.5^{L}	1.3^{SWD}
03	Bypass Screen Channel	1	1.5^{W}	7.5^{L}	1.5^{SWD}
04	Grit Chamber	2	$6.0^{Dia.}$		3.0^{SWD}
05	Parshall Flume	1	****W	****L	****SWD
06	Distribution Chamber	1	****W	****L	****SDW
07	Primary Clarifier	3	$31.2^{Dia.}$		3.5^{SWD}
08	Anoxic Tank 1,2	6	23.0^{W}	17.0^{L}	5.5^{SWD}
09					
10	Aerobic Tank 1,2	6	23.0^{W}	25.0^{L}	5.5^{SWD}
11	Secondary Clarifier	3	$40.0^{Dia.}$		3.5^{SWD}
12	Chlorine Contact Tank	1	Not in scope of project		
13	Primary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
14	Secondary Sludge Sump	3	3.0^{W}	4.0^{L}	4.0^{SWD}
15	Sludge Thickener	2	$11.5^{Dia.}$		4.0^{SWD}
16	WAS Sump	2	6.0^{W}	6.5^{L}	4.0^{SWD}
17	Thickened Sludge Sump	1	6.0^{W}	6.5^{L}	4.0^{SWD}
18	Anaerobic Sludge Digester	3	$29.0^{Dia.}$		7.0^{SWD}
19	Biogas Holder	2	$21.0^{Dia.}$		8.7^{SWD}
20	Centrifuge Feed Sump	2	6.0^{W}	6.0^{L}	3.5^{H}
21	Sludge Drying Bed	*	****W	****L	****H
22	Filtrate Sump House	1	12.7^{W}	13.0^{L}	****H
23	Air Blower Room	1	12.0^{W}	37.0^{L}	6.0^{H}
24	Treated Effluent Pump House	1	12.7^{W}	13.0^{L}	****H
25	Chlorination Building	1	Not in scope of project		
26	Thickened Sludge Pump House	1	6.0^{W}	6.0^{L}	4.0^{H}
27	Mechanical Thickener Building	1	10.0^{W}	15.0^{L}	8.0^{H}
28	Centrifuge Building	1	15.0^{W}	30.0^{L}	10.0^{H}
29	Control Room for Digester	1	4.2^{W}	4.3^{L}	****H
30	Power House	1	29.5^{W}	31.6^{L}	****H
31	Biogas Flare	2			
32	Administration Building	1	12.6^{W}	25.2^{L}	****H
33	Electrical Building	1	15.0^{W}	20.0^{L}	8.0^{H}

Figure 9.3.18 Layout plan of Dinapur STP (Alternative 2)

Source: JICA Survey Team

3) Assumption of design

The following values should be calculated for design of biological reactors to remove nitrogen:

- Required volume to secure nitrification in aerobic tank,
- Required volume for denitrification in anoxic tank,
- Circulation rate of nitrified mixed-liquor to achieve desired nitrogen removal performance.

If the above values are appropriate, BOD removal performance also will be achieved. Since those values does not mentioned in the DPR, they are calculated by JICA Survey team, which are referred to “Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION”, METCALF & EDDY/AECOM. Design condition for the calculation is shown in Table 9.3.7, which bases on the DPR, however some design values are arranged by JICA survey Team. And the result is shown in Table 9.3.8.

Table 9.3.7 Design Condition for Dinapur STP

Item	Design Value			Remarks
Flow Rate	80,000m3/d			
Temperature	20 ℃			
MLSS	3,000mg/l			at effluent of final reactor
Water quality	Influent	After Primary Clarifier	Effluent	
BOD	250mg/l	175mg/l	10mg/l	reduction 30% at Primary
COD	450mg/l	315mg/l	50mg/l	reduction 30% at Primary
TSS	400mg/l	160mg/l	10mg/l	reduction 60% at Primary
VSS	280mg/l	112mg/l	-	
T-N	50mg/l	45mg/l	10mg/l	reduction 10% at Primary
NH4-N	37mg/l	33.3mg/l	2mg/l	reduction 10% at Primary

Source: JICA Survey Team

Table 9.3.8 Comparison of Dinapur STP plans

Plan		DPR plan	Alternative 1	Alternative 2
Process		Single-stage CND	MBBR	Double-stage CND
Number of Series		2	3	3
Anoxic tank	Volume (m3/series)	6,799	3,371	4,268
	HRT	4h	3.03h	3.84h
Aerobic tank	Volume (m3/series)	10,722	3,560	6,267
	HRT	6.4h	3.2h	5.64h
Return Activated Sludge		60%	60%	60%
Internal Recycle		244%	214%	60%
Required Air (m3/d)		544,776	859,863	544,965

Source: JICA Survey Team

4) Comparison of plans

The demolished structures and rebuilt structures are shown in Table 9.3.9. and the comparison table is shown in Table 9.3.10.

Table 9.3.9 Demolished structures and rebuilt structure (Dinapur STP)

Plan	DPR plan	Alternative 1	Alternative 2
Process	Single-stage CND	MBBR	Double-stage CND
Demolished Facilities	1. Tricking Filters (Dia.22.5m x 3nos.) 2. Primary Clarifier (Dia.31.2m x 2nos.) 3. Aeration tank (4.500m3 x 2nos.) 4. Secondary Clarifier (Dia.40m x 2nos.) 5. RAS Pump House 6. Sludge Digester (4,600m3 x 3nos.) 7. Biogas holder (3,000m3 x 2nos.) 8. Engine House 9. Work Shop	1. Tricking Filters (Dia.22.5m x 3nos.) 2. RAS Pump House	1. Tricking Filters (Dia.22.5m x 3nos.) 2. Aeration tank (4.500m3 x 2nos.) 3. RAS Pump House 4. Work Shop
Rebuilt Facilities	1. Primary Clarifier (Dia.39m x 2nos.) 2. Aeration tank (17.500m3 x 2nos.) 3. Secondary Clarifier (Dia.46m x 2nos.) 4. RAS Pump House 5. Sludge Thickener (Dia.11.5m x 2nos.) 6. Sludge Digester (6,400m3 x 2nos.) 7. Biogas holder (2,700m3 x 2nos.) 8. Engine House 9. Air Blower Room 10. Mechanical Thickener 11. Centrifuge Building 12. Electrical Building	1.RAS Pump House 2. Sludge Thickener (Dia.11.5m x 2nos.) 3. Air Blower Room 4. Mechanical Thickener 5. Centrifuge Building 6. Electrical Building	1. Aeration tank (10.600m3 x 3nos.) 2. RAS Pump House 3. Sludge Thickener (Dia.11.5m x 2nos.) 4. Air Blower Room 5. Mechanical Thickener 6. Centrifuge Building 7. Electrical Building

Source: JICA Survey Team

Table 9.3.10 Comparison table of Dinapur STP plans

Plan	DPR plan	Alternative 1	Alternative 2
Process	Single-stage CND	MBBR	Double-stage CND
Treated water quality	4 x 2	4 x 2	4 x 2
	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.
Capital expense	2 x 2	5 x 2	4 x 2
	Most of existing facilities, including sludge treatment facilities are scrapped and renewed.	Aerobic tanks need remodelling. Existing Primary/Secondary Clarifiers can be used.	Aerobic/anoxic tanks need renewal. Existing Primary/Secondary Clarifiers can be used.
Operational expense	4 x 2	3 x 2	5 x 2
	The simplest system. The least electrical power.	Much electrical power is needed due to large Air Blower.	Electrical power of circulation is the least.
Easiness of maintenance	4 x 1	3 x 1	5 x 1
	The system is most simple and number of equipment is least in the three plans. Due to deep reactors, maintenance of diffusers are not easy.	In addition to normal biological treatment, knowledge peculiar to this system is necessary to operate.	Flexible operation is possible against variation of raw water characteristics.
Past record in India	4 x 1	3 x 1	5 x 1
Total	28	30	36

Evaluation Score: 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)
Importance Level: 2:High, 1:Moderate

Source: JICA Survey Team

As a result of the above comparison, Second-stage CND plan is proposed.

(2) Proposed plan (Double-stage CND)

Design parameters for proposed STP are shown in Table 9.3.11.

The minimum water temperature is set to 20 degrees, which is changed from the DPR. To secure 20 days of duration time in Sludge Digesters, thickening for secondary sludge is separated from primary sludge and mechanical thickener is introduced for it, which is also different from the DPR.

Table 9.3.11 Design Parameters for Proposed Dinapur STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	at peak flow
2	**Grit Chamber**		Vortex type	
(1)	Surface Load	$m^3/m^2/day$	4500	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	35	
4.	**Aerobic Tank 1,2**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	Final aerobic tank
(3)	SRT	day	4.9	
(4)	HRT	hour	5.64	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	60	
5.	**Anoxic Tank 1,2**			
(1)	HRT	hour	3.84	
(2)	Flow split ratio		First 0.5 : Second 0.5	
6.	**Secondary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	25	
7.	**Chlorination Tank**		Not in scope of project	
8.	**Gravity Thickener**			
(1)	Sludge loading	kg/m2・day	120	
(2)	Thickened sludge	%	5	Primary sludge
9.	**Mechanical Thickener**			
(1)	Thickened sludge	%	5	Secondary sludge
10.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
11.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	16.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

Description of the proposed STP is as follows.

1) Headworks

The headworks facility comprises one Inlet Chamber, three Fine Screen channels, two Grit Chambers, one

Parshall Flume, and one Distribution Chamber. Parshall Flume and Distribution Chamber are used existing structure, but the others are renewed.

Manually operated gates before Fine Screen channels are installed for maintenance of the screens. The Fine Screens are “Step screen” type whose openings are 6mm; one of three is for standby.

Because the space for installation is narrow, Grit Chambers are adopted “Vortex” type, which can be compact and high efficient separation.

2) Primary Clarifier

Three existing Primary Clarifiers, Column-supported circular type, continue to be used after rehabilitation, whose surface loading rate is capable. Primary sludge is withdrawn by Primary Sludge Pumps, which are installed in Primary Sludge Sump and transferred to Gravity Thickener.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)

The biological treatment facility is three series of Double-stage CND that comprise first Anoxic Tank, first Aerobic Tank, second Anoxic Tank, second Aerobic Tank, and Secondary Clarifier each. In this process, organic matter (BOD, COD), SS, and nitrogen are removed by MLE technology, which can achieved to the new standards that CPCB have notified except Faecal Coliforms.

Wastewater from Primary Clarifier flows to first Anoxic Tank and second Anoxic Tank dividedly, whose BOD is utilized for carbon source of denitrification where nitrified mixed-liquor comes from aerobic tank or Secondary Clarifier. Because the step feeding of wastewater increases MLSS/biomass concentration in first Anoxic/Aerobic Tank, the volume can be less than Single-stage CND. At the assumption of design, MLSS concentration in first Anoxic/Aerobic Tank is 3,844mg/l while that is 3,000mg/l in second Anoxic/Aerobic Tank, therefore, approximately 10% of the total volume can be reduced from Single-stage CND.

Each Anoxic tank has a volume of 2,134 m3, HRT 1.92 hours, where a submersible mixer is installed for stirring, which is reasonable price and no need of base and support structure at upper portion.

Each Aerobic Tank has a volume of 3,138m3, HRT 2.82 hours, where fine bubble diffusers are installed, whose oxygen transfer rate is required to be more efficient than 30.5%.

Nitrified mixed-liquor is transferred from the pit following second Aerobic Tank to first Anoxic Tank by circulation pumps that are submersible type equipped with a screw impeller. As a result of calculation regarding nitrogen removal, the capacity of circulation pumps is required to be more than 60% of internal recycle ratio.

Three existing Secondary Clarifiers, Column-supported circular type, continue to be used after rehabilitation, whose surface loading rate is capable. Secondary sludge is withdrawn by PAS Pumps, which are installed in Secondary Sludge Sump, and the sludge is transferred to first Anoxic Tank or WAS Sump, which is selected by the motorized valves.

4) Effluent Pumping station

Following Secondary Clarifier, treated water flows to Effluent Pumping Station and is pumped up to Chlorination Tank by Effluent Pumps. The facility is existing and continues to be used, however Effluent Pumps and the rerated piping are renewed.

5) Chlorination facility

This facility is not in scope of project.

6) Sludge treatment facilities

The sludge treatment process comprises thickening, anaerobic digestion, and sludge dewatering.

According to the DPR, primary sludge and secondary sludge went to Sludge thickeners, where they were combined. However, securing the HRT required in the existing Anaerobic Sludge Digesters is difficult, therefore, sludge thickening process is separated into primary sludge and secondary sludge, and then mechanical thickeners are taken for the secondary sludge, which can reduce volume of the sludge.

Three existing Anaerobic Sludge Digesters continue to be used after rehabilitation, but the mixers are required to be upgraded for high sludge concentration. The existing Biogas Holders are also capable, which can continue to be used. Following digesters, digested sludge are transferred to centrifugal facility, which consists of three centrifuges with a capacity of 25m3/h, three sludge feed pumps, a belt conveyer, two polyelectrolyte dosing system. Some existing Sludge Drying Beds remain as a backup of centrifuge facility.

Table 9.3.12 Facility List of Proposed Dinapur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**Basins & Tanks**					
1	Inlet Chamber	1	5.5	4.5	2.5	0.5
2	Main Screen Channel	3	1.5	7.5	1.3	0.5
3	Bypass Screen Channel	1	1.5	7.5	1.5	0.5
4	Grit Chamber	2	5.0	-	3.0	0.5
5	Parshall Flume	1	***	***	***	***
6	Distribution Chamber	1	***	***	***	***
7	Primary clarifier	3	31.2	-	3.5	0.5
8	Anoxic Tank 1,2	6	23.0	17.0	5.5	0.5
9	Aerobic Tank 1,2	6	23.0	25.0	5.5	0.5
10	Secondary Clarifier	3	40.0	-	3.5	0.5
11	Chlorine Contact tank (not in scope of project)	1	***	***	***	***
12	Primary Sludge Sump	3	3.0	4.0	4.0	0.5
13	Secondary Sludge Sump	3	3.0	4.0	4.0	0.5
14	Sludge Thickener	2	11.5	-	4.0	0.5
15	WAS Sump	2	6.0	6.5	4.0	0.5
16	Thickened Sludge Sump	1	6.0	6.5	4.0	0.5
17	Anaerobic Sludge Digester	3	29.0	-	7.0	1.5
18	Biogas Holder	2	21.0	-	8.7	0.5
19	Centrifuge Sludge Sump	2	6.0	6.0	3.5	0.5
20	Sludge Drying Bed	***	***	***	***	***
B	**Buildings**					
1	Filtrate Sump House	1	12.7	13.0	***	
2	Air Blower Room	1	12.0	25.0	6.0	
3	Treated Effluent Pump House	1	12.7	13.0	***	
4	Chlorination building (not in scope of project)	1	***	***	***	
5	Thickened Sludge Pump House	1	6.0	6.0	4.0	
6	Mechanical Thickener Building	1	10.0	15.0	8.0	
7	Centrifuge Building	1	15.0	30.0	10.0	
8	Control Room for Digester	1	4.2	4.3	***	
9	Power House	1	29.5	31.6	***	
10	Biogas Flare	2				
11	Administration Building & LAB	1	12.6	25.2	***	
12	Electrical Builging	1	15.0	20.0	8.0	

Source: JICA Survey Team

Table 9.3.13 Equipment List of Proposed Dinapur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 1.0(m)×Height :1.5(m)	-	4
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.50 (m)×SWD :1.30 (m) ×Open Space:6(mm)	2.20	2W+1S
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.50 (m)×SWD:1.30 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :9.0 (m)	1.50	1W
5. Grit Chamber	Vortex Type SS304	Dia. :5.00 (m)	11.0	2W
6. Primary Clarifier	Column-supported Circular Clarifier MS+ Epoxy	Dia. 31.2(m)×Height :3.5(m)	2.20	3W
7. Primary Sludge Pumps	Submersible, non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:50(m^3/h)×Total Head:10.0 (m)	5.5	3W+3S
8. Mixers for Anoxic Tank	Submersible SS304	Width :23.0 (m)×Length :17.0(m)×SWD :5.5(m)	5.0	12W
9. Diffusers	Fine Bubble Membrane	SOR:586 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	3W
10. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :250 (mm)× Air Flow :3800(m^3/h) ×Pressure: 65 (K Pa)	110.0	6W+3S
11. Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :300 (mm)×Discharge:670(m3/h)×Total Head:5.0 (m)	22.0	3W+3S
12. RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :300 (mm)×Discharge:670(m^3/h)×Total Head:5.0 (m)	22.0	3W+3S
13. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	6
14. Secondary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 40.0(m)×Height :3.5(m)	2.2	3W
15. Treated Effluent Pumps	Horizontal Centrifugal Cast Iron	Dia. :500 (mm)×Discharge:1670(m^3/h)×Total Head:12.0 (m)	130.0	4W+2S
16. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 11.5(m)×Height :4.0(m)	0.4	2W
17. Gravity Thickened Sludge Pumps	Progress Cavity Cast Iron / SS304	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:20.0 (m)	15.0	2W+1S
18. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :125 (mm)× Air Flow :600(m^3/h) ×Pressure: 40 (K Pa)	15.0	1W+1S
19. Mechanical Thickener	Rotary Drum	Capacity :50(m^3/h)	2.6	2W+1S

Items	Specification		kW	Pcs/Units
20. Mechanical Thickener Feed Pumps	Progress Cavity Cast Iron / SS304	Dia.:150 (mm)×Discharge :50(m^3/h)×Total Head:20.0 (m)	15.0	2W+1S
21. Mixer for digester		Dia.:29 (m)×SWD :7(m)×Tank Volume:4622 (m3)	30.0	3W
22. Biogas power generator		Output:600(kW)	-	2W+1S
23. Desulfurization equipment		Capacity :360(m3/h)	-	2W
24. Biogas Holder	Floating Type	Dia.:21 (m)×SWD :8.7(m)×Tank Volume:6027 (m3)	-	2W
25. Biogas Flare		Capacity :360(m3/h)		2W
26. Mixer for Centrifuge Feed Sump	Vertical Shaft SS304	Width :6.0 (m)×Length :6.0(m)×SWD :3.5(m)	22.0	2W
27. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :25 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
28. Centrifuge	Solids Bowl Type SS304	Capacity :25 (m3/h)	44.5	2W+1S
29. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :25 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
30. Crane for Centrifuge	Single-girder overhead	Capacity:5.0 (ton)×Lift:6.0 (m)	17.1	1W
31. Polyelectrolyte Dosing System		Width :2.5 (m)×Length :2.5(m)×SWD :2.5(m)	3.7	2W
32. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:40 (mm)×Discharge :0.9 (m3/h)×Total Head:20.0 (m)	0.75	2W+1S
33. Polyelectrolyte Dosing Pump For Thickener	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.45 (m3/h)×Total Head:20.0 (m)	0.4	2W+1S
34. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:150 (mm)×Discharge :150(m^3/h)×Total Head:15.0 (m)	15.0	2W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 33kV, VCB HV outgoing feeder panels, IP52, 33kV, VCB Power transformers: outdoor use, 33/0.415-0.24 kV,1500 kVA			1pc 2pcs 2pcs
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 4000A, LV feeder panels: IP52, 600V, ABSs with 100 A, MCCBs Auto power factor correction panels MCC for Raw sludge pump set			2pcs 6pcs 2pcs 1pc

Items	Specification	kW	Pcs/Units
	MCCs for Liquid process		1pc
	Air blower starter panels with VFD		4pcs
	MCCs for Solid process		1pcs
3. Instrumentation devices	Inlet flow meter		1pc
	Level meter in inlet chamber		1pc
	Level meters of pre and post screens		6pcs
	Level meter in primary sludge sump		1pc
	Primary sludge flow meters		1pc
	Air blow flow meters		3pcs
	Air blow pressure meters		3pcs
	MLR (Mixed Liquor Recycle) flow meters		3pcs
	RAS (Return Activated Sludge) flow meters		3pcs
	DO analyzers		6pcs
	MLSS analyzers		3pcs
	Residual chlorine analyzer		1pc
	Effluent flow meter		1pc
	Level meter in WAS (Waste Activated Sludge)sump		1pc
	WAS (Waste Activated Sludge) flow meters		1pc
	Thickened sludge flow meter		1pc
	Level meter in thickened sludge sump		1pc
	Level meters in polyelectrolyte solution tank for mechanical thickener		2pcs
	Polymer dosing flow meters		3pcs
	Level meters in digester		3pcs
	Digested sludge flow meters		1pc
	Temperature meters in digester		9pcs
	Level meter in centrifuge feed sump		1pc
	Centrifuge feed flow meters		3pcs
	Level meter in polyelectrolyte solution tank for centrifuge		2pcs
	Polymer dosing flow meters for centrifuge		3pcs
	Generated biogas flow meter		1pc
	Generated biogas pressure meter		1pc
	Filtrate flow meter		1pc
4. Local SCADA system	Operator stations, engineering station, SCADA/data servers, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.3 Bhagwanpur STP

(1) Consideration of biological treatment process

1) Point to review

At the DPR, the existing biological treatment facilities are not utilized entirely. Like as Dinapur STP, the DPR plan, SBR process, is compared to an alternative plan, Single-stage CND, by JICA Survey team.

2) Description of DPR's plan and alternative plan

a) SBR plan (DPR):

As mentioned at Item 9.3.1 c), SBR-process is carried out in a single tank, where cyclic actions are repeated: fill, aeration, reaction, settling, and decanting. To remove nitrogen, either putting anoxic reaction time in a cycle, or making an anoxic zone in a reactor is required.

In case of the former method, anoxic reaction time should be set in a fill action or before aeration, because anoxic reaction requires BOD as carbon source. Hence some nitrate generated at the aeration is decanted without denitrification. Therefore, a volume of SBR basin should be more than the capacity not to exceed the regulated amount of T-N when decanting.

In case of the latter method, an anoxic zone should be equipped with at inlet portion of a SBR basin, so that denitrification can occur during fill and aeration/ reaction actions by circulation; therefore, that may allow omission of anoxic reaction time in a cycle and reducing volume of the reactor. Besides, the anoxic zone can be used as a selector, which can increase growth of floc-forming bacteria and can suppress growth of filamentous bacteria. Consequently, the latter method has some advantages over the former method, however, it may be more expensive because of the patented technology, which is called C-Tech.

The design calculation by JICA Survey team has been done in the former method. As a result of the calculation, the required HRT of SBR basins is 24 hours, which is equal to the amount of calculation by the manufacture that are attached in Annexure of the DPR, while the amount proposed in the body of the DPR is 17.34 hours. As this design HRT of SBR basins, 24 hours are taken. However, the values of raw water quality referred to the DPR for design are higher than the actual values reported from the existing STP, therefore, the values of raw water characteristics should be reconsidered at the final detailed design.

The schematic process diagram and layout plan of SBR plan are shown in Figure 9.3.19, Figure 9.3.20 respectively.

b) Single-stage CND plan (Alternative 1):

As shown on Figure 9.3.6, CND comprises anoxic tanks, aerobic tanks, and final clarifiers. At this plan, two existing primary/ secondary clarifiers continue to be reused after rehabilitation and also two existing aeration tanks are utilized as anoxic tanks with improvement. Although the two series of existing biological treatment are a conventional ASP without nitrogen removal, these can be upgraded to single-stage CND by adding new aerobic tanks, if wastewater flowrate is half of the present design flowrate. For another half of design flowrate, additional a series of biological treatment facility is built newly: a primary clarifier, an anoxic tank, an aerobic tank, and a secondary clarifier.

The schematic process diagram and layout plan of Single-stage CND are shown in Figure 9.3.21, Figure 9.3.22 respectively.

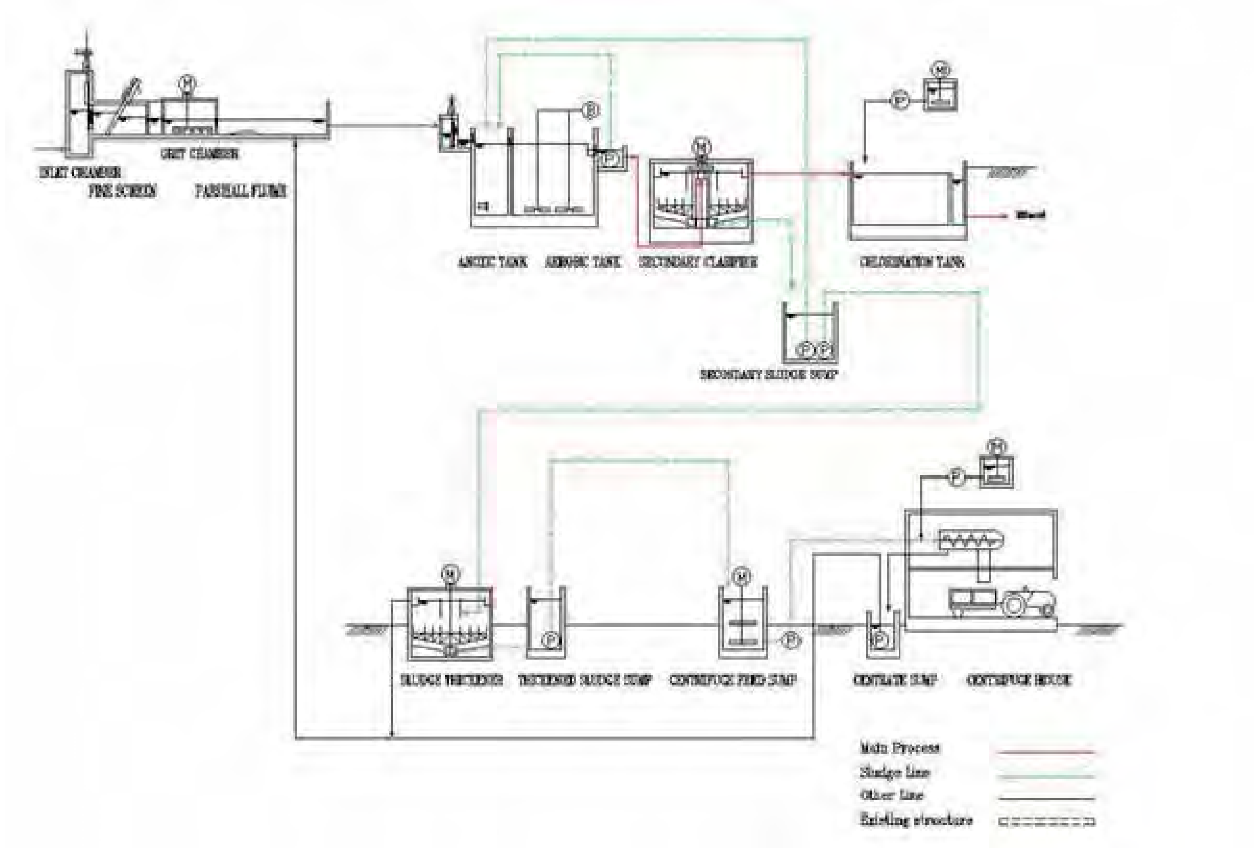
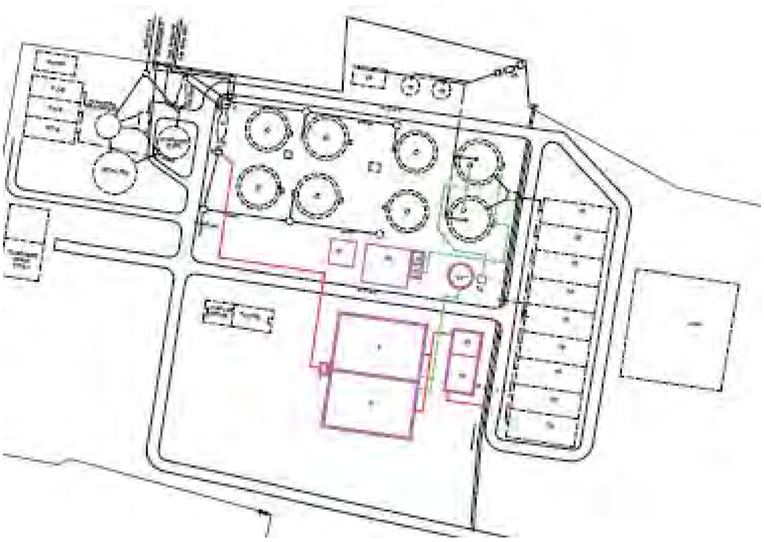


Figure 9.3.19 Schematic Process diagram of Bhagwanpur STP (SBR plan)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	$****^{H}$
02	Main Screen Channel	1	$****^{W}$	$****^{L}$	$****^{H}$
03	Bypass Screen Channel	1	$****^{W}$	$****^{L}$	$****^{H}$
04	Grit Chamber	1	$****^{W}$	$****^{L}$	$****^{H}$
05	Parshall Flume	1	0.35^{W}	$****^{L}$	$****^{SWD}$
06	Distribution Chamber 1	1	$****^{W}$	$****^{L}$	$****^{SDW}$
07	Distribution Chamber 2	1	$****^{W}$	$****^{L}$	$****^{SDW}$
08	SBR	2	22.0^{W}	34.0^{L}	5.5^{SDW}
12	Chlorine Contact Tank	1	$****^{Dia.}$	$****^{L}$	$****^{SWD}$
13	Sludge Thickener	1	$9.5^{Dia.}$		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	$18.0^{Dia.}$		9.8^{SWD}
16	Biogas Holder	3	$7.5^{Dia.}$		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	$****^{H}$
19	Filtrate Sump	1	$****^{W}$	$****^{L}$	$****^{H}$
20	Primary Sludge Pump House	1	$****^{W}$	$****^{L}$	$****^{H}$
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	$****^{W}$	$****^{L}$	$****^{H}$
23	Chlorination Building	1	$****^{W}$	$****^{L}$	$****^{H}$
24	Engine Room	1	8.5^{W}	15.0^{L}	$****^{H}$
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Figure 9.3.20 Layout plan of Bhagwanpur STP (SBR plan)

Source: JICA Survey Team

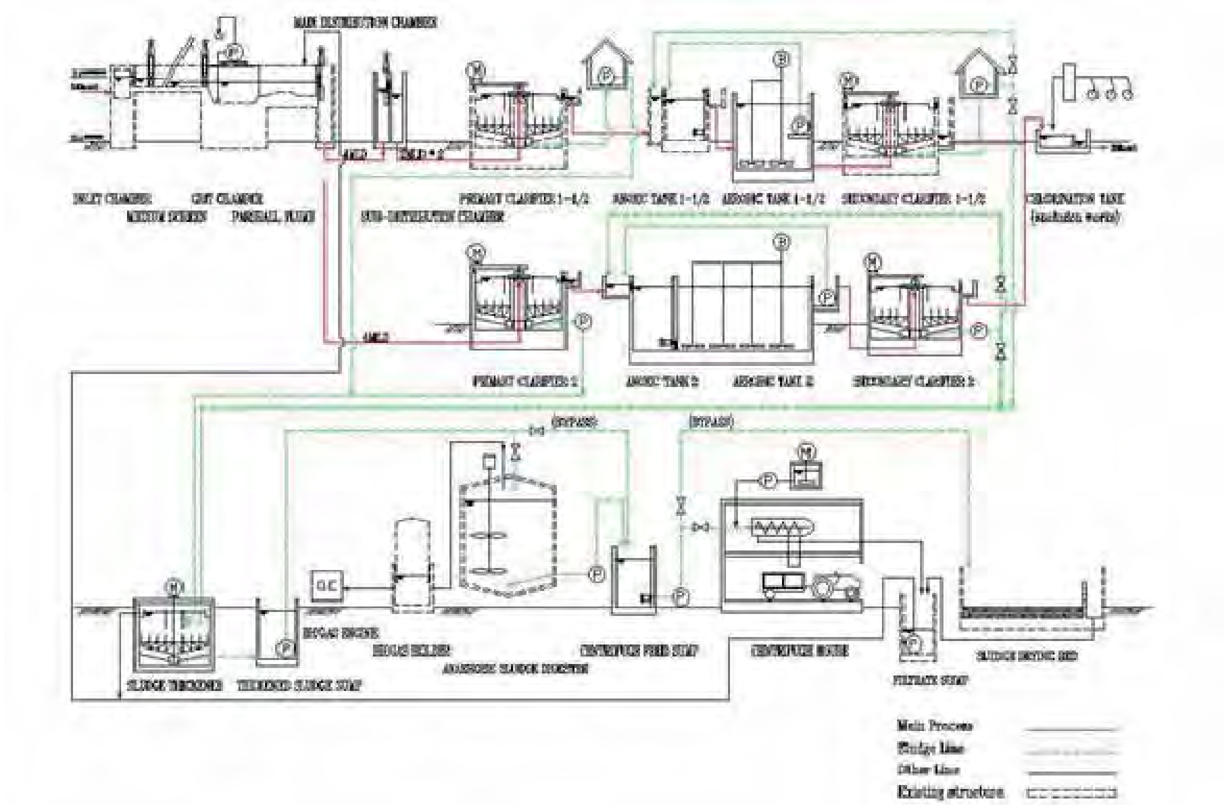
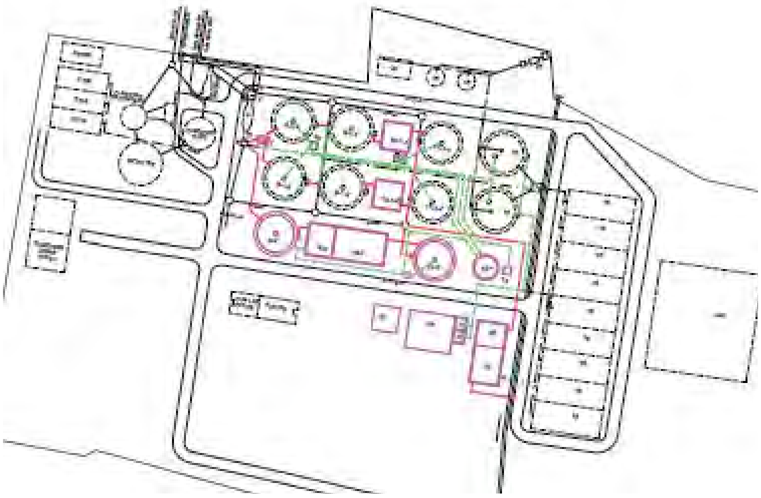


Figure 9.3.21 Schematic Process diagram of Bhagwanpur STP (Single-stage CND plan, Alternative)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
01	Inlet Chamber	1	1.2^{W}	1.2^{L}	$****^{H}$
02	Main Screen Channel	1	$*****^{W}$	$*****^{L}$	$****^{H}$
03	Bypass Screen Channel	1	$*****^{W}$	$*****^{L}$	$****^{H}$
04	Grit Chamber	1	$*****^{W}$	$*****^{L}$	$****^{H}$
05	Parshall Flume	1	0.25^{W}	$*****^{L}$	$****^{SWD}$
06	Main Distribution Chamber	1	$*****^{W}$	$*****^{L}$	$****^{SDW}$
07	Sub-distribution Chamber	1	$*****^{W}$	$*****^{L}$	$****^{SDW}$
08-1	Primary Clarifier 1-1/2	2	14.6^{Dia}		3.5^{SWD}
08-2	Primary Clarifier 2	1	14.6^{Dia}		3.5^{SWD}
09-1	Anoxic Tank 1-1/2	2	15.6^{Dia}		3.5^{SWD}
09-2	Anoxic Tank 2	1	12.0^{W}	10.5^{L}	5.5^{SWD}
10-1	Aerobic Tank 1-1/2	2	9.5^{W}	10.5^{L}	5.5^{SWD}
10-2	Aerobic Tank 2	1	12.0^{W}	16.5^{L}	5.5^{SWD}
11-1	Secondary Clarifier 1-1/2	2	16.0^{Dia}		3.5^{SWD}
11-2	Secondary Clarifier 2	1	16.0^{Dia}		3.5^{SWD}
12	Chlorine Contact Tank	1	$*****^{W}$	$*****^{L}$	$****^{H}$
13	Sludge Thickener	1	9.5^{Dia}		3.5^{SWD}
14	Thickened Sludge Sump	1	2.0^{W}	2.0^{L}	2.5^{SWD}
15	Anaerobic Sludge Digester	2	18.0^{Dia}		9.8^{SWD}
16	Biogas Holder	2	7.5^{Dia}		4.0^{SWD}
17	Centrifuge Feed Sump	2	4.0^{W}	4.5^{L}	3.5^{H}
18	Sludge Drying Bed	9	12.0^{W}	28.0^{L}	$****^{H}$
19	Filtrate Sump	1	$*****^{W}$	$*****^{L}$	$****^{H}$
20	Primary Sludge Pump House	1	$*****^{W}$	$*****^{L}$	$****^{H}$
21	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
22	RAS Pump House	1	$*****^{W}$	$*****^{L}$	$****^{H}$
23	Chlorination Building	1	$*****^{W}$	$*****^{L}$	$****^{H}$
24	Engine Room	1	8.5^{W}	15.0^{L}	$****^{H}$
25	Biogas Flare	1			
26	Centrifuge Building	1	15.0^{W}	18.0^{L}	8.0^{H}

Figure 9.3.22 Layout plan of Bhagwanpur STP (Single-stage CND plan, Alternative)

Source: JICA Survey Team

3) Assumption of design

The following values should be calculated for design of biological reactors to remove nitrogen:

- Required volume to secure nitrification in aerobic tank,
- Required volume for denitrification in anoxic tank,
- Circulation rate of nitrified mixed-liquor to achieve desired nitrogen removal performance.

If the above values are appropriate, BOD removal performance also will be achieved. Since those values does not mentioned in the DPR, they are calculated by JICA Survey team, which are referred to "Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION", METCALF & EDDY/AECOM. Design condition for the calculation is shown in Table 9.3.14, which bases on the DPR, however some design values are arranged by JICA survey Team. And the result is shown in Table 9.3.15.

Table 9.3.14 Design Condition of Bhagwanpur STP

Item	Design Value			Remarks
Flow Rate	8,000m3/d			
Temperature	20 ℃			
MLSS	3,000mg/l			at effluent of final reactor
Water quality	Influent	After Primary Clarifier	Effluent	
BOD	250mg/l	175mg/l	10mg/l	reduction 30% at Primary
COD	450mg/l	315mg/l	50mg/l	reduction 30% at Primary
TSS	400mg/l	160mg/l	10mg/l	reduction 60% at Primary
VSS	280mg/l	112mg/l	-	
T-N	50mg/l	45mg/l	10mg/l	reduction 10% at Primary
NH4-N	37mg/l	33.3mg/l	2mg/l	reduction 10% at Primary

Source: JICA Survey Team

Table 9.3.15 Comparison of Bhagwanpur STP plans

Plan		DPR plan	Alternative 1
Process		SBR	Single-stage CND
Number of Series		2	2 (0.25Q) + 1 (0.5Q)
Reactor	Total	8,228	4,170
	Anoxic	-	2,021
	Aerobic	-	2,149
	Total HRT	24.0h	10.4h
Return Activated Sludge		-	60%
Internal Recycle		-	244%
Required Air		86,570	54,378

Source: JICA Survey Team

4) Comparison of plans

The demolished structures and rebuilt structures are shown in Table 9.3.16 and the comparison table is shown in Table 9.3.17.

Table 9.3.16 Demolished structures and renewal structure (Bhagwanpur STP)

Plan	DPR plan	Alternative 1
Process	SBR	Single-stage CND
Demolished Facilities	1. Primary Clarifier (Dia.14.6m x 2nos.) 2. Aeration tank (Dia.15.6m x 2nos.) 3. Secondary Clarifier (Dia.16m x 2nos.) 4. Primary Pump House 5. RAS Pump House	
Rebuilt Facilities	1. SBR (4,000m3 x 2nos.) 2 Sludge Thickener (Dia.9.5m x 2nos.) 3. Air Blower Room 4. Centrifuge Building 5. Electrical Building	1. Anoxic tank (715m3 x 1) 2. Aerobic tank (1,076m3 x 2nos.,) 3 Sludge Thickener (Dia.9.5m x 2nos.) 4. Air Blower Room 5. Centrifuge Building 6. Electrical Building

Source: JICA Survey Team

Table 9.3.17 Comparison table of Bhagwanpur STP plans

Plan	DPR plan	Alternative 1	Remarks
Process	SBR	Single-stage CND	
Treated water quality	4 x 2	4 x 2	
	Capable of T-N, BOD, TSS removal under proper operation.	Capable of T-N, BOD, TSS removal under proper operation.	
Capital expense	4 x 2	5 x 2	
	SBR facility is expensive.	Existing Primary/Secondary Clarifiers can be reused. Reactor's volume is smaller.	
Operational expense	4 x 2	5 x 2	
	The system is simpler.	Less electrical power.	
Easiness of maintenance	4 x 1	5 x 1	
	The system is simpler. Difficult maintenance in SBR basin.	Can operate flexibly while maintenance.	
Past record in India	4 x 1	4 x 1	
Total	32	37	

Evaluation Score: 5: Best, 4: Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)
Importance Level: 2: High, 1: Moderate

Source: JICA Survey Team

As a result of the above comparison, Single-stage CND plan is proposed.

(2) Proposed plan (Single-stage CND)

1) Design parameters

The minimum water temperature is set to 20 degrees, which is changed from the DPR.

Table 9.3.18 Design Parameters for Proposed Bhagwanpur STP

	Facility	Unit	Design Value	Remarks
1	**Medium Screen**			
(1)	Opening	min	20	
(2)	Passage velocity	m/sec	Less than 0.8	at peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	1000	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	35	
4.	**Aerobic Tank**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	Final aerobic tank
(3)	SRT	day	4.9	
(4)	HRT	hour	6.4	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	244	
5.	**Anoxic Tank**			
(1)	HRT	hour	4.0	
6.	**Secondary Clarifier**			
(1)	Surface Load	$m^3/m^2/day$	25	
7.	**Chlorination Tank**		Not in scope of project	
8.	**Gravity Thickener**			
(1)	Sludge loading	kg/m2・day	50	
(2)	Thickened sludge	%	4	Combined sludge
9.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
11.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

Description of the proposed STP is as follows.

2) Headworks

The headworks facility comprises one Inlet Chamber, one Main Screen Channel, one Bypass Screen Channel, one Grit chamber, one Parshall Flume, one Main Distribution Chamber, and one Sub-distribution Chamber. All existing structures except one Distribution Chamber continue to be reused after the rehabilitations. All mechanical/ electrical equipment are replaced, gates, a medium screen, a grit collector, a grit classifier, a belt conveyer, etc. Main Distribution Chamber divides wastewater between existing Primary Clarifiers and a new Primary Clarifier, and besides, Sub-distribution Chamber divides the half of that into two existing Primary Clarifiers.

2) Primary Clarifier
Two existing Primary Clarifiers, peripheral drive circular type, continue to be used after the rehabilitation, and a half of design flowrate wastewater, 4 MLD as design average flowrate, flows to them from Distribution Chamber 2. Another one Primary Clarifier is built newly for the remaining wastewater, 4 MLD as average design flowrate. Primary sludge is withdrawn by Primary Sludge Pumps, which are transferred to Sludge Thickener.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)
The biological treatment facility consists of two existing series that have a capacity of 2MLD each, and one new series that have a capacity of 4MLD, and each series has one anoxic tank, one aerobic tank, and one secondary clarifier. The two existing series are upgraded from conventional ASP to Single-stage CND, which are completed by addition of new aerobic tanks and improvement of the existing aerobic tanks that are changed to anoxic tanks. Each Anoxic Tank has a volume of more than 4 hours as HRT, where a submersible mixer is installed for stirring. Each Aerobic Tank has a volume of more than 6.4 hours as HRT, where fine bubble diffusers having more than 30.5% of oxygen transfer rate efficiency are installed. Nitrified mixed-liquor is transferred from the pit following Aerobic Tank to Anoxic Tank by Circulation pump, submersible type with a screw impeller. As a result of calculation regarding nitrogen removal, circulation pumps are required more than 244% of internal recycle ratio. Two existing Secondary Clarifiers, peripheral drive circular type, continue to be used after the rehabilitation, and another Secondary Clarifier is built newly. Secondary sludge is withdrawn by PAS Pumps, which are transferred to the destination selected by manually valves, either Anoxic Tank or Sludge Thickener.

4) Chlorination facility
This facility is not in scope of project.

5) Sludge treatment facilities
Although primary/secondary sludge are being transferred to Sludge Digester directly at the existing facility, adding a Sludge Thickener is proposed to secure the required HRT in Sludge Digester. The thickened sludge is transferred to Sludge Digester by Thickened Sludge Pump, submersible type with screw impeller, in Thickened Sludge Sump.

Existing Sludge Digester facilities continue to be used after some safety devices are replaced.

The existing biogas holders are also capable, which can continue to be used. Following digesters, digested sludge are transferred to centrifugal facility, which consists of two centrifuges with a capacity of 12m3/h, two sludge feed pumps, two polyelectrolyte dosing system.

Table 9.3.19 Facility List of Proposed Bhagwanpur STP

A	Basins & Tanks					
Sr. no	Unit	Quantity	Width / Dia	Length	Liquid Depth	Free Board
			m	m	m	m
1	Inlet Chamber	1	1.2	1.2	****	****
2	Main Screen Channel	1	****	****	****	****
3	Bypass Screen Channel	1	****	****	****	****
4	Grit Chamber	1	****	****	****	****
5	Parshall Flume	1	0.35	****	****	****
6	Distribution Chamber 1	1	****	****	****	****
7	Distribution Chamber 2	1	****	****	****	****
8-1	Primary clarifier 1-1/2	2	14.6	-	3.5	0.5
8-2	Primary clarifier 2	1	14.6	-	3.5	0.5
9-1	Anoxic Tank 1-1/2	2	15.6	-	3.5	0.5
9-2	Anoxic Tank 2	1	12.0	10.0	5.5	0.5
10-1	Aerobic Tank 1-1/2	2	10.5	10.5	5.5	0.5
10-2	Aerobic Tank 2	1	12.0	20.0	5.5	0.5
11-1	Secondary Clarifier 1-1/2	2	16.0	-	3.5	0.5
11-2	Secondary Clarifier 2	1	16.0	-	3.5	0.5
12	Chlorine Contact tank	1	****	****	****	****
13	Sludge Thickener	1	9.0	-	3.5	0.5
14	Thickened Sludge Sump	1	2.0	2.0	12.5	0.5
15	Anaerobic Sludge Digester	2	18.0	-	9.8	1.5
16	Biogas Holder	2	7.5	-	4.0	0.5
17	Centrifuge Feed Sump	2	4.0	4.5	3.5	0.5
18	Sludge Drying Bed	9	12.0	28.0	****	****
19	Filtrate sump	1	****	****	****	****
B	Buildings					
Sr. no	Description	Quantity	Length	Width	Height above GL	
			m	m	m	
1	Primary sludge pump house	1	****	****	****	
2	Air blower room	1	10.0	10.0	4.0	
3	RAS pump house	1	****	****	****	
4	Chlorination building	1	****	****	****	
5	Gas engine room	1	8.5	15.0	****	
6	Biogas Flare	1	****	****	****	
7	Centrifuge Building, including electrical room, DG room	1	15.0	18.0	8.0	

Source: JICA Survey Team

Table 9.3.20 Equipment List of Proposed Bhagwanpur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 1.0(m)×Height :1.0(m)	-	2W
2. Bypass Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :1.0(m)	-	2W
3. Medium Screens (Mechanical)	Continuous Chain Scraper SS304	Channel Width :1.0 (m)×SWD :0.45 (m) ×Open Space:20(mm)	1.5	1W
4. Medium Screen (Manual)	Bar Screen SS304	Channel Width :0.5 (m)×SWD:0.45 (m) ×Open Space:50(mm)	-	1S
5. Belt Conveyor		Belt Width :0.60(m)×Length :4.0 (m)	1.50	1W
6. Grit Chamber	Grit removal travelling Type SS304	Width :2.0 (m)×Length :7.0(m)×SWD :1.3(m)	11.0	1W
7. Main Distribution Weir Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.5(m)	-	2W
8. Sub-distribution Weir Gates	Manually Operated Cast Iron	Width 0.3(m)×Height :0.4(m)	-	2W
9. Primary Clarifier	Peripheral driven Circular Clarifier MS+ Epoxy	Dia. 14.6(m)×Height :3.5(m)	0.75	3W
10. Primary Sludge Pumps	Vertical Centrifugal non-clog impeller Cast Iron	Dia. :80 (mm)×Discharge:10(m^3/h)×Total Head:15.0 (m)	2.2	2W+2S
11. Mixers for Anoxic Tank 1	Submersible SS304	Dia. :15.6 (m)×SWD :3.5(m)	4.0	2W
12. Mixers for Anoxic Tank 2	Submersible SS304	Width :12.0 (m)×Length :11.0(m)×SWD :5.5(m)	4.0	1W
13. Diffusers 1	Fine Bubble Membrane	SOR:44 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	2W
14. Diffusers 2	Fine Bubble Membrane	SOR:88 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	1W
15. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :150 (mm)× Air Flow :1200(m^3/h) ×Pressure: 65 (K Pa)	37.0	2W+1S
16. Circulation Pumps 1	Submersible Non-clog impeller Cast Iron	Dia. :150 (mm)×Discharge:210(m3/h)×Total Head:5.0 (m)	5.5	2W+2S
17. Circulation Pumps 2	Submersible Non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:410(m3/h)×Total Head:5.0 (m)	11.0	1W+1S
18. RAS Pumps 1	Horizontal Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:50(m^3/h)×Total Head:5.0 (m)	1.5	2W+1S
19. RAS Pumps 2	Horizontal Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:100(m^3/h)×Total Head:5.0 (m)	3.7	1W+1S

Items	Specification		kW	Pcs/Units
20. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3
21. Secondary Clarifier	Peripheral driven Circular Clarifier Cast Iron	Dia. 16.0(m)×Height :3.5(m)	0.75	3W
22. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 9.5(m)×Height :3.5(m)	0.4	1W
23. Thickened Sludge Pumps	Submersible Screw impeller Cast Iron / SS304	Dia.:100 (mm)×Discharge :15(m^3/h)×Total Head:15.0 (m)	2.2	1W+1S
24. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	1
25. Mixer for Centrifuge Feed Sump	Submersible SS304	Width :4.0 (m)×Length :4.5(m)×SWD :3.5(m)	5.0	2W
26. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :12 (m3/h)×Total Head:20.0 (m)	3.7	1W+1S
27. Centrifuge	Solids Bowl Type SS304	Capacity :12 (m3/h)	19.7	1W+1S
28. Crane for Centrifuge	Single-girder overhead	Capacity:2.0 (ton)×Lift:6.0 (m)	5.6	1W
29. Polyelectrolyte Dosing System		Width :1.2 (m)×Length :1.2(m)×SWD :1.5(m)	0.75	2W
30. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.4 (m3/h)×Total Head:20.0 (m)	0.4	1W+1S
31. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :70(m^3/h)×Total Head:15.0 (m)	7.5	2W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV,500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pcs 1pcs 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, ACB 630A x 1 LV feeder panels: IP52, 600V, MCCB 200 A x 3, MCCB 100 A x 9, Static capacitors MCC for Grit chamber MCCs for Liquid process (Primary clarifiers, aeration tanks, secondary clarifiers) Air blower starter panels with VFD MCCs for Solid process			1pc 1pc 2pcs 1pc 3pcs 1pc
3. Instrumentation devices	Inlet flow meter Level meter in inlet chamber Level meters of pre and post screens			1pc 1pc 2pcs

Items	Specification	kW	Pcs/Units
	Level meter in primary sludge sump		1pc
	Primary sludge flow meters		1pc
	Air blow flow meters		3pcs
	Air blow pressure meters		3pcs
	MLR (Mixed Liquor Recycle) flow meters		3pcs
	RAS (Return Activated Sludge) flow meters		3pcs
	DO analyzers		6pcs
	MLSS analyzers		3pcs
	Residual chlorine analyzer		1pc
	Effluent flow meter		1pc
	WAS (Waste Activated Sludge) flow meters		1pc
	Thickened sludge flow meter		1pc
	Level meter in thickened sludge sump		1pc
	Level meters in digester		2pcs
	Digested sludge flow meters		1pc
	Temperature meters in digester		6pcs
	Level meters in centrifuge sump		1pc
	Centrifuge feed flow meters		2pcs
	Level meter in polyelectrolyte solution tank		2pcs
	Polymer dosing flow meters		2pcs
	Generated biogas flow meter		1pc
	Generated biogas pressure meter		1pc
	Filtrate flow meter		1pc
4. Local SCADA system	Operator stations, SCADA servers, PLCs, router, etc.,		1ls

Source: JICA Survey Team

9.3.4 Ramna STP

(1) Design Parameter

As for the design condition of biological treatment, minimum water temperature and MLSS are set to 20 degrees and 3000ml/L respectively, which are changed from the DPR. It has been confirmed in changing of the design conditions above mentioned that dimension of proposed Anoxic tank and Aerobic tank in DPR are appropriate.

Table 9.3.21 Design Parameters for Proposed Ramna STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	m^3/m^2/day	100	at peak flow
3.	**Primary Clarifier**			
(1)	Surface Load	m^3/m^2/day	35	
4.	**Aerobic Tank**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	
(3)	SRT	day	4.83	
(4)	HRT	hour	6.16	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	184	
5.	**Anoxic Tank**			
(1)	HRT	hour	3.0	
6.	**Secondary Clarifier**			
(1)	Surface Load	m^3/m^2/day	15.	or Equivalent Tube settler
7.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
7.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	75	
8.	**Sludge Digester**			
(1)	**Duration**	day	more than 20	
9.	**Sludge Drying Bed**			
(1)	Drying duration	day	12	
(2)	Sludge loading	kg/m2	30	

Source: JICA Survey Team

(2) Description of the proposed STP

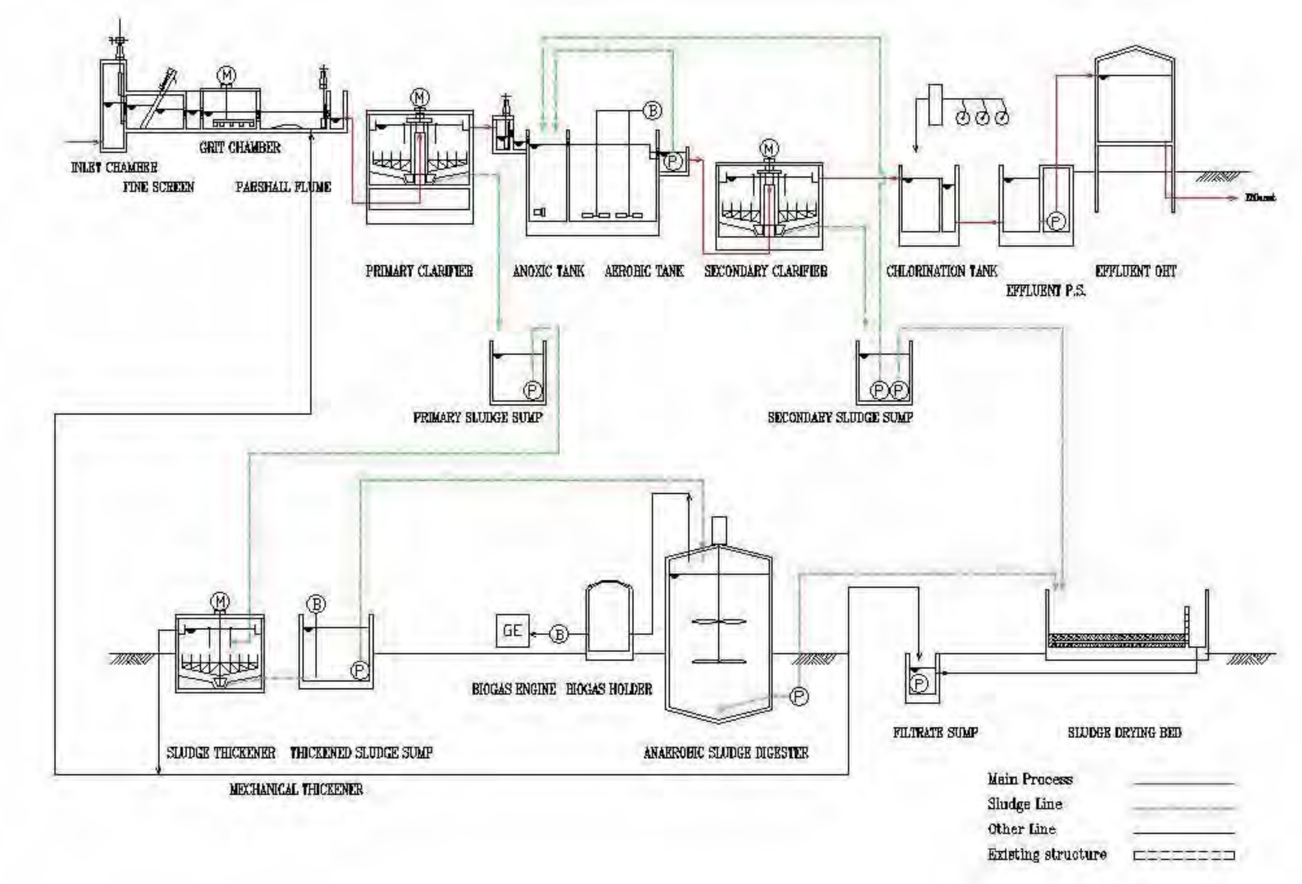


Figure 9.3.23 Layout plan of Ramna STP (Single-stage CND)

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet chamber, two Fine screen channels, two Grit chambers, and one Parshall Flume.

Manually operated gates before fine screen chambers are for the maintenance of the screens. "Step screen" type of the fine screens with opening of 6mm and "square horizontal-flow" type of the grit removal facility are adopted because a lot of them have been installed across India because of high reliability.

2) Primary Clarifier

Design surface loading rate of Primary Clarifier, Column-supported circular type, is 35m^3/m^2/day that is same as the DPR. The sludge is withdrawn by Primary Sludge Pumps which are installed in Primary Sludge Sump. The pumps and sump are placed separately in each Primary Clarifier for preventing imbalance of withdrawing sludge.

3) Biological Treatment (anoxic/aerobic tank, secondary clarifier)

Biological Treatment comprises Anoxic Tanks, Aerobic Tanks and Secondary Clarifiers. Combination of these three parts enables both organic matter and nitrogen removal.

For stirring of Anoxic Tanks, submersible mixers are adopted, since they are available at reasonable price without bases and supports at upper portion.

Aeration Tanks are recommended to be Plug-flow reactors with the width of 8.0m, length of 190m and depth of 5.7m because it is more effective reaction and easy in maintenance of diffusers e.g. air flow adjustment. The Aerobic Tanks are baffled channels that do not need to change the layout plan from the DPR.

The oxygen transfer rate of the diffusers should be more efficient than 30.5% as fine bubble membrane type.

Nitrified liquid is transferred to Anoxic tank from the pit following Aerobic tank by Circulation pump that is submersible type equipped with a screw impeller. As a result of calculation of nitrogen removal, return sludge pumps are required to have a capacity of more than 60% of return rate, and circulation pumps are required to have a capacity of more than 184% of circulation rate.

4) Disinfection

Disinfection facility is gas chlorination system that is same as DPR. It has many track records in India.

5) Effluent Pumping station

It is same as the DPR. In the detailed design at later stage, it should be carefully studied whether water hammer will occur or not, its countermeasure if required.

6) Sludge treatment facilities

As shown in the DPR, the primary sludge goes to Sludge thickeners and then after digestion treatment it is transferred to Sludge Drying Bed. However, there is no treatment process for secondary sludge. At this preliminary design, secondary sludge is supposed to be conveyed to sludge drying bed directly as planned in the DPR. However, the secondary sludge is recommended to be treated by the same process as the primary sludge for stable sludge quality in agriculture use. Otherwise it should be treated by a mechanical thickener for shortening the sludge duration.

Primary Sludge, design sludge concentration 3%, is transferred to Sludge Thickener from Primary Sludge Sump and then is thickened by the gravity, design thickened sludge concentration 4%. Thickened sludge is transferred to Anaerobic Sludge digester that is high rate type.

The Sludge Digesters, vertical cylindrical tanks, Dia. 25m, SWD 10m, have the volume of 20 days as design retention time, which is supposed to operate by mesophilic bacteria.

For stirring of the tank, mechanical mixers with sufficient stirring force shall be applied.

Generated biogas is utilized for Biogas Power Generator.

Sludge temperature in the digester should be kept between 30 to 37 degrees for good operation by mesophilic bacteria. If sludge temperature lowers less than the suitable condition in winter, additional heating system is recommended.

7) Sludge Drying Bed

As a result of calculation base on DPR, sludge drying duration 12days, no. of the basins 12, sludge load 30kg/m^2, the dimension of a bed is width 20m×length 36m (720m2). However, when the secondary sludge （calculated sludge volume 1168m3/day,0.8%) is received, it is hard to dry sludge less than 80% of moisture contents within 12 days.

Table 9.3.22 Facility List of Proposed Ramna STP

A	Basins & Tanks					
Sr. no	Unit	Quantity	Length / Dia	Width	Liquid Depth	Free Board
			m	m	m	m
1	Inlet Chamber	1	5.0	4.8	3.0	0.5
2	Mechanical Fine Screen Channel	2	8.5	1.4	0.9	0.5
3	Manual Fine Screen Channel	1	8.5	1.2	0.9	0.5
4	Grit Distribution Chamber	1	6.0	2.0	1.2	0.5
5	Grit Chamber	2	7.1	7.1	1.0	0.5
6	Parshall Flume	1	8.5	1.3	0.8	0.5
7	Primary clarifier distribution Chamber	1	4.0	-	1.5	0.5
8	Primary clarifier	2	34.0	-	3.0	0.5
9	Primary Sludge Sump	1	5.6	-	2.0	0.5
10	Bioreactor Distribution Chamber	1	4.5	2.5	1.5	0.5
11	Anoxic Tank	2	14.0	40.0	5.8	0.6
12	Aerobic Tank	2	38.0	40.0	5.7	0.6
13	Secondary Clarifier Distribution Chamber	1	4.0	-	1.5	0.5
14	Secondary Clarifier	2	46.0	-	3.2	0.5
15	Chlorine Mixing tank	1	5.5	4.5	3.0	0.5
16	Chlorine Contact tank	2	18.0	20.0	3.0	0.5
17	Dechlorinatin Chamber	1	5.5	4.5	3.0	0.5
18	Recirculation Sludge Sump	1	9.0	-	4.2	0.5
19	Effluent Pumping Station	1	15.0	-	6.0	-
20	Effluent Overhead Tank	1	250 KL			
21	Sludge Thickener	2	13.5	-	3.5	0.5
22	Thickened Sludge Sump	1	6.2	-	3.0	0.5
23	Anaerobic Sludge Digester	2	30.0	-	10.0	1.5
24	Gas Holder	2	12.0	-	8.7	0.5
25	Digested Sludge Sump	2	4.5	3.0	3.5	0.5
26	Sludge Drying Bed	12	36.0	20.0	0.3	0.3
27	Primary Sludge Sump	1	5.6	-	2.0	0.5
28	Secondary Sludge Sump	1	9.0	-	4.2	0.5
29	Filterate sump	1	5.5	-	2.0	0.5

B	Channels					
Sr. no	Description	Quantity	Length	Width	Liquid Depth	Free Board
			m	m	m	m
1	Grit Inlet Channel	2	20.0	0.9	0.6	0.5
2	Grit Outlet Channel	2	20.0	0.9	0.6	0.5
3	Channel upstream of Parshall flume	1	15.0	1.3	0.8	0.5
4	Channel downstream of Parshall flume	1	12.0	1.3	0.8	0.5
5	Primary Clarifier Outlet Channel	2	15.0	0.8	0.7	0.5
6	Common Channel to bioreactor distribution chamber	1	30.0	1.3	1.0	0.5
7	Combined channel to secondary DC	1	12.0	1.3	1.0	0.5
8	Individual Secondary Clarifier Outlet Channel	2	25.0	1.0	1.0	0.5

C	Buildings				
Sr. no	Description	Quantity	Length	Width	Height above GL
			m	m	m
1	Primary sludge pumping station	1	8.0	5.5	4.0
2	Process Air blower room	1	18.0	10.0	4.0
3	RAS pumping station	1	10.0	6.0	4.0
4	Chlorination building	1	5.0	3.5	4.0
5	Chlorine tonner room	1	8.0	4.5	4.0
6	Thickened sludge pumping station	1	6.5	4.0	4.0
7	Digester control building(2 Floor)	1	15.0	8.0	8.0
8	Sludge dewatering unit feed pumping station	1	6.5	4.0	4.0
9	Gas engine building	1	20.0	9.0	4.0
10	Substation & transformer yard	1	33.0	16.5	4.0
11	HT panel room	1	10.0	5.0	4.0
12	Meetring room	1	3.0	5.0	4.0
13	Administration Building & LAB	1	35.0	18.0	8.0
14	Maintenance work shop	1	15.0	10.0	4.0
15	Guard room	2	5.0	4.0	4.0
16	Storage room	1	10.0	5.0	4.0
17	Parking shed	1	14.5	6.0	4.0
18	Grit classifier platform	1	6.0	4.0	-

Source: JICA Survey Team

Table 9.3.23 Equipment List of Proposed Ramna STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 0.8(m)×Height :1.2(m)	-	3
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :1.40 (m)×SWD :0.90 (m) ×Open Space:6(mm)	2.20	2W
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :1.20 (m)×SWD:0.90 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Grit Chamber	Square Horizontal SS304	Width :7.10 (m)×Length :7.10(m)×SWD :0.80 (m)	2.25	2W
6. Primary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 34.0(m)×Height :3.0(m)	1.50	2W
7. Primary Sludge Pumps	Submersible, non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:65(m^3/h)×Total Head:10.0 (m)	5.5	2W+2S
8. Mixers for Anoxic Tank	Submersible SS304	Width :10.0 (m)×Length :14.0(m)×SWD :5.8(m)	5.0	8W
9. Diffusers	Fine Bubble Membrane	SOR:455 (kg/h・basin)×setting Depth :5.2(m) ×Efficiency:30.5 %	-	2W
10. Air Blowers	Rotary blower Tri-lobe Type	Dia. :250 (mm)× Air Flow :3300(m^3/h) ×Pressure: 65 (K Pa)	90.0	4W+2S
11. Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :400 (mm)×Discharge:960(m3/h)×Total Head:5.0 (m)	30.0	4W+2S
12. RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :250 (mm)×Discharge:320(m^3/h)×Total Head:5.0 (m)	11.0	4W+2S
13. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :25(m^3/h)×Total Head:15.0 (m)	3.70	2W+2S
14. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3
15. Secondary Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 46.0(m)×Height :3.5(m)	2.2	2W
16. Chlorinators	Gas Chlorination System	Dosing Rate :25.0(kg/h)	1.00	1W+1S
17. Chlorine Tonners		Volume:928(kg/Unit)	-	11
18. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1
19. Sludge Thickener	Bridge-supported Circular Clarifier Cast Iron	Dia. 13.5(m)×Height :3.5(m)	0.75	2W
20. Air Blowers For Thickened Sludge Sump	Rotary blower Tri-lobe Type	Dia. :50 (mm)× Air Flow:160(m^3/h) ×Pressure: 40 (KPa)	3.70	2

Items	Specification		kW	Pcs/Units
21. Thickened Sludge Feed Pumps	Submersible Screw impeller Cast Iron	Dia.:100 (mm)×Discharge :30(m^3/h)×Total Head:20.0 (m)	11.0	2W+2S
22. Mixer for digester		Dia.:25 (m)×SWD :10(m)×Tank Volume:4900 (m3)	15.0	2W
23. Biogas power generator		Output:660(kW)	-	1W+1S
24. Desulfurization equipment		Capacity :210(m3/h)	-	2W
25. Biogas Holder		Capacity :800(m3)	-	2W
26. Biogas Flare		Capacity :410(m3/h)		1W+1S
27. Biogas Blower		Dia.:40 (mm)×Discharge :210 (m3/h)×Pressure:10.0 (kPa)	3.7	2W+1S
28. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:150 (mm)×Discharge :150(m^3/h)×Total Head:15.0 (m)	15.0	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 33kV, VCB HV outgoing feeder panels, IP52, 33kV, VCB Power transformers: outdoor use, 33/0.415-0.24 kV, 2000 kVA Diesel engine generator set: 415 V, 50 Hz, 1000 kVA Diesel engine generator set: 415 V, 50 Hz, 750 kVA			1pc 1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 4000A x 2, LV feeder panels: IP52, 600V, ABSs with 100 A, MCCBs Auto power factor correction panels MCC for Grit chamber MCCs for Liquid process (Primary clarifiers, Aeration tanks, Secondary clarifiers) Circulation pump starter panels, 30 kW Air blower starter panels with VFD, 90 kW Treated effluent pump starter panels, 330 kW Treated effluent pump starter panels, 110 kW MCCs for Solid process (Gravity thickener, Digester/biogas utilization facilities)			1pc 6pcs 2pcs 1pc 1pc 6pcs 6pcs 3pcs 2pcs 1pc
3. Instrumentation devices	Inlet flow meter Level meter in inlet chamber Level meters of pre and post screens Level meter in primary sludge sump Primary sludge flow meters Air blow flow meters Air blow pressure meters MLR (Mixed Liquor Recycle) flow meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge flow meters Level meter in thickened sludge sump Level meters in digester Digested sludge flow meters			1pc 1pc 1pc 1pc 4pcs 2pcs 2pcs 2pcs 2pcs 4pcs 2pcs 1pc 1pc 1pc 1pc 1pc 2pcs 1pc

Items	Specification	kW	Pcs/Units
	Temperature meters in digester Generated biogas flow meter Generated biogas pressure meter Filtrate flow meter		6pcs 1pc 1pc 1pc
4. Local SCADA system	Operator stations, engineering station, SCADA servers, PLCs, UPS, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.5 Mirzapur STP

(1) Assumption for preliminary design

In this site, upgrading the existing 14 MLD STP and establish of a new 18 MLD STP are planned, total capacity is 32MLD as average flowrate in 2030.

In existing 14 MLD, SBR process is added after the existing UASB, which continues to be used for saving operation expense. However, the SBR is designed to be capable of operating by itself.

For reducing cost and footprint, and for efficient operation, the chlorination facility and the sludge facility are a common between the 14MLD STP and the 18 MLD STP. To make a space for their footprint, a half of the existing oxidation pond is reclaimed. Although MPS-8 for 18 MLD STP was planned at the DPR, it is omitted, because all sewage as design flowrate can be conveyed directly from IPS-5.

Design parameters are shown in Table 9.3.24.

Table 9.3.24 Design Parameters for Proposed Mirzapur STP

Facility	Unit	Design Value	Remarks
1 Fine Screen			
(1) Opening	min	6	
(2) Passage velocity	m/sec	Less than 0.8	At peak flow
2 Grit Chamber			
(1) Surface Load	$m^3/m^2/day$	1000	At peak flow
3. SBR Tank			
(1) Temperature (min)	℃	20	
(2) No. of cycles per tank	Nos./day	5.0	
(3) Full liquid depth	m	5.5	At average flow
(4) Decant depth	%	30% 0f Full liquid depth	
(5) HRT	hour	16	At full liquid depth
(6) MLSS	mg/L	3,000	At full liquid depth
4. Chlorination Tank			
(1) Contact time	min	more than 30	
(2) Injection rate	mg/L	10.0	
5. Thickener		Gravity thickener	
(1) Sludge loading	kg/m2・day	40	

Facility		Unit	Design Value	Remarks
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

(2) Description of the 14 MLD STP

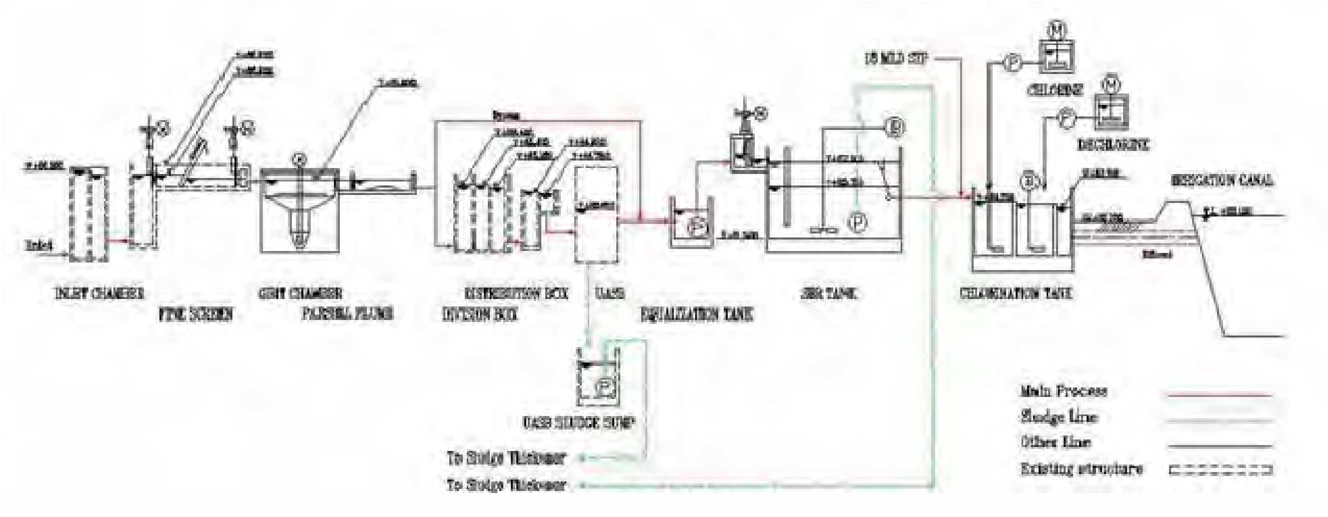


Figure 9.3.24 Schematic Process Diagram of Mirzapur 14 MLD STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, one Main Screen Channel, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume. The structure of the inlet chamber and fine screen are existing, however, a mechanical fine screen is replaced for aging and four gates are installed additionally at the upstream and downstream of the main/bypass screen channels. In the grit chambers, all structure and equipment are replaced and a Parshall Flume is added. Because the allowable footprint is narrow, Vortex type of grit cambers are adopted to save the footprint.

2) Biological Treatment (UASB, SBR)

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Mirzapur STP.

The process have to remove not only organic matter but also nitrogen to observe the new standards of effluent water quality, so that making aerobic and anoxic conditions in the SBR tank are required. There are two methods to do that generally, one is a method to operate anoxic and aeration time alternately in a cycle, the other is a method to establish the anoxic zone ahead of the main reactor in SBR tank. In either case, the required volume of SBR is larger than that of the SBR not to remove nitrogen. In this design, the later method is assumed, however, the SBR Tanks are also capable of the former method.

The existing UASB reactors continue to be used still and intended to reduce BOD and SS going to SBR Tanks as pre-treatment, however, the bypass line of UASB should be added, because SBR process may need more BOD as organic-carbon source for denitrification.

To relieve peak flow, Equalization Tank are added before the SBR, and the SBR's elevation is raised. Instead of that, CCT pumping station is omitted.

The SBR process has two tanks, and the HRT is 16 hours, which have increased from the value of the DPR.

The each series comprises one inlet gate, one SBR tank, one set of micro-bubble diffusers, one decanter, and one waste sludge pump in each unit. Further, six air blowers (two of them are for standby), are used as common to the two series.

Sludge generated at UASB and SBR is pumped up to common sludge thickener.

4) Chlorination Facility
The decanted water flows to common Chlorination Contact Tank (CCT) with the 18 MLD STP.

(3) Description of the 18MLD STP

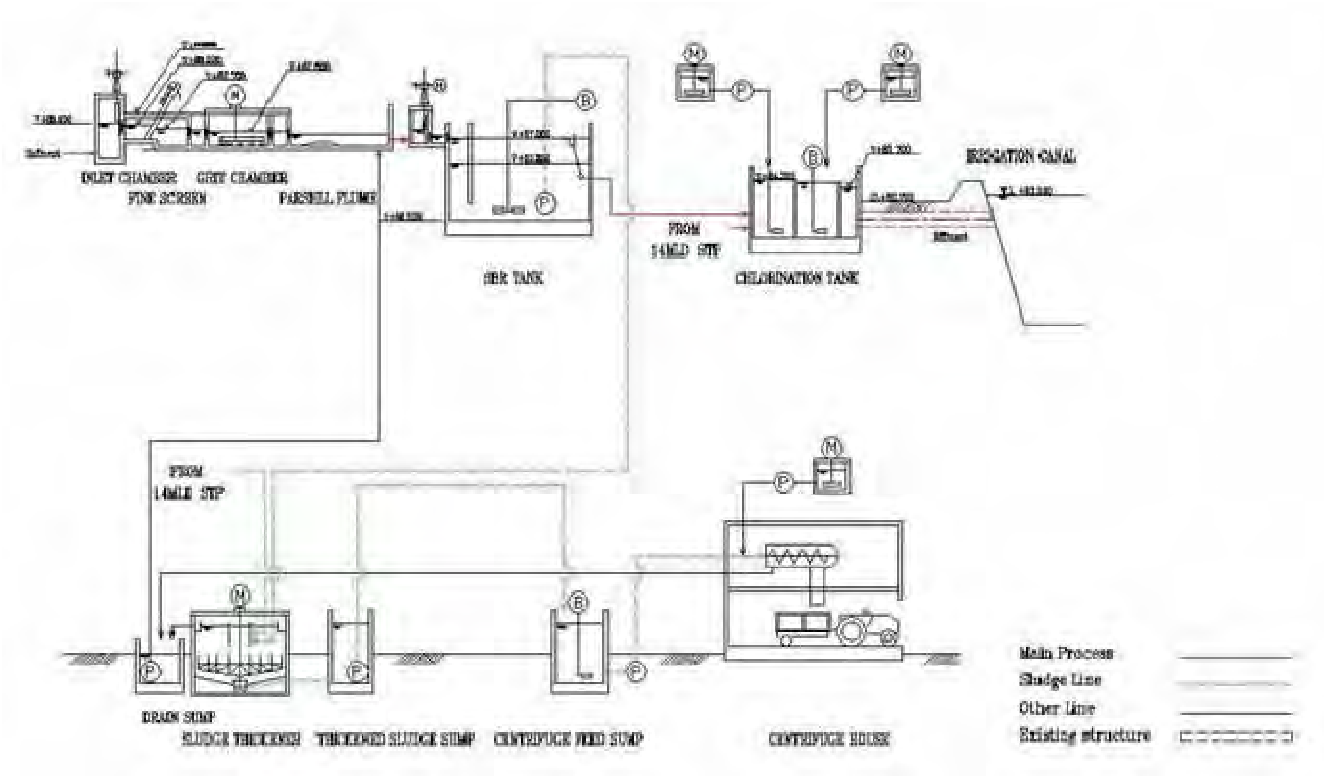


Figure 9.3.25 Schematic Process Diagram of Mirzapur 18 MLD STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, two Main Screen Channels, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume.

2) Biological Treatment

Although the details of design are not cleared in the DPR, in this design, the design HRT of SBR Tanks is determined to be 16 hours. The each unit comprises one inlet gate, one SBR tank, one set of micro-bubble diffusers, one decanter, and one waste sludge pump in each unit, so that cycle operation of filling, settling and decanting can be achieved. There are six numbers (4 working and 2 stand-by) air blowers proposed for four series SBR.

4) Chlorination facilities

The chlorine contact tank is designed as combined proposed 18 MLD STP and Existing 14 MLD STP due to efficient maintenance and saving expenses, HRT 30min, chlorine dosing rate 10 mg/l.

Although gas chlorination system is widely used in India, bleaching powder (Calcium Hypochlorite) dosing system are recommended due to more safety and easy operation. However, research of the purchase of chemicals is required at the detailed design.

5) Sludge treatment facilities

The sludge generated from the 14MLD STP and the 18 MLD STP is summarized and treated in common sludge treatment facilities to be concentrated for efficient operation and maintenance like the formation of the chlorine contact tank.

Sludge generated at the SBRs is transferred to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which have a capacity to continue operation of centrifuges in sufficient duration.

Centrifuges are introduced as dewatering equipment to the 14MLD and 18MLD STPs separately in the DPR. In this design, three Centrifuges having a capacity of 30 m3/h are proposed as common to the two STPs.

6) Electrical, instrumentation and SCADA

There are electricity power receiving/supply facilities proposed independently for both STPs with 14 MLD and 18 MLD. There are transformers with 630 kVA and 800 kVA introduced for 14 MLD STP and 18 MLD STP respectively to step down 11 kV to 415 V, while diesel generator sets with 500 kVA and 625 kVA are proposed for 14 MLD STP and 18 MLD STP respectively to back up essential equipment during power failure. The transformers and the diesel generator sets are to feed power to the equipment/facilities of the

STPs.

The incoming LV panels proposed for both the STPs are to receive power from the transformers and the diesel generator sets and distribute it to LV feeder panels followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers
- Residual chlorine analyzer
- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Thickened sludge feed flow meters (Centrifuge feed flow meters)
- Level meter in thickened sludge feed sump
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.25 Facility List of Proposed Mirzapur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**14 MLD STP**					
1	Inlet Chamber	1	4.0	5.5	4.0	0.5
2	Main Screen Channel	1	2.0	5.0	0.7	0.5
3	Bypass Screen Channel	1	***	***	***	***
4	Grit Chamber	2	3.0	-	3.0	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	Division Box	1	***	***	***	***
7	Distribution Box	4	***	***	***	***
8	UASB	2	17.0	28.0	5.5	***
9	Equalization Tank	1	7.0	30.0	2.0	0.5
10	DistributionChamber	1	3.0	3.5	2.0	0.5
11	SBR	2	29.0	30.0	5.5	1.0
12	UASB Sludge Sump	1	***	-	***	***
13	Filtrate Sump	1	***	-	***	***
14	Air Blower Room	1	12.0	25.0	6.0	-
B	**18 MLD STP**					
1	Inlet Chamber	1	3.2	4.5	2.0	0.5
2	Main Screen Channel	2	0.8	6.0	0.7	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.7	0.5
4	Grit Chamber	2	5.0	5.0	0.9	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	DistributionChamber	1	2.0	3.5	2.0	0.5
7	SBR	4	19.0	29.0	5.5	1.0
8	Air Blower Room	1	12.0	25.0	6.0	-
C	**Common**					
1	Chlorine Contact Tank	1	2.0	115.0	3.0	0.5
2	Sludge Thickener	2	13.5	-	4.0	0.5
3	Thickened Sludge Sump	2	2.5	2.5	3.0	0.5
4	Centrifuge Feed Sump	4	5.0	5.0	3.5	0.5
5	Sludge Drying Bed	4	***	***	***	***
6	Drain Sump	2	2.0	2.0	2.0	0.5
6	Chlorination Building	1	10.0	14.0	6.0	-
7	Centrifuge Building	1	16.0	30.0	10.0	-
8	Electrical Building	1	16.0	30.0	10.0	-

Source: JICA Survey Team

Table 9.3.26 Equipment List of Proposed Mirzapur STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
[14MLD STP]				
1. Inlet Gates	Motorized Cast Iron	Width 0.8(m)×Height :0.8(m)	0.75	2W
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :2.0 (m)×SWD :0.67 (m) ×Open Space:6(mm)	2.20	1W
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :2.0 (m)×SWD:0.67 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Outlet Gates	Motorized Cast Iron	Width 0.8(m)×Height :0.8(m)	0.75	2W
6. Grit Chamber	Vortex Type SS304	Dia. :3.00 (m)	8.5	2W
7. SBR Feed Pumps	Submersible Non-clog impeller Cast Iron	Dia. :200 (mm)×Discharge:330(m3/h)×Total Head:8.0 (m)	15.0	4W+2S
8. SBR Inlet Gates	Motorized Cast Iron	Width 0.6(m)×Height :0.6(m)	0.75	2W
9. Decanter	Swing Type SS304	Width :29.0 (m)×Length :30.0(m)×SWD :5.5(m)	2.20	2W
10. Diffusers	Fine Bubble Membrane	SOR:608 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	2W
11. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2000(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
12. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :125 (mm)×Discharge:60(m3/h)×Total Head:5.0 (m)	2.2	2W+1S
13. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:12(m^3/h)×Total Head:7.0 (m)	1.5	2W+1S
14. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
[18MLD STP]				
15. Inlet Gates	Motorized Cast Iron	Width 0.6(m)×Height :0.9(m)	0.75	2W
16. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.7 (m) ×Open Space:6(mm)	1.5	2W
17. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.7 (m) ×Open Space:20(mm)	-	1S
18. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
19. Grit Chamber	Square Horizontal SS304	Width :5.0 (m)×Length :5.0(m)×SWD :0.6(m)	2.25	2W
20. SBR Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	4W
21. Decanter	Swing Type	Width :19.0 (m)×Length :29.0(m)×SWD :5.5(m)	2.20	4W

Items	Specification		kW	Pcs/Units
	SS304			
22. Diffusers	Fine Bubble Membrane	SOR:314 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	4W
23. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2200(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
24. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m3/h)×Total Head:5.0 (m)	1.5	4W+2S
25. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m^3/h)×Total Head:7.0 (m)	2.2	4W+2S
26. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
[Common]				
27. Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :300(l/h)×Total Head:20.0 (m)	0.4	2W+1S
28. Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :2.0 (m)×Length :2.0(m)× SWD :2.5(m)	2.2	2W
29. Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :130(l/h)×Total Head:20.0 (m)	0.4	2W+1S
30. Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :1.2 (m)×Length :1.2 (m)× SWD :1.5(m)	0.75	2W
31. Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :65 (mm)× Air Flow :120(m^3/h) ×Pressure: 45 (K Pa)	3.7	1W+1S
32. Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
33. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 13.5(m)×Height :4.0(m)	0.75	2W
34. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :70 (m^3/h)×Total Head:10.0 (m)	5.5	2W+2S
35. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :80 (mm)× Air Flow :210(m^3/h) ×Pressure: 40 (K Pa)	2.2	2W+1S
36. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:125 (mm)×Discharge :30 (m3/h)×Total Head:20.0 (m)	7.5	2W+1S
37. Centrifuge	Solids Bowl Type SS304	Capacity :30 (m3/h)	62.5	2W+1S
38. Crane for Centrifuge	Single-girder overhead	Capacity:5.0 (ton)×Lift:6.0 (m)	17.1	1W
39. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W

Items	Specification	kW	Pcs/Units
40. Polyelectrolyte Dosing System	Width :2.0 (m)×Length :2.0(m)×SWD :2.0(m)	2.2	2W
41. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity Dia.:40 (mm)×Discharge :0.83 (m3/h)×Total Head:20.0 (m) SS304	0.75	2W+1S
42. Filtrate Transfer Pumps	Submersible Dia:100 (mm)×Discharge :100(m^3/h)×Total Head:15.0 (m) Non-clog impeller Cast Iron	15.0	2W+2S
(Electrical)			
[14MLD STP]			
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV,630 kVA Diesel engine generator set: 415 V, 50 Hz, 500 kVA		1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 1, 800A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 9, 100A x 6, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 6pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers WAS (Waste Activated Sludge) flow meter		1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc
[18MLD STP]			
4. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 800 kVA Diesel engine generator set: 415 V, 50 Hz, 625 kVA		1pc 1pc 1pc 1pc
5. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 2 No.1 LV feeder panels: IP52, 600V, MCCB 200A x 7, 100A x 3 No.2 LV feeder panels: IP52, 600V, MCCB 400A x 2, 200A x 1, 100A x 5, Static capacitor 20kVar x 40kVar x 1, 80kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 1pc 6pcs 1pcs
6. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters		1pc 4pcs 4pcs 4pcs 4pcs

Items	Specification	kW	Pcs/Units
	DO analyzers MLSS analyzers Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge feed flow meters Level meter in thickened sludge feed sump Level meter in polyelectrolyte solution tank Polymer dosing flow meters		4pcs 4pcs 1pc 1pc 1pc 3pcs 1pc 2pcs 3pcs
7. Local SCADA system	Operator stations, PLCs, UPS, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.6 Vindhyachal STP

(1) Existing 4MLD STP

The sewage treatment process of existing STP is Wastewater Stabilization Ponds (WSP), which is said to be the simplest operation and lowest operational expense in sewage treatment processes. However, according to the operation record attached to the DPR, the treated water has not achieved to the expected level, BOD 20mg/l and TSS 30mg/l, even if influent flowrate is less than a half of 4MLD. Therefore, improvement of the performance is required for the STP to treat full capacity.

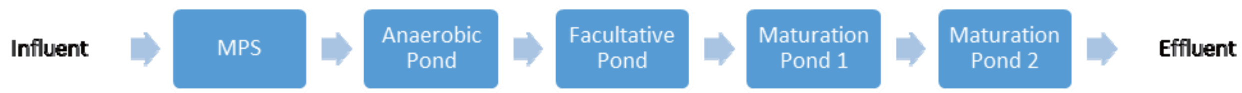


Figure 9.3.26 Process flow of existing Vindhyachal STP

(2) Description of the DPR's plan

As based on the DPR, the STP must increase a capacity from 4MLD to 6MLD and due to the revision of effluent standards its performance must be improved effluent water quality. In the DPR, the existing 4MLD STP is upgraded from WSP to Aerated Lagoon process, and for the remaining 2MLD, establishing new STP is proposed.

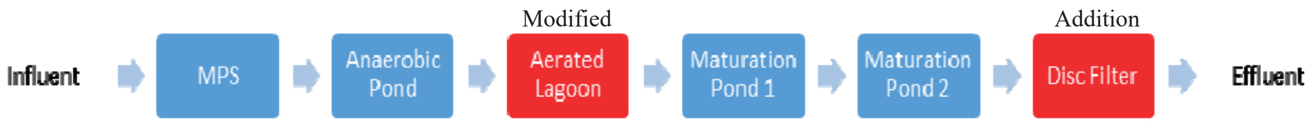


Figure 9.3.27 Process flow of Vindhyachal STP of DPR's plan

However, the plan has some shortcoming as follows:

- The upgrading 4MLD STP does not meet the new effluent standards of PCBC, since it does not have the performance of removing nitrogen.
- BOD/TSS at the inlet of the disc filters may be higher than the assumed value in the DPR;
  BOD 20mg/l, TSS 30mg/l are assumed.
- The two different sewage treatment processes make operation and operational expense inefficiency, since operation and maintenance for equipment increase.
- Footprint for expansion of future cannot be secured, because the proposed 2MLD STP needs large area for sludge treatment facilities, hence the area for future does not remain. In the DPR. (The layout plan of proposed 2MLD STP has not drawn.)
-

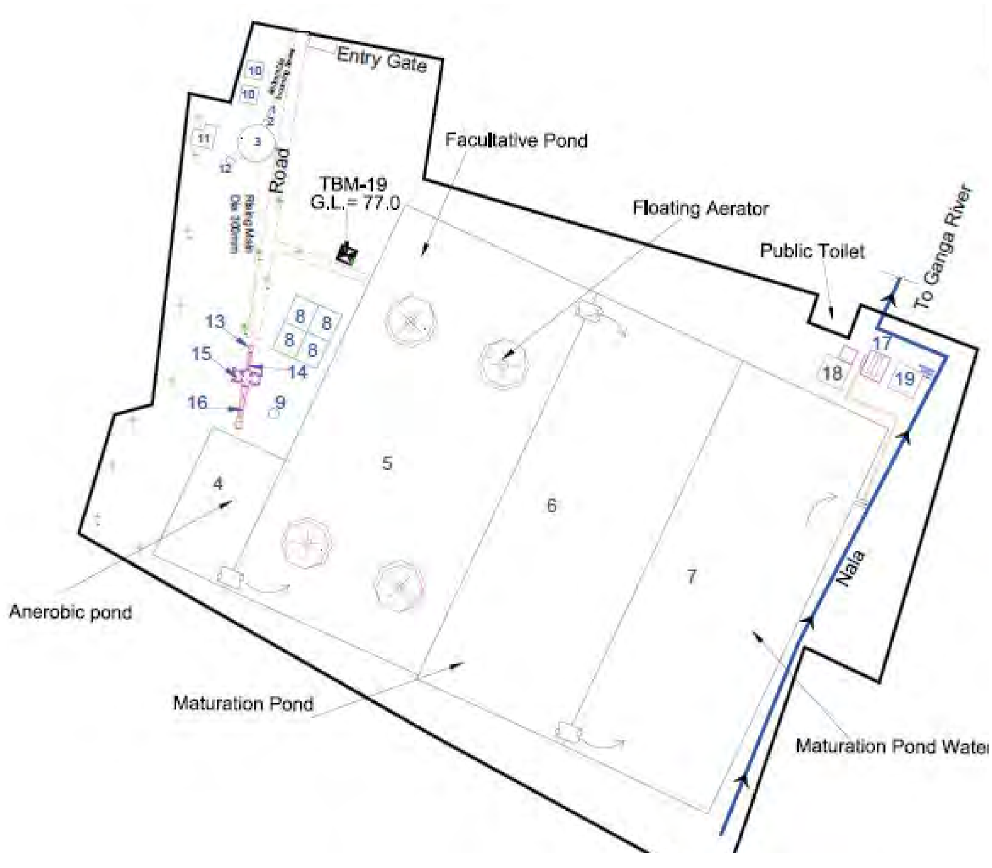


Figure 9.3.28 Layout at upgraded Vindhyachal STP (DPR plan)

Source: DPR for rehabilitation and process upgradation of existing STPs in Mirzapur.

(3) Comparison between DPR plan and alternative plan

To solve the matter mentioned above, SBR plan as alternative is proposed by JICA Survey Team, and the two plans are compared.

The comparison table is shown in Table 9.3.27, and the schematic process diagram and layout plan of SBR plan are shown in Figure 9.3.29, Figure 9.3.30 respectively.

Table 9.3.27 Comparison table of Vindhyacal STP plans

Plan	DPR plan	Alternative	Remarks
Process	4MLD Aerated Lagoon + 2MLD SBR	6MLD SBR	
Treated water quality	2 x 2	5 x 2	
	Not Capable of T-N removal.	Capable of T-N, BOD, TSS removal.	
Capital expense	4 x 2	4 x 2	
	Few difference	Few difference	
Operational expense	5 x 2	4 x 2	
	Less electrical power	More electrical power	
Easiness of maintenance	3 x 1	5 x 1	
	Inefficient for dispersed facility	Facility centralized	
Past records in India	3 x 1	5 x 1	
	Aerated lagoon is poor records	Many past records	
Total	28	36	

Evaluation Score: 5:Best, 4:Better, 3:Fair, 2:Poor, 1:Bad, 0:N/A(Not Applicable)

Importance Level: 2:High, 1:Moderate

Source: JICA Survey Team

As a result of the consideration above, 6MLD SBR plan is proposed.

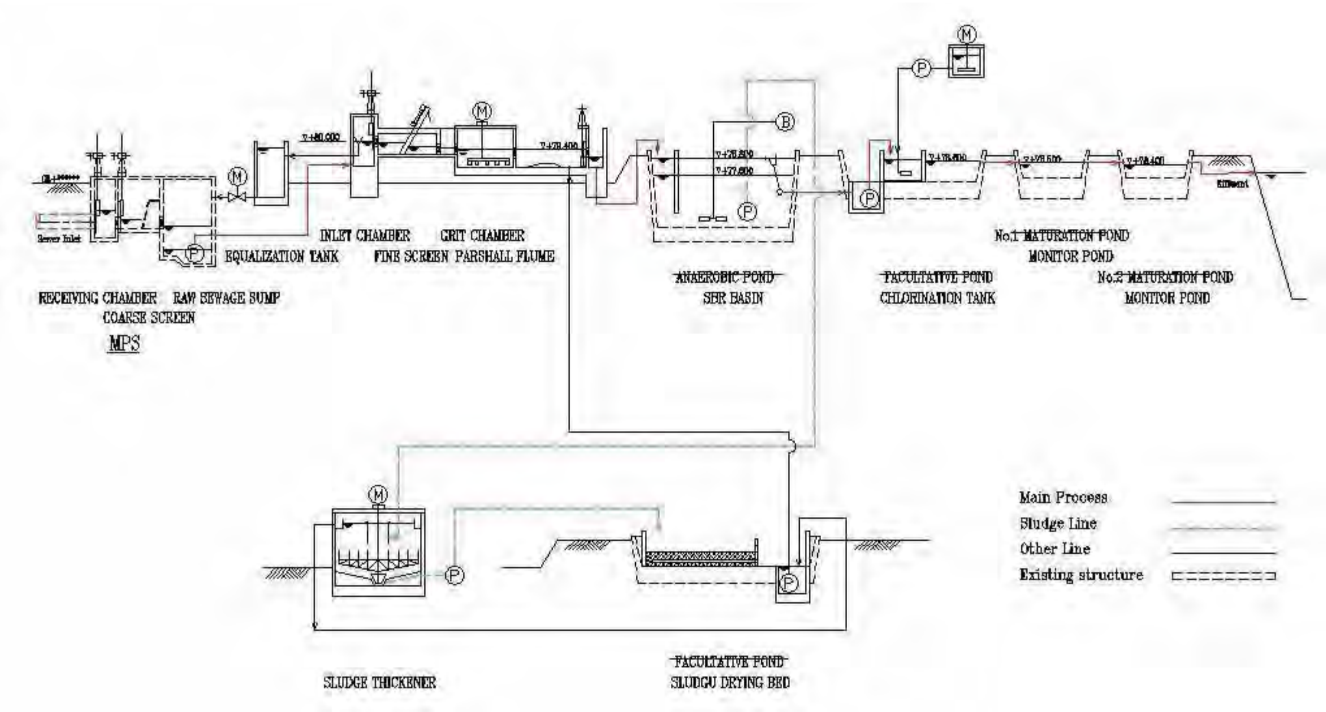
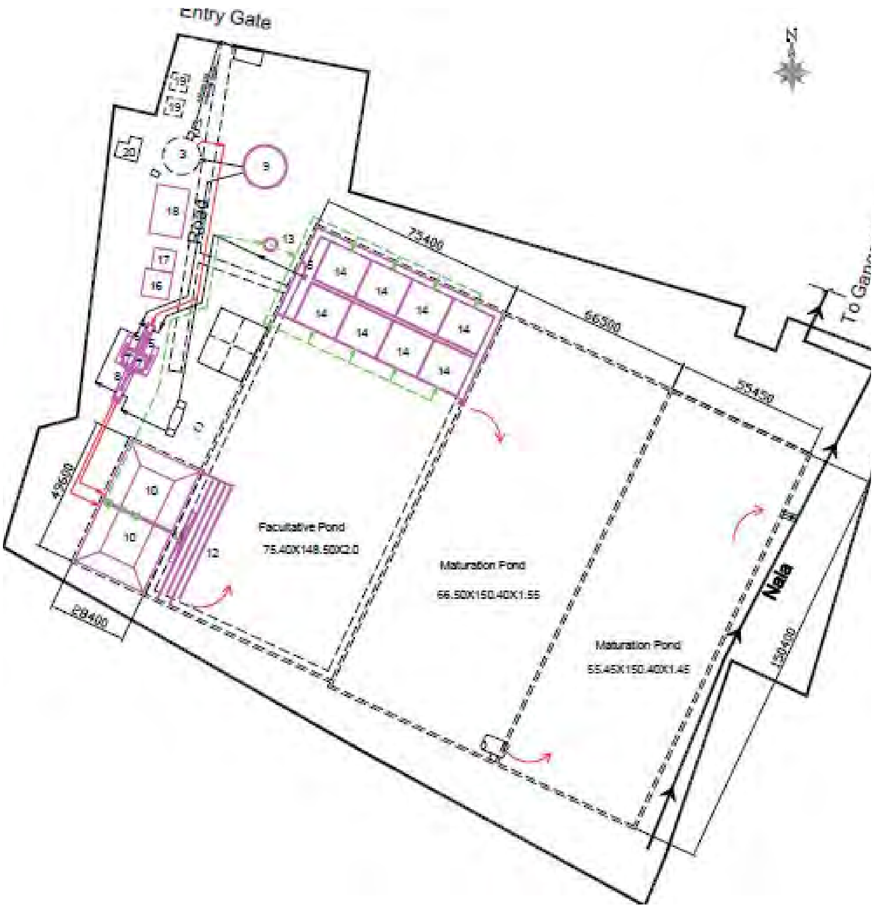


Figure 9.3.29 Schematic Process diagram of Proposed Vindhyachal STP (SBR plan)

Source: JICA Survey Team



Sr. No.	Facility	No.	W/Dia. (m)	L (m)	SWD/H (m)
	MPS				
01	Inlet Chamber	1	1.1^{W}	2.6^{L}	3.4^{H}
02	Distribution Chamber	1	2.6^{W}	2.0^{L}	3.9^{H}
03	Wet Well	1	$6.5^{Dia.}$		6.5^{H}
	STP				
04	Inlet Chamber	1	2.1^{W}	2.5^{L}	1.8^{SDW}
05	Main Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
06	Bypass Screen Channel	1	0.8^{W}	6.0^{L}	0.5^{SDW}
07	Grit Chamber	2	3.0^{W}	3.0^{L}	0.6^{SDW}
08	Parshall Flume	1	0.8^{W}	6.0^{L}	0.7^{SWD}
09	Equalization Tank	1	$15.0^{Dia.}$		3.0^{SWD}
10	SBR *At middle depth	2	*20.4^{W}	*20.4^{L}	5.0^{SWD}
11	Decanted Water Pit	1	2.0^{W}	20.0^{L}	2.0^{SWD}
12	Chlorine Contact Tank	1	2.0^{W}	138.0^{L}	1.5^{SWD}
13	Sludge Thickener	1	$8.0^{Dia.}$		4.0^{SWD}
14	Sludge Drying Bed	8	15.0^{W}	16.0^{L}	2.5^{H}
15	Filtrate Sump	1	1.5^{W}	1.5^{L}	1.5^{H}
16	Air Blower Room	1	10.0^{W}	10.0^{L}	4.0^{H}
17	Chlorination Building	1	8.0^{W}	8.0^{L}	5.0^{H}
18	Administration Building	1	12.0^{W}	18.0^{L}	8.0^{H}
19	Staff Quarters	2	6.3^{W}	6.3^{L}	4.0^{H}
20	Laboratory	1	6.3^{W}	6.3^{L}	4.0^{H}

Figure 9.3.30 Layout plan of Proposed Vindhyachal STP (SBR plan)

Source: JICA Survey Tea

(2) Assumption of design

Design condition for the calculation is shown in Table 9.3.28, which bases on the DPR, however some design values are arranged by JICA survey Team. .

The calculations are referred to “Wastewater Engineering Treatment and Resource Recovery FIFTH EDITION”, METCALF & EDDY/AECOM.

Table 9.3.28 Design Condition for Proposed Vindhyachal STP

Item	Design Value	
Flow Rate	6,000m3/d	
Temperature	20 ℃	
MLSS	3,000mg/l	
Water quality	Influent	Effluent
BOD	250mg/l	10mg/l
COD	450mg/l	50mg/l
TSS	400mg/l	10mg/l
VSS	280mg/l	-
T-N	40mg/l	10mg/l
NH4-N	25mg/l	2mg/l

Source: JICA Survey Team

(3) Design parameters

Table 9.3.29 Design Parameters for Proposed Vindhyachal STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.0	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Sludge Drying Bed**			
(1)	Drying duration	day	12	
(2)	Sludge loading	kg/m2	20	

Source: JICA Survey Team

(4) Description of the proposed STP

1) MPS

MPS exists in the STP site and continues to be used, however, sewage pumps, discharge pipes, and valves are replaced.

2) Headworks

The headworks facility comprises one Inlet chamber, one Main Screen channel, one Bypass Screen Channel, two Grit chambers, one Parshall Flume, and one Distribution Chamber. All structures and equipment are built newly, however, existing headworks facility remains for emergency. Manually operated gates before Main/Bypass Screen channels are installed for the maintenance of Fine Screen, “Step screen” type of openings 6mm.

2) Biological Treatment

As mentioned the above, the 6MLD SBR plan improved from existing anaerobic pond is adopted as compared to the DPR plan. The two SBR basins have the volume of HRT 16 hours, in which one set of micro-bubble diffusers, one decanter, one RAS pump, and one SAS pumps are installed. Further, three Air Blowers, two working and one standby, are proposed, which are used alternately for the two SBRs. Because the SBRs cannot have a buffering volume above itself, Equalization Tank is added separately to relieve peak flow. Decanted water from the SBR basin flows to Decanted Water Pit, which is built in the existing Facultative Pond, and then pumps up to Chlorine Contact Tank.

4) Disinfection

As the chemicals for chlorination, bleaching powder is proposed, which is more safety and easier operation than gas chlorination system. However, research of the purchase of chemicals will be necessary at the detailed design. Chlorination Contact Tank is built in the existing Facultative Pond that is demolished.

5) Sludge treatment facilities

The waste activated sludge is transferred from the SBR basin to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Sludge Drying Bed, which is built in the demolished Facultative Pond.

Table 9.3.30 Facility List of Proposed Vindhyachal STP

Sr. no	Unit	Quantity	Width /Dia	Length	Liquid Depth /Height	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	1.1	2.6	3.4	-
2	Distribution Channel	1	2.6	2.0	3.9	-
3	Wet Well	1	6.5	-	6.5	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	2.1	2.5	1.8	0.5
2	Main Screen Channel	1	0.8	6.0	0.5	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.5	0.5
4	Grit Distribution Chamber	1	2.1	1.0	0.6	0.5
5	Grit Inlet Channel	2	3.0	2.0	0.3	0.5
6	Grit Chamber	2	3.0	3.0	0.9	0.5
7	Grit Classifier Platform	2	2.0	10.0	-	-
8	Grit Outlet Channel	2	3.0	1.5	0.4	0.5
9	Parshall Flume	1	0.8	6.0	0.7	0.5
10	Bifurcation Chamber	1	2.1	3.0	2.0	0.5
11	Distribution Box	2	0.8	1.0	0.5	0.5
12	SBR Reactor *at middle water depth	2	20.4	20.4	5.0	0.5
13	Decanted Water Sump	1	2.0	20.0	2.0	0.5
14	Chlorine Contact Tank	1	2.0	138.0	1.5	0.5
15	Sludge Thickener	1	8.0	-	4.0	0.3
16	Sludge Drying Bed	8	15.0	16.0	2.5	-
17	Sludge Drying Bed (existing)	4	8.0	10.0	1.5	-
18	Filtrate Sump	1	1.5	1.5	1.5	-
B	**Buildings**					
19	Air Blower Room	1	10.0	10.0	4.0	-
20	Chlorination Building	1	8.0	8.0	5.0	-
21	Administration Building, including Electrical Room, DG Room,	1	12.0	18.0	8.0	-
22	Staff Quarters (existing)	2	6.3	6.3	4.0	-
23	Laboratory (existing)	1	6.3	6.3	4.0	-

Source: JICA Survey Team

Table 9.3.31 Equipment List of Proposed Vindhyachal STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
Inlet Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W
Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.5 (m) ×Open Space:6(mm)	2.20	1W
Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.5 (m) ×Open Space:20(mm)	-	1S
Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
Grit Chamber	Square Horizontal Type Cast Iron	Width :3.0 (m)×Length :3.0(m)×SWD :0.6(m)	2.25	2W
Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	2W
Decanter	Swing Type SS304	Width :20.4 (m) × Length :20.4(m) × SWD :5.0(m)	2.20	2W
Diffusers	Fine Bubble Membrane	SOR:225 (kg/h・basin)×setting Depth :4.5(m) ×Efficiency:27.5 %	-	2W
Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :1600(m^3/h) ×Pressure: 60 (K Pa)	55.0	2W+1S
RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:13(m3/h)×Total Head:5.0 (m)	1.5	2W+1S
SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:30(m^3/h)×Total Head:7.0 (m)	2.2	1W+1S
Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2W
Decanted Water Pumps	Submersible Non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:400(m^3/h)×Total Head:5.0 (m)	15.0	2W+2S
Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :200(l/h)×Total Head:20.0 (m)	0.4	2W+1S
Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.0 (m) × Length :1.0(m) × SWD :1.5(m)	0.4	2W
Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 8.0(m)×Height :4.0(m)	0.4	2W
Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :15(m^3/h)×Total Head:20.0 (m)	1.5	1W+1S
Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :20(m^3/h)×Total Head:15.0 (m)	1.5	1W+1S
(Electrical)				

Items	Specification	kW	Pcs/Units
Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 375 kVA		1pc 1pc 1pc 1pc
LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 10, Static capacitor 5kVar x 1, 10kVar x 1, 20kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 55 kW Raw sewage pump starter panels with Soft Starter, 37 k W MCCs for Solid process (Gravity thickener, Centrifuge)		1pc 1pc 1pc 1pc 3pcs 3pcs 1pcs
Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Thickened sludge feed flow meter Polymer dosing flow meters		1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc
Local SCADA system	Operator stations, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.7 Ramnagar STP

Based on calculation sheets attached on Ramna and Ramnagar DPR (Both STP adopted CND), recalculated in light of the 2013CPHEEO manual.

Table 9.3.32 Facility List of Proposed Ramnagar STP in design year

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
A	**Basins & Tanks**					
1	Inlet Chamber	1	3.2	3.5	2.0	0.5
2	Main Screen Channel	2	0.8	7.5	0.5	0.5
3	Bypass Screen Channel	1	0.8	7.5	0.5	0.5
4	Grit Chamber	2	4.0	4.0	0.8	0.5
5	Parshall Flume	1	1.5	10.0	0.7	0.5
6	Distribution Chamber	1	***	***	***	***
7	Anoxic Tank	2	8.0	29.0	5.0	0.5
8	Aerobic Tank	2	8.0	87.0	5.0	0.5
9	Secondary Clarifier	2	24.0	-	3.5	0.5
10	Chlorine Contact tank	1	2.0	70.0	2.0	0.5
11	Dechlorine Mixing tank	1	13.0	4.0	2.0	0.5
12	Secondary Sludge Sump	2	3.0	3.0	4.0	0.5
13	Sludge Thickener	2	9.0	-	4.0	0.5
14	Thickened Sludge Sump	2	3.0	3.0	3.0	0.5
15	Centrifuge Feed Sump	1	4.0	5.0	3.5	0.5
16	Filtrate Sludge Sump	1	3.0	3.0	3.0	0.5
B	**Buildings**					
17	Air Blower Room	1	12.0	25.0	6.0	
18	Chlorination building	1	10.0	15.0	6.0	
19	Centrifuge Building	1	12.0	18.0	10.0	
20	Administration Building	1	15.0	25.0	10.0	

Source: JICA Survey Team

Table 9.3.33 Design Conditions for Proposed Ramnagar STP

Facility		Unit	Design Value	Remarks
1	**Pump Sump**			
(1)	Duration	min	8	
2	**Coarse Screen**			
(1)	Opening	min	50	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
3	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
4	**Grit Chamber**			
(1)	Surface Load	m^3/m^2/day	100	at peak flow
5.	**Aerobic Tank**			
(1)	Temperature (min)	℃	20	
(2)	MLSS	mg/L	3,000	
(3)	SRT	day	4.83	
(4)	HRT	hour	12.3	
(5)	Return sludge ratio	%	60	
(6)	Circulation ratio	%	60	
6.	**Anoxic Tank**			
(1)	HRT	hour	4.0	
7.	**Secondary Clarifier**			
(1)	Surface Load	m^3/m^2/day	15	or Equivalent Tube settler
8.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
9.	**Sludge Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
10.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

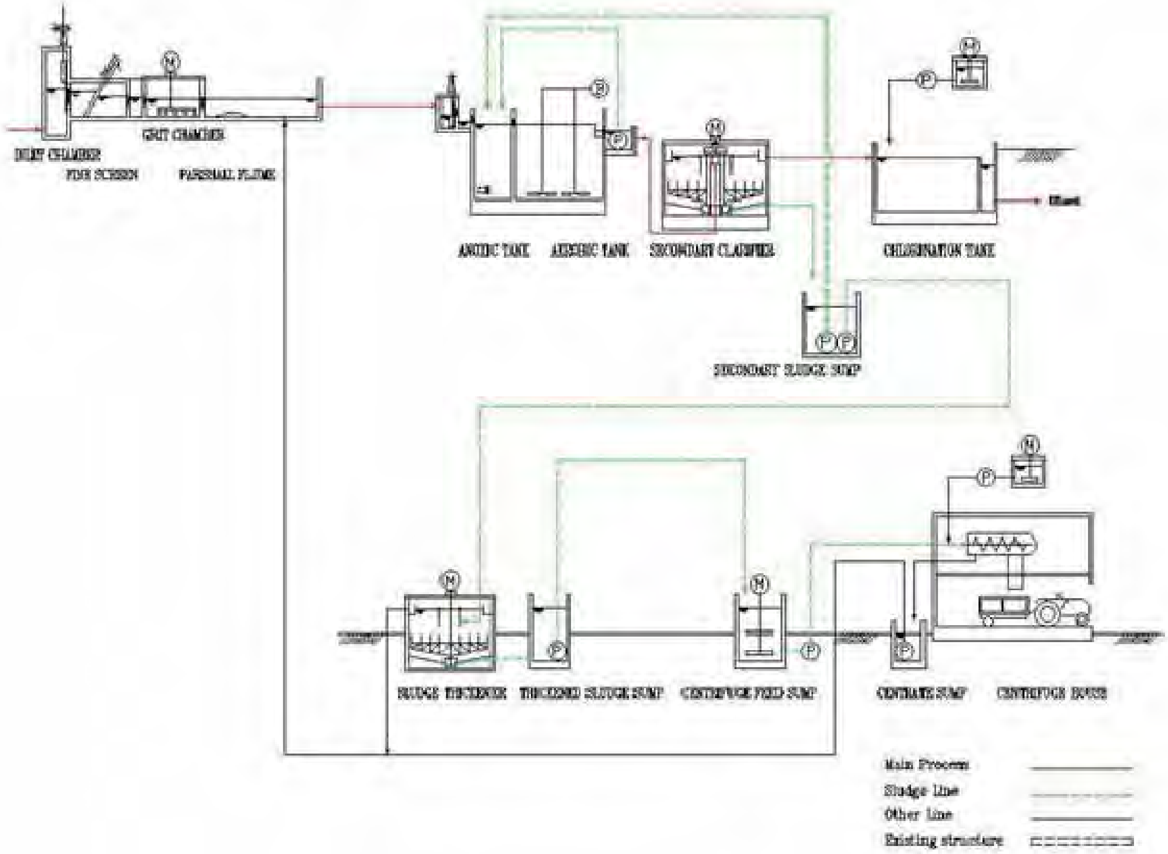


Figure 9.3.31 Schematic Process Diagram of Ramnagar STP

Source: JICA Survey Team

1) Headworks

Headworks facility comprises one Inlet chamber, two Fine screen channels, two Grit chambers, and one Parshall Flume. Inlet chamber, Fine screen and Grit chamber are designed in same design concept as Ramnagar STP. Manually operated gates before fine screen chambers are proposed for the maintenance of the screens. “Step screen” type of the fine screens with opening of 6mm and “square horizontal-flow” type of the grit removal facility, which have been installed across India, are adopted.

2) Anoxic & aerobic tank

Biological Treatment comprises anoxic tank, aerobic tank and secondary clarifier. Combination of these three parts enables both organic matter and nitrification removal. For stirring of Anoxic tanks, submersible mixers are adopted, since they are available at reasonable price without bases and supports at upper portion.

Aeration tanks are recommended to be Plug-flow reactors with the width of 7.2m, length of 160m and depth of 5.0m because it is more effective reaction and easy in maintenance of diffusers e.g. air flow adjustment. The Aerobic tanks are baffled channels that do not need to change the layout plan from the DPR. The oxygen transfer rate of the diffusers should be more efficient than 30.5% as fine bubble membrane type. Nitrified liquid is transferred to Anoxic tank from the pit following Aerobic tank by Circulation pump that is submersible type equipped with a screw impeller. The return sludge pumps are more than 60% of return rate, and circulation pumps are more than 110% of circulation rate.

3) Disinfection

Basing on the DPR, solution of bleaching powder is used for disinfection. The works of the chemical solution are manually operation. As design condition, effective concentration of chlorine 70%, dissolution concentration 2% are assumed. Two Solution tanks have 2 days of volume at 5mg/l of dosing rate. Chlorine Dosing Pump is Progress Cavity type that cannot be clogged by undissolved flour.

4) Sludge treatment facilities

Secondary sludge is transferred to sludge thickener and then thickened sludge is transferred to centrifuge facility. The operation period of a centrifuge is 8 hours per day, 6 days per week.

Table 9.3.34 Equipment List of Proposed Ramnagar STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Operated Cast Iron	Width 0.6(m)×Height :0.9(m)	-	2W
2. Coarse Screens (Mechanical)	Climber Type SS304	Channel Width :1.0 (m)×SWD :0.80 (m) ×Open Space:20(mm)	1.50	2W
3. Coarse Screens (Manual)	Manual Type SS304	Channel Width :1.0 (m)×SWD :0.80 (m) ×Open Space:50(mm)	-	2W
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Sewage Pumps	Submersible, non-clog impeller Cast Iron	Dia. :250 (mm)×Discharge:375(m^3/h)×Total Head:20.0 (m)	55.0	2W+1S
6. Sewage Pumps	Submersible, non-clog impeller Cast Iron	Dia. :150 (mm)×Discharge:188(m^3/h)×Total Head:20.0 (m)	22.0	1W+1S
7. Electric Hoist for Tonners		Rated Load :3.0(Ton)×Lift :6(m)	8.50	1W
8. Inlet Gates	Manually Operated Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W+1S
9. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.80 (m)×SWD :0.50 (m) ×Open Space:6(mm)	1.50	2W
10. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.80 (m)×SWD:0.50 (m) ×Open Space:20(mm)	-	1S
11. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W

Items	Specification		kW	Pcs/Units
12. Grit Chamber	Square Horizontal SS304	Width :4.00 (m)×Length :4.00(m)×SWD :0.80 (m)	2.25	2W
13. Inlet Weir Gates	Manually Operated Cast Iron	Width 0.8(m)×Height :0.5(m)	-	2W
14. Mixers for Anoxic Tank	Submersible SS304	Width :8.0 (m)×Length :9.7(m)×SWD :5.0(m)	4.0	6W
15. Diffusers	Fine Bubble Membrane	SOR:127 (kg/h・basin)×setting Depth :4.7(m) ×Efficiency:28.5 %	-	2W
16. Air Blowers	Rotary blower Tri-lobe Type	Dia. :150 (mm)× Air Flow :900(m^3/h) ×Pressure: 60 (K Pa)	30.0	4W+2S
17. Circulation Pumps	Submersible Screw impeller Cast Iron	Dia. :100 (mm)×Discharge:125(m3/h)×Total Head:5.0 (m)	3.70	2W+2S
18. RAS Pumps	Submersible Screw impeller Cast Iron	Dia. :100 (mm)×Discharge:125(m^3/h)×Total Head:5.0 (m)	3.70	2W+2S
19. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.50	2W+2S
20. Hand Operation Chain Block	With Geared Trolley	Rated Load :2.0(Ton)×Lift :6(m)	-	3W
21. Final Clarifier	Column-supported Circular Clarifier Cast Iron	Dia. 24.0(m)×Height :3.5(m)	1.5	2W
22. Mixers for chlorine solution	Vertical propeller	Width :1.50 (m)×Length :1.50(m)×SWD :1.50 (m)	1.50	2W
23. Chlorine dosing Pump	Progress Cavity	Dia.:15 (mm)×Discharge :100(L/h)×Total Head:20.0 (m)	0.40	2W+2S
24. Mixers for Dechlorine solution	Vertical propeller	Capacity :0.3 (m3)	0.10	2W
25. Dechlorine dosing Pump	Progress Cavity	Dia.:20 (mm)×Discharge :12(L/h)×Total Head:20.0 (m)	0.40	1W+1S
26. Air Blowers For Dechlorine Mixing Tank	Rotary blower Tri-lobe Type	Dia. :50 (mm)× Air Flow:104(m^3/h) ×Pressure: 35(K Pa)	2.20	1W+1S
27. Electric Hoist for Tonners		Rated Load :1.0(Ton)×Lift :6(m)	8.50	1W
28. Sludge Thickener	Bridge-supported Circular Clarifier Cast Iron	Dia. 9.0(m)×Height :4.0(m)	0.40	2W
29. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.50	2W+2S
30. Air Blowers For Thickened Sludge Sump	Rotary blower Tri-lobe Type	Dia. :65 (mm)× Air Flow:168(m^3/h) ×Pressure: 40 (K Pa)	3.70	1W+1S
31. Centrifuge Feed Pumps	Progress Cavity Cast Iron	Dia.:100 (mm)×Discharge :19(m^3/h)×Total Head:20.0 (m)	5.50	1W+1S

Items	Specification		kW	Pcs/Units
32. Centrifuge	Solis Bowl Type SS304	Capacity :19(m3/h)	44.5	1W+1S
33. Electric Hoist		Rated Load :5.0(Ton)×Lift :6(m)	17.10	1W
34. Polyelectrolyte Dosing System	Vertical propeller	Width :1.50 (m)×Length :2.0(m)×SWD :2.00 (m)	1.50	2W
35. Polyelectrolyte Dosing Pump	Progress Cavity	Dia.:20 (mm)×Discharge :0.52 (m3/h)×Total Head:20.0 (m)	0.40	1W+1S
36. Centrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	1.50	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 6, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 30 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters MLR (Mixed Liquor Recycle) flow meters Level meter in secondary sludge sump DO analyzers MLSS analyzers Chlorine dosing flow meters De-chlorine dosing flow meters Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meter Level meter in centrifuge sump Centrifuge feed flow meter Polymer dosing flow meters Filtrate flow meter			1pc 4pcs 2pcs 2pcs 2pcs 2pcs 1pc 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 1pc 2pcs 2pcs 1pc
4. Local SCADA system	Operator stations, SCADA/data servers, PLCs, Ethernet switch, etc.,			1ls

Source: JICA Survey Team

9.3.8 Chunar STP

Based on calculation sheets attached on Chunar DPR and other DPRs which employed SBR process, recalculation was made in light of the 2013CPHEEO manual.

Table 9.3.35 Facility List of Proposed Chunar STP

Sr. no	Unit	Quantity	Width /Dia	Length	Liquid Depth /Height	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	2.0	3.7	1.0	-
2	Main Screen Channel	1	0.8	7.5	0.7	-
3	Bypass Screen Channel	1	0.8	7.5	0.7	-
4	Wet Well	1	8.0	-	-	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	2.1	2.5	1.8	0.5
2	Main Screen Channel	1	0.8	6.0	0.5	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.5	0.5
4	Grit Distribution Chamber	1	2.1	1.0	0.6	0.5
5	Grit Inlet Channel	2	3.0	2.0	0.3	0.5
6	Grit Chamber	2	3.0	3.0	0.9	0.5
7	Grit Classifier Platform	2	2.0	10.0	-	-
8	Grit Outlet Channel	2	3.0	1.5	0.4	0.5
9	Parshall Flume	1	0.8	6.0	0.7	0.5
10	Bifurcation Chamber	1	2.1	3.0	2.0	0.5
11	Distribution Box	2	0.8	1.0	0.5	0.5
12	SBR	2	20.0	20.0	5.5	1.0
13	Chlorine Contact Tank	1	2.0	120.0	2.0	0.5
14	Dechlorine Mixing Tank	1	15.0	5.0	2.0	0.5
15	Sludge Thickener	1	8.5	-	4.0	0.5
16	Thickened Sludge Sump	1	1.5	2.0	2.0	0.5
17	Centrifuge Feed Sump	2	3.0	4.0	3.0	0.5
18	Filtrate Sump	1	1.5	1.5	1.5	0.5
B	**Buildings**					
19	Air Blower Room	1	10.0	10.0	4.0	-
20	Chlorination Building	1	8.0	15.0	5.0	-
21	Centrifuge Building	1	8.0	15.0	8.0	-
22	Administration Building, including Electrical Room, DG Room,	1	12.0	18.0	8.0	-

Source: JICA Survey Team

Table 9.3.36 Design Parameters for Proposed 6.5 MLD Chunar STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	m^3/m^2/day	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.5	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

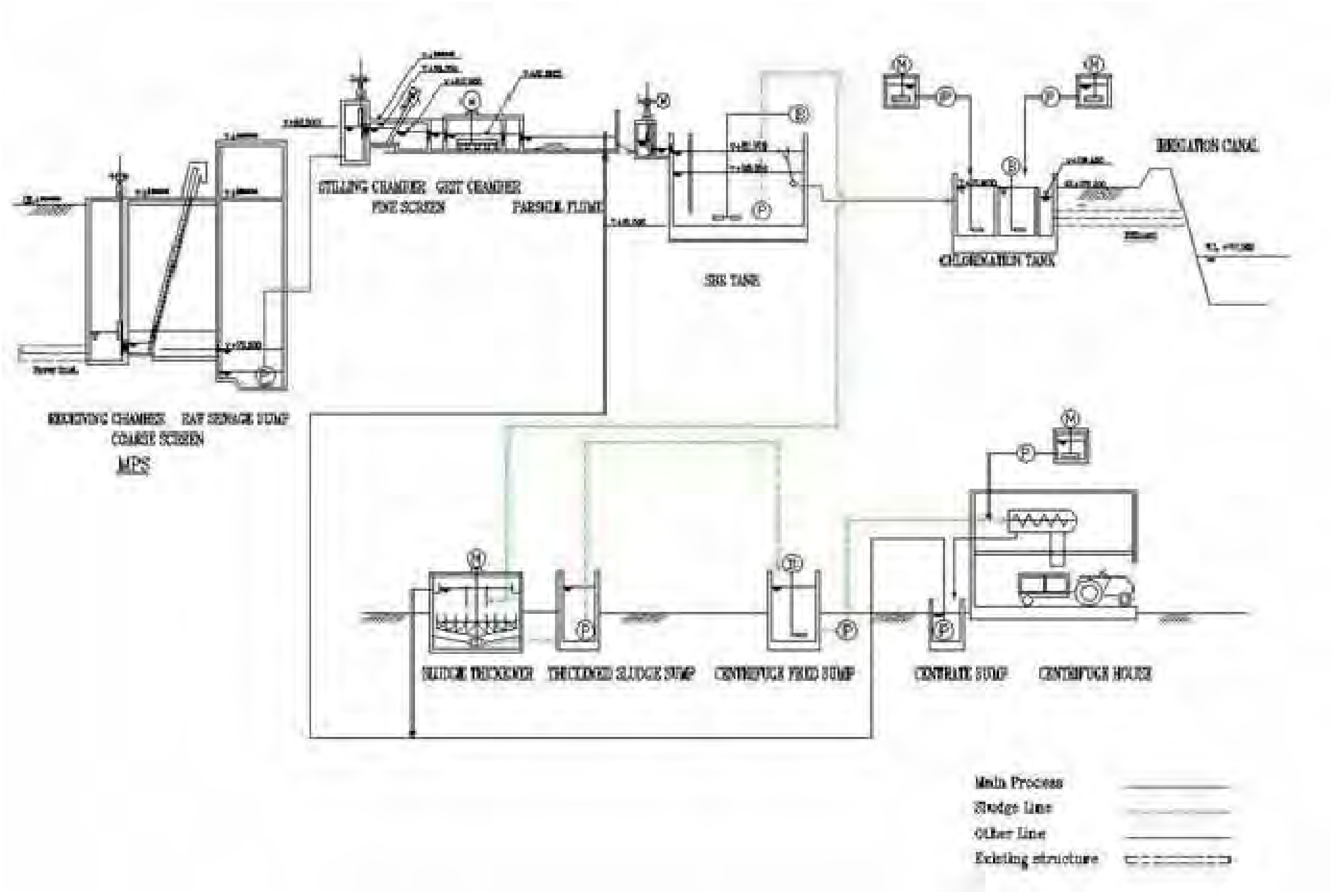


Figure 9.3.32 Schematic Process Diagram of Chunar STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet chamber, one Main Screen Channel, one Bypass Screen Channel, two Grit chambers, and one Parshall Flume.

2) Biological Treatment

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Chunar STP. For removing nitrogen, the two SBR tanks have the volume of HRT 16 hours which were extended from the original design of DPR. The each unit comprises one inlet gates, one selector, one SBR tank, one set of micro-bubble diffuser, one decanter, and one waste sludge pumps in each unit, by which cycle operation of filling, settling and decanting can be achieved. Further, three numbers (2 working and 1 standby) air blowers were proposed.

4) Disinfection

As the chemicals for chlorination, bleaching powder is proposed, which has been changed from gas chlorination system. DPR proposes the system due to safety and easy operation. However, research of the purchase of chemicals will be necessary at the detailed design.

5) Sludge treatment facilities

The waste activated sludge is transferred from the SBR tank to Sludge Thickener for reducing its volume and stabilization. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which should keep the volume to operate the centrifuges for sufficient duration. Centrifuges are introduced as dewatering units to the proposed and the existing STPs separately in the DPR. The generated sludge and the capacity of the facilities were increased from DPR after review.

6) Electrical, instrumentation and SCADA

There is a transformer with 500 kVA and a diesel generator set with 300 kVA provided for the 6.5 MLD STP as the power receiving/supply facilities. The diesel generator set is to back up essential equipment during power failure. The transformer and the diesel generator set are to feed power to the equipment/facilities of the STPs.

The incoming LV panels proposed for the STP is to receive power from the transformer and the diesel generator set and distribute it to LV feeder panel followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers
- Chlorine doing flow meter
- Residual chlorine analyzer

- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Level meter in thickened sludge sump
- Thickened sludge flow meters
- Level meter in centrifuge sump
- Centrifuge feed flow meters
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters
- Filtrate flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.37 Equipment List of Proposed Chunar STP

Items	Specification		kW	Pcs/Units
(Mechanical)				
1. Inlet Gates	Manually Cast Iron	Width 0.5(m)×Height :0.75(m)	-	2W
2. Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.5 (m) ×Open Space:6(mm)	2.2	1W
3. Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.5 (m) ×Open Space:20(mm)	-	1S
4. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5. Grit Chamber	Square Horizontal SS304	Width :3.0 (m)×Length :3.0(m)×SWD :0.6(m)	2.25	2W
6. SBR Inlet Gates	Motorized Cast Iron	Width 0.3(m)×Height :0.3(m)	0.4	2W
7. Decantor	Swing Type SS304	Width :20.0 (m)×Length :20.0(m)×SWD :5.5(m)	2.20	2W
8. Diffusers	Fine Bubble Membrane	SOR:242 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	2W
9. Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :1600(m^3/h) ×Pressure: 65 (K Pa)	55.0	2W+1S
10. RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:14(m3/h)×Total Head:5.0 (m)	1.5	2W+1S
11. SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:30(m^3/h)×Total Head:7.0 (m)	2.2	2W+1S
12. Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	2
13. Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :200(l/h)×Total Head:20.0 (m)	0.4	2W+1S
14. Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.0 (m)×Length :1.0(m)× SWD :1.5(m)	0.4	2W
15. Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :20(l/h)×Total Head:20.0 (m)	0.4	2W+1S
16. Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :0.8 (m)×Length :0.8 (m)× SWD :0.8(m)	0.2	2W
17. Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :75(m^3/h) ×Pressure: 35 (K Pa)	1.5	1W+1S
18. Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
19. Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 8.5(m)×Height :4.0(m)	0.75	2W
20. Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :20 (m^3/h)×Total Head:10.0 (m)	1.5	1W+1S

Items		Specification		kW	Pcs/Units
21.	Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :90(m^3/h) ×Pressure: 40 (K Pa)	3.7	1W+1S
22.	Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :12 (m3/h)×Total Head:20.0 (m)	3.7	1W+1S
23.	Centrifuge	Solids Bowl Type SS304	Capacity :12 (m3/h)	19.7	1W+1S
24.	Crane for Centrifuge	Single-girder overhead	Capacity:3.0 (ton)×Lift:6.0 (m)	8.5	1W
25.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
26.	Polyelectrolyte Dosing System		Width :1.0 (m)×Length :1.5(m)×SWD :2.0(m)	2.2	2W
27.	Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.32 (m3/h)×Total Head:20.0 (m)	0.4	1W+1S
28.	Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :30(m^3/h)×Total Head:15.0 (m)	3.7	1W+1S
(Electrical)					
1.	Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 500 kVA Diesel engine generator set: 415 V, 50 Hz, 300 kVA			1pc 1pc 1pc
2.	LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 800A x 1, 630A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 5, 100A x 10, Static capacitor 10kVar x 1, 20kVar x 1, 40kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 55 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3.	Instrumentation devices	Inlet flow meter Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow meter Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meters Level meter in centrifuge sump Centrifuge feed flow meters Level meter in polyelectrolyte solution tank			1pc 4pcs 2pcs 2pcs 2pcs 2pcs 2pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 2pcs 2pcs

Items	Specification	kW	Pcs/Units
	Polymer dosing flow meters Filtrate flow meter		2pcs 1pc
4. Local SCADA system	Operator stations, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.9 Ghazipur STP

Adopted STP process is SBR process. Based on calculation sheets attached on Chunar DPR and other SBR adopted DPR, recalculation was made in light of the 2013CPHEEO manual.

Table 9.3.38 Facility List of Ghazipur STP

Sr. no	Unit	Quantity	Widgth /Dia	Length	Liquid Depth	Free Board
			m	m	m	m
	MPS					
1	Inlet Chamber	1	2.5	3.7	2.0	-
2	Main Screen Channel	2	1.0	7.5	0.7	-
3	Bypass Screen Channel	1	1.0	7.5	0.7	-
4	Wet Well	1	12.0	-	-	-
	STP					
A	**Basins, Tanks, Channel**					
1	Inlet Chamber	1	3.2	4.5	2.0	0.5
2	Main Screen Channel	2	0.8	6.0	0.7	0.5
3	Bypass Screen Channel	1	0.8	6.0	0.7	0.5
4	Grit Chamber	2	5.0	5.0	0.9	0.5
5	Parshall Flume	1	1.5	10.0	0.8	0.5
6	DistributionChamber	1	2.0	3.5	2.0	0.5
7	SBR	4	17.0	33.0	5.5	1.0
8	Chlorine Contact Tank	1	2.0	156.0	2.0	0.5
9	Dechlorine Mixing Tank	1	7.0	15.0	2.0	0.5
10	Sludge Thickener	2	7.5	-	4.0	0.5
11	Thickened Sludge Sump	2	2.0	1.5	2.0	0.5
12	Centrifuge Feed Sump	2	4.0	5.0	3.0	0.5
13	Centrate Sump	2	2.0	2.0	2.0	0.5
B	**Buildings**					
14	Air Blower Room	1	12.0	25.0	6.0	-
15	Chlorination Building	1	10.0	15.0	6.0	-
16	Centrifuge Building	1	10.0	25.0	10.0	-
17	Administration/Electrical Building	1	16.0	25.0	10.0	-

Source: JICA Survey Team

Table 9.3.39 Design Parameters for Proposed 18 MLD Ghazipur STP

Facility		Unit	Design Value	Remarks
1	**Fine Screen**			
(1)	Opening	min	6	
(2)	Passage velocity	m/sec	Less than 0.8	At peak flow
2	**Grit Chamber**			
(1)	Surface Load	$m^3/m^2/day$	1000	At peak flow
3.	**SBR Tank**			
(1)	Temperature (min)	℃	20	
(2)	No. of cycles per tank	Nos./day	5.0	
(3)	Full liquid depth	m	5.5	At average flow
(4)	Decant depth	%	30% 0f Full liquid depth	
(5)	HRT	hour	16	At full liquid depth
(6)	MLSS	mg/L	3,000	At full liquid depth
4.	**Chlorination Tank**			
(1)	Contact time	min	more than 30	
(2)	Injection rate	mg/L	10.0	
5.	**Thickener**		Gravity thickener	
(1)	Sludge loading	kg/m2・day	40	
6.	**Dewatering**		Centrifuge	
(1)	Operating time	hr/day	8.0	6days per a week
(2)	Water contents	%	82	
(3)	Polyelectrolyte dosage rate	%	0.15	

Source: JICA Survey Team

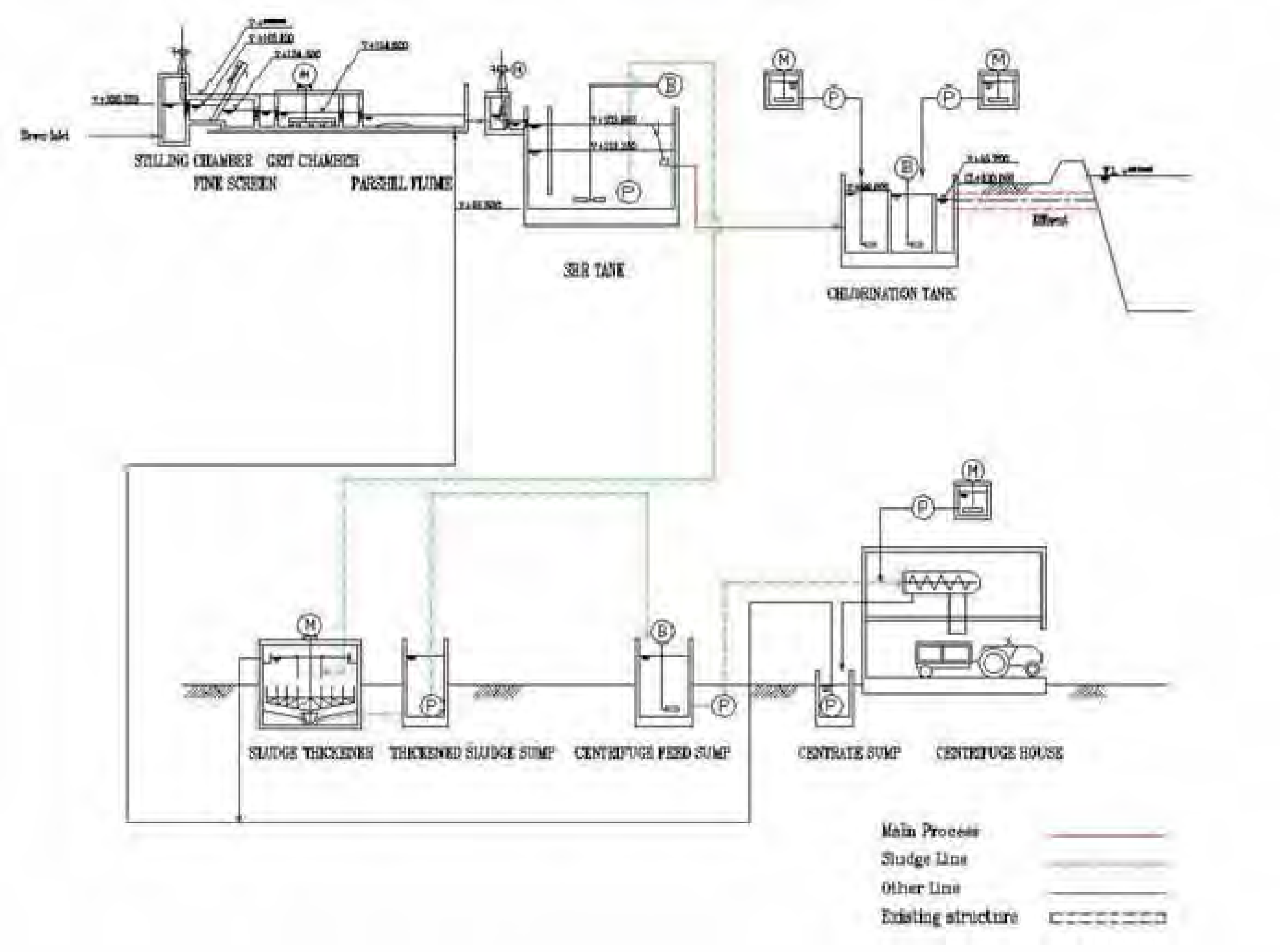


Figure 9.3.33 Schematic Process Diagram of Ghazipur STP

Source: JICA Survey Team

1) Headworks

The headworks facility comprises one Inlet Chamber, two Main Screen Channels, one Bypass Screen Channel, two Grit Chambers, and one Parshall Flume.

2) Biological Treatment

SBR process has been applied as biological treatment method through the study of lifecycle cost comparison among the biological treatment processes applicable to Ghazipur STP. For removing nitrogen, the four SBR tanks have the volume of HRT 16 hours, which have increased from the original design of DPR. The each unit comprises one inlet gates, one selector, one SBR tank, one set of micro-bubble diffuser, one decanter, and one waste sludge pump in each unit, so that cycle operation of filling, settling and decanting can be achieved. Further, six numbers (4 working and 2 standby) air blowers were proposed.

3) Disinfection

Regarding the chemicals for chlorination, bleaching powder is proposed, which has been changed from gas chlorination system DPR proposes due to safety and easy operation. However, research of the purchase of chemicals will be necessary at the detailed design.

4) Sludge treatment facilities

The waste activated sludge is transferred from the SBR tank to Sludge Thickeners for stabilization and reducing the volume. The thickened-sludge is withdrawn by submersible pump in the Thickened Sludge Sump and transferred to Centrifuge Feed Sump, which should keep the volume to operate the centrifuges for sufficient duration. Two units of Centrifuges are introduced as dewatering units to the proposed system with a unit capacity of 10 m^3/h.

5) Electrical, instrumentation and SCADA

There are a transformer with 630 kVA and a diesel generator set with 500 kVA provided for the 18 MLD STP as the power receiving/supply facilities. The diesel generator set is to back up essential equipment during power failure. The transformer and the diesel generator set are to feed power to the equipment/facilities of the STP.

The incoming LV panels proposed for the STP is to receive power from the transformer and the diesel generator set and distribute it to LV feeder panel followed by MCCs (Motor Control Centers), air blower starter panels, UPS and distribution board. There are three MCCs such as the headworks MCC, the SBR MCC, and the solid process MCC proposed to drive the related plant loads/equipment. Air blower starter panels are planned to be installed separately from the MCCs considering their large capacity of motor. UPS (Uninterruptible Power Supply) system is installed to back up instrumentation devices and SCADA system components for reliable plant operation even during power failures.

Instrumentation devices like flow meters, level meters, water quality analyzers etc., are planned to be arranged within the STPs to achieve automatic operation of the plant equipment/load in association of the MCCs and PLCs in adequate/proper manner. There are the instrumentation devices proposed as follows;

- Inlet flow meter
- Level meters in pump wet well
- Level meters of pre and post screens
- Air blow flow meters
- Air blow pressure meters
- RAS (Return Activated Sludge) flow meters
- DO analyzers
- MLSS analyzers

- Chlorine doing flow meter
- De-chlorine doing flow meter
- Residual chlorine analyzer
- Effluent flow meter
- WAS (Waste Activated Sludge) flow meters
- Level meter in thickened sludge sump
- Thickened sludge flow meters
- Level meter in centrifuge sump
- Centrifuge feed flow meters
- Level meter in polyelectrolyte solution tank
- Polyelectrolyte dosing flow meters
- Filtrate flow meters

A SCADA (Supervisory Control And Data Acquisition) proposed comprises PLCs, Operator Stations, UPS, Ethernet switch, printers to monitor control the plant loads/process within the STPs properly. The PLCs (Programmable Logic Controllers) plays a role of automatic operation of the plant loads/equipment in association of the instrumentation devices to achieve an adequate operation. The operator station plays roles of HMI (Human Machine Interface), system setting, data processing for reporting and alarming.

Table 9.3.40 Equipment List of Proposed Ghazipur STP

Items		Specification		kW	Pcs/Units
(Mechanical)					
1.	Inlet Gates	Manually Cast Iron	Width 0.6(m)×Height :0.9(m)	-	3W
2.	Fine Screens (Mechanical)	Step Type SS304	Channel Width :0.8 (m)×SWD :0.7 (m) ×Open Space:6(mm)	1.5	2W
3.	Fine Screen (Manual)	Bar Screen SS304	Channel Width :0.8 (m)×SWD:0.7 (m) ×Open Space:20(mm)	-	1S
4.	Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
5.	Grit Chamber	Square Horizontal SS304	Width :5.0 (m)×Length :5.0(m)×SWD :0.6(m)	2.25	2W
6.	SBR Inlet Gates	Motorized Cast Iron	Width 0.5(m)×Height :0.5(m)	0.4	4W
7.	Decantor	Swing Type SS304	Width :17.0 (m)×Length :33.0(m)×SWD :5.5(m)	2.20	4W
8.	Diffusers	Fine Bubble Membrane	SOR:357 (kg/h・basin)×setting Depth :5.0(m) ×Efficiency:30.5 %	-	4W
9.	Air Blowers	Rotary blower Tri-lobe Type Cast Iron	Dia. :200 (mm)× Air Flow :2400(m^3/h) ×Pressure: 65 (K Pa)	75.0	4W+2S
10.	RAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:40(m3/h)×Total Head:5.0 (m)	1.5	4W+2S
11.	SAS Pumps	Submersible Non-clog impeller Cast Iron	Dia. :100 (mm)×Discharge:25(m^3/h)×Total Head:7.0 (m)	2.2	4W+2S
12.	Hand Operation Chain Block	With Geared Trolley	Rated Load :1.0(Ton)×Lift :6(m)	-	4
13.	Chlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :300(l/h)×Total Head:20.0 (m)	0.4	2W+1S
14.	Mixer for Chlorine Solution	Vertical Shaft MS+NR	Width :1.7 (m)×Length :1.7(m)× SWD :2.0(m)	1.5	2W
15.	Dechlorine Dosing Pumps	Progress Cavity Cast Iron / SS304	Dia.:20 (mm)×Discharge :30(l/h)×Total Head:20.0 (m)	0.4	2W+1S
16.	Mixer for Dechlorine Solution	Vertical Shaft SS304	Width :1.0 (m)×Length :1.0 (m)× SWD :1.5(m)	0.4	2W
17.	Mixing Blower For Dechlorine	Rotary blower Tri-lobe Type Cast Iron	Dia. :50 (mm)× Air Flow :65(m^3/h) ×Pressure: 45 (K Pa)	2.2	1W+1S
18.	Electric Hoist	Single girder	Rated Load :1.0(Ton)×Lift :6(m)	4.7	1W
19.	Sludge Thickener	Bridge-supported Circular Clarifier MS+ Epoxy	Dia. 7.5(m)×Height :4.0(m)	0.4	2W
20.	Thickened Sludge Pumps	Submersible Non-clog impeller Cast Iron	Dia.:100 (mm)×Discharge :11(m^3/h)×Total Head:10.0 (m)	1.5	2W+2S

Items	Specification		kW	Pcs/Units
21. Mixing Blower For sludge sump	Rotary blower Tri-lobe Type Cast Iron	Dia. :65 (mm)× Air Flow :150(m^3/h) ×Pressure: 40 (K Pa)	3.7	1W+1S
22. Centrifuge Feed Pump	Progress Cavity SS304	Dia.:100 (mm)×Discharge :10 (m3/h)×Total Head:20.0 (m)	3.7	2W+1S
23. Centrifuge	Solids Bowl Type SS304	Capacity :10 (m3/h)	18.7	2W+1S
24. Crane for Centrifuge	Single-girder overhead	Capacity:3.0 (ton)×Lift:6.0 (m)	8.5	1W
25. Belt Conveyor		Belt Width :0.60(m)×Length :8.0 (m)	1.50	1W
26. Polyelectrolyte Dosing System		Width :1.5(m)×Length :1.5(m)×SWD :2.0(m)	1.5	2W
27. Polyelectrolyte Dosing Pump For Centrifuge	Progress Cavity SS304	Dia.:20 (mm)×Discharge :0.26 (m3/h)×Total Head:20.0 (m)	0.4	2W+1S
28. Filtrate Transfer Pumps	Submersible Non-clog impeller Cast Iron	Dia:100 (mm)×Discharge :50(m^3/h)×Total Head:15.0 (m)	5.5	1W+1S
(Electrical)				
1. Power receiving facilities at electrical substation	HV incoming panel: IP52, 11kV, VCB HV outgoing feeder panels, IP52, 11kV, VCB Power transformers: outdoor use, 11/0.415-0.24 kV, 630 kVA Diesel engine generator set: 415 V, 50 Hz, 500 kVA			1pc 1pc 1pc 1pc
2. LV incoming panel, LV switchgears, and MCCs	LV incoming panels: IP52, 600V, ACB 1250A x 1, 800A x 1 LV feeder panels: IP52, 600V, MCCB 200A x 8, 100A x 9, Static capacitor 12.5kVar x 1, 25kVar x 1, 50kVar x 1 MCC for Grit chamber MCCs for SBR Air blower starter panels with VFD, 75 kW MCCs for Solid process (Gravity thickener, Centrifuge)			1pc 1pc 1pc 1pc 3pcs 1pcs
3. Instrumentation devices	Inlet flow meter Level meters in pump wet well Level meters of pre and post screens Air blow flow meters Air blow pressure meters RAS (Return Activated Sludge) flow meters DO analyzers MLSS analyzers Chlorine dosing flow meter De-chlorine dosing flow meter Residual chlorine analyzer Effluent flow meter WAS (Waste Activated Sludge) flow meters Level meter in thickened sludge sump Thickened sludge flow meters Level meter in centrifuge sump			1pc 2pcs 4pcs 4pcs 4pcs 4pcs 4pcs 4pcs 1pc 1pc 1pc 1pc 1pc 1pc 1pc 1pc

Items	Specification	kW	Pcs/Units
	Centrifuge feed flow meters Level meter in polyelectrolyte solution tank Polymer dosing flow meters Filtrate flow meter		3pcs 2pcs 3pcs 1pc
4. Local SCADA system	Operator stations, SCADA/data servers, PLCs, Ethernet switch, etc.,		1ls

Source: JICA Survey Team

9.3.10 Summary Table of STP

Table 9.3.41 shows the result of the preliminary design for STPs. Effluent water quality from each STPs is in compliant with the New Effluent Standard which was disclosed in 2016 in CPHEEO.

In the table, Saidpur was excluded from the list due to no prospect of getting the site lot as well as no submission of DPR.

Table 0.1 Summary table of STP based on DPRs

STP Spec from DPR — Update: 22th-May.-2017

Item			Varanasi: Dinapur STP	Varanasi: Bhagwanpur STP	Varanasi: RamnaSTP	Mirzapur: Mirzapur STP (old)	Mirzapur: Mirzapur STP (new)	Mirzapur: Vindhyachal STP (old)	Mirzapur: Vindhyachal STP (new)	Ghazipur STP	Ramnagar STP	Chunar STP	Saidpur STP	New Standard (Planned)
Base Year		-	2020	2020	2020	2020		2020		2015	2020	2020		
Target Year		-	2030	2030	2050	2050		2050		2045	2050	2050		
Project Area		ha	-	-	-	1,795.44		292.82		2000	494.66	831.2		
Population Projection		no.	-	-	-	347,938		75,686		205,000	118,503	80,000		
Density of Population		no./ha	-	-	-	193.8		258.5		102.5	239.6	96.2		
Unit Rate of water supply		lpcd	150	150	150	135		135		135	135	135		
Sewage Generation (Daily Ave.)		MLD	-	-	-	41		9		24.36	14.06	9.48		
STP Spec	Existing	MLD	80	8	-	14	-	4	-	-	-	-		
	Future	MLD	80	8	50	14 (2030)	18 (2030)	4	2 (2030)	18 (2025)	13 (2050)	6.5 (2030)		
Raw Sewage Quality	pH	-	6-8	6-8	7-8	7-8	7-8	7-8		6-8	7-7.5	7-8		
	COD	mg/l	450	450	350	450	450	450		450	450	450		
	BOD	mg/l	250	250	200	250	250	250		250	250	250		
	SS	mg/l	400	400	600	400	400	400		250	400	400		
	NH_4-N	mg/l	37	37	25	25	25	25		25	10	25		
	TK-N	mg/l	50	50	40	40	40	40		35	30	35		
	Fecal Coliform	MPN/100 ml	10^8	10^8	10^7	10^8	10^8	10^8		10^8	10^8	10^8		
Treated Effluent Quality	pH	-	6.5-9	6.5-9	6.5-9	6.5-9	6.5-9	6.5-9		6.5-9	6.5-9	6.5-9		6.5-9
	COD	mg/l	≦50	≦50	≦50	≦50	≦50	≦50		≦50	≦50	≦50		≦50
	BOD	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	SS	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	NH_4-N	mg/l	≦5	≦5	≦5	≦5	≦5	≦5		≦5	≦5	≦5		≦5
	T-N	mg/l	≦10	≦10	≦10	≦10	≦10	≦10		≦10	≦10	≦10		≦10
	Fecal Coliform	MPN/100 ml	<230	<230	<230	<230	<230	<230		<230	<230	<230		<230
Sewage Treatment Process	Existing	-	ASP	ASP	-	UASB	-	WSP	-	-	-	-		
	Proposed in DPR		CND (Single-stage)	Advanced SBR	CND (Single-stage)	UASB +SBR	SBR	Aerated Lagoon	SBR	Advanced SBR	CND (Single-stage)	SBR		
	Proposed in JICA survey team		CND (Double-stage)	CND (Single-stage)		UASB +Advanced SBR	Advanced SBR	Advanced SBR				Advanced SBR		
		-			OK					OK	OK			
Disinfection Process		-	Chlorine Contact											
Sludge Treatment Process		-	Thickener Digestion Centrifuge / SDB	Thickener Digestion Centrifuge / SDB	Thickener Digestion SDB	Thickener Digestion Centrifuge / SDB		Sludge drying bed		Thickener Digestion Centrifuge	Thickener Digestion Centrifuge	Thickener Digestion Centrifuge		

Source: JICA Survey Team

9.4 SCADA system

1) Ramna STP

a) Local SCADA system at Ramna STP

There is no plan about instrumentation, PLC for automatic control of the plant equipment, and SCADA system for the Ramna STP in DPR. It is preferable to introduce the instrumentation, the PLC, and the SCADA system into the Ramna STP for effective and/or smooth operation and maintenance of the STP so that the STP would be in the similar condition with the on-going 140 MLD Dinapur STP.

There are three PLCs proposed to control and monitor the plant equipment in redundant hot standby formation at the electrical sub-station for head works and primary clarifiers, the blower house for the liquid process and the sludge treatment house for sludge process respectively. The instrumentation devices, such as flow meters, level meters, water quality analyzers etc., are proposed at the field level as sensors in the treatment plant to the PLCs to enable an automatic control of plant processes. The PLCs can control the plant processes in the auto mode according to a sequential control logic and/or a set-point control logic programmed in association of the instrumentation devices at the field level as mentioned above.

A PC based operator station is proposed as core component of the local SCADA system for the Ramna STP at the control room of the administration building. The operator station functions as HMI (Human-machine interface), engineering the system, reporting the plant equipment statuses and process values, alarming the abnormal conditions of the plant equipment and the process values. Further, there are a printer and an Ethernet Hub switch at the control room of the administration building for reporting and alarming, and interconnecting the SCADA system components respectively.

b) Master SCADA system at Ramna STP

Since there are many intermediate pump stations and STPs in Varanasi as follows, it is proposed to establish the master SCADA centre at the Ramna STP for monitoring the sewerage facilities entirely within Varanasi service area.

- Dinapur STP with 80 MLD at District I (existing)
- Five (5) Ghat Pump Stations, viz Harischandra SPS, Mansarovar SPS, Dr. R.P. Ghat SPS, Jalesan Ghat SPS, Trilochan Ghat SPS,
- Konia Main Pump Station
- Dinapur STP with 140 MLD (on-going, expansion within the existing Dinapur STP campus)
- Three pump stations (on-going), viz Chaukaghat pump station with 140 MLD, Phulwaria pump station with 7.6 MLD and Saraiya pump station with 3.7 MLD
- Bhagwanpur with 8.0 MLD (existing), which will be decommissioned at the end of its useful life,
- Diesel Locomotive Works (DLW) STP with 120 MLD (on-going under JNNURM funding project)

- Golthaha STP with 120 MLD (under construction in JNNURM funded project)

The master SCADA system comprises the components as follows;

- Operator station functioning as HMI
- Front end processor functioning as interface between the local SCADA systems at each intermediate pump station and each STP to reduce the burden of the servers,
- SCADA servers in redundant hot standby formation functioning as engineering the SCADA system, reporting the plant equipment statuses and abnormal conditions at daily, monthly yearly basis,
- LCD large screen functioning as demonstration for operating staffs and visitors so that a lot of people can see the graphics showing the plant equipment statuses simultaneously.
- Ethernet Hub switch interconnecting the components to control data transmission,
- Router and fibre optic cable patch panel functioning as data transmission terminal device through which data can be transferred from the outstations to the master SCADA centre,
- UPS (Uninterruptible Power Supply) system,

A router, a fibre optic cable patch panel and fibre optic cable will be provided as data transmission medium and terminal device on the Master SCADA system by an internet service provider, who may offer a reliable internet service in Varanasi. The fibre optic cable is suitable data transmission medium in dealing with big data volume at like the master SCADA centre. In the meantime, a GSP based GPRS module is applied as a data transmission terminal device to the local SCADA system of outstations, which are integrated into the master SCADA system. Existing IPSs such STPs will be integrated into the master SCADA centre when they are rehabilitated/replaced in future.

The master SCADA system configuration is shown in Figure 9.4.1 below.

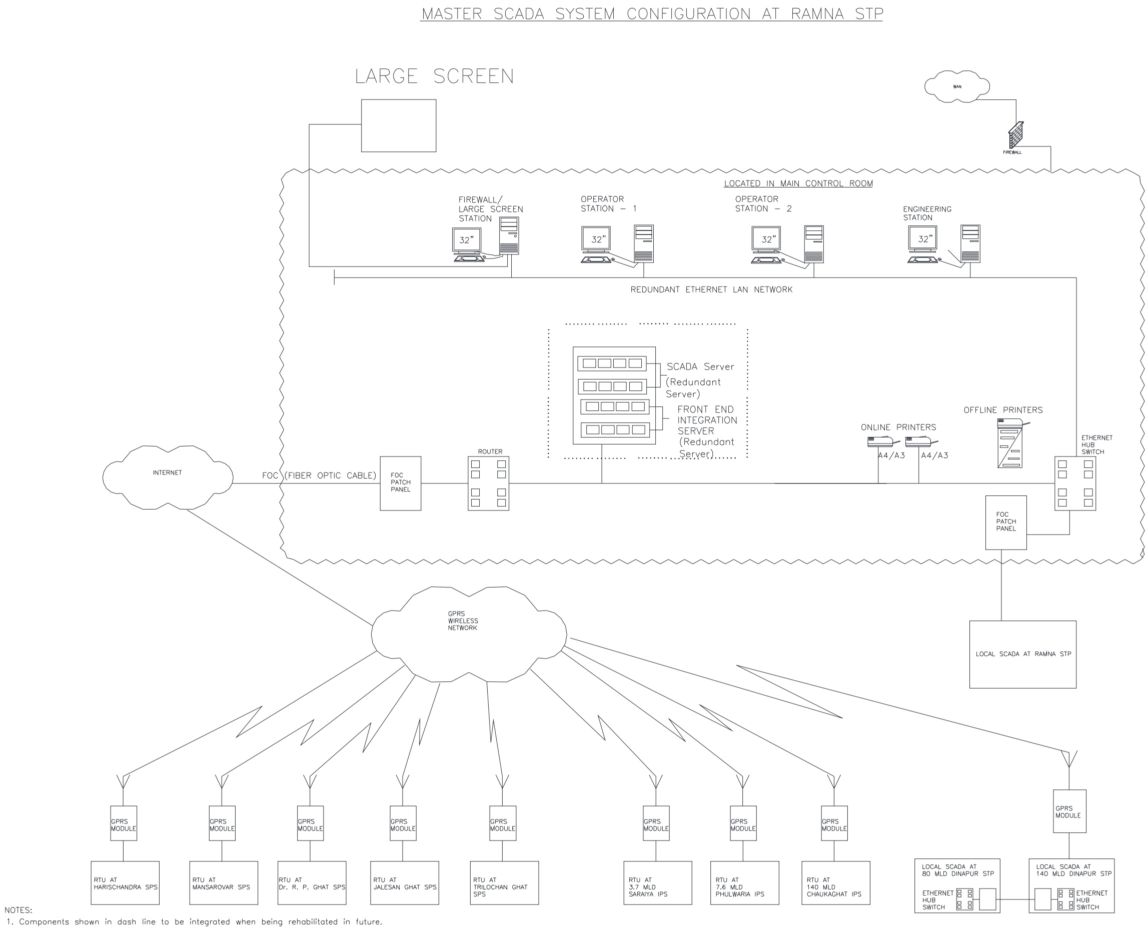


Figure 9.4.1 Master SCADA System Configuration

2) Other STPs

The local SCADA system at the on-going 140 MLD STP at Dinapur is under implementation in the Package 3 of GAP II of JICA assisted project. The system configuration is almost same as that of the Ramna STP. The local SCADS system at the existing 80 MLD Dinapur STP will be established in the same formation of that of the Ramna STP.

The local SCADA system at proposed STPs for other municipal councils such as Mirzapur, Ramnagar, Systems in Chunar, and Ghazipur will be established in the same concept of that of Ramna STP.

3) Pump Stations

A PLC based control and monitoring system will be established at the five Ghat pump stations and the three on-going pump stations to integrate them into the master SCADA system. The PLC and the GPRS module are mounted in a control panel, on which a LCD touch screen is flush mounted to function as HMI.