No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NATIONAL RIVER CONSERVATION DIRECTORATE (NRCD)
MINISTRY OF ENVIRONMENT AND FORESTS

THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA

FINAL REPORT

VOLUME IV FEASIBILITY STUDY FOR PROJECT CITIES

VOLUME IV-3 FEASIBILITY STUDY FOR ALLAHABAD CITY
PART I SEWERAGE SCHEME

JULY 2005

TOKYO ENGINEERING CONSULTANTS CO., LTD.
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FINAL REPORT
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GENERAL TABLE OF CONTENTS

VOLUME IV FEASIBILITY STUDY FOR PROJECT CITIES

VOLUME IV-1 FEASIBILITY STUDY FOR LUCKNOW CITY

PART I SEWERAGE SCHEME
PART II NON-SEWERAGE SCHEME
PART III PUBLIC PARTICIPATION AND AWARENESS PROGRAMME
PART IV INSTITUTIONAL DEVELOPMENT PROGRAMME
PART V ECONOMIC AND FINANCIAL EVALUATION
PART VI STAKEHOLDER MEETING
PART VII DRAWINGS

VOLUME IV-2 FEASIBILITY STUDY FOR KANPUR CITY

PART I SEWERAGE SCHEME
PART II NON-SEWERAGE SCHEME
PART III PUBLIC PARTICIPATION AND AWARENESS PROGRAMME
PART IV INSTITUTIONAL DEVELOPMENT PROGRAMME
PART V ECONOMIC AND FINANCIAL EVALUATION
PART VI STAKEHOLDER MEETING
PART VII DRAWINGS

VOLUME IV-3 FEASIBILITY STUDY FOR ALLAHABAD CITY

PART I SEWERAGE SCHEME
PART II NON-SEWERAGE SCHEME
PART III PUBLIC PARTICIPATION AND AWARENESS PROGRAMME
PART IV INSTITUTIONAL DEVELOPMENT PROGRAMME
PART V ECONOMIC AND FINANCIAL EVALUATION
PART VI STAKEHOLDER MEETING
PART VII DRAWINGS

VOLUME IV-4 FEASIBILITY STUDY FOR VARANASI CITY

PART I SEWERAGE SCHEME
PART II NON-SEWERAGE SCHEME
PART III PUBLIC PARTICIPATION AND AWARENESS PROGRAMME
PART IV INSTITUTIONAL DEVELOPMENT PROGRAMME
PART V ECONOMIC AND FINANCIAL EVALUATION
PART VI STAKEHOLDER MEETING
PART VII DRAWINGS

VOLUME V PILOT PROJECT FOR SANITARY IMPROVEMENT OF MANIKARNIKA GHAT

VOLUME IV-3

PART I SEWERAGE SCHEME

Table of Contents
List of Tables
List of Figures
Appendix
Abbreviations
Glossary of Terms

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

ABBREVIATIONS

AD/MM	Average Day / Max Month
ADF	Average Daily Flow
ADWF	Average Dry Weather Flow
AIWSP	Advanced Integrated Wastewater Stabilization Ponds
AL	Aerated Lagoon
AS	Activated Sludge
ASR	Aquifer Storage and Recovery System
Avg	Average
AWT	Advanced Wastewater Treatment
BOD	Biochemical Oxygen Demand
CI	Cast Iron
CMS	Cubic Meter per Second
CO_2	Carbon Dioxide
CPCB	Central Pollution Control Board
CWR	Clear Water Reservoir
DLW	Diesel Locomotive Work
DO	Dissolved Oxygen
DPR	Detailed Project Report
ES	Equalization/Storage
FAB	Fluidised Aerated Bioreactor
F/S	Feasibility Study
FSA	Future Service Area
GAP	Ganga/Gomti Action Plan
GoAP	Gomti Action Plan
GIS	Geographical Information System
gpd	Grams per day
GOI	Government of India
GOJ	Government of Japan
GWI	Ground Water Infiltration
HDR	High-Density Residential
HP	Horse Power
I/I	Infiltration/Inflow
ISC	Indian Standard Code
JICA	Japan International Cooperation Agency
JS	Jal Sansthan
KVA	Kilo Volt Ampere
LDR	Low-Density Residential
lpcd	Litres per capita per day
lpm	Litres per minute
lps	Litres per second
MC	Municipal Corporation
MDR	Medium-Density Residential
mg/l	Milligrams per Litre
ML	Million Litres
mld	Million Litres per Day
MLSS	Mixed Liquid Suspended Solids
M/P	Master Plan
MPN	Most Probable Number per 100ml
MPS	Main Sewage Pumping Station
MPS	Meter per Second
MUD	Ministry of Urban Development
MoEF	Ministry of Environment and Forests
N/A	Not Available
NBC	National Building Code
NH_3-N	Ammonia-Nitrogen
NRCD	National River Conservation Directorate
NSA	Non Sewerage Area
O&M	Operations and Maintenance
PDWF	Peak Dry Weather Flow
PFR	Project Feasibility Report
PS	Pumping Station
PSC	Pre-Stressed Concrete
RAS	Return Activated Sludge
SMF	Sankat Mochan Foundation
SPS	Sewage Pumping Station
SS	Suspended Solids
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UASB	Up flow Anaerobic Sludge Blanket
UFW	Unaccounted for Water
UPJN	Uttar Pradesh Jal Nigam
UPPCB	Uttar Pradesh Pollution Control Board
USAID	United States Agency for International Development
UV	Ultra Violet
VCP	Vitrified Clay Pipe
WAS	Waste Activated Sludge
WRF	Water Reclamation Facility
WSP	Waste Stabilization Pond
WTP	Water Treatment Plant
YAP	Yamuna Action Plan

GLOSSARY OF TERMS

***Aerated Lagoons**:* Like WSPs but with mechanical aeration. Oxygen requirement mostly from aeration and hence more complicated and higher O&M costs requires less land than WSP.

Activated-Sludge Process: A biological wastewater treatment process in which a mixture of wastewater and biologically enriched sludge is aerated to facilitate aerobic decomposition by microbes.

Advance Wastewater Treatment: Treatment process designed to remove pollutants that are not adequately removed by conventional secondary treatment processes.

Aeration: The addition of air or oxygen to water or wastewater, usually by mechanical means, to increase dissolved oxygen levels and maintain aerobic conditions.

Anaerobic Digestion: Sludge stabilization process in which the organic material in biological sludge is converted to methane and carbon dioxide in an airtight reactor.

Assimilative Capacity: The ability of a water body to receive wastewater and toxic materials without deleterious effects on aquatic life or the humans who consume the water.

Average Daily Flow: The total flow past a physical point over a period of time divided by the number of days in that period.

Biochemical Oxygen Demand (BOD): A standard measure of wastewater strength that quantifies the oxygen consumed in a stated period of time, usually 5 days and at 20^{o}C.

Biological Process: The process by which the metabolic activities of bacteria and other microorganisms break down complex organic materials to simple, more stable substances.

Bio solids: Solid organic matter recovered from municipal wastewater treatment that can be beneficially used, especially as a fertilizer. *Bio solids* are solids that have been stabilized within the treatment process, whereas sludge has not.

Chlorination: The addition of chlorine to water or wastewater, usually for the purpose of disinfection.

Coliform Bacteria: Rod shaped bacteria from intestinal track of man used as an indication that pathogenic organisms may also be present.

Collection System: In wastewater, a system of conduits, generally underground pipes, that receive and convey sanitary wastewater and/or storm water. In water supply, a system of conduits or canals used to capture a water supply and convey it to a common point.

Composting: Stabilization process relying on the aerobic decomposition of organic matter in sludge by bacteria and fungi.

Dechlorination: The partial or complete reduction of residual chlorine by any chemical or physical process.

Design Storm: The magnitude of a storm on which the design of a system and/or facility is based; usually expressed in terms of the probability of an occurrence over a period of years.

Diffused-Air Aeration: The introduction of compressed air to water by means of submerged diffusers or nozzles.

***Digester**:* A tank or vessel used for sludge digestion.

Disinfection: The selective destruction of disease-causing microbes through the application of chemicals or energy.

Diurnal: A daily fluctuation in flow or composition that is of similar pattern from one 24-hour period to another.

Effluent: Partially or completely treated water or wastewater flowing out of a basin or treatment plant.

Fine-Bubble Aeration: Method of diffused aeration using fine bubbles to take advantage of their high surface areas to increase oxygen-transfer rate.

Fixed Film Process: Biological wastewater treatment process whereby the microbes responsible for conversion of the organic matter in wastewater are attached to an inert medium such as rock or plastic material. Also called *attached-growth process.*

Force Main: The pipeline through which flow is transported from a point of higher pressure to a point of lower pressure.

Friction Factor: A measure of the resistance to liquid flow that results from the wall roughness of a pipe or channel.

Gravity Thickening: A process that uses a sedimentation basin designed to operate at high solid loading rate, usually with vertical pickets mounted to revolving sludge scrapers to assist in releasing entrained water.

Grit Chamber: A settling chamber used to remove grit from organic solids through sedimentation or an air-induced spiral agitation.

Head Loss: The difference in water level between the upstream and downstream sides of a conduit or a treatment process attributed to friction losses.

Headworks: The initial structure and devices located at the receiving end of a water or wastewater treatment plant.

Infiltration: Water entering a sewer system through broken or defective sewer pipes, service connections, or manhole walls.

Influent: Water or wastewater flowing to a basin or treatment plant.

Invert: The lowest point of the internal surface of a drain, sewer, or channel at any cross section.

Land Application: The disposal of wastewater or municipal solids onto land under controlled conditions.

Lift Station: A chamber that contains pumps, valves, and electrical equipment necessary to pump water or wastewater.

Methane: A colourless, odourless combustible gas that is the principal by-product of anaerobic decomposition or organic matter in wastewater. Chemical formula is CH_4.

Mixed Liquid Suspended Solids (MLSS): Suspended solids in the mixture of wastewater and activated sludge undergoing aeration in the aeration basin.

Nitrification: Biological process in which ammonia is converted first to nitrite and then to nitrate.

Nutrient: Any substance that is assimilated by organisms to promote or facilitate their growth.

Pathogen: Highly infectious, disease-producing microbes commonly found in sanitary wastewater.

Peak Flow: Excessive flows experienced during hours of high demand; usually determined to be the highest 2-hour flow expected under any operational conditions.

Preliminary Treatment: Treatment steps including screening, grit removal, preparation, and/or flow equalization that prepare wastewater influent for further treatment.

Pump Station: (see lift station)

Primary Clarifier: Sedimentation basin that precedes secondary wastewater treatment.

Primary Treatment: Treatment steps including sedimentation and/or fine screening to produce an effluent suitable for biological treatment.

***Rising Main*:** (see force main)

Reclaimed Wastewater: Wastewater treated to a level that allows its reuse for a beneficial purpose.

Return Activated Sludge (RAS): Settled activated sludge that is returned to mix with raw or primary settled wastewater.

Sanitary Sewer Overflow (SSO): Overloaded operating condition of a sanitary sewer that results from inflow/infiltration.

Screening: (1) A treatment process using a device with uniform openings to retain coarse solids. (2) A preliminary test method used to separate according to common characteristics.

Scum: Floatable materials found on the surface of primary and secondary clarifiers consisting of food wastes, grease, fats, paper, foam, and similar matter.

Secondary Clarifier: A clarifier following a secondary treatment process and designed for gravity removal of suspended matter.

Secondary Treatment: The treatment of wastewater through biological oxidation after primary treatment.

Sludge: Accumulated and concentrated solids generated within the wastewater treatment process that have not undergone a stabilization process.

Sludge Dewatering: The removal of a portion of the water contained in sludge by means of a filter press, centrifuge, or other mechanism.

Sludge Stabilization: A treatment process used to convert sludge to a stable product for ultimate disposal or use and to reduce pathogens to produce a less odorous product.

Suspended-Growth Process: Biological wastewater treatment process in which the microbes and substrate are maintained in suspension within the liquid.

Thickening: A procedure used to increase the solids content of sludge by removing a portion of the liquid.

Trickling Filters: Sewage passes down through a loose bed of stones, and the bacteria on the surface of the stones treats the sewage. An aerobic process in which bacteria take oxygen from the atmosphere (no external mechanical aeration). Has moving parts, which often break down.

Total Suspended Solids (TSS): The measure of particulate matter suspended in a sample of water or wastewater. After filtering a sample of a known volume, the filter is dried and weighed to determine the residue retained.

Waste Activated Sludge (WAS): Excess activated sludge that is discharged from an activated-sludge treatment process.

Wetlands Treatment: A wastewater treatment system using the aquatic root system of cattails, reeds, and similar plants to treat wastewater applied either above or below the soil surface.

Waste Stabilization Pond: Large surface area ponds that provide treatment essentially by action of sunlight, encouraging algal growth which provides the oxygen requirement for bacteria to oxidize the organic waste. Requires significant land area, but one of the few processes, which is effective at treating pathogenic material. Natural process with no power/oxygen requirement. Often used to provide water of sufficient quality for irrigation, and very suited to hot, sunny climates.

UASB: Anaerobic process using blanket of bacteria to absorb polluting load. Suited to hot climates. Produces little sludge, no oxygen requirement or power requirement, but produces a poorer quality effluent than processes such as ASP. (NOTE: other anaerobic processes exist, but UASB is the most common at present).

Collection System Terminology

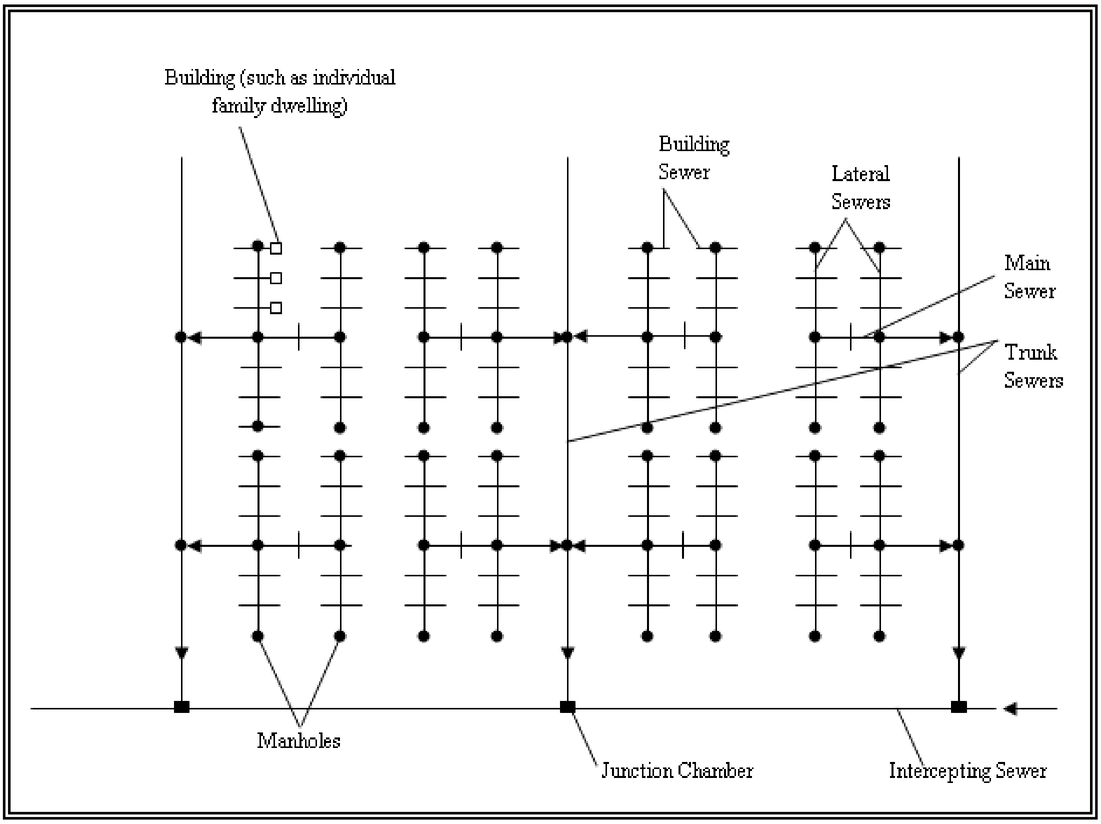
1. ***Interceptor Sewer:*** A sewer that receives flow from a number of other sewers or outlets for disposal or conveyance to a treatment plant.

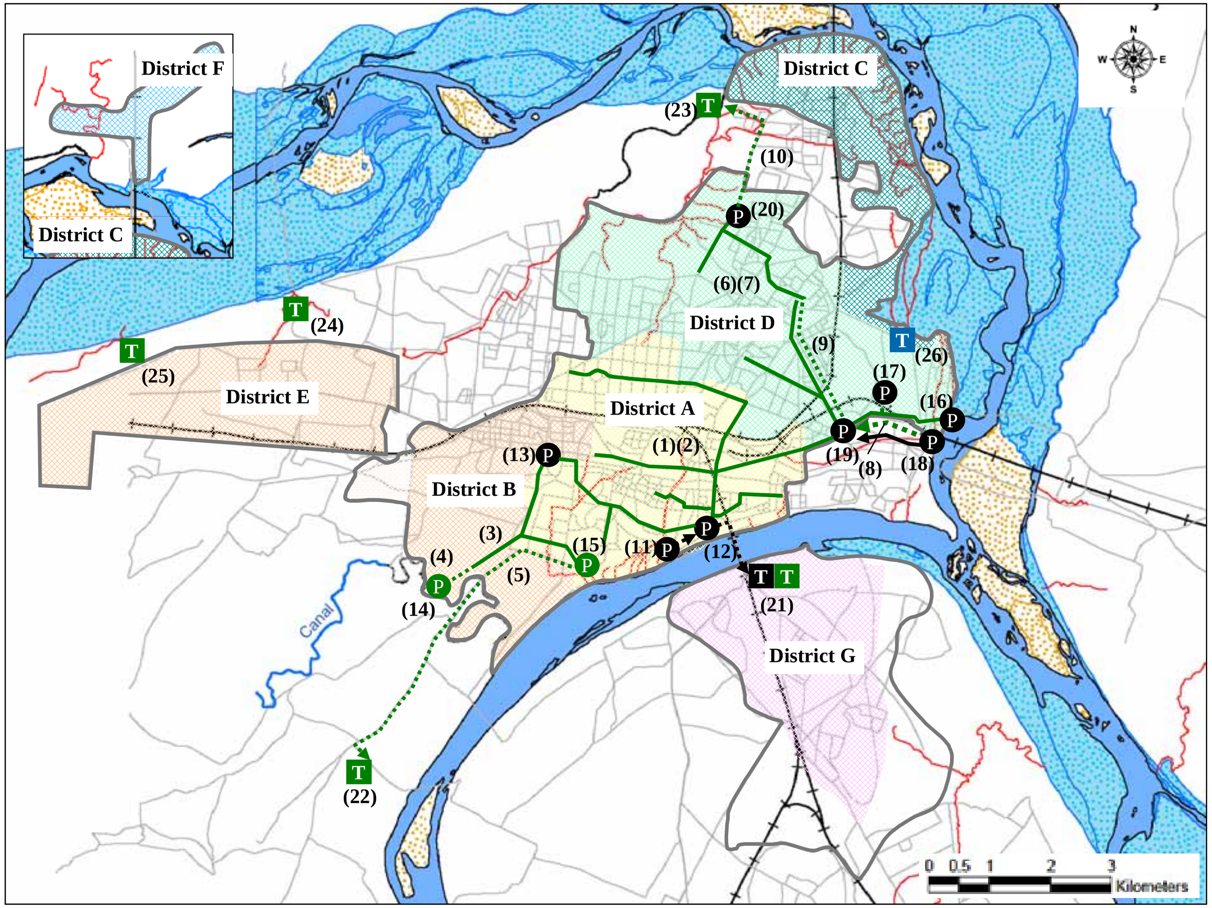
2. ***Manhole:*** An opening in a vessel or sewer to permit human entry. Also called *manway.*

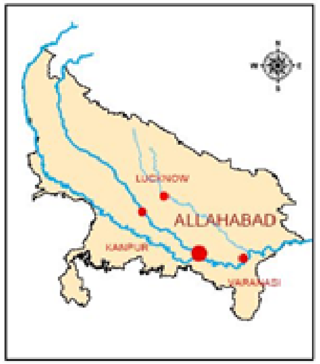
3. ***Trunk Sewer:*** Trunk sewers are large sewers that are used to convey wastewater from main sewers to treatment or other disposal facilities or to large intercepting sewers.

4. ***Main Sewer:*** Main sewers are used to convey wastewater from one or more lateral sewers to trunk sewers or to intercepting sewers.

5. ***Lateral Sewer:*** Lateral sewers form the first element of a wastewater collection system and are usually in streets or special easements. They are used to collect wastewater from one or more building sewers and convey it to main sewers.







Legend

- Municipal Boundary
- Sewer
- Rising Main
- P: Pump Station
- T: Treatment Plant
- Black : Existing Facility
- Blue : Sanctioned Facility
- Green : Proposed Facility

	Sewer / Rising Main	District	Status	Diameter / Length
1	Existing trunk sewer in District A	A	E/R/Rp	Desilting: 600-1150 mm, 4.1 km Rehb.: 700-1400 mm, 1.7 km Replace.: 700-1400 mm, 5.2 km
2	New trunk sewer in District A	A	P	500-700 mm, 4.0 km
3	New trunk sewer in District B	B	P	300-1000 mm, 4.9 km
4	Rising main of Sasur Kaderi SPS	B	P	600 mm, 0.2 km
5	Rising main of Ghaghar Nala SPS	B	P	1000 mm, 7.7 km
6	Existing trunk sewer in District D	D	E/R	Desilting: 500-1300 mm, 5.5 km
		D	E/Rp	Replace.: 500-1300 mm, 3.8 km
7	New trunk sewer in District D	D	P	450-1200 mm, 6.7 km
8	Rising main of Morigate SPS	D	P	800 mm, 1.8 km
9	Rising main of Alopibagh SPS	D	P	1000 mm, 3.1 km
10	Rising main of Mumfordganj SPS	D	P	1000 mm, 2.7 km

	Pumping Station	District	Status	Capacity (mld)	Remarks
11	Chachar nala SPS	A	E/R	30	Average flow in 2015
12	Gaughat SPS	A	E/R	80	
13	Lukerganj SPS	B	E/R	9.2	
14	Sasur Kaderi SPS	B	P	13	
15	Ghaghar nala SPS	B	P	50	
16	Daraganj SPS	D	E/R	2.6	
17	Allahpur SPS	D	E/R/A	2.8	
18	Morigate SPS (Additional)	D	E/A	6	
19	Alopibagh SPS	D	E/R/A	44.5	
20	Mumfordganj SPS	D	E/R/A	50	

	Treatment Plant	District	Status	Capacity (mld)	Remarks
21	Naini STP (ASP)	A	E/A	80	Average flow in 2015
22	Numaya Dahi STP (WSP)	B	P	50	
23	Rajapur STP (UASB)	D	P	65	
24	Kodara STP (UASB)	E	P	15	
25	Ponghat STP (WSP)	E	P	10	
	Total			220	

Existing / Sanctioned Facility

	Facility	District	Status	Remarks
26	Salori STP (FAB)	C	S	

E: Existing
S: Sanctioned
P: Proposed

R: Rehabilitation
A: Augmentation
Rp: Replacement

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PROJECT	LOCATION	
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	Allahabad City	Proposed Sewerage Facilities for Feasibility Study (Allahabad)

CHAPTER 1

GENERAL

PART I SEWERAGE SCHEME

CHAPTER 1 GENERAL

1.1 INTRODUCTION

1.1.1 Preamble

This report is the result of the Techno-Economic Feasibility Study carried out by M/s STUP Consultants P. Ltd., Delhi, India, for projects identified for immediate augmentation of the Allahabad Sewage Collection and Treatment System. STUP was appointed to carry out the study by M/s TEC & M/s CTI of the JICA (Japan International Cooperation Agency) Study Team.

The projects whose feasibility has been studied are ‘Priority Projects’ identified in the Master Plan for the Allahabad Sewerage System prepared by the JICA Study Team. These are projects, which are to be implemented within 1-5 years of adopting the Master Plan with the aim of reducing the pollution load on the rivers passing through Allahabad. The priority projects are listed in Table 1.1.

1.1.2 Objective of the Study

The objectives of the study could be summarized as follows:

- To carry out field surveys to examine the technical feasibility of identified priority projects.
- To analyse various project alternatives and recommend the preferred alternative
- To carry out preliminary design for the preferred alternative
- To calculate capital & O&M costs for the recommended alternative
- To carry out a Rapid EIA study
- To recommend an Institutional and O&M set up for the projects

1.1.3 Project City

(1) General

Area	63.07 km^2.
Altitude	98 m above sea level.
Population	1,081,622 (As per 2001 census)
Languages	Hindi, Urdu and English.
Festivals	Magh Mela, Kumbh Mela and Dussehra
Geographical location	25.28 deg. N, 81.52 deg E

Allahabad nestles near the confluence of two of India’s holiest rivers, Ganga River and Yamuna River. Sangam, as the confluence is called, is the venue of many sacred fairs and rituals, and attracts thousands of pilgrims throughout the year. This number swells to millions during the world-famous Kumbh Mela. A third mythical Saraswati river, believed to flow underground towards the Sangam, gives the confluence its other name 'Triveni'.

Accessibility

By Road: Allahabad is on National Highways 2 and 27 and is about 643 kms from Delhi by road.
By Rail: The city has direct rail connections with important cities viz. Kolkata, Delhi, Patna, Guwahati, Chennai, Mumbai, Gwalior, Meerut, Lucknow, Kanpur and Varanasi.

(2) Climate and Rainfall

The mean of monthly maximum temperature varies from 23.6°C (January) to 42.3°C (May), and the mean of monthly minimum temperature in the range between 8.7°C (January) and 28.5°C (June).

The normal annual total rainfall is 1,017.7 mm. August is the month with maximum precipitation (307.6 mm), followed closely by July (300.1 mm). The period from June to September (southwestern monsoon) accounts for about 87% of total rainfall. Winter rains occur mostly during the months of January and February, and account for about 1.6% of total rainfall.

(3) General Geology

The city of Allahabad occupies the interfluvial sediment of the Ganga River and Yamuna River. These sediments are essentially a sequence of clays, sands, silts with interspread bands of Kankar having limited extent. Broadly these fluvial sediments are grouped as younger and older alluvium. The younger alluvium is generally confined to a depth of 60 m below the ground and it occupies the present day flood plain area. The older alluvial sediments marginally differ in lithology from that of younger alluvium sediments, with presence of sandy clay and lenses of gravel/pebbles and Kankar. The older alluvium overlies the Siwalik group of formations, which in turn overlies the pre-Cambrian formation.

(4) Area under the Present Study

The Master Plan has divided Allahabad into seven sewerage Districts A-G, as shown in Figure 1.1. All the projects identified for the present feasibility study fall into four sewerage Districts viz. A, B, D and E except the existing Naini STP, which is located in the sewerage District G.

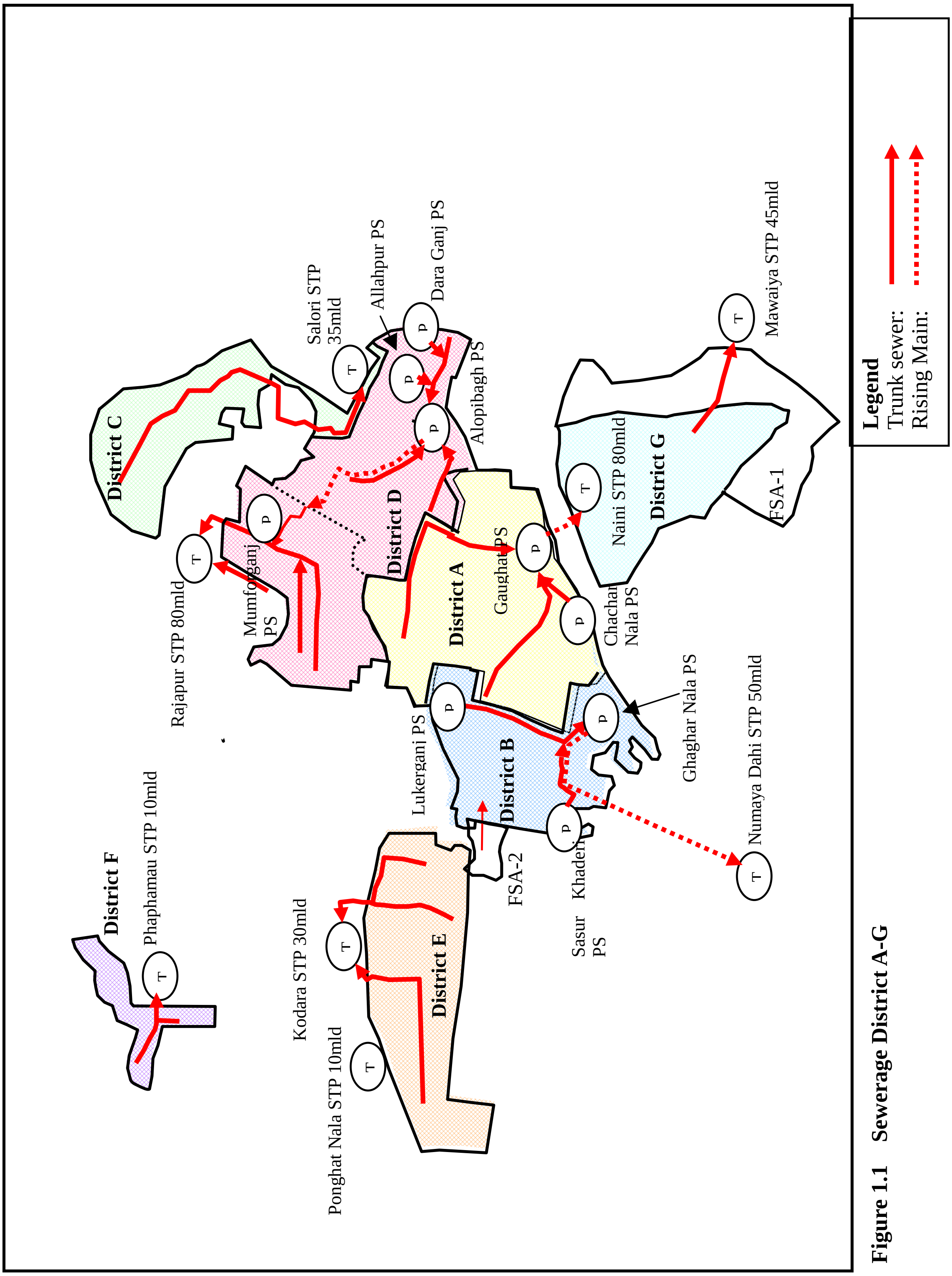


Figure 1.1 Sewerage District A-G

1.1.4 Priority Projects

The priority projects have been listed in Table 1.1.

Table 1.1 Priority Projects

District A

- Augmentation of Naini STP from 60 to 80 mld
- Rehabilitation of Gaughat PS and Chachar Nala SS
- Rehabilitation / Replacement of existing trunk sewers and installation of new trunk sewers

District B

- Rehabilitation of Lukerganj SPS
- Construction of Ghaghar Nala SPS
- Construction of Sasur Khaderi SPS
- Construction of Numaya Dahi STP
- Installation of new trunk sewers
- Installation of rising main to STP

District D

- Construction of Rajapur STP, tapping facility
- Rehabilitation of Alopibagh SPS
- Reconstruction of Morigate SPS
- Reconstruction of Mumfordganj SPS
- Rehabilitation of Allahpur SPS
- Rehabilitation of Daraganj SPS
- Rehabilitation / Replacement of existing trunk sewers and installation of new trunk sewers and rising mains
- Construction of Rajapur Nala tapping facility

District E

- Construction of Kodara STP and tapping facility
- Construction of Ponghat Nala STP and tapping facility

Priority projects are defined as projects that should be implemented as soon as possible to achieve pollution reduction targets.

1.2 PLANNING BASIS

1.2.1 Design Horizon

The design period considered for sewers is 30 years (single phase). Civil works for SPS facilities are designed for 30 years, E&M works are designed for two phased implementation, first phase up to 2015 and second phase up to 2030. Treatment facilities will be implemented in two phases. First phase would be up to 2015 and wherever flow is increasing / raw wastewater quality changes after 2015, the treatment facility would be augmented for the requirement of 2030.

1.2.2 Population

The population of Allahabad as per 2001 census is 1,081,622. The Master Plan has finalised the population growth rates as 26.43% for 2001-2011, 24.82% for 2011-2021 and 22.89% for 2021-31. With these growth rates and with 2001 census figure as the base, the Master Plan has calculated district wise population figure and these are reproduced in Appendix A1.1.

1.2.3 Water Supply

(1) Municipal Water Supply

The main source of raw water for the municipal piped water supply system is Yamuna river. Intake of water from the river in 2003 was about 80 mld (approximately 35% of the total water supplied). Water is taken from a number of intake wells along the banks of Yamuna River at Karelibagh Raw Water Pumping Station. Raw water is pumped to Khusrobagh Water Works where it is treated using chemical and physical clarification followed by rapid sand filtration. Present treatment capacity is 130 mld.

In 2003, approximately 137 mld was extracted from 134 deep tube wells operated by Jal Sansthan. In addition to tube wells operated by Jal Sansthan, there are many privately owned and institutional tube wells that provide an unknown amount of water. A total of 2,438 hand pumps provide water in places of water scarcity.

Table 1.2 Total Municipal Water Production

	Production capacity (mld)
Yamuna River	80**
Tube Well	137**
Total	217

******** *Production figures reported by Jal Sansthan*
Estimated by JICA Study Team

Estimated water production from municipal supplies is 217 mld

(2) Estimated Per Capita Water Consumption

Table 1.3 Estimated Per Capita Water Consumption

Municipal Supply	217 mld
Population served	1,049,831 (in 2003)
Production capacity per capita*	207 lpcd
Les leakage losses estimated at 15%	180 lpcd

**Including institutional/commercial components but excluding private supplies.*

Hence, the present per capita water consumption of Municipal Water is 180 lpcd. This has been modified as follows in the Master Plan, to arrive at the final per capita water consumption.

- Add 20% to account for private supplies
- Add 30% (UFW allowance)
- Add 22 lpcd for commercial / institutional (C/I) demand.

The final figure thus works out to 295 lpcd for 2003.

The corresponding calculations for 2015 & 2030 are as follows :

2015 – 170 lpcd + 20% UFW allowance + 42 lpcd (C/I) = 254 lpcd

2030 – 150 lpcd + 15% UFW allowance + 42 lpcd (C/I) = 221 lpcd

1.2.4 Wastewater Generation

(1) Per Capita Wastewater Discharge

Wastewater generated from an area is estimated by multiplying the per capita wastewater discharge by the area's population. Per capita wastewater discharge has been arrived at in the Master Plan by applying a return factor of 0.7 on the per capita water consumption (lpcd), as given in the Table below:

Table 1.4 Per Capita Wastewater Generation Rates

	2003	2015	2030
Per capita water consumption (lpcd)	295	254	221
Return factor	0.70	0.70	0.70
Per capita wastewater discharge (lpcd)	206 say (205)	172 say (175)	155

(2) Ground Water Infiltration

No increase has been made on account of ground water infiltration in the Master Plan, as the ground water table in Allahabad is generally deeper than sewer depths.

(3) Connection Ratios

The proportion of wastewater generated that reaches the sewers depends on the ratio of the population of an area that is connected to the sewerage system. The connection ratios (existing and targeted) considered in the Master Plan are presented below:

Table 1.5 Existing and Proposed Sewer Connection Targets

	2003	2010	2015	2030
District A	40%	45%	55%	80%
District B (Lukerganj PS area)	30%	40%	50%	80%
District B (Zone-B2)	0%	0%	0%	50%
District D1 (Pumping Area)	30%	35%	45%	80%
District D2 (Gravity Sewer Area)	0%	0%	0%	80%
District E	0%	0%	0%	50%

The figures for the contributory population and waste water generated district wise for Districts A to G taken from the Master Plan are given in Appendix A1.2.

1.2.5 The Sewerage Districts

The Master Plan has divided Allahabad into seven Sewerage Districts A-G. Five alternative configurations have been studied. The details of the preferred configuration are as follows:

- The boundaries of District C are drawn up in such a manner that the wastewater generation in this area is limited to 35 mld.
- District D covers a greater area. Part of the wastewater generated in this area gets conveyed

into Alopibagh SPS via existing sewers. The balance wastewater flows either to Mumfordganj SPS or, via a new trunk sewer, direct to the Rajapur STP. Alopibagh SPS shall boost the wastewater to Mumfordganj SPS, which shall convey the same to Rajapur STP (ultimate capacity – 80 mld).

- For District B, an SPS is to be constructed to tap Ghaghar Nala. Additionally, wastewater generated in District B would be collected by a new trunk sewer and conveyed to Ghaghar Nala SPS by gravity / pumping. The combined flow would be pumped to 50 mld Numaya Dahi STP for treatment.

The route identified in the Master Plan for trunk sewer of District B was not found feasible. The alternative arrangement proposed consists of tapping an existing Nala by constructing an SPS at Sasur Khaderi. The SPS would pump the sewage into the proposed sewer, which discharges into the proposed Ghaghar Nala SPS.

In addition to the seven sewerage districts, the Master Plan has identified two future service areas (FSA) which are outside the municipal limits but have or will have, within the design horizon, a population density of more than 120 person / ha. Hence, the sewerage system needs to be extended to FSAs in the future.

A non-sewer area has been identified in the Jhunsi district, where population densities are expected to remain below 120 persons / ha within the design horizon and hence, for this area on-site sanitation has been recommended.

1.2.6 The Existing Sewerage System

The existing sewerage system has been marked in drawings. The system has been described in detail, separately for Districts A and D in Chapters 2 and 3. General observations are presented here:

- Sewerage system exists only in the central core of Allahabad city (Sewerage Districts A & D).
- Eights sewage pumping stations exist which tap Nalas / convey wastewater received through trunk sewers ultimately to Gaughat SPS.
- One 60 mld STP exists at Naini, it receives raw wastewater from the Gaughat SPS.

The present flow direction of wastewater from the entire city is towards the Gaughat SPS. The wastewater flowing into the SPS is greater than the treatment capacity at Naini STP and hence, large amounts simply overflow untreated into Yamuna River.

The state of existing sewers is summarised below:

- Most of the existing sewers are old brick sewers which have outlived their design life
- The structural condition of sewers in most stretches is poor
- Hydraulic capacities are insufficient even for the present flows
- All existing lines have heavily silt deposition
- Sewers are severely choked due to ingress of solid waste
- All lines have large variations in constructed slopes

Due to the inadequacies of the existing system, as described above, most of the city’s wastewater ends up in the city’s surface drains which convey it to Ganga River / Yamuna River.

- **Sewage Pumping Stations**

  Details of the existing pumping stations are given in Chapters 2 to 4. General observations are as given here below:

- The existing capacities do not get fully utilised because of extensive daily power cuts
- None of the pumping stations have dedicated feeders
- None of the pumping stations have more than a single power supply source
- None of the pumping stations have adequate diesel to operate the pumps during long power cuts
- All pumping stations are facing problems due to the large load of solid waste being carried in with the wastewater

- **60 mld Naini STP**

  A review of the STP has been presented in Chapter 2 to 4.

1.2.7 Surface Drains

Surface drains are being discussed here as they are at present carrying a major part of the wastewater load within the study area. The major drains (estimated discharge > 5 mld in 2005) are:

Table 1.6 Major Surface Drains

Drain	District	Discharge in 2005 (mld)
Main Ghaghar Nala	B	40.
Chachar Nala	A	34.
Morigate Nala	D	33.94
Salori Nala	C	27.1
Rajapur Nala	D	7
Kodara Nala	E	6.75

Of the above listed nalas, Chachar and Morigate have already been tapped under GAP-I and the balance three are planned to be tapped on implementation of the Master Plan.

1.3 DESIGN CRITERIA

1.3.1 General

The priority projects identified in the Master Plan for the Allahabad city can generally be divided into the following four technical categories:

- Rehabilitation / Replacement works for existing works (sewers, pumping stations & STPs)
- Construction of new gravity sewers / rising mains
- Construction of new pumping stations
- Construction of new STPs.

The design criteria for each type of these project components is listed in the subsequent Chapter.

1.3.2 Design Criteria for Sewers

(1) General

Sewerage design is influenced by a number of factors, principal among these are the following:

- Topography
- Population Projections

- o Spatial population distribution
- o Water supply in the region

The above listed factors have been discussed in the previous section. The other technical design criteria are discussed hereafter.

All designs generally conform to the Manual on Sewerage and Sewage Treatment, 1993 of Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development, Government of India.

(2) Design Horizon

Design horizon for sewers and rising mains is 2030.

(3) Design Flow

Design flows in terms of average flow and peak flow, for all trunk sewers and rising mains have been adopted as per Master Plan recommendations for all design horizons.

(4) Selection of Material

The various available materials for sewers are RCC (pre-cast or cast-in-situ), stoneware, cast iron, ductile iron and plastic pipes. A comparison statement, giving the advantages and disadvantages of each type is given below in Table 1.7.

External Traffic / Earth Load

Considering all the above factors, RCC pipes are found to be technically suitable and the least cost solution for gravity lines.

More over, the materials used extensively for sewerage in most Indian cities are glazed stoneware / vitrified clay and reinforced concrete pipes for gravity sewers whereas PSC /cast iron / ductile iron pipes are employed for rising / force mains of pumping stations. Concrete pipes conforming to IS: 458 of appropriate strength with proper anti-corrosive lining may even last for about 50-60 years. Considering the capital cost, durability and availability of the pipes, RCC pipes, preferably NP3/NP4 class as per IS: 458-1988, has been proposed for gravity sewers. Concrete pipes are usually laid and jointed by collar joints.

For rising mains, Ductile Iron (DI)/PSC pipes have been found suitable, but DI pipes are costlier than PSC; hence PSC pipes have been considered here.

Table 1.7 Comparison Between Various Types of Pipe

ITEM	PSC	CI	MS	PVC	DI	RCC	Remarks
Availability (Location)	Locally	Calcutta	Locally	Calcutta	Calcutta	Local	RCC / PSC preferable
Required internal test pressure	Available up to 10kg/m^2	Available up to 18kg/m^2	Available in wide range	Available up to 10 kg/m^2	Available up to 18 kg/m^2	Available up to 10kg/ m^2 (depending on class of pipes and diameter)	RCC suitable
Specials	Available	On order	To be fabricated at site	Available	On order	Available	RCC preferable
Treatment against corrosion	Not Required if made of SRC	Not required	Required	Not required	Not required	Not Required if made of SRC	MS is costlier due to the requirement of corrosion protection.
Jointing	Tyton joint with rubber gasket	Tyton joint with rubber gasket	Welding	By solvent cement	Same as CI	Same as CI	PVC is easy to lay
Breakage during transportation	Heavy cracks may develop	Brittle	Only denting occurs	Light weight but fragile	Same as CI	Heavy cracks may develop	MS and PVC preferable
Cost	Least Cost	Minor cost different with DI	More than PVC	Cheapest	Costliest	Least cost	PVC & RCC / PSC preferable
Maintenance	Generally no maintenance is required, but needs replacement, incase of crack.	Needs replacement, incase of even hair crack.	Easy to replace	Easy to replace	Same as CI	Generally no maintenance is required, but needs replacement, incase of crack.	RCC/PSC, MS and PVC preferable
Durability	Being used for a considerable period	Being used for a considerable period	Same as CI	Yet to be established	Being used in out side India for a long time. Recently introduced in Indian Market.	One of the oldest pipe being used in India. Hence no problem.	RCC / PSC, MS and CI have proven record.

(5) Peak Factors

Depending on the contributory population, the peak factor changes - it being higher for less population and low for high population.

Table 1.8 Peak Factors Considered for Sewerage Design

Contributory Population	Peak Factor as per CPHEEO Manual
Up to 20,000	3.00
20,000 - 50,000	2.50
50,000 - 7,50,000	2.25
Above 7,50,000	2.00
For tapping nalas	2.50

(6) Hydraulics of Sewers

For design purposes, the flow of sewage in pipes is presumed to be steady and uniform flow. The most popular equation for calculating the velocity and head loss for flow conditions in gravity sewers is Manning's formula, which has been used in this feasibility study for designs of gravity sewers.

Roughness factor n= 0.015 (RCC Pipes)
n= 0.017 old brick sewer

(7) Depth of Flow

The sewerage system for the ultimate design year has been designed to utilise 80% of the full bore of the pipe at peak flows.

(8) Velocities

The sewerage system has been designed for a minimum velocity of 0.8 m/sec. for design flow i.e. peak flow at design horizon.

Minimum velocity	0.60 m/s initial flow
	0.80 m/s ultimate flow
Maximum velocity	3.00 m/s

The maximum velocity is restricted to just below the scouring velocity, which is 3 m/sec as recommended in the CPHEEO manual.

(9) Sizing of Pipes and Slopes

The pipe diameter is selected by selecting the corresponding flattest slope while achieving the minimum required self-cleaning velocity; with an aim to minimize sewer depth thus ensuring reduced cost. In cases where (i) the topography does not permit to have the calculated gradient and/or (ii) the proposed sewer is to be connected to an existing line, which is at a shallow depth, a higher size pipe is selected to match the crown of connecting sewers.

Wherever the proposed sewers are to be discharged in existing sewers, invert level constraints and available slope has been considered for sizing the pipe in addition to the other criteria.

(10) Minimum Pipe Size

The interceptor sewers have been designed considering the minimum size of sewer as 500 mm and secondary sewers as 300 mm.

(11) Minimum Depth of Cover

The starting manhole depth of the proposed sewers ranges from 2 m to 3 m depending upon the topography and considering the depth of secondary sewer and laterals. The minimum depth of cover thus depends on the depth of starting manhole and the subsequent ground level of the road along the sewer.

(12) Maximum Depth of Sewer

In many areas construction of sewers below 10 meters becomes very difficult. This increases the cost of construction and maintenance. As per the prevailing practice sewage has to be lifted up by pumping once the sewer depth reaches 10 meters.
The sewerage system has been designed such that the maximum cover of sewer will be less than 10 meters below ground level. Hence it does not require any intermediate pumping station. Wherever it is not possible to convey the sewage by gravity, existing intermediate pumping facilities have been used by augmenting them.

(13) Sewer Appurtenances

Manholes

Standard circular manholes have been recommended for pipe diameter up to 1200 mm. However, rectangular manholes should be provided for shallow depths. Spacing of manholes has been kept between 30-60 m considering factors such as cleaning of sewers, ventilation requirements for men working in sewers and conveying material for repairs. Diameter of the manhole shall be per Table 1.9.

Table 1.9 Details of Manholes

Sr.	Depth	Diameter
	Up to 1000 mm dia Sewers	
A	For depths above 0.90 m and up to 1.65m	900 mm
B	For depths above 1.65m and up to 2.50 m	1200 mm
C	For depths above 2.5m and up to 5.0m	1500 mm
D	For depths above 5.0m and up to 9.5 m	1500 mm

Since the cost of RCC manhole is very high and stone is not available in Allahabad, brick masonry manholes have been provided in design.

Scraper Manholes

For sewers of diameter 600 mm and above, scraper manholes shall be provided at major junctions and at an interval of every 150 m. Scraper manhole openings will be of minimum 900 to 1200 mm size to permit lowering of sewer cleaning equipment. It is very important to construct scraper manholes as the sewers have been designed to serve for long term, and shall run with less flow during the initial years, resulting into silting.

Drop Arrangement

The drop arrangement consists of a pipe that drops the invert of the incoming sewer to that of the main sewer in the manhole. The diameter of the drop pipe should be at least as large as the incoming pipe. Theoretically drop arrangements are provided where the drop of an incoming sewer in manhole exceeds 600 mm. Drop arrangements are provided in manhole for the following reasons:

- To convey the sewage to bottom of the manhole without splashing
- To minimize the scouring action of the sewage falling from a height on the cement concrete floor of the manhole
- For the safety of the personnel who enter the manhole

Receiving Manhole at Pressure Line Discharge

A 2 m x 2 m receiving sump with the provision of PVC splash pad has been proposed for chamber-type manhole into which pressure line is discharged prior to joining the gravity sewer.

Vent Shafts

Ventilation shafts must be provided at the head end of every sewer and along the sewers at about 150-m interval as well as at junctions.

Encasement of Sewer

It is not advisable to have sewer pipeline above any water supply pipeline. It is also not desirable to have sewer at close proximity of water supply pipelines. However, in the event of any unavoidable situation the sewer will be encased with M15 grade concrete.

(14) Selection of Pipe Class

The class of concrete pipes is decided on the basis of analysis of design loads likely to be imposed upon the sewer depending upon its depth.

Structural Design of Buried Sewers

Any sewer line buried into the ground should have adequate strength to withstand the stresses imposed not only by the internal pressure but also more importantly, by the stresses induced by external loads. There are two types of external loads, one is due to the backfill material known as backfill load and other is due to superimposed loads. Besides these external loads, the sewer line is also subjected to the load of water in the pipeline, especially during surcharge conditions.

(a) Load on Conduit due to Backfill

The load on a buried conduit is equal to the weight of the prism of earth directly over the conduit plus the frictional shearing forces transferred to the prism by the adjacent prism of earth. The most widely used method for determining the vertical load due to backfill on buried conduit is Martson's Formula, the general form of which is

W = C.w.B2

where,

W = Vertical load in kg per meter length acting on the conduit due to gravity loads

w = Unit weight of earth, kg/m3

B = Width of trench or conduit depending upon type of installation condition, m

C = Dimensionless coefficient that measures the effect of ratio of height of fill to width of trench or conduit

The value of C for various types of installation and depending on the height / width ratio is given in the Manual of Sewerage and Sewage Treatment (CPHEEO) published by the Ministry of Housing and Urban Affairs, New Delhi. The C-value for 'Ordinary maximum for clay' has been considered for design purposes.

The unit weight of earth varies from 1,600 kg / m^3 for dry sand to 2,100 kg/ m^3 for saturated clay.

(b) Load on Conduit due to Superimposed Load

Superimposed loads may be either concentrated or distributed loads. The formula for load due to concentrated load such as truck wheel is given by Boussinesq's formula

Wsc = Cs(PF/L)

where,

Wsc = load on the conduit, kg/m
P = concentrated load acting on the surface, kg
F = impact factor (1.0 for air field runways, 1.5 for highway traffic and air taxi ways, 1.75 for railway traffic) and
Cs = load coefficient which is a function of Bc/2H and L/2H, where
H = the height of the top of conduit to ground surface, m
Bc = the outside width of conduit, m and
L = effective length of the conduit to which the load is transmitted, m.

(c) Distributed Superimposed Loads

For distributed superimposed loads, the formula for the conduit is given by

Wsd = Cs.p.F.Bc

where,

Wsd = load on conduit, kg/m
p = intensity of distributed load, kg/m2
F = impact factor
Bc = width of conduit, m
Cs = load coefficient, a function of D/2H and L/2H
H = height of the top of conduit to the ground surface, m and D and L are width and length respectively of the area over which the distributed load acts, in meters.

For class AA IRC loading in the critical case of 6.25 tones wheel load, the intensity of distributed load with wheel area 300mm x 150mm is given by P = 6.25/(0.3x0.15) T/m2.

(d) Supporting Strength of Rigid Conduit

The ability of a conduit to resist safely the earth load depends on its inherent strength as well as the distribution of vertical load and bedding reaction and on the lateral pressure acting against the sides of the conduit. The inherent strength of a rigid conduit is usually expressed in terms of the three edge bearing test results, the condition of which are however different from the field load conditions. For strength calculations of NP class precast RCC pipes, IS: 458 (1988) is used.

(e) Field Supporting Strength

The field supporting strength of a rigid conduit is the maximum load per unit length, which the pipe will support while retaining complete serviceability when installed under specified conditions of bedding and backfilling. The field supporting strength however does not include any factor of safety. The ratio of the strength of a pipe under any stated condition of loading and bedding to its strength measured by the three edge-bearing test is called the load factor. The load factor does not contain a factor of safety. Load factors have been determined experimentally and analytically for the commonly used construction condition for both trench and embankment conduits.

The basic design relationships between the different design elements are:

Safe supporting strength,

W = Field supporting strength/Factor of safety
= (Load factor x three edge bearing strength)/Factor of safety

A factor of safety of at least 1.5 should be applied to the specified minimum three edge bearing strength to determine the working strength for all the rigid conduits. The class of bedding considered is B type, whose load factor as per the CPHEEO Manual is 1.9.
Based on the above consideration, a general guide for selecting the class of pipe from 200 to 600-mm diameter is given in Table 1.10. However, in our case we have carried out the structural designs for all pipes above 300mm.

Table 1.10 Guideline for Selection of Pipe Class for Sewers with B-class Bedding

Diameter	NP2	NP3	NP4
200	1.2 to 7.0 m		
250	1.2 to 7.0 m		
300	1.2 to 4.2 m	4.2 to 6.0 m	6.0 to 10.0 m
350	1.2 to 2.7 m	2.7 to 3.5 m	3.5 to 10.0 m
400	1.2 to 2.7 m	2.7 to 3.5 m	3.5 to 10.0 m
450	1.2 to 2.7 m	2.7 to 3.5 m	3.5 to 9.5 m
500		1.5 to 3.5 m	3.5 to 8.5 m
600		1.5 to 3.5 m	3.5 to 7.5 m

Note: *For larger diameters of 700-mm and above, pipe class cannot be generalized and has to be calculated on a case-to-case basis.*

RCC NP3 class pipes have been proposed for laying of gravity sewers by open excavation while RCC NP4 class pipes have been proposed where the sewer is to be laid by trenchless technology.

(15) Type of Bedding

The type of bedding provided for pipes will be selected from granular bedding, concrete (M20) cradle bedding or concrete encasement (M20) and the choice will depend on the depth at which the sewer is laid, three edge bearing strength of pipes used, load due to backfill and superimposed vehicular traffic loads. Technical suitability of such bedding, as per the guidelines of CPHEEO, is studied and adopted as found acceptable.

Table 1.11 Type of Bedding

Dia	RCC NP_3 PIPE				RCC NP_4 PIPE	
	Granular bedding	PCC Bedding	RCC -0.4% Bedding	RCC – 1% Bedding	Granular Bedding	PCC Bedding
	TYPE "A"	TYPE "B"	TYPE "C"	TYPE "D"	TYPE "A"	TYPE "B"
150	-	-	-		up to 8.0 m	-
200	-	-	-	-	up to 8.0 m	-
250	-	-	-	-	up to 8.0 m	-
300	-	up to 3.5 m	3.5 to 6.0 m	-	up to 8.0 m	-
350	-	up to 3.5 m	3.5 to 5.5 m	5.5 to 8.0 m	-	-
400	-	up to 3.5 m	3.5 to 5.5 m	5.5 to 8.0 m	-	-
450	-	up to 3.5 m	3.5 to 5.0 m	5.5 to 8.0 m	-	-
500	-	up to 3.5 m	3.5 to 5.0 m	5.5 to 8.0 m	-	-
600	-	up to 3.0 m	3.5 to 4.5 m	5.5 to 8.0 m	-	-
700	-	up to 3.0 m	3.5 to 4.5 m	5.5 to 10.0m	-	-
800	-	up to 3.0 m	3.5 to 4.5 m	5.5 to 10.0m	-	-

All types of bedding A, B, C,D have been used here.

(16) Software used for Design of Trunk Sewers and Design Methodology

For the present project, design and analysis of trunk sewers and interceptors has been done by computer software SEWERCAD 5.5. This software has been developed by the Haestad methods, Waterburry USA, and finds wide usage worldwide for sanitary sewer modeling. It has all flexibilities regarding size, shape, material and roughness coefficients and flow characteristics for sewers.

The software directly uses the Auto Cad profile of the pipeline alignment as an input analysis / design. A picture file or base map of the city can also be used by defining pipelines and manholes.

While calculating the optimized size and slope of the sewer, certain constraints regarding minimum and maximum velocity, minimum cover, minimum and maximum slope, etc. are defined. The size and slope of the pipe is decided within the defined constraints. Accordingly the slope of pipe from manhole to manhole is designed so that cost of earthwork is minimised.

1.3.3 Design Criteria for Rising Mains

For calculating the optimum pumping mains the initial cost of pipeline and cost of pumping for different sizes have been taken into account and design has been carried out as per the procedure given in Appendix 6.5 of the CPHEEO manual of water supply.

Frictional losses have been calculated using Hazen Williams formula. Velocities considered are 1.1 to 1.5 m/sec for design peak flows. Roughness factors taken in design are as follows:

- Roughness factor C= 100 new cast iron pipe
  C= 80 old cast iron pipe
  C= 110 PSC pipes
- Minimum velocity 0.6 m/s at non-peak flow
- Maximum velocity 2.0 m/s

Losses in valves, fittings, etc. are dependent upon the velocity head $V^2/2g$. Loss in bends, elbows depend upon the ratio of absolute friction factor to pipe diameter, besides the velocity head. Loss due to sudden enlargement depends upon the ratio of diameters.

The pump capacity together with rising main diameter have been calculated considering pump cost, rising main cost and annual operation & maintenance cost. Lesser diameter rising main may be cheaper in initial cost but the operation cost may be more due to increased pump head.

The most economical size of the pumping main have been selected as per CPHEEO manual and following factors have been analysed:

- The different diameter of pipes for different head losses, which can be considered for the quantity of sewage, intended to be transported.
- The design period and the quantum of flow to be carried out for design period.
- The pipe and its relative cost including cost of laying and jointing.
- The cost of pump and its installation against the various diameters of pipes.
- The annual and capitalised cost of electric charges.
- Minimum required velocity (scouring) in pipeline (should be 0.6 m/sec) during non-peak condition.
- Maximum allowable velocity in pipe line (should not be more than 2.0 m/sec)

Following parameters have been taken for designing of most economical size of rising main:

Electric charges	Rs. 3.25 per unit
Capitalised energy charges	CC = CR *{ [1 – (1+r) ^ (-n)]/ r }
Where	CR = annual energy charges
	n = period in years = 15
	r = rate of interest = 10%
	For n=15 & r=10%; CC=7.61 CR

(1) Appurtenances

Air Relief Valves

Air relief valves are designed specifically to vent, automatically and when necessary, air accumulations from lines in which water is flowing. Such accumulations of air tend to collect at high points in the pipe line. Air that accumulates at such peaks reduces the useful cross sectional area of the pipe and therefore has the effect of increasing the friction head factor, lowering the pumping capacity of the entire line. The use of air release valves eliminates the possibility of this air binding and permits the flow of water without damage to pipe line.

Kinetic Double air relief valves would be installed at peaks in the pipe line, both with respect to horizontal and maximum hydraulic gradient. They should also be installed at the ends and intermediate points along a length of pipe line which is parallel to the hydraulic gradient.

Double air valves would also be fitted every 1/2 to 1 km along descending sections, especially at points where the pipe dips steeply.

The sizes of the air valves have been decided considering the ratios of air valves to pipe diameter as 1:8. Material of valves will be Cast Iron.

Scour Valves

CI Sluice valves should be installed at intermediate locations of the pipe line in order to provide scouring facilities for maintenance purposes. Locations of such valves have been decided depending upon the availability of a nala/drain nearby for disposal of the drained wastewater. Diameter of sluice valve will be 1/2 of pipe line diameter. Generally scour valves have been provided at a distance of approx. 1 to 1.5 km.

Isolation Valves

CI Sluice valves of the same size as the pipe line size have been provided at suitable locations in order to facilitate the isolation of the part of the pipe line for maintenance purposes.

Valve Chambers

The valve chamber shall be provided to house the different valves. The walls of chambers shall be constructed in brick or grade specified in IS 456 and 150 mm thick CC (M-20) shall be provided in the chamber at the bottom.

The roof of valve chamber shall be of RCC two way slab with two clear opening of size and covered with Ferro Cement cover sheet with cast iron frame and having lock & key arrangement to facilitate removal of appurtenance by crane/chain pulley blocks for maintenance through larger opening and valve operation through a smaller opening. The walls shall be designed to withstand lateral earth pressures. The roof and slabs shall be designed to withstand load as per IS: 875. Pre-cast removable Ferro cement covers shall be provided in the center portion of the chamber roof and a manhole size 900 mm x 900 mm having locking arrangement is to be provided to provide access within the chamber.

The roof of valve chamber shall have manhole of size 900 x 900 mm for entry and maintenance purpose.

1.3.4 Design Criteria for SPS

(1) Design Horizon

- For the design of civil structures — 2030
- For the design of mechanical and electrical items — 2015 and 2030
- For the design of rising main — 2030

(2) Wet Well Capacity

- Design year — 2030
- Detention time of wet well at peak flow
  - 5 minutes for horizontal centrifugal pumps
  - 3.75 minutes for submersible pumps
- Maximum detention time at average flow — 30 minutes

(3) Dry Well/ Valve Chamber Size

Based on number of pumps and clear spacing requirement for pumps, pumps dimension, valves, fittings and working space requirement.

(4) Pumps

Design year	2015
Number of pumps	
For small capacity plant	
i) When rising main is long	a) 3 nos. pumps of Half Peak Flow b) 2 nos. pumps of Non Peak Flow

ii) When rising main is short	a) 5 nos. pumps of One fourth Peak flow

For large capacity plant (or critical facilities)

equal capacity pumps (6 to 8)
+ 50% standby on peak flow,
+100% standby for non-peak flow

Submersible pumps are proposed up to 150 HP capacity
Horizontal Centrifugal Pumps are selected for higher (>150 HP) capacities.

Pump capacity in kW	9.81 * H * Q/ (Ep * Em)
Where	H =Required pumping head m
	Q = pump discharge, m3/sec
	Ep = Pump efficiency
	Em = Motor efficiency

(5) Screens & Screen Channel

Screening of incoming wastewater is required for the removal of large floating materials, which can damage the pumps. This will be carried out in two stages, viz. 40 mm opening manually cleaned bar screen followed by a 20 mm opening mechanically cleaned bar screen.

Design year	2030
Standby Units	50 % (normally)

Stage - I

Clear spacing between screen bar	40 mm
Thickness of screen bar	10 mm
Type of working screens	Manual screen

Stage - II

Clear spacing between screen bar	20 mm
Thickness of screen bar	10 mm
Type of working screens	Mechanical screen
Type of standby screen	Manual screen
Minimum Approach velocity @ avg. flow	0.3 m/sec
Minimum velocity through screens	0.6 m/sec
Maximum velocity through screens	1.2 m/sec

1.3.5 Design Criteria for Sewage Treatment Plants

(1) Design Capacities

The Master Plan has been consulted for deciding the STP capacities. As per the final sewerage system configuration, 4 new STPs are to be constructed, details are as follows:

Table 1.12 Design Capacity of Sewage Treatment Plant

Location	Catchment Area	Capacity mld)	
		Year 2015	Year 2030
Numaya Dahi	District B	50	50
Ponghat	District E (Part)	10	10
Kodara	District E (Part)	15	30
Rajapur	District D	65	80

The existing Naini STP is to be augmented to 80 mld capacity by adding a new stream of 20 mld.

(2) Raw Sewage Characteristics

The raw sewage characteristics for waste water reaching the STPs have been decided based on the following:

- In the initial years of operation, the STPs will receive flows tapped from nalas, hence the raw sewage will be dilute. From the available data regarding BOD values of nala flows, it is seen that the BOD (max.) levels rarely exceed 140-150 mg/l.
- As the branch and trunk sewers are put in place, the strength of raw WW reaching the STPs will increase; in Phase II STPs will have to treat higher BOD & SS loads.
- The BOD and SS loads will increase in Phase II due to a progressive decline in per capita water consumption also (from 295 lpcd in 2003 to 221 lpcd in 2030).
- As per the data available with CPCB, the average BOD and SS figures at Naini inlet for the period July 1999 to March 2002 were 97 mg/l and 335.6 mg/l respectively.
- As per the data made available to the consultants by UPJN, the corresponding figures for the period March-May (summer months, when WW strength is high), 2004, were 110 and 365 mg/l.
- The existing Naini STP has been designed for BOD = 300 mg/l and SS = 600 mg/l
- The under construction Salori STP has been designed for BOD = 150-250 mg/l and SS = 375-400 mg/l.

In order to optimise the treatment cost, the wastewater characteristics used for design of the proposed sewage treatment plants are based on the projected wastewater characteristics presented in the Table 1.13.

Table 1.13 Raw Sewage Characteristics (Average Values)

Sr.	Parameter	Rajapur STP		N. Dahi STP		Ponghat STP		Kodara STP	
		2015	2030	2015	2030	2015	2030	2015	2030
1.	Minimum Temperature, ^{o}C	20	20	20	20	20	20	20	20
2.	pH	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5	6-8.5
3.	BOD_5, mg/l	103	250	112	225	115	200	115	200
4.	Total Suspended Solids, mg/l	185	450	200	400	207	360	207	360
5.	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$	$2x10^7$

(3) Effluent Standards

The effluent standards considered in the design of STPs, as specified in the Master Plan and in accordance with NRCD guidelines, are listed in the Table 1.14:

Table 1.14 Treated Wastewater Quality

Sr.	Parameter	Value (Irrigation Field/River)
1.	pH	5.5 – 9.0
2.	BOD_5, mg/l	< 30
2.	Total Suspended Solids, mg/l	< 50
3.	Faecal Coliform Count, MPN/100ml	<10,000

(4) Comparison of Treatment Technologies

For treatment of municipal wastewater, the various stages of treatment can broadly be categorized as:

- Preliminary treatment – In this stage, large sized solids (rags, wood pieces, carcasses, etc.) are separated by screening and the inert grit is removed in the grit removal units.
- Primary treatment – The settleable solids are separated in settling tanks
- Secondary treatment – The volatile solids are stabilized mostly by biological processes, which may be aerobic or anaerobic, suspended growth or fixed film type.
- The various treatment technologies differ mainly in the type of secondary treatment employed. Conventionally the most commonly used treatment technologies employed in India are:
- Waste Stabilisation Ponds
- Aerated Lagoons
- Activated Sludge Process and its modifications
- Extended Aeration Process

In the recent years, UASB process has become popular in the country. However, UASB as a stand alone system has not been successful in meeting the discharge standards and is mostly followed either by a maturation pond / aerated lagoons or by mechanical aeration followed by solids separation. Other recent technologies include the FAB (Fluidized Aerated Bioreactor) and SBR (Sequential Batch Reactor) processes; however, each of these technologies is available with a single party only.

A comparison of these technologies is presented in Table 1.15.

Table 1.15 Comparison of Treatment Technologies

Technology	WSP	Aerated Lagoons + Chlorination	ASP + chlorination	EA + chlorination	FAB + chlorination	UASB + Aerated Lagoon + chlorination	UASB + Mechanical aeration + chlorination
Comparison Parameter							
Land requirement (Ha/MLD)	1.25-1.35	0.2-0.3	0.15-0.2	0.08-0.1	.06	0.3-0.35	0.1
Power requirement	Least	High	Very high	Highest	Highest	High	High
Capital Cost (Rs. Lakhs / MLD)	55-60	58-60	50-60	45-50	50-55	25-27	26-28
O&M cost	Least	Higher than WSP	Very high	Highest	Very high	Low	High
Sludge disposal cost for a lead of 10 km	Sludge disposal once in several years, hence, disposal costs negligible.	Sludge disposal once in several years, hence, disposal costs negligible.	Not considered here as sludge can be sold to farmers as manure	Not considered here as sludge can be sold to farmers as manure	Not considered here as sludge can be sold to farmers as manure	Not considered here as sludge can be sold to farmers as manure	Not considered here as sludge can be sold to farmers as manure
O&M requirements	No special skill set needed	No special skill set needed	Skilled operation required	Skilled operation required	Special training for UPJN officials necessary, or O&M to be contracted out.	No special skill set needed	No special skill set needed
Performance reliability in face of power cuts	Highest	Low	Low	Low	Low	High	High
Resource recovery – Bio-gas	Gas not produced	Gas not produced	Gas produced can be used for generating power to run the plant, but only for higher capacity plants.	Gas not produced	Gas not produced	Gas is not produced in sufficient quantities to consider power production for plants less that 40 mld.	Gas is not produced in sufficient quantities to consider power production for plants less that 40 mld.

1.3.6 Existing Sewers Condition Survey

A condition survey was carried out for the existing sewers in Districts A and D. All traceable and open-able manholes were inspected and the following data noted:

- Manhole chainage
- Ground level
- RL of manhole cover top
- IL of sewer
- Top level of sewer
- Water level in the manhole / top level of loose deposit (in case manhole is dry)
- Shape of manhole cover
- Material and condition of manhole cover
- Material of manhole
- Condition of manhole
- Sewer shape
- Sewer material
- Sewer condition

Photos of the manholes were also taken.

From the observed data, L-Section drawings were generated. The data was analysed to arrive at the following for each stretch:

- Slope between two consecutive manholes
- Variation in discharge capacity due to variation in slopes
- % of sewer depth choked due to deposited silt

The proposal for replacement / de-silting / rehabilitation of each stretch has been worked out taking into consideration all of the following parameters:

- Discharge capacity of the stretch, after cleaning of the sewer v/s proposed design discharge
- Variations in slope and hence, discharge capacity from average values
- Length of sewer for which slope / discharge capacity is inadequate
- General structural condition of the sewer
- Replacement costs v/s rehabilitation costs

In general, it is observed (on the basis of price proposals received), that it is cheaper to replace a pipe stretch than to rehabilitate it.

1.3.7 Rehabilitation Techniques

(1) Sewer Cleaning Techniques

In many sewerage systems, sediments deposit at the bottom of the pipe line as the system grows older. This sediment consists of silt or sludge or a semi dry, viscous mass that is very difficult to handle. It frequently contains toxic substances also. The sediment hinders normal operation of the sewerage system, causes chocking and overflow and therefore should be removed.

❑ **Conventional Methods of Sewer Cleaning**

Conventionally following equipments are being used for cleaning of sewers.

1) Sectional Sewer Rod

This is used for cleaning of small sewers up to 200 mm only. Rods may be of Bamboo or metal about one meter long.

2) Rope and Bucket Machines

These consist of two powered winches and cable in between them, fitted with a bucket. The winches are established at two consecutive manholes of the sewer section to be cleaned. These are used for sewers from 200 mm to 900 mm dia. and are more suitable for de silting of sewers.

3) Electrical or Mechanical Flexible Coil Machine

This consists of a flexible coil, which is attached to a cleaning auger and can be rotated manually or electrically. These are very effective and could be used in all sizes.
These conventional technologies are inimical to the human health.

- **Latest Technologies of Sewer Cleaning**

With the advent of the machine technology, manual maintenance works have come to an end. Maintenance by machines not only enhances productivity, it also ensures the safety of the environment and humans, against waste and poisonous gases which accumulate in the sewers.

1) Silt Scraper Machines

These machines are equipped with a powerful motor designed for maximum flexibility. Specially designed, spiral fixed with unique head configurations are used to clean the drains. A two gear reversing gear box is coupled to the motor, so that the direction of rotation of the spiral can be switched accordingly. The rotation speed of the spiral is controlled via a manual gas lever. Rods are used to clean solid formed wastes in the drains.
There are different diameter spirals for different applications. Different head configurations designed for cleaning different waste in the drains.
After de silting of the sewers through these sewer cleaning tools and jetting machines, silt is removed from the sewer by vacuum technology and discharged safely to the dumping site.

2) Jetting Machine

This machine basically works on the principle of high velocity water jet. These are more effective for removing local blockages. The pressure can be as high as 80 kg/sqm. The whole machine is installed on a moving trolley/truck. These are also available in small models to suit congested sites.

3) Vacuum Technology

This is based on the principle of negative pressure. The machine consists of a vacuum loader with large quantities of air. These deal with the sludge more efficiently. This machine is very efficient compared to traditional sludge sucker or a combined unit. Sucking the sludge as dry as possible reduces both the handling and the dumping costs, especially if the sludge is environmentally hazardous. Vacuum technology thus contributes towards a better environment.

(2) CCTV Sewer Inspection System

This technology is relatively new in India but is used extensively by Municipal Corporations / PHED / Water Supply and Sewerage Boards throughout the world to assess the condition of existing sewers, and to prepare sewer maintenance, rehabilitation and / or replacement programmes.

Most important reason for the use of sewer inspection systems are:

- The approval of newly constructed sewers.
- The inspection of old sewers to locate ground water infiltration, faulty connections and fragmentation.
- Determination of the reason for blocked sewer.
- For the cost estimation of sewer rehabilitation programme.
- Updating of asset register if sewer network plans either do not exist or have been lost.
- Preparation of sewer maintenance programme

- **Purpose**

The purpose of CCTV inspection of sewer lines is to identify the various types of structural, service and construction features of pipe line. i.e. dislocated and separated joints, cracked pipe, collapsed pipes, silted bottom, corroded or eroded pipe, deformed pipe, roots, debris and encrustation in the pipe, services, infiltration in to the system, etc.

The CCTV inspection will also show the depth of flow at average and peak levels by the water marks on the interior of the pipe. All this work is done without excavation and disturbance of the road traffic by inserting a special waterproof camera into one manhole and pulling it through the sewers into the next manhole.

- **Methodology for CCTV**

In CCTV inspection of sewer, a specially designed camera head with diode light and quartz glass lens cover is passed through the sewers that are to be inspected. The result is a clear colour video picture showing conditions inside the sewer. The video picture from the camera is relayed back to the operators control panel. The control panel consists of a colour television screen displaying the picture from the camera, a video cassette recorder (VCR), and a keyboard (video type writer) for entering information, which is displayed on the screen during the survey. The specialized equipment like distance counter and camera locating unit allows the position of the camera to be accurately measured and this information is shown on the video to locate any defects observed in the sewer pipe line. Following the fieldwork, the video tapes are analyzed and a detailed report of the sewer conditions is prepared which includes a description and exact location of all defects in the system.

Pneumatic plugs are used for plugging the up stream flow. Necessary arrangements are also made to pump out the sewage down stream of the reach being surveyed.

Basically two types of arrangements are used for pulling the camera inside the sewer. One is using “Slider” fitted with steel wires, which are used for non-flow condition in the sewer. Another arrangement is using “Floaters” which are used when the sewer is charged. The sewer should be at least 50% emptied for capturing good pictures and defects through the camera.

If required, high level camera systems can be used, which can be remotely controlled, self-propelled, ensuring a 360 degree picture of the drain. Picture generated from these systems can be linked on to specially designed software. This further helps in analyzing the situation of the drain to the finest detail thereby enabling design of the appropriate repair procedure.
After the fieldwork is finished, the video tapes are thoroughly analysed and recommendations

are made for onward rehabilitation.

- **Constraints**

The minimum size that can be surveyed using this technology is 200 mm.
The maximum length of sewers that can be surveyed in a day is 150 m to 200 m but depends upon the site condition mainly.
The minimum space and access requirement for the inspection equipment is 4 m. However it can be managed up to 3 m also.

(3) Rehabilitation Methodology

Maximum size of sewer considering all districts is 1.2m x 1.4 m, the sewer is approx. 20% silted; hence, manual inspection is not recommended in any of the existing Trunk Sewers in the city. The sewers where de-silting has been recommended (refer Chapters 2 and 3), should be diverted and de-silted. A CCTV survey is recommended to assess the structural condition of sewers and to assess the efficiency of the de-silting operations.

1.4 COST ESTIMATE

1.4.1 Basis of Cost Estimate

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh. All the figures are in INR.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated as Lucknow rates on the basis of Delhi schedule of rates (DSR) taking localities and deflator into account. Furthermore, prices of items such as sewer pipe, reinforcing steel bars, manhole covers and so on that are not found in DSR are obtained by quotation.

(a) To apply schedule of rates provided by UPJN in principle.
(b) For rates of items not provided by UPJN, to use modified rates based on Delhi schedule of rates.
(c) To use market prices for items not available in (a) and (b).

Cost estimates of Civil & Electro-Mechanical Work are primarily based on the following:

(1) Sewage Treatment Plants

<u>UASB STP at Rajapur and Kodara Nala</u>

- On mld basis for the main STP, based on recent works awarded.
- Flood protection measures have been provided with side slope (1 vertical : 2 horizontal). The width of the embankment at top is kept 6 m & 3 m and the height 10 m and 5 m respectively depending on the ground level and highest flood level of the area.

The items considered in the Bund construction are:

i) Earthwork in excavation
ii) Supply of good earth and filling of sand in foundation and super structure
iii) Supply of good earth and forming embankment
iv) Stone pitching

v) Suitable ground treatment with geo-synthetics to enhance the safe bearing capacity, and micro reinforced geo-grid and non-woven geo-textile for slope protection has been provided. The costing of these items is based on price obtained from specialised agencies.

WSP STP at Numaya Dahi and Ponghat Nala

The cost of the ponds in each of these STPs has been worked out on the basis of excavation & the embankment on the basis of actual filling. Care has been taken to see that total cutting & filling gets compensated, so that neither extra earth is to be brought in nor disposed off. The general ground level at Numaya Dahi & Ponghat are normally above the HFL at Allahabad, hence no flood protection measures have been adopted. The items considered are:

i) Earthwork in excavation for the ponds.
ii) Earth filling in embankments
iii) Pond impermeable lining work
iv) Filling to attain finished ground level
v) Road work

LDPE reinforced geo-membrane and non woven geo-textile have been provided for impermeable lining of the stabilization ponds. Costs of these are based on prices received from Specialized Agencies. Costs for service buildings, roads and chain link fencing are based on actual quantities and rates taken from UPSR when available, otherwise from DSR, with necessary cost index for Allahabad for 06/2005, as shown in Table 1.16.

Table 1.16 Cost Index Calculation

As per 07/1999, Cost Index = 171
As per 01/1997, Cost Index = 155
As per 09/1995 Cost Index = 136

Comparing 09/1995 and 07/1999,
Rate of increase of Cost Index in one year = (171-136) x 12/46 = 9.13 ---------(1)

Comparing 01/1997and 07/1999,
Rate of increase of Cost Index in one year = (155-136)x 12/30= 6.4 -----------(2)

Comparing The above (1) & (2),
Average Rate of increase of Cost Index in one year = (9.13 + 6.4)/2 = 7.765

As per 07/1999, Cost Index = 171
Therefore Cost Index for 06/2002 = 171+(7.765x35/12) = 193.65
Cost Index for 20/12/2004 = 193.65 + (7.765x30.67/12) = 213.50
Cost Index Over 06/2002 = (213.50 – 193.65)/193.65
= 10.25 %

Modification of Naini STP

The cost for construction of 20 mld additional stream is based on mld basis, considering the cost of recent works awarded. A certain escalation has been considered to take into account the recent sharp increase in steel prices. The price of Gas Engines is based on quotation received. As it would be an imported item, the cost is given in Euros. However local taxes and erection commissioning are considered in Indian Rupees.

Power transmission cost for individual STP's and Pumping Stations have been taken as per estimated rates. Above-ground transmission lines have been considered for supplying power to Sasur Kahderi SPS and Numaya Dahi STP as they are located in sparsely populated areas and above-ground transmission costs are 80% of the underground transmission costs. However, for all the other facilities, which are within the urbanized area, underground transmission lines are considered.

(2) Sewage Pumping Stations

Sewage Pumping Stations mainly consist of dry well, wet well, pump houses and other service buildings, roads, platforms and chain link fencing.

Loading and design are based on relevant BIS codes. M25 has been considered as minimum grade of concrete for RCC design. Walls and bases of wells have been designed as uncracked section. Monorail Block / HOT Crane has been provided in the pump houses. Wherever necessary, platforms along with handrails have been provided.

Costing of the pump houses is based on actual quantities worked out from preliminary design with special emphasis on protection against flooding, considering HFL recorded in Allahabad.

For the new pumping stations at Ghaghar nala and Sasur Khaderi, tension bored piles have been provided below the wet and dry well to protect against possible uplift during floods. While calculating the uplift, the weight of the structure has been considered to avoid uplift during construction stage, holes will be left at the base slab, which ultimately will be filled by pressure grouting.

In case of these two pump houses the intake channels, screens, bifurcation chambers, service buildings, roads, platforms etc. have been provided on stilts to avoid flooding.

Items considered in the pumping stations are as follows:

- i) Excavation
- ii) Refilling
- iii) P.C.C. below foundation
- iv) R.C.C work in foundations, walls, slab, columns, beams etc.
- v) Shuttering
- vi) Brickwork
- vii) All finishing items
- viii) Rolling shutters, Doors windows etc.
- ix) RCC flooring
- x) Fencing
- xi) Hard standing
- xii) Tension Piles wherever necessary

The rates assumed for major civil work items are based on UPSR when available, otherwise from DSR 2002 (civil work) updated to June 2005 for Allahabad.

Market rates are considered for pipes, reinforcement steel, structural steel etc.

Electromechanical costs of the pump houses are based on the following:

Costing of pumps and motors are based on the price of reputed supplier, and other facilities like screen, pipe, valves, etc. are based on market rate.

Costing of electrical equipment is based on the price list of standard suppliers.

(3) Proposed Rising Main, Sewer Pipe Line and Manholes

These are based on the following:

Pipe-line: Cost is based on budgetary offers received from standard supplier over which prevalent taxes, cartage, laying & jointing and testing is added.

Items considered in laying of pipe lines are as follows:

i) Earthwork in excavation and refilling
ii) Granular / RCC bed
iii) Close timbering in trenches.
iv) Centering & shuttering
v) Road cutting & repair
vi) Steel reinforcement wherever applicable.
vii) Major road crossings by trenchless technology
viii) Railway crossings by culvert

For Manholes

i) Earthwork in excavation and refilling.
ii) Close timbering
iii) R.C.C. including shuttering and reinforcement
iv) Brick work in C.M.
v) Plastering
vi) Manhole cover heavy duty

(4) Rehabilitation / Replacement of Existing Pipe Line

Wherever possible existing sewers would be rehabilitated after de-silting and subsequently CCTV inspection should be carried out. Where the discharge capacity is not found adequate or where the lines are damaged / varying in slopes / the pipes are almost choked due to silting, existing pipelines and manholes are to be dismantled and new pipelines and manholes would be laid. Cost of desilting operation and CCTV inspection are based on offers received from Specialized Agencies.

The rates assumed for major civil work items are based on UPSR when available, otherwise from DSR 2002 (civil work) updated to June 2005 for Allahabad.

Market rates are considered for pipes, reinforcement steel, structural steel, specialized items like geo-synthetic etc.

As these rates are very high and replacement of pipes works out to be cheaper, pipe replacement has been preferred over pipe rehabilitation in all cases.

(5) Land Acquisition Cost

Wherever land is required for the construction of New STPs and Pumping Stations, the cost of the Land Acquisition is included in the Project Cost.

The land prices considered for individual sites are based on UP Government circular dated 16.6.04 and valid for two years.

Table 1.17 Land Acquisition Cost

Location	Unit Prices Rupees/per acre
A. STP	
1. a. Numaya Dahi STP	390,000
b. Drain from Numaya Dahi to Bisona Irrigation Channels	390,000
2. Rajapur	390,000
3. Kodara	390,000
4. Ponghat	390,000
B. SPS	
1. Chachar Nala	Rs. 8,000/ m^2
1. Ghaghar Nala	390,000
2. Sasur Khaderi	390,000
3. Mumfordganj	Rs. 7,000/ m^2
4. Morigate	Rs. 7,000/ m^2

The above land rates are inclusive of the surcharge on account of the land being adjacent to existing roads.

Although the land to be acquired for Morigate PS is with the Cantonment Board, its acquisition costs have been considered as per the rates given in the circular.

(6) EIA Cost

The above is based on the following

1. Green belt along sewer routes
10 hectare @ Rs.30,000/hectare for technological and biological reclamation of the disturbed area, planting of trees & grass.
= Rs.3,00,000 ≈ Rs. 0.3 million

2. 4 STPs & SPS
15 hectare @ Rs.30,000/hectare
= Rs. 4,50,000 ≈ Rs. 0.45 million

3. Training of Environmental Officers
= Rs.15,00,000 ≈ Rs. 1.5 million
Total = Rs. 2.25 million

This Cost Estimate does not include:

i) The environmental monitoring.
ii) Land acquisition costs

iii) Excavating and closing of trenches, soil compaction and relaying of roads.

These items are included in project costs.

1.5 PROJECT IMPLEMENTATION

1.5.1 Contract Packages

The proposed Allahabad Sewerage and Sewage Treatment System will require multi-disciplinary construction. It also will require specialized construction agencies for execution of some of the schemes. The project consists of the following construction works:

1. Supply and laying of new Trunk Sewer Lines and Rising Mains
2. Desilting of existing Trunk Mains
3. Replacement of existing Trunk Mains
4. Construction of New Pump House
5. Replacement of Pumps and upgradation of existing Pump Houses
6. Supply and installation of Mechanical Equipments in Pump Houses
7. Construction of Sewage Treatment Plants based on Waste Stabilization Pond Technology
8. Construction of Sewage Treatment Plants based on UASB Process Technology
9. Upgradation of Naini Sewage Treatment Plant

In view of the different nature of works, it has been recommended to divide the construction works into the following packages:

Table 1.18 Construction Works

1.	**Supply and laying of new Trunk Sewer Lines and Replacement of Existing Trunk Mains**:
	Sufficient number of experienced construction agencies are available within the country for such works. Hence, construction bids can be invited from amongst pre-qualified bidders. While pre-qualifying the parties, some important points to be considered are experience of the parties in working on congested city roads, availability of dewatering system, experience in providing diversion facilities for the traffic, protection of existing structures in deep excavation areas etc. In most cases, sufficient space is not available within the right of way of PWD roads for laying new lines. Hence, new pipes are to be laid along the same alignment as the existing pipeline. As a sufficient number of experienced firms are available for such works, this could be an open bid. As in other packages, traffic diversion plans will be very important. Special care should be taken in the deep excavation area and necessary protection to the existing structures should be provided.
2.	**Construction of New Pump Stations and Rising Mains:**
	There are two new Pump Houses to be constructed namely at Ghaghar Nala and Sasur Khaderi. For construction of Pump Houses, it is always advisable to first short-list the pump suppliers and a combined bid may be invited for all the pumps in the two pump houses. The advantage of this procedure is that all the pumps and motors will be of the same make. The spare parts requirement will also be streamlined in view of the above. The pump manufacturer can propose an associate construction agency to carry out the civil works. However, it is to be noted that sewage pump houses generally require deep excavation and RCC construction works. The associate civil construction company should have sufficient experience in such works. Special care should also be taken to avoid any damage to the existing structures.
3.	**Construction of Sewage Treatment Plants:**

	There are two sewage Treatment Plants viz. Numaya Dahi (50 mld) and Ponghat (10 mld) based on WSP process. These projects will require large amount of excavation work where mechanical excavation will be required. Hence it is important that instead of inviting bids from specialized Public Health Engineering contractors, the bid should be invited among experienced civil construction companies having sufficient manpower and machinery for large excavation works. The ponds are being lined with LDPE sheets and the contractor either should have their own capacity in LDPE work or they can associate with another firm to carry out the same. Uttar Pradesh is the first State in India which had Sewage Treatment Plant constructed based on UASB Technology. U.P has also built a number of UASB plants under Yamuna Action Plan Phase I. Hence, UPJN has sufficient experience in construction and operation of UASB Plants. Further, a number of Indian construction companies specialize in UASB Plants design and construction. Hence bids could be invited from the experienced bidders for the construction of proposed UASB Plant at Kodara (15 mld) and Rajapur (65 mld). Further, Rajapur site will require extensive work of construction of bund to protect the site from high flood level of river Ganga. Geo-synthetic work will be required for the construction of bund for which association of a specialized agency will also be required. Hence, this work should be eliminated from the scope of the contractor for construction of Sewage Treatment Plant and a separate bid should be invited.
4.	**Desilting of Existing Trunk Mains:**
	CCTV survey and cleaning of existing sewers will be taken up under the scope of this package. It has been noted that existing sewers have around 50% deposition. Hence, cleaning of sewers is to be carried out with care. A number of Indian agencies in association with overseas companies are carrying out similar jobs in various metropolitan cities.
5.	**Replacement and Upgradation of Existing Pump Station:**
	Replacement of the old pumps will be required for Mumfordganj and Alopibagh Pump Houses. Additional pumps will be installed in Allahpur Pumping Station. Along with the pumps, necessary electro-mechanical works are also to be carried out. A bid could be invited among the pump manufacturers for this package.
6.	**Upgradation and Extension of Naini Sewage Treatment Plant:**
	A large number of specialized agencies with sufficient expertise are available within the country for execution of works under the package. However, it is recommended that a specialized agency be appointed to prepare tenders as due thought will have to be given to rectify the shortcomings in the existing plant as well as integrating the solids stream of the new 20 mld plant with that of the existing plant.

While formulating the above process of implementation of various packages, it has been decided that an Engineering Consultant will be engaged to carry out all the engineering works. The construction agency will carry out all works as per the approved drawings to be issued by Govt. of U.P. for construction of the project. The entire project can be summarized as below:

Table 1.19 Summary of Implementation Activities

Sr. No.	Name of the Works	Estimated Cost (In Million Rupees)
1.	Installation and replacement of Trunk Sewers	249.0
2.	Construction of New Sewage Pumping Stations	158.6
3.	Construction of New Sewage Treatment Plants	1,080.3
4.	Desilting of existing Trunk Sewers	37.9
5.	Rehabilitation of existing Trunk Sewers	120.4
6.	Upgradation of existing Sewage Pump Stations	261.9
7.	Up gradation of Naini Sewage Treatment Plant	151.6
	Total	2,059.8

(1) Implementing Agency

For effective and timely implementation of the project, it is recommended that an independent and autonomous Project Management Unit (PMU) be created under the Department of Urban Development. This should be headed by a Project Director not below the rank of Joint Secretary or in the rank of a Chief Engineer. The PMU should have independent project officers (preferably in the rank of Superintending Engineers) to manage and monitor the progress of the Project in the four sewerage districts.

This PMU would have an administrative, financial and support service unit. The unit would administer and maintain project activities, develop project database, release funds etc. The PMU would be further responsible for liaison with other State Government departments and would be supported by an officer in this regard. This official would also assist in developing the institutional linkages and in carrying out combined HRD activities. The PMU would be guided by a high level Steering Committee, which would be represented by Chief (Secretary/Additional Secretary) of Department of Urban Development and include representatives of Department of Housing, Department of Urban Environment and Poverty Alleviation, Department of Environment (UP Pollution Control Board), Department of Industries etc. The Steering Committee would oversee the project progress and would make necessary policy recommendations for the timely implementation of the project.

However, for review, appraisal and approval of various projects (which would be mostly technical in nature) there would be a strong need for technical and management expertise. It is suggested to have additional support in form of consultants: The consultants could play a part at two different levels: One consultant/ group of consultants would look after the detailed engineering designs (Design Consultants) and the second group would look after the project management (PMC Consultant).

The design consultants would be responsible for preparing detailed engineering reports (including cost estimates) and tender contracts of various projects to be undertaken. Whereas, the role of PM Consultant would be two fold: First, it would develop a project management plan in consultation with PMU and would manage and monitor its implementation. Secondly, it would support institutional development and HRD activities.

This is necessary because, when both design and project management consultants leave the Project after a specified period, they would have supported in creating an institutional set-up (organisations, linkages, policies etc.) supporting the project operation. Further, the officials of concerned organisations (Jal Sansthan etc.) would have developed sufficient competencies in managing the Project not only in day to day operations but in design, financial analysis, contract supervisions etc. so that project could be made sustainable in the long run.

The project implementation framework as outlined above has been used successfully in the implementation of Urban Development Projects carried out under multilateral funding, in the states of Karnataka, Rajasthan etc.

1.5.2 Recommendations for O&M

Detailed recommendations for setting up of O&M organizational report and O&M practices are set out in the O&M report. The salient points are reproduced here:

- Reorganisation of the Institutions involved at the State level in order to provide single point responsibility, preferably with the Jal Sansthan, under the local municipality.
- To earmark funds for maintenance out of the tax revenues.
- To increase / levy cess to generate funds, in order to achieve long term financial sustainability
- Improvement of O&M practices – regular, planned and pro-active maintenance of all facilities.
- Acquisition of modern sewer cleaning tools and machines

- Training of personnel at worker and managerial level
- Creation of a computerized GIS based database of all existing and planned facilities
- Regular monitoring of performance of all SPS and STPs by creation of an Environmental Monitoring Group
- Creation of sinking funds for replacement of mechanical equipment
- Contracting out of STP operation

1.5.3 Private Sector Participation

Private Sector's participation would be necessary in the project implementation stage, in the transition phase while the GoUP and its agencies build managerial and worker capacity. It can also make good sense economically during the operation phase, particularly in respect to some specialized jobs as listed later in this section.

Even if it is decided to let some tasks out to another public agency or to private sector contractors**,** the Sewerage Authority should always retain overall responsibility for and should closely control and supervise the work carried out by others, and so it will still require competent managers and supervisors.

In view of the above discussion, it is recommended that at least the following activities be contracted out to specialized agencies:

- CCTV inspection of sewers
- De-silting of sewers
- Creation of a computerized, GIS based, asset inventory
- Design and Project Management of works under the project
- Construction of works under the project
- O&M of STPs
- Rehabilitation of sewers

The design and construction of new facilities would of course be carried out by specialized agencies, under UPJN/UPJS's supervision. However, it is recommended that the project implementation be carried out as recommended in item 1.4.2 (2) with the aid of consultants.

O&M of the Numaya Dahi and Ponghat STPs, based on WSP technology, could be carried out by GoUP. For Kodara and Rajapur STPs, O&M could possibly be contracted out, by implementing these STPs under a Design-Build-Operate scheme, with a 5-10 year O&M period built into the construction contract itself.

CHAPTER 2

PROVISIONS FOR DISTRICT A

CHAPTER 2 PROVISIONS FOR DISTRICT A

2.1 INTRODUCTION

2.1.1 General

Sewerage District A covers the densely populated central core of the city and has a well developed existing sewerage system. It drains into the Yamuna, which forms its southern boundary. The total length of existing sewers in the district is 10.95 km, with sizes ranging from 0.3m diameter to 1.2m x 1.4m. Except for a small stretch of 2.13 km along the Mahatma Gandhi Marg, where concrete sewers have been laid, all other sewers are brick sewers.

Gaughat SPS, which is the main pumping station in Allahabad, lies in District A. Almost the entire waste water of Allahabad converges towards this SPS which pumps the waste water to the existing 60 mld STP at Naini. Chachar Nala SPS also lies in District A. It taps the Chachar Nala.

2.1.2 Population

The present and estimate future population in Master Plan for District A is as follows:

Table 2.1 Population of District A

Year	Population within Municipal Area	Population outside Municipal Area	Floating Population	Total
2003	368,007	-	5,763	373,770
2015	425,188	-	7,209	432,397
2030	494,279	-	9,190	503,469

2.1.3 Present and Future Wastewater Flows

The flows as given in the Master Plan, are reproduced in Table 2.2.

Table 2.2 Present and Estimated Future Wastewater Flows by Sub-catchment in District A

District	Sub-Catchment	Resident									Floating			Total		
		Inside of Municipality			Outside of Municipality			Total								
		2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030
District A	A-1	3.64	4.53	6.23	0.00	0.00	0.00	3.64	4.53	6.23	0.06	0.08	0.12	3.70	4.60	6.34
	A-2	1.51	1.89	2.63	0.00	0.00	0.00	1.51	1.89	2.63	0.02	0.03	0.05	1.53	1.93	2.67
	A-3	1.39	1.57	1.85	0.00	0.00	0.00	1.39	1.57	1.85	0.02	0.03	0.03	1.41	1.60	1.88
	A-4	6.69	5.87	5.33	0.00	0.00	0.00	6.69	5.87	5.33	0.10	0.10	0.10	6.80	5.97	5.43
	A-5	10.66	9.37	8.59	0.00	0.00	0.00	10.66	9.37	8.59	0.17	0.16	0.16	10.82	9.53	8.75
	A-6	5.54	6.13	6.64	0.00	0.00	0.00	5.54	6.13	6.64	0.09	0.10	0.12	5.62	6.23	6.76
	A-7	1.57	1.38	1.27	0.00	0.00	0.00	1.57	1.38	1.27	0.02	0.02	0.02	1.59	1.40	1.29
	A-8	6.24	5.48	5.02	0.00	0.00	0.00	6.24	5.48	5.02	0.10	0.09	0.09	6.33	5.57	5.11
	A-9	1.99	1.74	1.58	0.00	0.00	0.00	1.99	1.74	1.58	0.03	0.03	0.03	2.02	1.77	1.61
	A-10	12.78	12.56	12.92	0.00	0.00	0.00	12.78	12.56	12.92	0.20	0.21	0.24	12.98	12.78	13.16
	A-11	4.21	4.61	4.88	0.00	0.00	0.00	4.21	4.61	4.88	0.07	0.08	0.09	4.27	4.69	4.97
	A-12	3.38	2.98	2.73	0.00	0.00	0.00	3.38	2.98	2.73	0.05	0.05	0.05	3.43	3.03	2.78
	A-13	8.35	8.87	9.34	0.00	0.00	0.00	8.35	8.87	9.34	0.13	0.15	0.17	8.49	9.02	9.51
	A-14	7.50	7.42	7.64	0.00	0.00	0.00	7.50	7.42	7.64	0.12	0.13	0.14	7.62	7.55	7.78
	Sub Total	75.44	74.41	76.61	0.00	0.00	0.00	75.44	74.41	76.61	1.18	1.26	1.42	76.62	75.67	78.04

2.1.4 Existing and Proposed Sewerage Pattern

The trunk sewers of the area drain into the Gaughat SPS which also receives the wastewater of Districts D via two rising mains from Alopibagh SPS which in turn receives flows from Mumfordganj, Daraganj and Allahpur SPS, all of which lie in District D. A portion of District B drains into the Gaughat SPS from the 54" trunk sewer, which carries sewage, pumped from Lukerganj SPS located in district B. Hence, the sewage flowing into Gaughat SPS is much more than the treatment capacity of the Naini STP and the sewage overflows into the Yamuna untreated. The Gaughat SPS pumps an average of 66 mld to the Naini STP located on the right bank of the Yamuna.

In the proposed system, the sewage from Alopibagh will be diverted to Mumfordganj SPS. Flow from Lukerganj SPS will be diverted to the new proposed Ghaghar Nala SPS in district B. Hence, Gaughat will receive flow only from the catchment consisting of District A. This is expected to be below 80 mld till 2030. The Naini STP will be augmented to treat 80 mld flow. In this manner, overflows from Gaughat are proposed to be eliminated.

2.1.5 Proposed System

The proposed augmentation/ new construction measures, under priority projects, for this district are:

- Desilting of existing trunk sewers – 5.40 km
- Rehabilitation of existing trunk sewers – 1.34 km
- Replacement of existing trunk sewers – 5.55 km
- Construction of new trunk sewers – 4.006 km
- Rehabilitation of Chachar Nala SPS
- Rehabilitation of Gaughat Nala SPS
- Augmentation of Naini STP capacity to 80 mld

2.1.6 Cost Summary

Summary of cost has been given in Table 2.3.

Table 2.3 Summary of Estimated Project Cost (District A)

	Item	Capital Cost (Million Rs.)	Annual O&M cost (Million Rs./year)
1	Branch Sewers		
	Sub total	**0.00**	**0.00**
2	Trunk Sewers - new		
2.1	GT Road (Node 4-5-7)	22.44	0.11
2.2	Salik Ganj (Node 8-15-Gaughat PS)	11.14	0.06
2.3	S.K. Dey (Node 11-12-Saukat Ali Marg)	6.09	0.03
	Sub total	**39.67**	**0.20**
3	Trunk Sewer – replace		
3.1	Node 10-12	6.46	0.03
3.2	Node 12-12A-13	21.41	0.11
3.3	Node 1-1A-2	13.90	0.07
3.4	Node 2-2A-3	6.63	0.03
	Sub total	**48.40**	**0.24**
4	Trunk Sewer- rehabilitate		
4.1	Node 3-7	46.92	0.23
4.2	Node 9-10	1.85	0.01
4.3	Node 13-Gaughat PS	73.49	0.37

	Item	Capital Cost (Million Rs.)	Annual O&M cost (Million Rs./year)
4.4	Node 14-15	2.61	0.01
4.5	Node 6-7-Gaughat PS	11.49	0.06
	Sub total	**136.36**	**0.68**
5	Rising Mains		
	Sub total	**0.00**	**0.00**
6	Pumping Stations - new		
	Sub total	**0.00**	**0.00**
7	Pumping Station – improved		
7.1	Chachar Nala PS	16.82	2.80
7.2	Gaughat PS	28.10	14.65
	Sub total	**44.92**	**17.45**
8	Treatment Plants – new		
	Sub total	**0.00**	**0.00**
9	Treatment Plants – improved		
	Sub total	**151.63**	**21.86**
	Direct Construction Cost (Total)	**420.98**	**40.43**

2.2 EXISTING SYSTEM DESCRIPTION

2.2.1 General

The existing sewerage system in District A is well developed and consists of the following:

- 10.95 km of trunk sewers – only 2.13 km stretch is of concrete pipes, rest are brick sewers.
- Gaughat SPS, peak capacity – 160 mld.
- Chachar Nala, peak capacity – 57 mld.
- 60 mld Naini STP. (Although the physical location of Naini STP is in District G, it is being considered here as it will, on implementation of the MP, treat flows from District A only.)

2.2.2 Existing Trunk Sewers

(1) Summary of Replacement / Desilting / Rehabilitation Cost of Sewer

Table 2.4 Summary of Trunk Sewer (Replacement / Desilting / Rehabilitation Cost)

Pipe Line No.	Node No.	Road	From	To	Cost (Million Rs.)				
					Replace	Desilting	CCTV Inspection	Rehabili.	Total
EA1	1-1A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	13.90	-	-	-	13.90
	1A-2	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing					
	2-2A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	6.63	-	-	-	6.63
	2A-3	Lala Sitaram Road	High Court Chowk	Rambagh Level Crossing					
EA2	6-7	GT Road	Baiharna Chowk	Gaughat PS	-	10.76	0.73	-	11.49
	7-Gaughat PS	Lauder Road	Baiharna Chowk	Gaughat PS					
EA3	3-7	Lala Sitaram Road	Rambagh Level Crossing	Kotha Parch Chowk	-	1.18	0.25	45.49	46.92
EA4	14-15	SL& ML Bhargava Road	Krishna Nagar	Gaughat PS	-	2.28	0.33	-	2.61
EA5	10-12	Shaukat Ali Marg	Atarsuiya	Gaughat PS	6.46	-	-	-	6.46
	12-12A	Shaukat Ali Marg	Atarsuiya	Gaughat PS	21.41	-	-	-	21.41
	12A-13	Shaukat Ali Marg	Atarsuiya	Gaughat PS					
	13-PS	Yamuna Road	Atarsuiya	Gaughat PS	-	3.48	0.28	69.73	73.49
EA6	9-10	Nurullah Road	-	-	-	1.61	0.24	-	1.85
Total					48.40	19.31	1.83	115.22	184.76

(2) Sewer Details

The line-wise details of the existing sewers are as follows:

Table 2.5 Details of Existing Sewers in District A

Pipe Line No.	Node No.	Road	From	To	Surveyed data			Master Plan data		
					Dia/ Size (M)	Length (m)	Material	Dia/ Size (M)	Length (m)	Material
EA1	1-1A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.30	1591.38	Concrete	0.70	2200	-
	1A-2	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.50	541.65	Concrete			
	2-2A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.60	916.61	Brick Masonry	0.70	1650	-
	2A-3	Lala Sitaram Road	High Court Chowk	Rambagh Level Crossing	0.60	649.44	Brick Masonry			
EA2	6-7	GT Road	Baiharna Chowk	Gaughat PS	1.0x1.15	1,504	Brick Masonry	0.70	1500	-
	7-Gaughat PS	Lauder Road	Baiharna Chowk	Gaughat PS	1.0x1.15	791.84	Brick Masonry	1.4	800	-
EA3	3-7	Lala Sitaram Road	Rambagh Level Crossing	Kotha Parch Chowk	0.70	784.32	Brick Masonry	0.61	700	-
EA4	14-15	SL& ML Bhargava Road	Krishna Nagar	Gaughat PS	0.9x0.6	1036	Brick Masonry	0.61	1350	-

Pipe Line No.	Node No.	Road	From	To	Surveyed data			Master Plan data		
					Dia/ Size(M)	Length (m)	Material	Dia/ Size(M)	Length (m)	Material
EA5	10-12	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x0.6	496.99	Brick Masonry	0.90	750	-
	12-12A	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x1.2	386.39	Brick Masonry	1.20	1050	-
	12A-13	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x1.2	649.59	Brick Masonry			
	13-PS	Yamuna Road	Atarsuiya	Gaughat PS	1.2x1.4	871.65	Brick Masonry	1.40	850	-
EA6	9-10	Nurullah Road	-	-	0.9x0.6	732.23	Brick Masonry	0.559	300	-

(3) Line-wise Condition Survey Data and Data Analysis

1) Summary

Table 2.6 Summary of Condition Survey for Existing Sewers, District A

Pipe Line No.	Node No.	Road	From	To	Sewer Details									Ref. Sheet Nos.
					Dia/Size (M)	Length (m)	Material	Slope			Silting (%)			
								Min	Max	Avg.	Min	Max	Avg.	
EA1	1-1A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.30	1591.38	Concrete	1 in 985.05	1 in 98.33	1 in 265.27	11	57	43	69-70 -71
	1A-2	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.50	541.65	Concrete	1 in (-ve) 498.62	1 in 768.43	1 in 485.78	21	44	30	71-72
	2-2A	Mahatma Gandhi Marg	High Court Chowk	Rambagh Level Crossing	0.60	916.61	Brick Masonry	1 in 1910.2	1 in 52.24	1 in 164.71	9	37	16	72-73
	2A-3	Lala Sitaram Road	High Court Chowk	Rambagh Level Crossing	0.60	649.44	Brick Masonry	1 in 5041	1 in 140.89	1 in 662.69	22	50	35	74
EA2	6-7	GT Road	Baiharna Chowk	Gaughat PS	1.0x1.15	1504	Brick Masonry	1 in 10706	1 in 76.9	1 in 1915.9 2	18	69	37	75-76 -77
	7-Gaug hat PS	Lauder Road	Baiharna Chowk	Gaughat PS	1.0x1.15	791.84	Brick Masonry	1 in 4368.6	1 in 137.66	1 in 891.71	15	37	27	77-78
EA3	3-7	Lala Sitaram Road	Rambagh Level Crossing	Kotha Parch Chowk	0.70	784.32	Brick Masonry	1 in 7491.8	1 in 166.4	1 in 392.75	15	83	46	79-80
EA4	14-15	SL& ML Bhargava Road	Krishna Nagar	Gaughat PS	0.9x0.6	1036	Brick Masonry	1 in 3129.5	1 in 399	1 in 800.62	9	70	36	81-82

Pipe Line No.	Node No.	Road	From	To	Sewer Details									Ref. Sheet Nos.
					Dia/Size (M)	Length (m)	Material	Slope			Silting (%)			
								Min	Max	Avg.	Min	Max	Avg.	
EA5	10-12	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x0.6	496.99	Brick Masonry	1 in 3029.3	1 in 182.23	1 in 581.96	16	37	28	83-84
	12-12A	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x1.2	386.39	Brick Masonry	1 in 27645	1 in 331.9	1 in 1174.4 4	12	42	27	84
	12A-13	Shaukat Ali Marg	Atarsuiya	Gaughat PS	0.9x1.2	649.59	Brick Masonry	1 in 2444.8	1 in 94.66	1 in 280.36	8	44	18	84-85
	13-PS	Yamuna Road	Atarsuiya	Gaughat PS	1.2x1.4	871.65	Brick Masonry	1 in 4550.4	1 in 41.97	1 in 549.94	5	29	17	86-87
EA6	9-10	Nurullah Road	-	-	0.9x0.6	732.23	Brick Masonry	1 in 1353.1	1 in 29.43	1 in 234.54	14	100	85	88-89

2) EA1

EA1 (High Court Chowk to Rambagh Level Crossing)

Node 1-1A (EA1/1 to EA1/28): (Avg. slope 265.67, Avg. discharge capacity 3.83 mld, Estimated design discharge for 2030, 15.81 mld)
Discharge capacity in this stretch is very low compared to design discharge given in Master Plan; hence it requires replacement at average slope of this existing sewer line.
(Ref. Sheet No. 69, 70, 71)

Node 1A-2 (EA1/28 to EA1/36): (Avg. slope 485.78, Avg. discharge capacity 11.05 mld, Estimated design discharge for 2030, 15.81 mld)
Discharge capacity in this stretch is low compared to design discharge given in Master Plan; hence it requires replacement at average slope of this existing sewer line.
(Ref. Sheet No. 71, 72,)

Node 2-2A (EA1/36 to EA1/50): (Avg. slope 164.71, Avg. discharge capacity 30.86 mld, Estimated design discharge for 2030, 20.22 mld)
Only two-three stretches are efficient to carry design discharge, remaining all do not fulfill the requirement that given in Master Plan, hence it requires replacement at average slope of this existing sewer line.
(Ref. Sheet No. 72, 73)

Node 2A-3 (EA1/50 to EA1/59): (Avg. slope 662.69, Avg. discharge capacity 15.38 mld, Estimated design discharge for 2030, 20.22 mld)
Almost all stretches have lower discharge capacity than design discharge; hence it requires replacement at average slope of this existing sewer line.
(Ref. Sheet No. 74)

3) EA2

EA2 **(Baiharna Chowk to Gaughat PS)**

Node 6-7 (EA2/1 to EA2/27): (Avg. slope 1915.92, Avg. discharge capacity 50.39 mld, Estimated design discharge for 2030, 16.85mld)
Slight slope variations have been found but all stretches are most efficient to carry design discharge for the year 2030. This line needs desilting and CCTV inspection to carry the discharge.
(Ref. Sheet No. 75, 76, 77)

Node 7-Gaughat PS (EA2/27 to Gaughat PS): (Avg. Slope 891.71, Avg. discharge capacity 115 mld, Estimated design discharge for 2030, 74.48 mld)
Slight slope variations have been found but all stretches are efficient to carry design discharge for the year 2030. This line needs desilting and CCTV inspection to carry the discharge.
(Ref. Sheet No. 77, 78)

4) EA3

EA3 **(Rambagh Level Crossing to Kotha Parch Chowk)**
Node 3-7 (EA3/1 to EA3/14): (Avg. Slope 392.75, Avg. discharge capacity 30.14 mld, Estimated Design discharge for 2030, 24.54 mld)
Some of the stretches have random slope therefore, inefficient to carry design discharge for the year 2030. Almost all stretches have sufficient discharge capacity but slope is varying, hence this line needs replacement. However as per UPJN, replacement of sewer is not possible in this stretch, hence rehabilitation is being considered in this report.

(Ref. Sheet No. 79, 80)

5) EA4

EA4 **(Krishna Nagar to Gaughat PS)**
Node 14-15 (EA4/1 to Gaughat PS): (Avg. slope 800.62, Avg. discharge capacity 29.32 mld, Estimated design discharge for 2030, 17.53 mld)
Except two stretches, all stretches are efficient to carry design discharge for the year 2030, those two stretches will flow 90% full flow. This line needs desilting and CCTV inspection.
(Ref. Sheet No. 81, 82)

6) EA5

EA5 **(Atarsuiya to Gaughat PS)**

Node 10-12 (EA5/40 to EA5/32): (Avg. slope 581.96, Avg. discharge capacity 32.33 mld, Estimated design discharge for 2030, 33.26 mld)
Many stretches are inefficient to carry design discharge for the year 2030; however, some stretches have sufficient discharge capacity but are in between the inadequate stretches regarding slope and design discharge. Hence this line needs replacement to have adequate discharge.
(Ref. Sheet No. 83, 84)

Node 12-12A (EA5/32 to EA5/26): (Avg. slope 1174.44, Avg. discharge capacity 58.23 mld, Estimated design discharge for 2030, 50.72 mld)
All stretches have random slope and many of these are inefficient to carry design discharge for the year 2030, however, some stretches have sufficient discharge capacity but are in between the inadequate stretches regarding slope and design discharge. Hence this line needs replacement to have adequate discharge.
(Ref. Sheet No. 84)

Node 12A-13 (EA5/26 to EA5/13): (Avg. slope 280.36, Avg. discharge capacity 119.19 mld, Estimated design discharge for 2030, 50.72 mld)
All stretches have random slope and some of these are inefficient to carry design discharge for the year 2030, however, some stretches have sufficient discharge capacity but are in between the inadequate stretches regarding slope and design discharge. Hence this line needs replacement to have adequate discharge.
(Ref. Sheet No. 84, 85)

Node 13-Gaughat PS (EA5/13 to Gaughat PS): (Avg. Slope 549.94, Avg. discharge capacity 155.67 mld, Estimated Design discharge for 2030, 72.14 mld)
Some of the stretches have random slope therefore, inefficient to carry design discharge for the year 2030. Almost all stretches have sufficient discharge capacity but slope is varying, hence this line needs replacement. However as per UPJN, replacement of sewer is not possible in this stretch, hence rehabilitation is being considered in this report.
(Ref. Sheet No. 85, 86, 87)

7) EA6

EA6 **(Nurullah Road)**

Node 9-10 (EA6/1 to EA6/27): (Avg. slope 234.54, Avg. discharge capacity 54.17 mld, Estimated design discharge for 2030, 4.92 mld)
All stretches have sufficient discharge for the year 2030, slope is also some how adequate except some, which are efficient to carry design discharge.

(Ref. Sheet No. 88, 89)

(4) Recommendations

Table 2.7 Summary of Replacement / Desilting Requirements for District A

Pipe Line No.	Node No.	Road	Structural Condition of sewer	Existing Sewer										Design Dis-charge in 2030 (mld)	Proposed		
				Dia/Size (m)	Length (m)	Material	Slope			Silting (%)			Avg. Discharge Capacity (mld)		Proposal	Dia/ Size (M)	Slope
							Min	Max	Avg.	Min	Max	Avg.					
EA1	1-1A	Mahatma Gandhi Marg	Poor	0.30	1591.38	Concrete	1 in 985.05	1 in 98.33	1 in 265.27	11	57	43	3.83	15.81	Replace	0.60	1 in 265.27
	1A-2	Mahatma Gandhi Marg	Poor	0.50	541.65	Concrete	1 in (-ve) 498.62	1 in 768.43	1 in 485.78	21	44	30	11.05	15.81	Replace	0.60	1 in 485.78
	2-2A	Mahatma Gandhi Marg	Poor	0.60	916.61	Brick Masonary	1 in 1910.24	1 in 52.24	1 in 164.71	9	37	16	30.86	20.22	Replace	0.60	1 in 164.71
	2A-3	Lala Sitaram Road	Poor	0.60	649.44	Brick Masonary	1 in 5041	1 in 140.89	1 in 662.69	22	50.00	35	15.38	20.22	Replace	0.70	1 in 662.69
EA2	6-7	GT Road	Poor	1.0x1.15	1504	Brick Masonary	1 in 10706	1 in 76.9	1 in 1915.92	18	69	37	50.39	16.85	Desilting + CCTV	-	-
	7-Gaughat PS	Lauder Road	Poor	1.0x1.15	791.84	Brick Masonary	1 in 4368.57	1 in 137.66	1 in 891.71	15	37	27	115	74.48	Desilting + CCTV	-	-
EA3	3-7	Lala Sitaram Road	Poor	0.70	784.32	Brick Masonary	1 in 7491.82	1 in 166.4	1 in 392.75	15	83	46	30.14	24.54	Rehabilitation	0.70	1 in 392.75
EA4	14-15	SL& ML Bhargava Road	Poor	0.9x0.6	1036	Brick Masonary	1 in 3129.5	1 in 399	1 in 800.62	9	70	36	29.32	17.53	Desilting + CCTV	-	-
EA5	10-12	Shaukat Ali Marg	Poor	0.9x0.6	496.99	Brick Masonary	1 in 3029.35	1 in 182.23	1 in 581.96	16	37	28	32.33	33.26	Replace	0.80	1 in 581.96
	12-12A	Shaukat Ali Marg	Poor	0.9x1.2	386.39	Brick Masonary	1 in 27645	1 in 331.9	1 in 1174.44	12	42	27	58.73	50.72	Replace	1.20	1 in 1174.44
	12A-13	Shaukat Ali Marg	Poor	0.9x1.2	649.59	Brick Masonary	1 in 2444.80	1 in 94.66	1 in 280.36	8	44	18	119.19	50.72	Replace	1.20	1 in 280.36
	13-PS	Yamuna Road	Poor	1.2x1.4	871.65	Brick Masonary	1 in 4550.4	1 in 41.97	1 in 549.94	5	29	17	155.67	72.14	Rehabilitation	1.20	1 in 549.94
EA6	9-10	Nurullah Road	Poor	0.9x0.6	732.23	Brick Masonary	1 in 1353.14	1 in 29.43	1 in 234.54	14	100	85	54.17	4.92	Desilting + CCTV	-	-

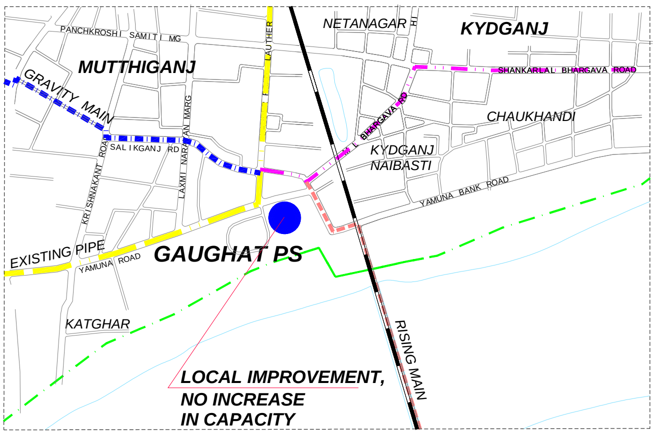
(5) Cleaning and Inspection Methods

The method recommended is:

- An initial CCTV survey of lines EA2, EA4 and EA6 should be carried out to get a better understanding of the structural condition of the sewers and to decide the desilting method to be used.
- The desilting should be carried out by the jetting / vacuum machines. For larger sized sewers, the cost economics of using a jetting machine v/s using an auger based machine can be worked out, another consideration would be the amount of water required for cleaning the large sewers.
- A final CCTV survey should be carried out to check the results of the desilting operation.

2.2.3 Existing Pumping Stations and STP

(1) Gaughat Pumping Station



LOCATION PLAN

<u>Preamble</u>

Inlet Chamber at Gaughat SPS

Garbage at Inlet Chamber – Gaughat SPS

Mechanical Coarse Screen at Gaughat SPS – Non Functional

Wet Sump – Gaughat SPS

Gaughat main pumping station is located on the left bank of Yamuna River near the Yamuna Bridge (Ref Drg. Sheet No. 116A). It was commissioned in the year 1988. It has an average pumping capacity of 80 mld and peak capacity of 160 mld with 50% stand-by. At present this pumping station receives almost the entire volume of sewage collected by the sewerage system in Allahabad.

Upon implementation of the scheme proposed in the Master Plan, this pumping station will receive only the waste water generated in District A, including the wastewater intercepted at Chachar nala SPS.

<u>Existing System and Status of E&M Equipment</u>

- Wet Sump

Table 2.8 Wet Sump of Gaughat Pumping Station

Capacity (m^3)	Retention Time (In Minutes)		Adequate	Additional Sump (m^3)
	Avg. flow	Peak flow		
185*	3.2	1.6	Inadequate	332

* As per Handing Over note of assets created under Ganga Action Plan, provided by UPJN to the consultants.

- Pumps and Motors

Table 2.9 Pumps and Motors of Gaughat Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Pump Make	Motor capacity (kW)	Motor Type	Pipe Dia (mm)	
							Suction	Delivery
616.67	35	5	VNC	Jyoti	312	Sq. Cage TEFC	600	500

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

- Dry Sump

  The dry sump houses the pumps and motors on different level. The pump floor level is at 75.05 R.L. and the motor floor level is at 85.4 R.L.

- Rising main

  900 mm and 700 mm dia L = 1,500 m up to Naini STP.

- Electrical System

  1. Incoming Supply - The electric supply is taken through a cable from sub station distribution system of UPPCL at high voltage of 11kV for operation of the pumping station.
  2. Distribution Panel at 3.3 kV - Three incoming Oil Circuit Breakers and five outgoing feeders for operation of the five existing pumps are provided through protective switch gears.
  3. Cables – PVC insulated and PVC sheathed armoured cable.
  4. Starters - Star delta / ATS starters are provided for starting the pumps.
  5. Two DG sets – 1000 kVA and 500 kVA capacity, one each are available as stand by power.
  6. Five Nos liquid rotor starters
  7. Three transformers of 800 kVA and 11 / 3.3 kV each
  8. Shunt type of capacitor bank of 140 kVAR rating.

Future Flows

If the sewerage system is re-organised as indicated in the Master Plan, the average discharge in the year of 2030 will be 74.4 mld and peak capacity 158.8 mld. At present, the station has a total installed capacity of 3,083 lps (266.4 mld) and an allowable pumping capacity of 1,850 lps (159.84 mld) with 3 out of 5 pumps in operation.

Therefore the existing pumping capacity is sufficient for 2030.

Inadequacies of the Existing System

- The extended pump shafts are coupled with each other to provide the drives from the motor to pump, which often go out of alignment and develop vibration in the pump house. While starting of the pumps and during normal full load operation abnormal vibrations develop which results in shaft failure.
- Due to floatings entering in the pump, they develop excessive vibration and heavy torque at the start and results in shaft failure.
- The existing screens have clear openings of 37mm against 20mm is required.

Rehabilitation / Upgradation Proposed

- Replace the two sets of existing bar screens with two sets of Mechanical Bar screen with 20 mm clear distance; conveyor belt shall be provided for both bar screens. The wet sump is full of floating material, which rushes to the suction of the pumps.
- Replacement of 5 no. pumps and motors of same capacity including accessories.
- Auto tripping arrangement.
- Automation of the pumping station is not considered as per the staffing pattern in India.
- Accurate alignment tools are required to minimize the vibration thus ensuring smooth operation of the pumps. Since, shaft diameter is purely based on the recommendations of the manufacturer and alignment is only solution. Strengthening of bearing housing with the structure is required to be increased to counter heavy thrust. Ultrasonic meter are required for proper alignment.
- Since the power is provided from UPPCL sub station, and sub stations are provided power from two sources; hence the 2nd feeder is not proposed.
- Providing of additional sump capacity 370 m^3
- DG sets should be operated under power failure. In case they are not operated, the sewer gets surcharged and sewers back flows, causing insanitation thereby settlement takes place in the System, which chokes the sewerage system.
- The capacity of the pumps is adequate but electro mechanical equipment has out lived its useful life hence needs replacement.
- Replacement of electrical system, HT panels, motor starters etc.
- Renovation and repair of buildings etc.

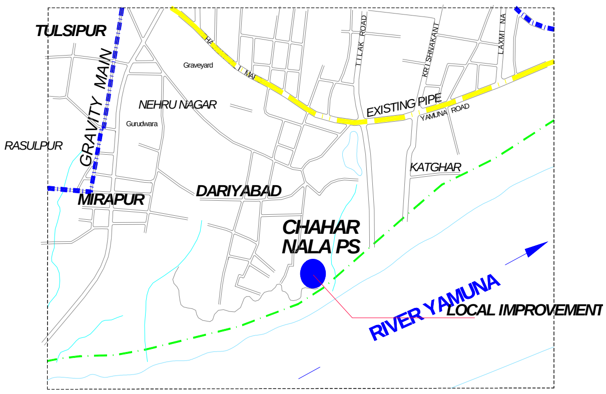
Rehabilitation Cost

The total cost for rehabilitation of Gaughat SPS is Rs. 28.1 million, civil cost is Rs. 3.6 million and E&M cost is Rs. 24.5 million.

Table 2.10 Rehabilitation Cost of Gaughat Pumping Station

	Amount (Rs. thousand)
Civil	3,600
E & M	24,500
Total	28,100

(2) Chachar Nala Pumping Station



LOCATION PLAN

Preamble

This pumping station is situated at the outfall of the Chachar Nala, on the right bank of the Nala. (Ref Drg. Sheet No. 114 and 115). This pumping station was implemented under the Ganga Action Plan (GAP) to intercept the Chachar Nala. The catchment of Chachar Nala is a part of District A. The wastewater is discharged into a sewer leading to the Gaughat Pumping Station.

The P/H has an average pumping capacity of 30 mld and peak capacity of 57 mld. The flow to the P/H in 2003 is 787 lps (68 mld).

The Nala is tapped up stream of the storm water pumping station. The wastewater is carried to the wet sump through a covered channel. There are two parts of wet sump, which are fed through two sluice gates. At the down stream, a regulating gate has been provided to check back flow into Nala during floods in Yamuna River.

Existing System and Status of E&M Equipment

- Wet Sump

Table 2.11 Wet Sump of Chachar Nala Pumping Station

Capacity (m^3)	Retention Time (Minutes)		Adequate	Additional Sump (m^3)
	Avg. flow	Peak flow		
65	3.5	1.4	No	171

- Pumps and Motors

Table 2.12 Pumps and Motors of Chachar Nala Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Pump Make	Motor capacity (kW)	Motor Type
300	17	3	VNC	MM	70	Sq. Cage TEFC
57.8	13	2	VNC	MM	12	Sq. Cage TEFC

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

- Rising main

600 mm and 450 mm dia, Length = 450 m.

- Dry Sump

The dry sump houses the pumps and motors on different level. The pump floor level is at 75.90 RL and the motor floor level is at 89.0 RL.

- Electrical System

Incoming Supply - The electric supply is taken from Over Head Distribution system of UPPCL at high voltage of 11 kV for operation of the pumping station.

1. LT Panel - One incoming SFU and five outgoing feeders for operation of the five existing pumps, provided through protective switch gears.
2. Cables – PVC insulated and PVC sheathed armoured cable.
3. Starters - Star delta / ATS starters are provided for starting the pumps.
4. DG Sets - 63 kVA Diesel Generating Set is available as stand by power.
5. Transformer - 2 Nos 400 kVA transformers.
6. 3 panels HT unit of oil circuit breakers

Future Flows

As per MP, anticipated peak flows from the tributary of Chachar Nala are:

- 787 lps in the year 2003
- 594 lps in the year 2015

- 278 lps in the year 2030

The total installed capacity is 1,016 lps and the allowable discharge with a 50% de-rating is 677 lps.

The present peak flows from the Nala are more than the allowable pumping capacity. Progressive implementation of sewerage improvement programme should result in reduction of flow in the Nala. Therefore the capacities of the pumps are considered adequate and no change is proposed in the pump house and rising mains.

Inadequacies of the Existing System

- No mechanical bar screen
- Removal of screening is not done on regular basis
- Supply of diesel is inadequate and irregular also capacity of DG set is inadequate.
- The stand-by at peak for year 2003 flow is 30% instead of 50%; however, as flow to the P/H is decreasing in future, no augmentation is proposed.
- No dedicated feeders for electric supply
- The existing sump capacity of 65 m^3 provides for a holding time of only 1.4 minutes at peak sewage discharge in 2015 and is considered inadequate even with a reduction in Nala flows. The sump must be enlarged by an additional 171 m^3 by year 2015.

Rehabilitation / Upgradation Proposed

The implementation of sewerage improvements should result in a reduction of nala flows. The present capacity of the SPS meets the requirement. The sump capacity must be enhanced to meet the peak sewage discharge in the year of 2015. Mechanical Bar screens 2 Nos. and Manual bar screens 3 Nos. with necessary sluice gates, channels for diverting the flow are to be provided.

- Out of total 5 no. of pumps, 2 pumps of 57.8 lps have outlived their useful life, hence need immediate replacement. Since other 3 pumps of 300 lps have been installed in GAP II in year 2000 hence they will be replaced in year 2015. (As per CPHEEO manual, useful life of pumps taken as 15 years).
- Auto tripping arrangement
- Replacement of existing 63 KVA DG set with 125 KVA DG set
- DG sets should be operated under power failure. In case they are not operated, the sewer gets surcharged and sewers back flows, causing insanitation thereby settlement takes place in the System, which chokes the sewerage system.
- Replacement of electrical system, HT panels, LT panels, motor starters, transformer etc.
- Renovation and repair of buildings etc.
- Since supply of power is from OH transmission line, hence 2nd feeder is to be laid from the other source so that dedicated power is available. Cost of the same has been taken separately.
- Additional sump of 171 m^3 capacity. Provision of land acquisition and fencing for the same has been considered in the report.

Pump Design for the Year 2015

Since the requirement for the year 2030 is even less than that of the year 2015, no additional pumps are required to upgrade the existing system.

Rehabilitation Cost

The total cost for rehabilitation is Rs. 16.82 million including dedicated electrical feeders. Civil cost is Rs. 2.80 million and E&M cost is Rs. 10.62 million.

Table 2.13 Rehabilitation Cost of Chachar Nala Pumping Station

	Amount (Thousand Rs.)
Civil	2,800
E & M	10,620
Electrical Feeder	3,400
Total	16,820

(3) Existing STP at Naini

The Naini Sewage Treatment Plant receives wastewater from Gaughat SPS through two MS rising mains, one of 900 mm dia. and other of 700 mm dia. These two mains are laid on the old Rail cum Road Bridge. Gaughat SPS is the only source of wastewater to the Naini STP. Hence, whenever the power supply is not available at Gaughat SPS, the STP remains un-operational and as informed by authorities, 8-10 hrs a day power failure is a normal occurrence in Allahabad.

The Plant has been designed for an ultimate capacity of 80 mld based on Activated Sludge Process. Presently three streams (total 60 mld) have been constructed; provision has been kept for an additional stream of 20 mld. Augmentation of the plant from the existing 60 mld to 80 mld can be done by adding a unit of grit removal, primary sedimentation tank, Aeration arrangement for 20 mld and a secondary settling tank of 20 mld. However the other structures have been provided for 80 mld.

The treated effluent from the plant is being utilized for irrigation to the nearby areas and rest is finally discharged into Ganga River down stream of Sangam. However, the treated effluent being utilised for irrigation has a high MPN count. Gas is being generated at present is being flared in the atmosphere even though this could be utilized for power generation.

The plant is being maintained and operated by a private agency on an annual contract basis. However, major repairs are being undertaken by the Ganga Pollution Control Unit of UP Jal Nigam. The monthly expenditure for operation and maintenance comes to about Rs.190,000 while the contractor gives a rebate of Rs. 39,000 for sale of dry sludge; however the supervision is provided by UP Jal Nigam. Major maintenance and replacement is also being undertaken by UP Jal Nigam.

(4) Raw Sewage Quality

Design Values

The Naini STP has been designed for the treatment of raw sewage with BOD5 – 300 mg/l and SS - 600 mg/l.

Actual Values

Data on actual incoming wastewater quality is available from the following sources:

- As per the data available with CPCB, the average BOD and SS figures at Naini inlet for the period July 1999 to March 2002 were 97 (min-max = 43-146) mg/l and 335.6 (min-max = 202-496, with one value of 930 in Dec-01) mg/l respectively.
- As per the data made available to the consultants by UPJN, the corresponding figures for the period March-May (summer months, when wastewater strength is high), 2004, were 110 (min-max = 99-120) and 365 (min-max = 315-392) mg/l.
- As per the data made available to the JICA Study Team by UPJN, the corresponding figures

for the period Jan-02 to March-03 (excluding Aug-02), 2004, were 138.97 (min-max = 130-153) and 379.8 (min-max = 354-400) mg/l.

- Testing of influent, effluent grab samples and samples from other units was carried out by the consultants. The results are as follows:

Table 2.14 Raw Sewage Quality

Plant Unit / Parameters	Influent	Effluent	PST effluent	Sump of recycle sludge P/H	Digested sludge	Aeration tank	Thickener outlet
pH	7.2	7.3	7.1	7.3	7	7.3	7
Temperature (°C)	27	27.5	28	27	26	26	27
BOD	128	34	86	105	58	81	39
COD	271	93	187	213	109	194	84
TSS	38	46	37	747	20,794	183	343
VSS	16	28	23	493	9,352	84	213
Sulphates	50	55	47	44	74	58	15

The following points are noted on an analysis of the above data:

- Data supplied by UPJN is unusually consistent, showing little variation across seasons
- CPCB data exhibits a more normal pattern.
- The average BOD and SS values of incoming wastewater are much less than the designed values.
- SS/BOD ratio is higher than usual, with an average value of 3.28.
- The sample tested by the consultants shows unusually low TSS and VSS; this situation could arise immediately after a long power cut; as the solids in the sewage would tend to settle in the sump.

(5) Treated Effluent Quality

The plant has been designed to achieve a treated effluent quality of BOD – 30 mg/l, SS – 50 mg/l.

CPCB has monitored the performance of Naini STP 22 times between July 1999 and March 2002. As per data published by CPCB, the treated effluent BOD showed significant variation (in excess of 10%) over the discharge requirement (30 mg/l) in 5 out of the 22 samples. Similarly, SS values were significantly higher in 8 of the 22 samples collected and tested. The incidence of failure to meet discharge requirements is thus on the higher side.

However, as per the data supplied by UPJN to the consultants, for March-May, 2004, there was no incidence of violation of desired effluent quality values with regards to SS. BOD values are reported to have exceeded the desired limit only for 4 days in the three months, but even for these 4 days, they remained within +10% of the limits. However, BOD values have not been reported in the data for 14/70 days.

(6) Treatment Process

The Naini STP is based on the Activated Sludge Process. The layout drawing for the plant as received from UPJN, has been digitized (Ref. Drg. Sheet No. 146). The details of existing plant units (sizes and design criteria as available) are given in Table 2.15. No data was available regarding the ILs, TWLs and various other levels. These were measured by the consultant’s survey team and are included in the same table. The photographs of various units are presented here below:

Table 2.15 Data Received for Existing Plant Unit of Naini STP

S. No.	Unit	Nos.	Size	Design Parameters	Detention Time	Rem	Top Level	E. Water Level	I.L.	Water Depth	Depth - F.B.
				Surface loading / any other							
1	Collection Chamber	1	4.5 x 8 x 4.1		1 min		89.098	88.011	82.311	5.7	6.287
2	Grit Chamber	3	4.65 x 4.65 x 3.2	1300 $m^3/day/m^2$ at 10 deg C	1 min	1.1 m total depth as per levels taken	88.703	88.03	87.53	0.5	0.873
3	PST	3	31.0 m dia	28 $m^3/day/m^2$ at average 60 m3/day/m2 at peak	2.49 hrs.		87.164	86.443	83.243	3.2	3.621
4	Aeration Tank	3	17.8 x 16.6	F/M = 0.36, MLSS = 3750 mg/l 9 aerators of 50 HP each	4.1 hrs. (HRT)	50 x 17.5 scaled from layout drawing	85.564	85.517	81.664	3.853	3.4
5	FST	3	34 m dia	22 $m^3/day/m^2$ at average 50 m3/day/m2 at peak	3.26 hrs.		84.898	84.301	81.404	2.897	3.194
6	Sludge Thickener	2	19.75 m dia	40 $kg/day/m^2$ at average solid loading			85.02	84.47	83.27	1.2	1.45
7	Sludge Digestor	3	27 m dia	Mixing arrangement - screw mixture in each, HP 90 each	30 days						
8	SDB	24	24.6 x 24.6	Total Solids = 13464 kg/day depth of sludge = 0.2m			84.48	83.58			
9	Gas Holder	2	17m dia x 6 depth	Gas producn = 11000 cum/day (max) Guaranteed gas producn = 7500 cum/day 6 hrs. capacity			89.998		89.998		
10	Gas Burner	2	50 % of daily gas	213 cum/hr							
11	Return Sludge Pumps	2+2	625 cum/hr, 12m hd	Motor = 37 KW							
12	Treated Effluent Pumps								80.391		
	(i) For Naini	6	1250cum/hr, 12 m hd	Motor = 55 KW							
	(ii) For Dandi	4	925 cum/hr, 17m hd	Motor = 55 KW							
13	Thickened Sludge Pumps	4	15 cum/hr, 16m hd	Motor = 5.5 KW							
		3	16 cum/hr, 16m hd	Motor = 15 HP							
14	Filtrate Pumps	4	281 cum/hr, 13m hd	Motor = 18.5 KW					79.018		
15	Power Generation			.							
	(a) Duel Fuel Generator	2W+1S	400 KW								
	(b) Gas Compressor	3	175 cum/hr, 3 kg/sqcm								
	c) H_2S Scrubber	2	300 cum/hr								

Primary Settling Tank

Thickener

Digesters

Gas Holder (in the background)

Dual Fuel Engine Room

Electric Panels

Dual Fuel Engines (not being used)

Surface Aerators

Sludge Drying Beds

Secondary Settling Tank

(7) Design Review

A review of the plant design was carried out considering the inlet parameters as taken during the STP design. The following points are observed:

- Design data received is not complete, certain assumptions had to be made on the basis of the actual unit sizes.
- Detention time in PST exceeds the limits specified in the CPHEEO Manual.
- SWD of the aeration tank (3.5 m)is low, usual values are 4-6 m.
- HRT (3.7 hrs.) in the aeration tank is low. Min value recommended in the CPHEEO Manual is 4 hrs.
- Detention time in SST exceeds the limits specified in the CPHEEO Manual.
- Targeted gas production of 11,000 m^3/day is very much on the higher side.
- The recycle of excess sludge to PST inlet is undesirable. The SST sludge is comparatively difficult to settle and likely to interfere with the settling of the primary sludge.
- The digesters have no heating arrangements and are fitted with mechanical mixers.

(8) Performance Monitoring

On the basis of the data available in the CPCB publication, “State of Environment, Allahabad” (CUPS/55/2003-04), general observations which can be made are:

- The plant does not show any consistency as regards process performance.
- Due to low inlet SS values, design MLSS in aeration tanks is rarely achieved.
- The DO levels in aeration tanks dip below the desired values, in general, when the inlet BOD exceeds 100 mg/l. On the basis of the data in the CPCB publication and general observations during the consultants’ site visits, it is concluded that the aerators do not function to the full capacity quite often; the reasons would have to be investigated in details further. However, a preliminary observation suggests frequent power failures as a possible cause.

Table 2.16 Performance of Naini Sewage Treatment Plant

Sample ID	Inlet Quality		Primary Settling Tank		Aeration Tank + SST		Overall Process Efficiency			Rem.	Effluent Quality	
	BOD	SS	% Ave.SS removal	% Ave BOD removal	% Ave.SS removal	% Ave BOD removal	DO	BOD	SS		BOD	SS
May 2001	60	231	42	37	33	55	1.57	71.7	60.6	Only 2 aer[n] functional DO in one aer[n] tank was 0, Ave. value is for 2 tanks	17	**91**
June 2001	68	327	71	38	52	80	1.17	86.8	86.2		09	45
July 2001	78	347	75	41	23	52	-	71.8	81		22	**66**
Aug 2001	83	250	63	50	51	61	2.6	80.7	82		16	45
Sept 2001	115	320	69	41	63	78	Nil	87	88		15	37
Oct 2001	68	348	69	32	55	54	-	69	86		21	49
Nov 2001	125	400	66	47	60	58	0.32	78	86.5		28	**54**
Dec 2001	146	930	26	36	67	22	4.8	50.7	75		**72**	**230**
Jan 2002	145	322	51	35	61	64	0.3	76.6	81		**34**	**61**
Feb 2002	82	342	56	36	30	35	0.63	58.5	69		**34**	**107**
Mar 2002	83	282	41	33	58	35	1.13	56	75.5		**36**	**69**

Figures in bold indicate values in excess of designed effluent quality.

Other observations (based on visual inspections are as follows):

- As per the ground staff, the surface mixers of the digesters do not function most of the time.
- Gas production is very less, possibly the main reason for this is very low inlet SS, as explained above and inadequate mixing of the contents.
- The equipment for production of power from sewage gas (Dual Fuel engines, gas scrubbers etc.) are lying unused as diesel required for operating the Dual Fuel engines is not available.
- Gas bubbles were observed in the thickener, one possible reason is that the designed capacity far exceeds the required capacity, increasing the retention in the thickener, the sludge probably starts decomposing. The mixing of the secondary sludge prior to the PST units also contributes to the poor performance of the thickener. The gas bubbles will prevent the sludge from settling.
- One or more aerators were found to be un-operational during most of the visits to the plant.

Process data for the month of January, 2005 was supplied to the consultant, in which the following values were reported:

- Average discharge throughput of the plant.
- pH value of incoming flow and treated effluent, in PST, each of the three aeration tanks, return sludge and digesters.
- Dissolved Oxygen (DO) in each of the aeration tanks and in the treated effluent.
- BOD values in incoming flow, treated effluent and PST.
- SS values in incoming flow, treated effluent and PST.
- MLSS values in each of the three aeration tanks and in return sludge.
- COD values in incoming flow, treated effluent and PST.

From the data made available the following can be interpreted:

- The average flow for the month of January was 49.59 MLD and the average inlet BOD and SS values were 118 mg/l and 345 mg/l respectively; the plant was underloaded for the entire month.
- The PST performance was satisfactory for the month, with almost 50% BOD and SS removal being achieved in the unit.
- The treated effluent quality was within / near the targeted quality of BOD = 30mg/l and SS = 50 mg/l.
- Design MLSS in the aeration tanks is not being developed due to the incoming SS value being almost half of the design values.
- DO values in each of the aeration tanks remains generally satisfactory, it was above recommended values even on the day the power cut lasted 9 hrs. 50 min.

(9) Design of 20 mld stream

The design has been carried out for revised raw sewage quality, more in line with the actual incoming quality:

- BOD = 250 mg/l, SS = 400 mg/l

Design Summary of main plant units (to be added for augmenting capacity by 20 MLD) is as follows:

- Grit Chambers – 5.3 m square, SWD = 1.2 m
- PST = 27 m dia, SWD = 3.5 m
- Aeration Tank = 50 m x 14.5 m x 4 m SWD, aerators of 440 HP
- SST = 34.1 m dia, 2.5 m SWD
- Digesters – 19m dia, 10 m total depth – 1 Nos.

- Sludge Drying Beds – 24.6m x 24.6m, 6 nos.

(10) Augmentation / Rehabilitation Measures

Apart from the construction of units as listed in the preceding section, the following measures are recommended:

- Disposal of excess sludge directly to the digesters
- Providing Gas Engines for power production (cost considered in the report)
- Providing heating arrangements and gas mixing in the digesters (cost not considered in the report)
- Providing Chlorination facilities for 80 mld capacity.

(11) Augmentation Cost

Table 2.17 Augmentation Cost of Naini STP

	Amount (Thousand Rs.)
Total	151,630

2.3 Proposed Sewer- Gravity and Rising Mains

2.3.1 Proposed System

The new facilities proposed for this district are:

- Construction of new trunk sewers – 4.01 km.
- No new SPS is proposed
- 20 mld stream is to be added to existing Naini STP

2.3.2 Proposed Gravity Sewers

As part of Master Plan recommendations, certain routes and flows for proposed trunk sewers (gravity and rising mains) have been defined for each district. Summary of these is presented in Table 2.18 and in the key plan of proposed sewers for District A. Details of these gravity sewers are given below in brief:

(1) Alignment Details

<u>Pipe line 1A & 2A (node 4-5-7) (Ref. Sheet No. 6-9)</u>

General

The gravity trunk sewer starts from Roshan Bagh area (node 4) and is to be laid along GT road. The pipe line routes through Nakhas Kohna, Sarai Mir Khan, Jauhritola, Bahadur ganj areas and finally ends at the intersection of Lauder road (node 7), where it discharges into an existing sewer, ultimately flowing towards Gaughat Raw Sewage Pumping Station.

Constraints

There are existing sewers on both sides of the road. GT road is of RCC construction and it would be very difficult to cut the road and lay the sewer through the middle of the road. Hence alignment of sewer has been proposed along the road parallel to the existing sewer.

Moreover, the proposed sewer has to discharge to the existing sewer at Lauder road flowing towards Gaughat Raw Sewage Pumping Station. Invert level of the existing sewer at connection point is 81.335 m; hence sewer has been designed accordingly.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 158 lps from Roshan Bagh area (node 4) up to node 5 near Banerjee road at MH 24. Designed diameter of the pipe is 500 mm and designed slope is 1 in 300.

For node 5 to node 7, maximum peak flow in the sewer is 370 lps. Diameter of the pipe is 700 mm and slope is 1 in 300.

Detailed SEWERCAD data output and analysis has been given in Appendix A2.1.

Depth of Sewer

Detailed description of sewer and manholes has been given in Appendix A 2.2 and 2.3.

Table 2.18 Proposed Gravity Sewers for District A

Pipe line No.	Node No.	Road	From	To	Peak Flow in 2030 (lps)	Dia. (mm)	Length (m)	Material	Installation cost (Million Rs.)
1A	4-5	GT Road	Roshan Bagh	Banerjee Road (MH 24)	158	500	998	RCC	22.44
2A	5-7	GT Road	Banerjee Road (MH 24)	Kotha Parcha Chowk	370	700	1,177	RCC	
3A	8-15	Salik Ganj Road	Bans Mandi	Lauder Road	148	600	1,139	RCC	11.14
4A	11-12	S. K. Dey Marg	Mirapur	Atala Chowk	143	500	692	RCC	6.09
Total							4,006		39.67

Pipe line 3A (node 8-15) (Ref. Sheet No.10-11)

General

The gravity trunk sewer starts from Malviya Nagar area (node 8) and is to be laid along Salik Ganj road. The pipe line routes through Timber Market, intersection of Krishna Kant road, Mutthi ganj areas and finally ends at the intersection of Lauder road (node 15) near Gaughat sewage pumping station.

Constraints

There is existing sewer on one side of the road up to Tilak road and hence, the new pipe cannot be laid on this side. Hence, sewer has been proposed on other side of the road in this reach. Total length of this portion is approx. 350 m. After Tilak road there is an existing sewer on one side of the road and there is no space on other side hence sewer alignment has been proposed through the middle of the road for a length of approx. 250 m. (ch. 600 m). After that alignment has been proposed on one side of the road as there is an existing sewer on other side.

Moreover, the proposed sewer has to discharge to existing sewer at Lauder road towards Gaughat Raw Sewage Pumping Station. Invert level of the sump is 79.2 m, hence sewer has been designed accordingly.

Hydraulic Design

The sewer has been designed for a peak flow of 148 lps. Designed diameter of the pipe is 600 mm and designed slope is 1 in 600.

Detailed SEWERCAD data output and analysis has been given in Appendix A 2.4.

Depth of Sewer

Detailed description of sewer and manholes has been given in Appendix A 2.5 and 2.6.

Pipe line 4A (node 11-12) (Ref. Sheet No. 12-13)

General

As per MP recommendations, the gravity trunk sewer has to start from Fish Market near Mirapur area (node 11) and is to be laid along S K Dey Marg. After alignment survey of this pipe line, it was found that from chainage 122 m up to 600 m, ground level goes down steeply by about 2.5 m. This sewer is to finally discharge into an existing sewer at node 12 at Shaukat Ali Marg; invert level of this existing sewer is high at the connection point. As a consequence, gravity sewer would not be possible and an additional Pumping Station would be required.

Therefore, it has been proposed that the trunk sewer will start from chainage 600 m onwards from Mirapur chowk and up to Shaukat Ali Marg. The pipe line routes through Nehru Nagar and Tulsipur areas along S K Dey Marg and finally ends at the intersection of Saukat Ali Marg (node 12).

Constraints

There are two existing drains on both sides of the road. Hence, the sewer has been routed between the drain and the road.

The proposed sewer has to discharge into the existing sewer laid along Nurullah road and flowing towards Gaughat Raw Sewage Pumping Station, near Gol Park Atala. Invert level of the existing manhole is 84.631 m, hence sewer has been designed accordingly.

Hydraulic Design

The sewer has been designed for a peak flow of 143 lps. Designed diameter of the pipe is 500 mm and designed slope is 1 in 400.

Detailed SEWERCAD data output and analysis has been given in Appendix A 2.7.

Depth of Sewer

Detailed description of sewer and manholes has been given in Appendix A 2.8 and 2.9.

(2) Crossings

Details of road /nala crossings and railway crossing culverts are given in Table 2.19.

Table 2.19 Details of Road/Nala Crossing

	No. of Man-holes	Nala Crossing		Road Crossing (Ordinary)		Road Crossing by Trench less		Railway Crossing/ Culvert	
		No.	Total length (m)	No.	Total length (m)	No.	Total length	No.	Total length (m)
GT Road (1A & 2A)	52	-	-	12	91	8	112	1	8
Salik Ganj Road (3A)	34	1	3.5	1	6	3	46	-	-
S K Dey Marg (4A)	18	-	-	5	45	2	25	-	-

(3) Material

The trunk sewers shall be RCC pipes of NP3 class made with Sulphate Resisting Cement. Since most of the pipe stretches are along the main road, NP3 pipe has been proposed. For the stretches where the pipe crosses the road and trench less construction is proposed, RCC NP4 pipe has been chosen.

(4) Bedding

Two types of bedding have been mainly used for all proposed trunk sewers in District A. Trunk sewers up to depth 5 m have been proposed with type “C” bedding i.e. Reinforced Cement Concrete bedding with 0.4% steel (RCCB), and trunk sewers up to 9 m depth have been provided with type “D” bedding i.e. Reinforced Concrete Arch (RCA) with 1% steel at top and granular material at bottom.

CHAPTER 3

PROVISIONS OF DISTRICT D

CHAPTER 3 PROVISIONS OF DISTRICT D

3.1 INTRODUCTION

3.1.1 General

Sewerage District D is the rapidly growing zone of the city; the existing sewerage system in this area is relatively new. It is bound on the northern side by Ganga River and on the eastern side by Yamuna River.

The total length of existing trunk sewers in the district is 9.27 km, with sizes ranging from 0.3 m diameter to 1.1 m x 1.3 m. Except for some small stretches of total length 2.62 km, where concrete sewers have been laid, all other sewers are brick sewers. The district includes five existing pumping stations. Four of these have been configured to pump the collected wastewater and tapped Nala flows, to the fifth SPS i.e. Alopibagh SPS. The Alopibagh SPS in turn discharges into the Gaughat SPS, which lies in the sewerage District A.

3.1.2 Population

The present and estimated future population in Master Plan for District D is as follows:

Table 3.1 Population of District D

Year	Population within Municipal Area	Population outside Municipal Area	Floating Population	Total
2003	271,311	-	3,501	274,812
2015	359,533	-	4,916	364,449
2030	495,161	-	7,253	502,414

3.1.3 Present and Future Wastewater Flows

The flows as given in the Master Plan, are reproduced in Table 3.2.

Table 3.2 Present and Estimated Future Wastewater Flows by Sub-catchment in District D

District	Sub-Catch ment	Resident									Floating			Total		
		Inside of Municipality			Outside of Municipality			Total								
		2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030
District D	D-1	1.43	1.81	2.54	0.00	0.00	0.00	1.43	1.81	2.54	0.02	0.03	0.05	1.45	1.84	2.58
	D-2	2.36	2.82	3.77	0.00	0.00	0.00	2.36	2.82	3.77	0.04	0.05	0.07	2.39	2.87	3.84
	D-3	2.04	2.63	3.76	0.00	0.00	0.00	2.04	2.63	3.76	0.03	0.04	0.07	2.07	2.67	3.83
	D-4	3.60	4.35	5.33	0.00	0.00	0.00	3.60	4.35	5.33	0.06	0.07	0.10	3.65	4.42	5.43
	D-5	1.11	1.40	1.95	0.00	0.00	0.00	1.11	1.40	1.95	0.02	0.02	0.04	1.13	1.43	1.99
	D-6	0.50	0.64	0.88	0.00	0.00	0.00	0.50	0.64	0.88	0.01	0.01	0.02	0.51	0.65	0.90
	D-7	0.81	1.05	1.51	0.00	0.00	0.00	0.81	1.05	1.51	0.01	0.02	0.03	0.82	1.06	1.54
	D-8	2.58	3.46	4.76	0.00	0.00	0.00	2.58	3.46	4.76	0.04	0.06	0.09	2.62	3.52	4.85
	D-9	2.43	3.10	4.36	0.00	0.00	0.00	2.43	3.10	4.36	0.04	0.05	0.08	2.47	3.15	4.44
	D-10	4.34	4.37	4.85	0.00	0.00	0.00	4.34	4.37	4.85	0.07	0.07	0.09	4.41	4.44	4.94
	D-11	5.02	5.26	5.20	0.00	0.00	0.00	5.02	5.26	5.20	0.08	0.09	0.10	5.10	5.35	5.30
	D-12	2.62	2.65	2.69	0.00	0.00	0.00	2.62	2.65	2.69	0.04	0.04	0.05	2.66	2.70	2.74
	D-13	1.83	1.61	1.48	0.00	0.00	0.00	1.83	1.61	1.48	0.03	0.03	0.03	1.85	1.63	1.50
	D-14	7.52	6.90	6.76	0.00	0.00	0.00	7.52	6.90	6.76	0.12	0.12	0.13	7.63	7.02	6.89
	D-15	3.60	4.35	5.33	0.00	0.00	0.00	3.60	4.35	5.33	0.06	0.07	0.10	3.65	4.42	5.43
	D-16	4.02	4.37	5.26	0.00	0.00	0.00	4.02	4.37	5.26	0.06	0.07	0.10	4.08	4.45	5.36
	D-17	9.82	12.17	16.32	0.00	0.00	0.00	9.82	12.17	16.32	0.00	0.00	0.00	9.82	12.17	16.32
	Sub Total	55.62	62.92	76.75	0.00	0.00	0.00	55.62	62.92	76.75	0.72	0.86	1.12	56.34	63.78	77.87

3.1.4 Existing and Proposed Sewerage Pattern

All sewered / pumped wastewater of the district converges towards the Alopibagh SPS which lies towards the southern boundary of the district.

The trunk sewers of the area flow southwards into the Alopibagh SPS. The Daraganj and Allahpur SPS pump collected flows into the trunk sewer on Allahpur road, which discharges into the Alopibagh SPS. The wastewater from Morigate SPS reaches the Alopibagh SPS via a 500 mm dia rising main. Flow from the Mumfordganj SPS is pumped half way to the Alopibagh SPS, up to a local ridge line and from thereon travels under gravity. Alopibagh SPS pumps all collected flows to Gaughat SPS in District A.

To divert flow in excess of 80 mld away from the Gaughat SPS, the flow pattern in District D will be reconfigured to some extent. The flows from Daraganj, Allahpur and Morigate SPS will continue as at present, to the Alopibagh SPS. However Alopibagh itself will discharge into the Mumfordganj SPS instead of Gaughat SPS. From Mumfordganj, the wastewater will be pumped to the proposed Rajapur STP which is to be located towards the North, on the bank of Ganga River.

3.1.5 Proposed System

The proposed augmentation/ new construction measures, under priority projects, for this district are:

- Augmentation of Alopibagh Pumping Station capacity to 1,064 lps (92 mld) for 2015, flow decreasing in 2030.
- New Pumping Station near existing Morigate Pumping Station of capacity 12 mld for 2015, flow decreasing thereafter.
- Augmentation of Allahpur Pumping Station capacity to 6.3 mld for 2015, 11 mld, for 2030.
- Daraganj Pumping Station – replacement of present pumps for 2015 capacity (4.8 mld); Augmentation of capacity to 8.5 mld in 2030.
- New Sewage Pumping Station at Mumfordganj (Capacity 99.9 mld for 2015, 122.6 mld in 2030.)
- Desilting of existing trunk sewers – 5.47 km
- Replacement of existing trunk sewers – 3.79 km
- Construction of new trunk sewers – 8.56 km
- Construction of New Rising Mains– 7.46 km
- Construction of Rajapur STP, 65 mld in 2015, 80 mld in 2030.

3.1.6 Cost Summary

Summary of cost has been given in Table 3.3.

3.2 EXISTING SYSTEM DESCRIPTION

3.2.1 General

The existing sewerage system in District D consists of the following:

- 9.27 km of trunk sewers – only 2.62 km is of concrete pipes, rest are brick sewers.
- Alopibagh SPS, peak capacity – 74 mld.
- Morigate SPS, peak capacity – 20 mld.
- Allahpur SPS, peak capacity – 5.6 mld.
- Daraganj SPS, peak capacity – 5.2 mld.
- Mumfordganj SPS, peak capacity – 13.7 mld.

Table 3.3 Summary of Estimated Project Costs (District D)

	Item	Capital Costs (Million Rs.)	Annual O&M Costs (Million Rs.)
1	Branch Sewers		
	Sub-Total	**0.00**	**0.00**
2	Trunk Sewers - new		
2.1	Thorn Hill Road to Mumforganj PS (Node 1-2-4-18)	37.49	0.19
2.2	Muir Road (Node 3-4)	14.16	0.07
2.3	Alopibagh - Mumfordganj (Start Chainage 3,100m, Node 18-18(Mumfordganj PS) + Interceptor to Rajapur Nala)	35.30	0.18
	Sub-Total	**86.95**	**0.43**
3	Trunks sewers - replace		
3.1	Node 9-11	12.44	0.06
3.2	Node 6-7	1.78	0.01
3.3	Node 7-7A-7B-10A	1.96	0.01
3.4	Node 10-10A-11A-11B	7.84	0.04
	Sub-Total	**24.02**	**0.12**
4	Trunk sewers – rehab. (itemize by facility)		
4.1	Node 13-15	0.50	0.00
4.2	Node 15-Alopibagh	3.62	0.02
4.3	Node 7-7A-7B-10A	1.83	0.01
4.4	Node 10-10A-11A-11B	3.18	0.02
4.5	Node 5-8- Alopibagh SPS	12.86	0.06
	Sub-Total	**21.99**	**0.11**
5	Force Mains (itemize by facility)		
5.1	Morigate Pumping Station to Alopibagh Pumping Station	11.84	0.03
5.2	Alopibagh Pumping Station to Mumforganj Pumping Station	32.80	0.08
5.3	Mumford Pumping Station to Rajapur STP	27.34	0.07
	Sub-Total	**71.98**	**0.18**
6	Pumping Station - new (itemize by facility)		
	Sub-Total	0.00	0.00
7	Pump Stations Improved (itemize by facility)		
7.1	Mumforganj including electrical feeder	47.53	6.93
7.2	Morigate including electrical feeder	28.07	1.58
7.3	Daraganj including electrical feeder	10.51	1.65
7.4	Allahapur including electrical feeder	13.84	1.67
7.5	Alopibagh including electrical feeder	28.25	8.06
	Sub-Total	**128.20**	**19.89**
8	Treatment Plants - new (itemize by facility)		
	Rajapur STP	583.68	14.20
	Sub-Total	**583.68**	**14.20**
9	Treatment Plants - improved (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
	Direct Construction Cost (Total)	**911.21**	**34.93**

3.2.2 Existing Trunk Sewers

(1) Summary of Cost

Table 3.4 Summary of Trunk Sewer (Replacement / Desilting / Rehabilitation Cost)

Pipe Line No.	Node No.	Road	From	To	Cost (Million Rs.)			
					Replace	Desilting	CCTV Inspection	Total
ED1	5-8-11A	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS	-	12.19	0.67	12.86
	11A-11B	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS				
	11B-Alopibagh PS	-	Bhardwaj Asram Marg	Alopibagh PS				
ED2	10-10A	Chintamani Marg	Darbanga Colony	Alopibagh PS	7.84	-	-	7.84
	10A-11	Chintamani Marg	Darbanga Colony	Alopibagh PS				
	11-11B	JawaharLal Nehru Road	Darbanga Colony	Alopibagh PS	-	2.92	0.26	3.18
ED3	6-7	Kamla Nehru Marg	Saint Josheph	Tagore Town	1.78	-	-	1.78
	7-7A	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	-	1.07	0.37	1.44
	7A-7B	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	1.96	-	-	1.96
	7B-10A	-	Saint Josheph	Tagore Town	-	0.29	0.10	0.39
ED4	9-11	LIC Road	Hasimpur Chowk	George Town	12.44	-	-	12.44
ED5	13-15	Allahpur Road	Railway O.B.	Alopibagh PS	-	0.41	0.09	0.50
	15-Alopibagh	Allahpur Road	Railway O.B.	Alopibagh PS	-	3.34	0.28	3.62
Total					24.02	20.22	1.77	46.01

(2) Sewer Details

The line-wise details of the existing sewers are as follows:

Table 3.5 Details of Existing Sewers in District D

Pipe Line No.	Node No.	Road	From	To	Survey data			Master Plan data	
					Dia/ Size (m)	Length (m)	Material	Dia/ Size (m)	Length (m)
ED1	5-8-11A	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	1267.95	Brick Masonary	1.0	2,500
	11A-11B	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	747.61	Brick Masonary		
	11B-Alopibagh PS	-	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	85.49	Brick Masonary		
ED2	10-10A	Chintamani Marg	Darbanga Colony	Alopibagh PS	0.30	516.44	Concrete	0.61	1,500
	10A-11	Chintamani Marg	Darbanga Colony	Alopibagh PS	0.60	767.61	Brick Masonary		
	11-11B	JawaharLal Nehru Road	Darbanga Colony	Alopibagh PS	0.99	777.63	Brick Masonary	0.991	700
ED3	6-7	Kamla Nehru Marg	Saint Josheph	Tagore Town	0.30	328.14	Concrete	0.50	1,100
	7-7A	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	0.50	1124.67	Concrete	0.50	1,200
	7A-7B	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	0.50	343.51	Concrete		
	7B-10A	-	Saint Josheph	Tagore Town	0.50	309.04	Concrete		
ED4	9-11	LIC Road	Hasimpur Chowk	George Town	0.30	304.28	Brick Masonary	0.60	1,500
		LIC Road	Hasimpur Chowk	George Town	0.50	1208.56	Brick Masonary		
		LIC Road	Hasimpur Chowk	George Town	0.60	324.33	Brick Masonary		
ED5	13-15	Allahpur Road	Railway O.B.	Alopibagh PS	0.70	272.24	Brick Masonary	0.70	400
	15-Alopibagh	Allahpur Road	Railway O.B.	Alopibagh PS	1.0	889.5	Brick Masonary	1.0	900

(3) Line-wise Condition Survey Data and Data Analysis

1) Summary

Table 3.6 Summary of Condition Survey for Existing Sewers, District D

Pipe Line No.	Node No.	Road	From	To	Existing Sewer								
					Dia/Size (m)	Length (m)	Material	Slope			Silting (%)		
								Min	Max	Avg.	Min	Max	Avg.
ED1	5-8-11A	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	1267.95	Brick Masonary	1 in 4806.86	1 in 60.81	1 in 212.53	11.92	16.15	13.31
	11A-11 B	JawaharLal Nehru Road	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	747.61	Brick Masonary	1 in 1388	1 in 152.25	1 in 281.16	14.61	34.38	24.38
	11B-Al opibagh PS	-	Bhardwaj Asram Marg	Alopibagh PS	1.1x1.3	85.49	Brick Masonary	1 in 339.08	1 in 113.8	1 in 222.05	12.7	15.4	14.00
ED2	10-10A	Chintamani Marg	Darbanga Colony	Alopibagh PS	0.30	516.44	Concrete	1 in 373.56	1 in 26.84	1 in 49.70	16.67	82.33	30.46
	10A-11	Chintamani Marg	Darbanga Colony	Alopibagh PS	0.60	767.61	Brick Masonary	1 in 1766.67	1 in 91.26	1 in 451	25.80	56.30	43.20
	11-11B	JawaharLal Nehru Road	Darbanga Colony	Alopibagh PS	0.99	777.63	Brick Masonary	1 in 3513.6	1 in 277.96	1 in 668.64	15.20	39.40	26.82
ED3	6-7	Kamla Nehru Marg	Saint Josheph	Tagore Town	0.30	328.14	Concrete	1 in 848.67	1 in 77	1 in 260.43	73.33	100	100
	7-7A	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	0.50	1124.67	Concrete	1 in 1305.06	1 in 63.55	1 in 67.73	24.00	75.60	36.25
	7A-7B	Maharshi Dayanand Marg	Saint Josheph	Tagore Town	0.50	343.51	Concrete	1 in (-ve) 956.27	1 in 56.29	1 in 379.57	30.00	100	71.49
	7B-10A	-	Saint Josheph	Tagore Town	0.50	309.04	Concrete	1 in 527.50	1 in 234.07	1 in 386.78	20.00	52.00	28.04

Pipe Line No.	Node No.	Road	From	To	Existing Sewer								
					Dia/Size (m)	Length (m)	Material	Slope			Silting (%)		
								Min	Max	Avg.	Min	Max	Avg.
ED4	9-11	LIC Road	Hasimpur Chowk	George Town	0.30	304.28	Brick Masonary	1 in (-ve) 1044.22	1 in 156.10	1 in 330.74	51.70	82.70	69.00
		LIC Road	Hasimpur Chowk	George Town	0.50	1208.56	Brick Masonary	1 in 5076.66	1 in 58.03	1 in 439.80	33.33	100	91.10
		LIC Road	Hasimpur Chowk	George Town	0.60	324.33	Brick Masonary	1 in (-ve) 6759	1 in 1203.92	1 in 1287.0	23.17	55.83	45.8
ED5	13-15	Allahpur Road	Railway O.B.	Alopibagh PS	0.70	272.24	Brick Masonary	1 in 2770.67	1 in 263.43	1 in 760.45	47.70	71.40	32.97
	15-Alopibagh	Allahpur Road	Railway O.B.	Alopibagh PS	1.0	889.5	Brick Masonary	1 in 7710.91	1 in 403.23	1 in 1051.42	17.7	45.3	42.00

2) ED1 (Bhardwaj Ashram Marg to Alopibagh SPS)

Node 5-8-11A (Manholes ED1/1 to ED1/16): (Avg. Slope 212.53, Avg. discharge capacity 201.73 mld, Estimated Design discharge for 2030, 13.65 mld)
(Ref. Sheet No. 91, 92, 93)

Node 11A-11B (Manholes ED1/16 to ED1/26): (Avg. Slope 281.16, Avg. discharge capacity 175.39 mld, Estimated Design discharge for 2030, 22.55 mld)
(Ref. Sheet No. 93, 94)

Node 11B- Alopibagh SPS (Manholes ED1/26 to Alopibagh PS): (Avg. Slope 222.05, Avg. discharge capacity 197.36 mld, Estimated Design discharge for 2030, 54.26 mld).
(Ref. Sheet No. 94)

Discharge capacity for this entire stretch is high because of the large sewer size, so it can easily carry the design discharge given in MP. However, it should be desilted to remove the existing deposits.

3) ED2 (Darbanga Colony to Alopibagh SPS)

Node 10-10A (Manholes ED2/1 to ED2/8): (Avg. Slope 49.70, Avg. discharge capacity 8.85 mld, Estimated Design discharge for 2030, 11.06 mld)
(Ref. Sheet No. 95, 96)

Node 10A-11 (Manholes ED2/8 to ED2/22): (Avg. Slope 451, Avg. discharge capacity 18.65 mld, Estimated Design discharge for 2030, 19.61 mld)
(Ref. Sheet No. 96, 97)

The calculated average discharge capacity of these parts of the sewer is close to the design discharge for 2030 as given in the MP, however, large stretches have inadequate slopes and will prove critical bottlenecks. Moreover as the structural condition is poor, it is advisable to replace the entire stretch.

Node 11-11B (Manholes ED2/22 to ED2/37): (Avg. Slope 668.64, Avg. discharge capacity 58.22 mld, Estimated Design discharge for 2030, 31.71 mld)

Existing sewer in this part of the line is sufficiently large and to carry the design discharge for 2030. after desilting.
(Ref. Sheet No. 97, 98)

4) ED3 (Saint Joseph to Tagore Town)

Node 6-7 (Manholes ED3/1 to ED3/9): (Avg. Slope 260.43, Avg. discharge capacity 3.86 mld, Estimated Design discharge for 2030, 5.96 mld)

Pipeline in this stretch is almost fully choked. Even after de-silting the pipe would not have adequate discharge capacity to carry the design discharge for the year 2030. Hence replacement of the existing line at the average slope is recommended.
(Ref. Sheet No. 99)

Node 7-7A (Manholes ED3/9 to ED3/21): (Avg. Slope 67.73, Avg. discharge capacity 30.30 mld, Estimated Design discharge for 2030, 8.55 mld)

Almost all stretches would have the capacity to carry design discharge for the year 2030 after desilting. A few stretches could carry 2030 discharge flowing 90% full. Hence

pending the results of a detailed CCTV inspection, desilting rather than replacement is recommended for this stretch.
(Ref. Sheet No. 99, 100, 101)

Node 7A-7B (Manholes ED3/21 to ED3/27): (Avg. Slope 379.57, Avg. discharge capacity 12.80 mld, Estimated Design discharge for 2030, 8.55 mld)

In general, the pipe does not have sufficient capacity to carry the design discharge for 2030, plus the line shows tremendous slope variations. There is even negative slope in some parts. Hence this line needs to be replaced at the average slope to carry the discharge.
(Ref. Sheet No. 101)

Node 7B-10A (Manholes ED3/27 to ED3/31): (Avg. Slope 386.78, Avg. discharge capacity 12.68 mld, Estimated Design discharge for 2030, 8.55 mld)
This line is efficient to carry design discharge for the year 2030 after desilting.
(Ref. Sheet No. 101, 102)

5) ED4 (Hasimpur Chowk to George Town)

Node 9-11 (Manholes ED4/1 to Alopibagh SPS): This reach is can be split in three parts based on different diameters and the whole reach does not have sufficient capacity to carry the design discharge for the year 2030; hence it needs to be replaced at average slope.

(i) (Manholes ED4/1 to ED4/9): (Avg. Slope 330.74, Avg. discharge capacity 3.43 mld, Estimated Design discharge for 2030, 12.10 mld)
(Ref. Sheet No. 103)

(ii) (Manholes ED4/9 to ED4/32): (Avg. Slope 439.80, Avg. discharge capacity 11.61 mld, Estimated Design discharge for 2030, 12.10 mld)
(Ref. Sheet No. 103, 104, 105)

(ii) (Manholes ED4/32 to ED4/38) (Avg. Slope 1287.02, Avg. discharge capacity 11.04 mld, Estimated Design discharge for 2030, 12.10 mld)
(Ref. Sheet No. 105)

6) ED5 (Alopibagh PS to Railway O.B. near Daraganj Boosting PS)

Node 13-15 (Manholes ED5/20 to ED5/14): (Avg. Slope 760.45, Avg. discharge capacity 21.66 mld, Estimated Design discharge for 2030, 18.06 mld)

One stretch of length will flow 90% full flow for discharge of 2030, other stretches have sufficient capacity to carry the discharge; hence desilting after CCTV inspection is recommended.
(Ref. Sheet No. 108)

Node 15- Alopibagh PS (Manholes ED5/14 to ED5/1): (Avg. Slope 1051.42, Avg. discharge capacity 47.69 mld, Estimated Design discharge for 2030, 36.98 mld)
Discussion same as above. (Ref. Sheet No. 108, 107, 106)

(4) Recommendations

Table 3.7 Summary of Replacement / Desilting Requirements for District D

Pipe Line No.	Node No.	Road	Structural Condition Of Sewer	Existing Sewer										Design Dis-charge in 2030 (mld)	Proposed		
				Dia/ Size (m)	Length (m)	Material	Slope			Silting (%)			Avg. Discharge Capacity (mld)		Proposal	Dia/ Size (m)	Slope
							Min	Max	Avg.	Min	Max	Avg.					
ED1	5-8-11 A	Jawahar Lal Nehru Road	Poor	1.1x1.3	1267.9	Brick Masonary	1 in 4806.8	1 in 60.81	1 in 212.53	11.92	16.15	13.31	201.73	13.65	Desilting + CCTV	-	-
	11A-1 1B	Jawahar Lal Nehru Road	Poor	1.1x1.3	747.61	Brick Masonary	1 in 1388	1 in 152.25	1 in 281.16	14.61	34.38	24.38	175.39	22.55	Desilting + CCTV	-	-
	11B-Alopibagh PS	-	Poor	1.1x1.3	85.49	Brick Masonary	1 in 339.08	1 in 113.8	1 in 222.05	12.7	15.4	14.00	197.36	54.76	Desilting + CCTV	-	-
ED2	10-10 A	Chintamani Marg	Poor	0.30	516.44	Concrete	1 in 373.56	1 in 26.84	1 in 49.70	16.67	82.33	30.46	8.85	11.06	Replace	0.40	1 in 49.70
	10A-1 1	Chintamani Marg	Poor	0.60	767.61	Brick Masonary	1 in 1766.6	1 in 91.26	1 in 451	25.80	56.30	43.20	18.65	19.61	Replace	0.70	1 in 451
	11-11B	Jawahar Lal Nehru Road	Poor	0.99	777.63	Brick Masonary	1 in 3513.6	1 in 277.96	1 in 668.64	15.20	39.40	26.82	58.22	31.71	Desilting + CCTV	-	-
ED3	6-7	Kamla Nehru Marg	Poor	0.30	328.14	Concrete	1 in 848.67	1 in 77	1 in 260.43	73.33	100	100	3.86	5.96	Replace	0.40	1 in 260.4
	7-7A	Maharshi Dayanand Marg	Poor	0.50	1124.67	Concrete	1 in 1305.0	1 in 63.55	1 in 67.73	24.00	75.60	36.25	30.0	8.55	Desilting + CCTV	-	-
	7A-7B	Maharshi Dayanand Marg	Poor	0.50	343.51	Concrete	1 in (-ve) 956.27	1 in 56.29	1 in 379.57			30.00	100	8.55	Replace	0.50	1 in 379.5

Pipe Line No.	Node No.	Road	Structural Condition Of Sewer	Existing Sewer										Design Dis-charge in 2030 (mld)	Proposed		
				Dia/ Size (m)	Length (m)	Material	Slope			Silting (%)			Avg. Discharge Capacity (mld)		Proposal	Dia/ Size (m)	Slope
							Min	Max	Avg.	Min	Max	Avg.					
	7B-10 A	-	Poor	0.50	309.04	Concrete	1 in 527.50	1 in 234.07	1 in 386.78	-	-	20.00	52.00	8.55	Desilting + CCTV	-	-
ED4	9-11	LIC Road	Poor	0.30	304.28	Brick Masonary	1 in (-ve) 1044.2	1 in 156.10	1 in 330.74	51.70	82.70	69.00	3.43	12.10	Replace	0.50	1 in 330.7
		LIC Road	Poor	0.50	1208.5	Brick Masonary	1 in 5076.6 6	1 in 58.03	1 in 439.80	33.33	100	91.10	11.61	12.10	Replace	0.60	1 in 439.8
		LIC Road	Poor	0.60	324.33	Brick Masonary	1 in (-ve) 6759	1 in 1203.9	1 in 1287.0	23.17	55.83	45.8	11.04	12.10	Replace	0.60	1 in 1287
ED5	13-15	Allahpur Road	Poor	0.70	272.24	Brick Masonary	1 in 2770.6	1 in 263.43	1 in 760.45	47.70	71.40	32.97	21.66	18.06	Desilting + CCTV	-	-
	15-Alopibagh	Allahpur Road	Poor	1.0	889.5	Brick Masonary	1 in 7710.9	1 in 403.23	1 in 1051.4	17.7	45.3	42.00	47.69	36.98	Desilting + CCTV	-	-

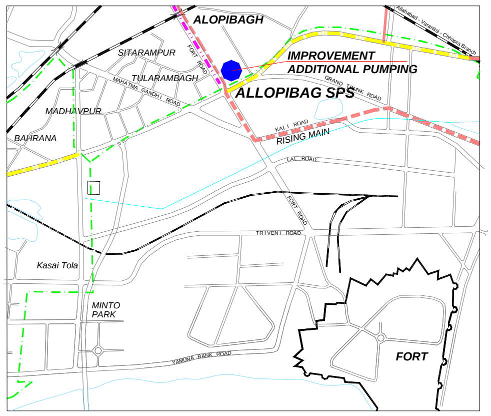
(5) Cleaning and Inspection Methods

The method recommended is:

- An initial CCTV survey of lines ED1, ED2 (node 11-11B), ED3 (node 7-7A, 7B-10A), ED4 and ED5 should be carried out to get a better understanding of the structural condition of the sewers and to decide the de silting method to be used.
- The de silting should be carried out by the jetting / vacuum machines. For larger sized sewers, the cost economics of using a jetting machine v/s using an auger based machine can be worked out, another consideration would be the amount of water required for cleaning the large sewers.
- A final CCTV survey should be carried out to check the results of the desilting operation.

3.2.3 Existing Pumping Stations

(1) Alopibagh Pumping Station



LOCATION PLAN (N.T.S.)

Preamble

This pumping station is situated in District D (Ref Sheet No. 128-130). It was originally commissioned in the year 1964 and renovated as a part of Ganga Action Plan in the year of 1988. At present this pumping station receives wastewater from Daraganj, Tagore Town, Alopibagh, Sohbatia Bagh, and Tularam Bagh areas. In addition to this, it also receives sewage from Mori gate, Allahpur, Daraganj and Mumfordganj Pumping stations. The future catchment area will be reduced by the re-organisation of the sewer system. Presently the sewage is being pumped to the Gaughat Pumping Station through two rising mains of 900 mm and 600 mm dia.

Anticipated flow in 2030 is 1,014 lps. At present the total installed capacity is 1,326 lps and the peak allowable discharge capacity is 854.9 lps (74 mld) with approx. 50% stand-by, taking into consideration the total installed pumping capacity and pump configurations.

The incoming sewers / rising mains are:

i. 39 x 57 inch dia sewer from Mumfordganj
ii. 24 inch dia trunk sewer from Pared
iii. 30 inch dia sewer from Daraganj
iv. 500 mm dia rising main from Morigate pumping station.

The incomers sewers / rising mains fall into the inlet chamber, from where the flow passes into the wet sump. The coarse bar screens are installed in the wet sump. The clear gap between the bars is 50 mm. Removal of screenings is carried out by manual labour by physically lifting the floating material from the wastewater wet sump.

Wet Sump at Alopibagh SPS (Manual Collection of Screenings)

<u>Existing System and Status of E&M Equipment</u>

- Wet Sump

Table 3.8 Wet Sump of Alopibagh Pumping Station

Capacity (m^3)	Retention Time for 2030 (IMinutes)		Adequate	Additional Copy for 2015/2030** (m^3)
	Avg. flow	Peak flow		
17*	0.56	0.28	No	302

* As per information provided by UPJN – Handing over note of assets created under GAP
** Whichever is more

- Pumps and Motors

Table 3.9 Pumps and Motors of Alopibagh Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Motor capacity (HP)	Motor Type
333.3	20	2	HNC	150	Sq. Cage TEFC
188.3	9	2	HNC	40	Sq. Cage TEFC
141.6	10	2	HNC	35	Sq. Cage TEFC

TEFC – Totally Enclosed Fan Cooled
HNC – Horizontal Non Clog

Total installed capacity is 1,326 lps and the peak allowable discharge capacity is 854.9 lps (74 mld) Dry Well.

The dry well houses the pumps and motors on same level. The pump floor level and the motor floor level is at 77 meter RL. An typical feature of the P/H is that the by-pass arrangement falling into the Morigate nala is via the rising main.

- Electrical System

  i) Incoming Supply - The electric supply is taken through an underground cable from Over Head Distribution system of UPPCL at High voltage of 11 kV for operation of the Pumping Station.
  ii) LT Panel - Two incoming SFU and six outgoing feeders for operation of the existing pumps are provided through protective switch gears.
  iii) Cables – PVC insulated and PVC sheathed armoured cable.
  iv) Starters - Star delta / ATS starters are provided for starting the pumps.
  v) DG Sets - 160 kVA Diesel Generating Set is available as stand by power.
  vi) Transformer – 11 / 0.415 kV , 400 kVA ,ONAN (Oil Natural Air Natural) type (2 4Nos.)
  vii) Three unit HT panel of Oil Circuit Breaker

The details of the available equipment differ from those given in the Master Plan.

Future Flows

Projected peak flows are:

- 1,064 lps in 2015
- 1,031 lps in 2030

The discharge for 2015 is more than present flow and the discharge capacity and head of the pumps is not sufficient to cater for pumping sewage to Mumfordganj; Hence for 2015 replacement is required. Wet sump capacity is to be increased.

Inadequacies of the Existing System

- The installed pumping capacity and head is insufficient for projected flows.
- The present sump capacity is insufficient for present and ultimate peak flows.
- There is no Mechanical Bar Screen.
- Cleaning of the screens done manually.
- Electrical System is to be improved
- DG set available but inadequate.
- Supply of Diesel is inadequate and irregular.

Rehabilitation / Upgradation Proposed

Table 3.10 Pump Design for the Year 2015 for Alopibagh SPS

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
1,064	6	266	4	2	1,064	1,064	532	532	266	266

Inlet Chamber of 4.8 x 2.4 m is being provided to receive the waste water from various sources. Form this chamber; the flow will pass to the new proposed screen channels. An additional wet sump has been created to cater to additional pumps; this sump is connected to the old sump for distribution of flow to the two wet sumps. There is hardly any land available within the existing boundary of the pump house or construct new pump house; hence submersible pumps have been proposed in the new wet sump. Rising main and trunk sewers have to be connected from the old sump to new inlet chamber.

Invert level of the existing sump (incoming) : 77.67m
Slope towards the pump house : 77.36m

Two fine mechanical bar screens along with conveyor belt shall be provided at the top level of the channel above the free board for both the channels, however 3rd channel shall be provided with a manual bar screen resting on a platform.

Four nos. of horizontal centrifugal non-clog pumps will be installed in existing PS and two nos. of submersible pumps will be installed in additional wet sump and there will be a provision for one additional pump during Mela/Carnivals etc. (Religious fair).

Replacement of Pumps:

- i) Existing two pumps of 20,000 lpm at 20 m head to be replaced with two pumps of 15,960 lpm at head 24 m.
- i) Existing two pumps of 11,300 lpm at 9 m head to be replaced with two pumps of 15,960 lpm at head 24 m.
- ii) Two submersible pumps of 15,960 lpm at a head of 24 m to be installed.
- iii) Space for an additional submersible pump has been made for future use, if required to cater to extra flows due to Mela etc..

Delivery Header Pipes:

- i) Existing 600 mm dia collector pipe for two existing pumps of 20,000 lpm shall be used without change.
- ii) Existing 600 mm dia collector pipe for 11,300 lpm shall be used with the new pumps installed in the place of old pumps.
- iii) A new header of 600 mm dia collector pipe shall be provided for the new submersible pumps proposed in the newly created wet sump.

All of these three pipes will be connected to the 1000 mm dia rising main from Alopibagh to Mumfordganj. Other new works include:

- Rising Main : 1000 mm dia , Length = 3.1km.
- Additional sump capacity: 302 m^3
- Mechanical and manual bar screens with sluice gates and conveyor system
- Suction, Delivery lines with necessary valves and other accessories
- Replacement of existing transformer by 630 kVA transformers – 2 Nos.
- LT cabling, bus trunk system, cable tray arrangement
- LT panel with proper protection and metering arrangement
- Squirrel cage TEFC motors of 112 kW capacity – 4 Nos.
- Automatic power factor control (APFC) panel for power factor improvement
- Necessary interlocks between transformer incomers and DG set
- Interlocking arrangement for DG incomer and APFC panel
- Complete earth protection system
- Solid state level indicator for easy and smooth control over the motors' duty cycle.
- DG set to be connected through AMF panel to the LT panel.

Civil Work

Additional civil works is executed to achieve the provision of master plan. Incoming chamber of size 4.8m x 2.4m shall be provided and existing rising mains and trunk sewers are to be shifted accordingly to new incoming chamber. A new rising main is to be laid from proposed Morigate Nala pump house to be connected to the proposed chamber.

Crack in Existing Pump House

A coarse bar screen chamber shall be provided for housing the manual bar screen with a platform of 1.2 m wide for manual cleaning in each channel at 2 m height from IL of the channel to support manual bar screen and provide platform for cleaning staff.

Generator room to be modified for converting it to LT control room.

Existing store room to be converted for installing DG set.

Some rehabilitation of existing civil structure of the pump house is also required.

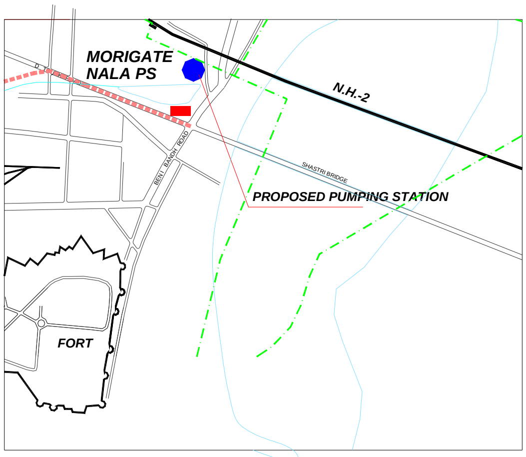
Rehabilitation Cost

The total cost for rehabilitation of Alopibagh SPS is Rs. 61.05 million including dedicated electrical feeders. Civil cost is Rs. 7.00 million and E&M cost is Rs 17.85 million.

Table 3.11 Rehabilitation Cost of Alopibagh Pumping Station

	Amount (Thousand Rs.)
Civil	7,000
E &M	17,850
Electrical Feeder	3,400
Rising main	32,800
Total	61,050

(2) Morigate Pumping Station



LOCATION PLAN(N.T.S.)

Preamble

This Pumping Station is situated in District D (Ref Sheet. No. 131-135) and it has been designed to divert flows from Morigate Nala to Alopibagh Pumping Station. It was renovated in the year of 2000. Anticipated peak flow in 2003 is 786 lps (68 mld). The present peak capacity with approx. 50% stand-by is 233 lps (20 mld).

Projected peak flows are:

786 lps in 2003
696 lps in 2015
281 lps in 2030

As per information provided by UPJN, two tapping points exist u/s of the pumping station. These carry 28 mld flow to Alopibagh by gravity. Hence net flow to Morigate SPS in 2015 will be 68-28 = 32 mld. As capacity of the existing SPS is 20 mld, only 12 mld extra pumping capacity is required.

As there is no space for additional new SPS near the existing one, this will be located across the road on defence land.

Morigate Pumping Station

Existing Coarse Screen at Morigate Pumping Station

Existing By Pass Chamber to Ganga River

Existing Submersible Sewage Pumps at Morigate

Existing System and Status of E&M Equipment

- Wet Sump

Required Sump Capacity is 111 m^3 with 5 minutes holding capacity at peak flow 32 mld for 2015 (considering that 20 mld flow is being diverted to existing facility).

- Pumps and Motors

Table 3.12 Pumps and Motors of Morigate Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Motor capacity (kW)	Motor Type
140	12	2	VNC	27	Sq. Cage TEFC
70	12	1	VNC	19	Sq. Cage TEFC

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

- Rising main (existing) – 500 mm dia and 1,950 m length
- One manual bar screen without conveyor system
- Electrical System

i) Incoming Supply - The electric supply is taken through an underground cable from Over Head Distribution system of UPPCL at medium voltage of 415 v for operation of the Pumping Station.
ii) LT Panel - One Incoming SFU and three outgoing feeders for operation of the three existing pumps are provided through protective switch gears.
iii) Cables – PVC insulated and PVC sheathed armoured cable.
iv) Starters - Star delta / ATS starters are provided for starting the pumps.
v) DG set - 63 kVA Diesel Generating Set is available as stand by power.
vi) Three Nos. liquid starters and 2 Nos. manual star delta starters

The existing sub station is in a dilapidated condition and it is recommended for complete overhaul of the existing distribution system.

Future Flows

The total installed capacity is 350 lps and maximum allowable discharge is 233 lps with stand by provision. Projected peak flows are as follows:

- 696 lps in the year 2015
- 281 lps in the year 2030

Inadequacies of the Existing System

The capacity is insufficient to accommodate present and projected flows. Hence a new pumping station of 12 mld capacity will be required across the road and just upstream of the existing site where open land is available.

Site for Proposed Additional Pumping Station

Rehabilitation / Upgradation Proposed

The new Pumping station, sized to handle all of the flow would have the following characteristics:

- Pumps of capacity 70 lps at 10 m Head – 2 Nos.
- Pumps of capacity 35 lps at 10 m Head – 2 Nos.
- Rising main : 500 mm dia (proposed), Length = 1.8 km.
- Sump capacity: 42 m^3 (5 minutes retention, in year 2015)

The other equipments to be installed for successful operation are enumerated below:

- Mechanical and manual bar screens with sluice gates and conveyor system
- Suction, Delivery lines , rising main with necessary valves and other accessories
- 2 ton capacity HOT crane – 1 No.
- 250 kVA transformers – 2 Nos.
- Five Panel HT vacuum circuit breaker as one incomer and two out going.
- One DG set of 63 kVA
- HT / LT cabling, bus trunk system, cable tray arrangement as required
- LT panel with proper protection and metering arrangement
- Squirrel cage TEFC motors of 11.5 kW capacity – 2 Nos.

- Squirrel cage TEFC motors of 6 kW capacity – 2 Nos.
- Automatic power factor control (APFC) panel for power factor improvement
- Necessary interlocks between transformer incomers and DG set
- Interlocking arrangement for DG incomer and APFC panel
- Solid state level indicator for easy and smooth control over the motors' duty cycle.
- Complete earth protection system

Table 3.13 Pump Design for the Year 2015 (Additional PS)

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
140	2	70	140	140	70	70	35	35
	2	35						

Table 3.14 Pump Design for the Year 2015 (Existing PS)

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
233	2	140	233	280	117	140	59	70
	2	70						

No change in existing pumps in the year 2015 is envisaged, as the pumps installed in Phase –I, could have useful life up to year 2030; as from year 2015 onwards the flow is decreasing, hence no additional pumps are required.

Augmentation / Rehabilitation Cost

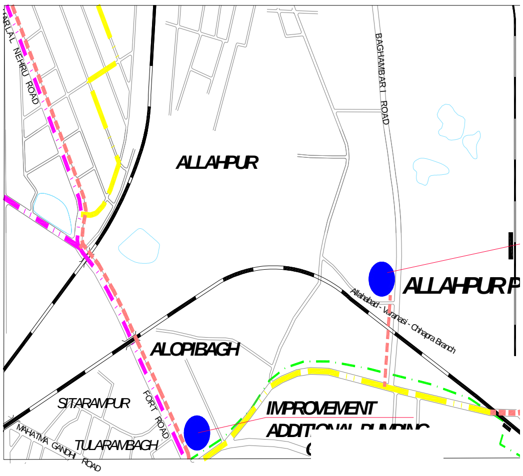
The total cost for construction of additional SPS at Morigate is Rs. 39.91 million including dedicated electrical feeders. Civil cost is Rs. 12.10 million and E&M cost is Rs. 12.57 million.

Table 3.15 Augmentation Cost of Morigate Pumping Station

	Amount (Thousand Rs.)
Civil	12,100
E &M	12,570
Electrical Feeder	3,400
Rising main	11,840
Total	39,910

Land acquisition ($2,400\ m^2$)	16,800

(3) Allahpur Pumping Station



LOCATION PLAN

Preamble

This pumping Station is situated in District D (Ref Sheet No. 140-142). It was commissioned in the year of 1988 under Ganga Action Plan Ph – I. It requires a peak pumping capacity of 53 lps (4.6 mld in year 2003). Total installed capacity – 108.3 lps, peak capacity with approx. 50% stand-by = 65 lps (5.6 mld).

It has been designed to cater to Allahpur area and a part of Daraganj area.

The pump house receives sewage through the sewer system of the area.

The Pump House pumps the sewage through a rising main of 300 mm dia and 220 meter long to the existing Trunk sewer of 30´´ dia. Subsequently the sewer flows by gravity to Alopibagh SPS (Sewage Pumping Station). The incoming sewer falls into the inlet chamber, to wet sump where coarse bar screen is installed. These screens are manually cleaned with 40 mm clear opening between bars.

Existing System and Status of E&M Equipment

- Wet Sump

Table 3.16 Wet Sump of Allahpur Pumping Station

Capacity (m^3)	Retention Time for 2030 (min)		Adequate
	Avg. flow	Peak flow	
41	10.8	5.4	yes

The sump capacity provides 5.4 minutes holding time for the anticipated discharge of the year 2030. It is sufficient for the present as well as for the year 2015 & 2030 projected peak flow too. The present equipment lifting system is sufficient and adequate for the existing pumping sets.

- Pumps and Motors

Table 3.17 Pumps and Motors of Allahpur Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Pump Make	Motor capacity (HP)	Motor Type	Pipe Dia (mm)	
							Suctn	Dlvry
43.3	20	2	VNC	MM	22.5	Sq. Cage TEFC	200	300
21.7	20	1	VNC	MM	12.5	Sq. Cage TEFC	200	300

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

Total installed capacity – 108.3 lps, peak capacity with approx. 50% stand-by = 65 lps (5.6 mld).

- Rising main- 300 mm dia and 220 meter long
- Dry Sump

The dry sump houses the pumps and motors on different level . The pump floor level is at 79.37 RL and the motor floor level is at 88.5 RL

- Electrical System

Incoming Supply - The electric supply is taken through an underground cable from Over Head Distribution system of UPPCL at medium voltage of 415 V for operation of the Pumping Station.

1. LT Panel - One Incoming SFU and three outgoing feeders for operation of the three existing pumps are provided through protective switch gears.
2. Cables – PVC insulated and PVC sheathed armoured cable.
3. Starters - Star delta / ATS starters are provided for starting the pumps.
4. DG Sets - 63 kVA Diesel Generating Set is available as stand by power.
5. Transformer - Not Applicable.

The details of the available equipment differ from those shown in the Master Plan.

Future Flows

The anticipated peak flows are as follows:

- 73 lps in the year 2015
- 128 lps in the year 2030

Inadequacies o the Existing System

- No Mechanical bar screen
- Pump and Motor alignment is improper
- Removal of screening is not done on regular basis
- Supply of Diesel is inadequate and irregular.

Rehabilitation / Upgradation Proposed

The present pumping capacity of the SPS meets the requirement. Mechanical Bar screens 2 Nos. and

Manual bar screens 3 Nos. with necessary sluice gates, channels for diverting the flow are to be provided.

The discharge for 2015 is more than the present flow and pumps are not performing satisfactorily. Hence for 2015 replacement is required. Wet sump arrangement is sufficient for 2030. Direction of pumped flow remains the same.

Table 3.18 Pump Design for the Year 2015

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
73	3	43.3	2	1	73	86.6	37	43.3	18.25	21.7
	2	21.7	1	1		21.7		10.85		5.42
Total	5					108.3		54.15		27.12

Rehabilitation / Up gradation Measures:

- Immediate:
  Install Mechanical and manual bar screens, provide diesel, align pumps.

- In year of 2015:
  Replace the existing pumps in addition to installation of two more pumps (1 no. of 43.3 lps @20 m head and 1 no. of 21.7 lps @20 m head) with similar characteristics, without changes in the civil structures as the space for additional pumps to be installed is provided. Electrical equipment is also to be replaced with updated system.

- In year of 2030:

Table 3.19 Pump Design for the Year 2030

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
128	3	50	2	1	128	100	64	50	32	25
	2	28	1	1		28		14		7
Total	5					128		64		32

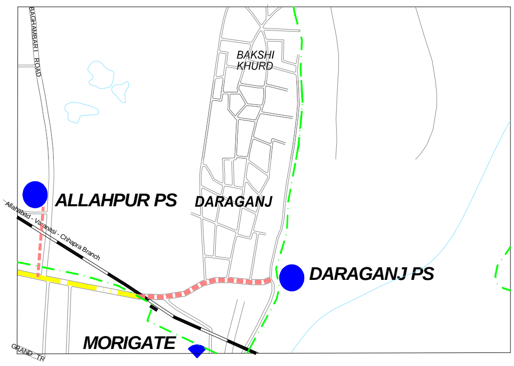
Rehabilitation Cost

The total cost for rehabilitation of Allahpur SPS is Rs.13.84 million including dedicated electrical feeders. Civil cost is Rs. 6.0 million and E&M cost is Rs. 7.59 million.

Table 3.20 Rehabilitation Cost of Allahpur Pumping Station

	Amount (Thousand Rs.)
Civil	6,000
E & M	7,590
Electrical Feeder	250
Total	13,840

(4) Daraganj Pumping Station



LOCATION PLAN

Preamble

This pumping station is situated in District D (Ref sheet no. 143-145). The pumping station was constructed in the year of 1988. It was designed to receive discharge from the newly laid Daraganj Ghat Sewer. This sewer has been laid to receive at present only sullage discharges from 18 small Nalas conveying wastewater from a part of the Daraganj area. The IL of the Nalas does not permit flow by gravity to any of the treatment plant hence lift pumping station is considered necessary. Anticipated flow in 2003 is 35 lps (3 mld), installed peak capacity with approx. 50% stand-by – 60 lps (5.18 mld).

The incomers for the Pump House are Ganga River Ghat Parallel Trunk Sewer.


OFFICE OF THE GENERAL MANAGER GANGA POLLUTION CONTROL
UNIT, U.P. JAL NIGAM, ALLAHABAD
SALIENT FEATURES
PUMPING STATION
MOTOR
CURRENT
VOLTAGE
R.P.M.
INSULATION
MAKE OF MOTOR
INSTALLED & COMMISSIONED
U.P. JAL NIGAM, ALLAHABAD

Existing System and Status of E&M Equipment

The motors are installed above the H.F.L level of 88.5 m through extended shafts.

- Wet Sump

Table 3.21 Wet Sump of Daraganj Pumping Station

Capacity (m^3)	Retention Time for 2030 (Minutes)		Adequate
	Avg. flow	Peak flow	
25.83	8.8	4.4	Almost OK

The sump capacity and hydraulic retention time is almost sufficient for the present as well as for the year 2015 & 2030 projected peak flow. The present equipment lifting system is sufficient and adequate for the existing pumping sets.

- Pumps and Motors

Table 3.22 Pumps and Motors of Daraganj Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers		Pump Type	Pump Make	Motor capacity (kW)	Motor Type	Pipe Dia (mm)	
		Wrkg	Std By					Suctn	Dlvry
25	22	2	1	VNC	Jyoti	15	Sq. Cage TEFC	125	100
10	22	1	1	VNC	MM	7.5	Sq. Cage TEFC	100	80

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

Total installed capacity – 95 lps, peak capacity with approx 50% stand-by – 60 lps (5.18 mld).

- Rising main 200 mm
- Dry Sump

  The dry sump houses the pumps and motors on (different) level. The pump floor level is at 73.00 R.L. and the motor floor level is at 89.20 R.L.

- Electrical System
  1) Incoming Supply - The electric supply is taken through an underground cable from Over Head Distribution system of UPPCL at medium voltage of 415 V for operation of the Pumping Station.
  2) LT Panel - One Incoming SFU and five outgoing feeders for operation of the five existing pumps are provided through protective switchgears.
  3) Cables – PVC insulated and PVC sheathed armoured cable.
  4) Starters - Star delta / ATS starters are provided for starting the pumps.
  5) DG set - 63 kVA Diesel Generating Set is available as stand by power.
  6) Three Nos liquid starters and 2 Nos. manual star delta starters

Future Flows

Anticipated peak flows that this pumping station will receive are :

- 56 lps in the year 2015
- 98 lps in the year 2030

Inadequacies of the Existing System

The present sump capacity is sufficient for present flows and slightly undersized for ultimate peak flows.

- No Mechanical bar screen
- Removal of screening is not done on regular basis
- Supply of Diesel is inadequate and irregular.
- Pump and Motor alignment is improper

Rehabilitation / Upgradation Proposed

The present capacities of the SPS meet the requirement. The sump capacity must be enhanced to meet the peak sewage discharge in the year of 2015. Mechanical Bar screens 2 Nos. and Manual bar screens 3 Nos. with necessary sluice gates, channels for diverting the flow are to be provided.

The sullage to be trapped from the open Nalas to the newly laid Daraganj sewer gradually will necessitate enhancing the capacity on the basis of 2030 AD and the pumps shall have to be replaced.
The installed capacity is considered adequate for 2015 AD, hence it is not to be increased. Although the Electrical and mechanical equipment has outlived its useful life, but their operation is still trouble free. Now it is proposed to divert the flow to Alopibagh for further treatment at proposed Rajapur STP.

Table 3.23 Pump Design for the Year 2015

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
56	3	25	2	1	56	50	28	25	14	12.5
	2	10	1	1		10		10		5
Total	5					60		35		17.5

- Immediate:

  Mechanical Works:
  Following items are to be installed

  1) Mechanical Fine Bar Screen 640 mm wide - 2 Nos.
  2) Manual Coarse Bar Screen 650 mm wide - 2 Nos.
  3) Sluice Gates 600 x 600 - 3 Nos.
  4) Sluice Gates 650 x 650 - 2 Nos.

- Civil Works

Wet sump has retention capacity for 4.4 minutes, based on the projected peak flow in the year 2030, which is slightly undersized for ultimate peak discharge; hence it can serve the purpose. To house mechanical bar screens and manual bar screen; necessary channel shall have to be constructed.

- In year of 2030:

Table 3.24 Design for the Year 2030

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
98	3	40	2	1	98	80	39	40	19	5
	2	20	1	1	-	20	-	-	-	-
Total	5	5			98	100	39	40	20	

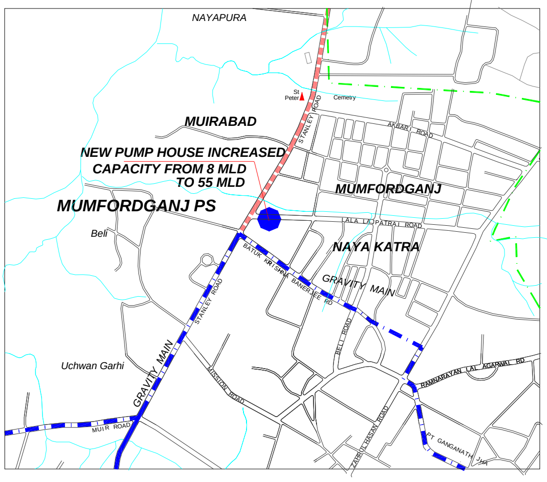
Rehabilitation Cost

The total cost for rehabilitation of Daraganj SPS is Rs. 10.51 million including dedicated electrical feeders. Civil cost is Rs. 2.50 million and E&M cost is Rs. 7.76 million.

Table 3.25 Rehabilitation Cost of Daraganj Pumping Station

	Amount (Thousand Rs.)
Civil	2,500
E & M	7,760
Electrical Feeder	250
Total	10,510

(5) Mumfordganj Pumping Station



LOCATION PLAN

Preamble

This pumping Station is located in District D (Ref sheet 136-139), and it was commissioned in the year of 1968 and renovated under Ganga Action Plan. It receives sewage from 32 inch dia sewer serving areas of Mumfordganj, Naya Katra, etc. at present.

Anticipated flow for 2003 is 1,068 lps.

Existing System and Status of E&M Equipment

At present the pumping station is equipped with the following equipment:

- Wet Sump

Table 3.26 Wet Sump of Mumfordganj Pumping Station

Capacity (m^3)	Retention Time (Minutes)		Adequate	Capacity Reqd.
	Avg. flow	Peak flow		
220.5	6.88	3.44	No	426 m^3 (5 min retention at peak)

- Pumps and Motors

Table 3.27 Pumps and Motors Mumfordganj Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Numbers	Pump Type	Motor capacity (kW)	Motor Type	Pipe Dia(mm)	
						Suctn	Dlvry
113.3	27	2	VNC	50,55	Sq. Cage TEFC	200	150
22.5	15	2	VNC	9.3,7.5	Sq. Cage TEFC	100	75

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

At present the total installed capacity is 272 lps and the maximum allowable discharge with 50% standby is 158 lps (13.7 mld).

- Manual bar screen, sluice gate
- Rising main – 20 inch dia.
- Electrical System:

1) Single panel HT OCB - 1 No.
2) 400 kVA ,11 kV / 415 V Transformer – 1 No.
3) DG set 125 kVA – 1 No.
4) LT Panel - One Incoming SFU and four outgoing feeders for operation of the four existing pumps, provided through protective switch gears.
5) Cables – PVC insulated and PVC sheathed armoured cable.
6) Starters - Star delta / ATS starters are provided for starting the pumps.

Floor of one HT room caved in. HT end termination at transformer to be made again. LT panel is to be rewired or overhauled.

Future Flows

Projected peak flows are:

- 1,156 lps in the year 2015
- 1,420 lps in the year 2030

Inadequacies of the Existing System

Under the master Plan this will become the Main pumping station for District D, receiving sewage from Alopibagh in addition to sewage from local branches. Therefore, existing pumps and sump capacity will be insufficient for the design flow. The discharge from the pumping station will be conveyed to the proposed Rajapur STP via a new rising main.

Rehabilitation / Upgradation Proposed

The present pumping station is totally inadequate for catering to reconfigured sewage flow pattern; hence, a new SPS is to be constructed. Only the existing DG housing facilities, transformer room HT panel room will be used.

The new pumping station would have the following characteristics:

- Pumps of capacity 289 lps at 22 m Head – 6 Nos
- Rising Main: 1000 mm dia, Length = 2 km.
- Sump capacity required: 426 cubic meter (5 minutes retention)
- Mechanical and manual bar screens with sluice gates and conveyor system
- Suction, Delivery lines, rising main with necessary valves and other accessories
- 5 ton capacity HOT crane – 1 No.
- 630 kVA transformers – 2 Nos.
- 5 Panels HT vacuum circuit breakers
- One DG set of 160 kVA
- HT / LT cabling, bus trunk system, cable tray arrangement
- LT panel with proper protection and metering arrangement
- Squirrel cage TEFC motors of 95 kW capacity – 6 Nos.
- Automatic power factor control (APFC) panel for power factor improvement

- Necessary interlocks between transformer incomers and DG set
- Interlocking arrangement for DG incomer and APFC panel
- Complete earth protection system
- Solid state level indicator for easy and smooth control over the motors' duty cycle.

Table 3.28 Pump Design for the Year 2015 and 2030

Year	Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
2015	1,156	6	289	4	2	1,156	1,156	578	578	289	289
2030	1,420	6	355	4	2	1,420	1,420	710	722.5	355	355

Augmentation / Rehabilitation Cost

The total cost for rehabilitation of Mumfordganj SPS is Rs. 74.87 million including dedicated electrical feeders. Civil cost is Rs. 19.10 million and E&M cost is Rs. 25.03 million.

Table 3.29 Augmentation and Rehabilitation Cost of Mumfordganj Pumping Station

	Amount (Thousand Rs.)
Civil	19,100
E & M	25,030
Electrical Feeder	3,400
Rising main	27,340
Total	74,870

Land acquisition ($6,500\ m^2$)	45,500

3.3 PROPOSED SEWAGE COLLECTION AND TREATMENT SYSTEM

3.3.1 Proposed System

The new facilities proposed for this district are:

- Construction of new trunk sewers – 8.01 km.
- Construction of New Rising Mains – 7.55 km
- New SPS at Mori gate
- New SPS at Mumfordganj
- 80 mld Sewage Treatment Plant at Rajapur

Design Criteria for the facilities has been given in Chapter 1, design and details are presented here.

3.3.2 Proposed Gravity Sewers

As part of master plan recommendations, certain routes and flows for proposed trunk sewer (gravity and rising mains) have been defined for District D. Summary of these have been shown in Key plan of proposed sewer for District D. Details of these gravity sewers are given in Table 3.30 in brief.

Table 3.30 Proposed Gravity Sewers for District D

Pipe line No.	Node no.	Road	From	To	Peak Flow in 2030 (lps)
1D	1-2	Thorn hill road	Bar Council Bhawan	Junction of Stanley Road	90
2D	2-4	Stanley Road	UPSEB office	Junction of Muir Road	186
4D	4-18	Stanley Road	Junction of Muir Road	Mumfordganj PS	296
3D	3-4	Muir Road	Ashok Nagar Chowk	Junction of Stanley Road	110
5D	17-18	Pt. Ganga Nath Jha Marg	G N Jha Hospital	Mumfordganj PS	1,206
Total					

Pipe line No.	Node no.	Dia.	Length (m)	Material	Installation cost (Million Rs.)
1D	1-2	450	1,587	RCC	
2D	2-4	600	892	RCC	37.49
4D	4-18	700	1,126	RCC	
3D	3-4	500	1,965	RCC	14.16
5D	17-18	1200	1,106	RCC	35.30
Total			8,010		86.95

Line 7D intercepts the Nalas d/s of the STP site and up to the Rasoolabad Ghat, bringing their flows to the Rajapur STP by gravity.

- **Alignment details of Pipe line 1D (node 1-2) (Ref. Sheet No. 25-27)**

General

Proposed sewer starts from node 1 (Bar Council Bhawan) towards Stanley Road (node 2) along the Thorn hill road via Civil Lines area. There is one existing sewer and one water main on one side of the road, hence sewer has been proposed on left side of the road parallel to the existing drain. An abandoned sewer also exists nearby.

Constraints

Alignment is clear and there is no problem except crossing of Lucknow – Kanpur road.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 90 lps. Diameter of the pipe is 450 mm and slope is 1 in 500.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.1.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.2 and 1.3.3.

- **Alignment details of Pipe line 2D (node 2-4) (Ref. Sheet No. 27-29)**

General

Proposed sewer starts from node 2 (UPPCL office) at Stanley Road, where it crosses Stanley road and comes on the right side of the road. Further the sewer has been proposed on right side of the Stanley road up to Mauhal chowk where it crosses the Stanley road and comes on left side as there are two existing services on right side of the road, one is existing water main of 10” dia and other is OFC cable. Finally, it ends at the junction of Muir road along Stanley road.

Constraints

Alignment is clear and there is not any problem except two major crossings as described above.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 186 lps. Diameter of the pipe is 600 mm and slope is 1 in 500.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.1.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.2 and 1.3.3.

- **Alignment details of Pipe line 3D (node 3-4) (Ref. Sheet No. 31-34)**

General

Proposed sewer starts from (node 3) Ashok Nagar Chowk at Muir Road near Yogendra Puri Colony and has been proposed on left side of the road, as there are two existing services on right side of the road, one is existing water main and other is OFC cable. The pipe line passes through Railway Colony, Maa Kali Temple, Traffic Police Line and finally ends at node 4 at Junction of Stanley road.

Constraints

Alignment is clear and there is no problem except for some part of the reach from ch. 900 m to ch. 1500 m, which is slightly congested.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 110 lps. Diameter of the pipe is 500 mm and slope is 1 in 700.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.4.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.5 and 1.3.6.

- **Alignment details of Pipe line 4D (node 4-18) (Ref. Sheet No. 29-30)**

General

From (node 4), the trunk main has been proposed up to Mumfordganj PS (node 18). Trunk sewer has been proposed on left side of the Stanley road as there are two existing services on right side of the road, one is existing water main and other is OFC cable. The sewer passes through Traffic Police Line area, Katchery road, Tej Bahadur Sapru Hospital, Allahabad Bible Seminary and finally ends at Mumfordganj Raw Sewage Pumping Station.

Constraints

There is no major constraint however the sewer terminates at the inlet of new proposed pumping station at Mumfordganj, hence it has been designed accordingly.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 296 lps. Diameter of the pipe is 700 mm and slope is 1 in 500.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.1.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.2 and 1.3.3.

- **Alignment details of Pipe line 5D (node 17-18) (Ref. Sheet No. 35-37)**

General

The proposed sewer is an extension of the rising main from Alopibagh to Mumfordganj Pumping station. Since this point (ch. 3100 m) near G N Jha Hospital (node 17) is a ridge point of this pipe line hence rising main from Alopibagh discharges to the receiving chamber at this point. Further sewage from this point is carried to the Mumfordganj PS (node 18) by gravity.

Trunk sewer has been proposed on left side of the road, which passes through the premises of Pump house at ch. 3500 m as there is no space because of existing rising main on other side of the road that is to be abandoned by renovating the Mumfordganj PS.

Constraints

The pipe line is to pass through existing pump house premises as described. In addition, the other major constraint is the intersection of Bali Road, where the pipe crosses the Krishna Bannered mar and pipe comes to right side of the road as the existing rising main has been laid on left side onwards. Finally the proposed sewer terminates at the inlet of new proposed pumping station at Mumfordganj; hence it has been designed accordingly

Hydraulic Design

The sewer has been designed for a maximum peak flow of 1206 lps. Diameter of the pipe is 1200 mm and slope is 1 in 700.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.7.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.8 and 1.3.9.

- **Alignment details of Pipe line 6D (node 19-STP)**

General

The proposed intercepting sewer is along the Rajapur Nala to intercept lateral drains discharging to the nala. Since this nala is already being tapped on down stream side near Rajapur Sewage Treatment Plant; hence there is no need of providing intercepting sewer at this location.

- **Alignment details of Pipe line 7D (node 20-STP) (Ref. Sheet No. 38-40)**

General

The intercepting sewer has been proposed parallel to River bank from the drain near Rasoolabad ghat towards Rajapur Sewage Treatment Plant. Since the flow is very less in initial stretches hence minimum velocity can not be obtained in initial reach even by reducing pipe dia. This area is also being used as grave yard. Most of the houses have been built up to the last edge of the embankment and after that slope is very steep up to the river bed.

Constraints

Main constraint is that the flow in these nalas is very less. Nalas, which are to be tapped at some higher level so that invert level at termination point of interceptor remains approx. equal to the level of Rajapur Nala and adequate slope can be provided to obtain minimum velocity for such a less flow. Hence most of these nalas requires re modeling and raising of invert level at tapping point.

Hydraulic Design

Peak flow in these nalas has been taken from Master plan (Table 7.1, Drain 11 to 11D). Diameter of the pipe is 150 mm in initial stretches after that is increases as the flow increases and maximum dia. of the pipe is 600 mm.

Detailed SEWERCAD data output and analysis has been given in Annexure 1.3.10.

Depth of Sewer

Detailed description of sewer and manholes has been given in Annexure 1.3.11 and 1.3.12.

- **Crossings**

Details of road /nala crossings and railway crossing culverts are given in Table 3.31.

Table 3.31 Details of Road /Nala Crossings

	No. of Manholes	Nala Crossing		Road Crossing (Ordinary)		Road Crossing by Trench less		Railway Crossing/ Culvert	
		No.	Total length (m)	No.	Total length (m)	No.	Total length (m)	No.	Total length, (m)
Pipe line 1D, 2D & 4D	68	3	10	7	65	10	235	-	-
Pipe line 3D	47	1	6	7	58	1	27	-	-
Pipe line 5D	39	2	10	9	107	2	60	-	-

Material:

Material of the trunk sewer shall be RCC pipe of NP3 class made of Sulphates resisting Cement. Since most of the pipe line is along the main road hence NP3 pipe has been proposed. Wherever the pipe is to cross the road through trench less technology, RCC NP4 pipe has been proposed.

Bedding:

Two types of bedding have been mainly used for all proposed trunk sewers in district “D”. Trunk sewers up to depth 5 m have been proposed with Reinforced Cement Concrete bedding with 0.4% steel (RCCB) type “C” bedding, and trunk sewers up to 9 m depth have been provided with type “D” bedding i.e. Reinforced Concrete Arch (RCA) with 1% steel at top and granular material at bottom.

3.3.3 Rising Main(s)

All rising mains have been designed for design year 2030 and the design method is in accordance with the guidelines specified in CPHEEO manual for design of most economical size of rising main.

There are three rising main (s) in District D under the study. Details of these are given in Table 3.32.

Table 3.32 Proposed Rising Main(s) for District D

	From	To	Peak Flow in 2030 (lps)	Dia. (mm)	Length (m)	Material	Installation Cost (Million Rs.)
8D	Morigate PS	Alopibagh PS	786	500	1,800	PSC	11.84
9D	Alopibagh PS	GN Jha Hospital (node 17) -ridge line	1,064	1000	3,100	PSC	32.80
10D	Mumfordganj PS	Rajapur STP	1,420	1100	2,650	PSC	27.34
Total					7,550		71.98

- ❑ **Alignment details of Rising Main (8D) (Ref. Sheet No. 54-56)**

General

As per master plan recommendations, a new pumping station is to be installed at Mori gate Nala to tap it because there is no space to provide additional pumps in existing pumping station at Mori gate.

Rising main has been proposed along the nala in initial stretches (ch. 1639 m - ch. 1150 m) after that it crosses National high way no. 2, below the Shastri Bridge. Again it is parallel to the nala up to ch. 900 m where it crosses Sangam road and the nala also. After that pipe line has been proposed on left side of the road up to ch. 400 m where it crosses one nala and the road leads to Fort. Since there are two services on right side of the road, one is OFC cable and other is PSC water main (500 mm dia.) hence it is necessary to cross the road. After crossing this road pipe line has been proposed on left side of this road up to Alopibagh pumping station

Constraints

There is no problem in this alignment except the nala crossings and road crossings as defined above. However this rising main terminates at the inlet chamber of proposed augmentation at Alopibagh Raw Sewage Pumping Station. Invert level of this receiving chamber has been kept designed such that invert level of the proposed additional sump will be same as of existing sump.

Hydraulic Design

As per design, the required size:

Diameter – 500 mm
Length – 1,800 m
Material – PSC

Minimum cover for laying of the rising main has been considered as 1.5 m from the ground level.

- **Alignment details of Rising Main (9D) (Ref. Sheet No. 57-62)**

General

Presently sewage from the Alopibagh is discharged towards Gaughat Raw Sewage Pumping Station. However, as per master plan recommendation this sewage has to be carried out towards Mumfordganj Raw Sewage Pumping Station and ultimately to Rajapur STP. Accordingly rising main has been proposed from Augmented Alopibagh pumping station, parallel to Bahraini road and further parallel to Jawaharlal All Nehru Marg towards Mumfordganj PS.
Rising main passes through Tulare Baugh, Tag ore town, Blazon chowk, Indian Press Chowk, An and Bhawan, D J hostel and Allahabad university.

Rising main is parallel to Jawaharlal Lal Nehru Marg up to LIC road. Further there are two water mains and one existing brick sewer on right side hence it has been kept on the left side again up to G N Jha hostel at Pt. Ganga Nath Jha Marg where it terminates to the receiving man hole at ch. 3100m.

Constraints

There are under ground water mains, drains and existing sewers on both sides of Jawaharlal All Nehru mar. Further there are two Railway embankments which are to be crossed at ch. 550 m and ch. 825 m. Further there are two major crossing at Blazon chowk and Indian Press chowk which are to be taken care of while executing the work.

In addition to these there are some important roads, which are required to be crossed by trench less technology.

Hydraulic Design

As per design, the required size:

Diameter – 1000 mm
Length – 3,100 m
Material – PSC

Ground levels from Alopibagh PS up to this point are continuously rising and after wards ground levels are decreasing, hence this point onwards this rising main converts to the gravity pipe line (5D) up to Mumfordganj PS.

Minimum cover for laying of the rising main has been considered as 1.5 m from the ground level.

- **Alignment details of Rising Main (10D) (Ref. Sheet No. 63-67)**

General

Existing rising main from Mumfordganj PS, discharge in to existing sewer towards Alopibagh pumping station. However as per master plan recommendations, proposed rising main from Augmented Mumfordganj PS (new PS) is to discharge towards Rajapur Sewage Treatment Plant. Rising main first crosses the Stanley road and after that it has been proposed parallel to the road on left side of it.

After chainage 900 m, cantonment area starts on both sides of the road. Rising main will be along the road unto ch. 1850 m after that it will enter to the cantonment area and finally terminates at the inlet chamber of Rajapur Sewage Treatment Plant.

Constraints

There are two major constraints in this alignment one is crossing of Stanley road and other constraint is that rising main is to pass through cantonment area.

Hydraulic Design

As per design, the required size:

Diameter – 1100 mm
Length – 2,559 m
Material – PSC

Minimum cover for laying of the rising main has been considered as 1.5 m from the ground level.

Crossings

Details of road /nala crossings and railway crossing culverts are given in Table 3.33.

Table 3.33 Details of Road /Nala Crossings

	Nala Crossing		Road Crossing (Ordinary)		Road Crossing by Trenchless		Railway Crossing/ Culvert	
	No.	Total length (m)	No.	Total length (m)	No.	Total length (m)	No.	Total length (m)
Morigate PS to Alopibagh PS (8D)	2	13	5	90	1	11	-	-
Alopibagh PS to Mumfordganj PS (9D)	-	-	23	190	7	160	2	10
Mumfordganj PS to Rajapur Sewage Treatment Plant (10D)	2	17	7	28	1	16	-	-

Valves

Details of valves are given in Table 3.34.

Table 3.34 Details of Valves

	Air Valve		Scour Valve		Isolation Valve
	No.	Size (mm)	No	Size (mm)	No.
Morigate PS to Alopibagh PS (8D)	4	100	2	400	1
Alopibagh PS to Mumfordganj PS (9D)	5	150	3	500	2
Mumfordganj PS to Rajapur Sewage Treatment Plant (10D)	4	150	3	600	2

Bedding

For all rising main(s) in District D, PCC bedding type “B” has been used.

3.3.4 Proposed Rajapur STP (ref. drg. sheets number 177 – 183)

(1) Design Flow

The design flow as specified in the Master Plan is 65 mld for 2015, and 80 mld ultimate capacity.

(2) Sitting of the STP

Two possible locations were identified in the MP, for sitting the Rajapur STP, ref photos attached below.


Rajapur STP site – Alternative I


Rajapur STP site – Alternative II

Alternative Sites of Rajapur STP site

Two locations were examined for siting the STP, both sites are located along the bank of the Rajapur Nala and are at a very low elevation of R.L. 79.00 to 81.00. The HFL of Ganga River is R.L. 87.9. Hence, the STP campus at both sites would be required to be enclosed in a bund of approx. 9-10 m height. Such a high bund entails large capital expenditure. However, as a substantial part of the district is under the administration of Cantonment Board and obtaining land in this part for involves administrative delays, and as the area required for the STP is not available within the remainder settled areas, perforce the STP has to be located in the low lying area.

The main points to be noted for site labeled Alternative I, are:

- All the main tributaries of Rajapur Nala join the Nala upstream of this site. Thus the need for interceptors is minimized.
- A few small Nalas located downstream of the site, up to the Rasoolabad Ghat can be intercepted by gravity.
- The site is the winter habitat of a number of migratory birds.

For site labeled Alternative II, the points of consideration are:

- A number of Nalas d/s of the site have to be tapped and brought back to the site by providing pumping arrangements.
- The site is the winter habitat of a number of migratory birds.

Both sites are environmentally not acceptable. However, in absence of a better option, Alternative I is chosen as it minimizes the pumping requirements.

(3) Raw Sewage Characteristics

Ref the discussion in Chapter 1, the raw sewage characteristics fixed for Numaya Dahi STP are as follows:

Table 3.35 Raw Sewage Characteristics for Rajapur STP

Sr.	Parameter	Numaya Dahi STP	
		2015	2030
	Minimum Temperature, ^oC	20	20
2	pH	6-8.5	6-8.5
3	Biochemical Oxygen Demand (BOD_5), mg/l	103	250
4	Total Suspended Solids, mg/l	185	450
5	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$

(4) Treated Effluent Quality

Table 3.36 Treated Effluent Quality

Sr.	Parameter	Value (Irrigation Field/River)
1	pH	5.5 – 9.0
2	Biochemical Oxygen Demand, mg/l	< 30
3	Total Suspended Solids, mg/l	< 50
4	Faecal Coliform Count, MPN/100ml	<10,000

(5) Treated Effluent Disposal

The treated effluent from the Rajapur STP will be discharged back to the Rajapur Nala, d/s of the STP site.

The water level in the effluent sump is maintained at R.L. 82.00. Hence, during normal i.e. non-flood conditions, gravity discharge of the effluent would be possible. When the water level of the Rajapur Nala rises above R.L. 82.00, the treated effluent will have to be pumped into the Nala. For this purpose, an effluent sump cum pump house has been provided in the STP.

(6) Treatment Technology

As stated earlier, the STP site is low lying and needs to be enclosed in a flood protection bund, the cost of which has been calculated to be approx. Rs. 0.115 million / meter length of the bund. To minimize this cost, a treatment technology that minimizes the land requirements appears to be advantageous. Fluidized Aerobic Bio-reactor (FAB) is one such technology.

The requirement of land area minimization is to be balanced against the requirements of low power consumption and process reliability in the face of long power cuts. The power consumed by a process can be quantified and taken into account in its life cycle cost, as explained below. However, the requirement of process reliability in the face of long power cuts is more qualitative in nature. In general, aerobic processes require a certain start-up time after an extended power cut, as during the power cut the aerobic conditions in the reactor are destroyed due to lack of oxygen and the wastewater becomes septic. UASB process is an anaerobic process and hence, offers greater reliability if frequent power cuts is envisaged.

In Allahabad there is a large power deficit. Even the present treatment facilities and pumping stations are facing problems; pumping stations are not operated for long hours because of power cuts. DG sets are installed in some of the facilities as back-up power source but as diesel for their operation is not available, they do not effectively address the problem.

For comparative evaluation of various possible alternative technologies, life cycle cost parameter is used. Life cycle cost includes, apart from the capital cost, O&M cost for life-cycle of the STP, usually taken as 30 years. The O&M cost for thirty years is capitalized and added to the capital cost to arrive at the life cycle cost. The O&M costs include cost of power consumed, manpower required for STP operation, cost of chemicals added, if any, and cost of maintenance of civil and E&M works.
In view of the foregoing discussion, a life cycle cost evaluation was carried out for the following treatment options, to arrive at the preferred option:

(a) FAB process
(b) UASB reactor followed by aeration reactor with 4 hr retention time
(c) UASB reactor followed by aerated lagoons
(d) Activated Sludge Process (ASP)
(e) UASB reactor followed by aerated lagoons, with power generation
(f) Activated Sludge Process, with power generation

Processes (a) and (b) offer the advantage of low land area requirements, but have high power requirements. Process (c) requires comparatively larger land area, for lagoons, but power requirement is lower. ASP cuts down on neither power nor land but is a proven process, used very commonly in India. Processes (e) and (f) offer the advantage of resource recovery and the power generated can be used to cut down the net power required from UPPCL.

The life-cycle cost evaluation is presented in Table 3.38; UASB followed by aerated lagoons and with power generation works out to be the most economical option and has been adopted as the preferred option for Rajapur site.

(7) Design Methodology and Design

Design methodology is as per standard textbooks. Process Flow diagram is given in Figure 1.3.

(8) Cost of Works

Table 3.37 Construction Cost of Rajapur STP

	Amount (Thousand Rs.)
Civil	304,400
Embankment	274,380
E & M	4,900
Total	583,680

Land acquisition	32,800

Table 3.38 Comparison of Treatment Technologies for Rajapur STP

Parameter		FAB + Chlorination	UASB + Aeration Lagoons + Chlorination	ASP + chlorination	UASB + Mechanical Aeration (4 hr HRT) + Chlorination	UASB + Aeration Lagoons + Chlorination with power generation	ASP + chlorination with power generation
Land	Land area (Ha) required for ultimate capacity	5.4	32	18.4	12	34	20.4
	Land Cost	5.20	30.83	17.72	11.56	32.75	19.65
Bund	Bund length (m)	940	2280	560	1400	2289	1,73
	Bund cost	108.1	262.2	64.4	161	263.3	203.9
Construction Cost	Civil	202.3	179.2	264	190.4	177.6	264
	E&M	202.3	76.8	176	81.6	118.4	216
Total Capital Expenditure		**517.90****	**549.03**	**522.12**	**444.56**	**592.01**	**703.57**
Process Power	Power requirement (kW)*	973.48**	305	720	630	115	420
	Annual Power Cost	27.7	8.7	20.5	17.9	3.3	12.0
O&M cost, excluding power		12.6	10.6	14.3	10.9	10.7	14.5
Total O&M expenditure		**40.3**	**19.2**	**34.8**	**28.9**	**14.0**	**26.5**
NPV of 30 yrs. O&M cost at discount rate of 8%		**550.7**	**263.0**	**475.6**	**394.4**	**191.3**	**361.6**
Life cycle Cost		**1,068.6**	**812.0**	**997.7**	**838.9**	**783.3**	**1065.1**
RANK		6	2	4	3	1	5

Notes: ** Based on information received from the supplier
All costs in Rs. Million
Land Cost @ Rs. 0.9633 million / Ha
Bund cost @ Rs. 0.115 million per RM
* exclusive of inlet and effluent pumping
SDB considered for Sludge dewatering
Power cost @ 3.25 per unit
Civil maintenance cost @ 3% of capital cost
E&M maintenance cost @ 0.5% of capital cost

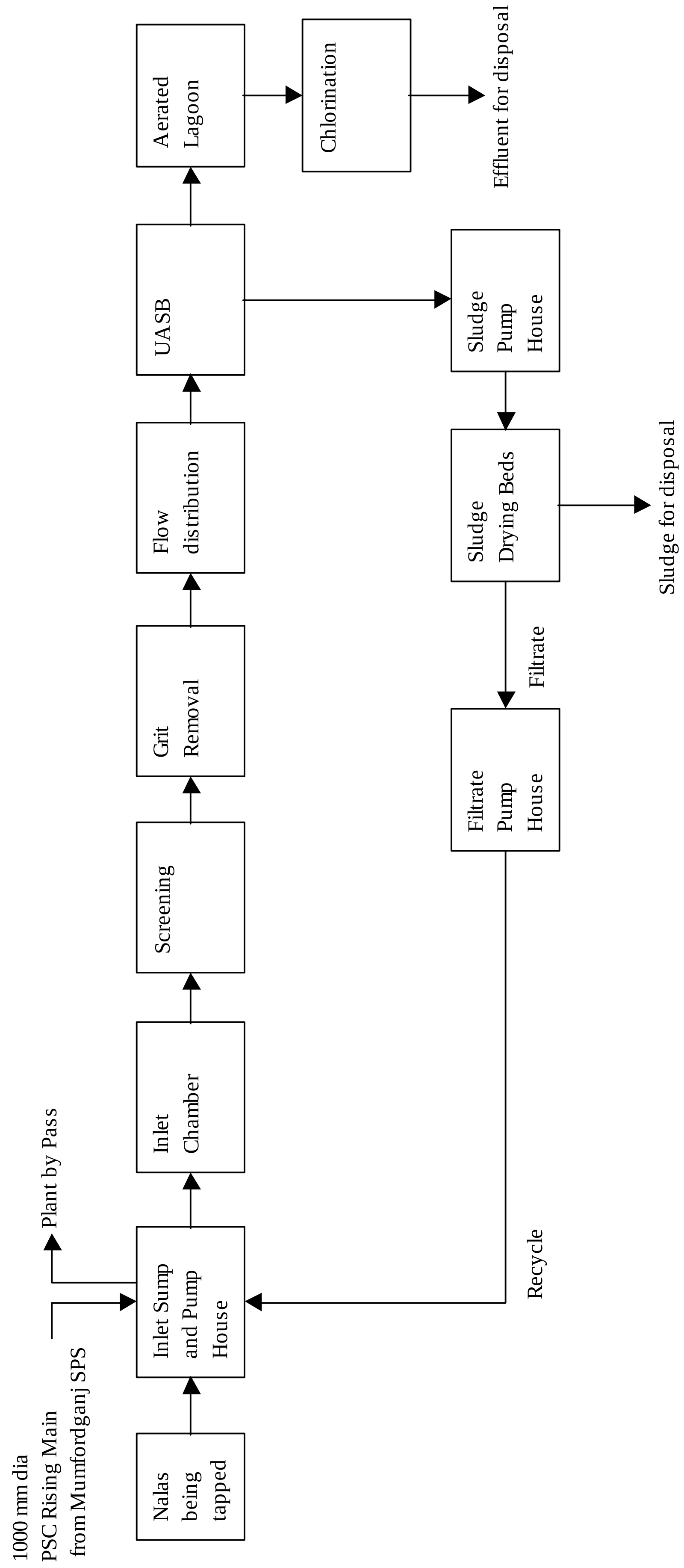


Figure 3.1 Process Flow Diagram for Rajapur STP

CHAPTER 4

PROVISIONS FOR DISTRICT B AND DISTRICT E

CHAPTER 4 PROVISIONS FOR DISTRICT B AND DISTRICT E

4.1 INTRODUCTION

4.1.1 General

(1) District B

Sewerage District B lies along the Southwestern municipal boundary of Allahabad. The population density in this district is less compared to Districts A and D, so is the extent of urbanization and infrastructure development. In terms of sewerage infrastructure, a small area lying north and west of Nurullah Road is sewered; the sewers carry the flow to Lukerganj SPS, the only existing SPS in the district. This SPS pumps the wastewater to an existing sewer laid along Saukat Ali Marg, the sewer carries the wastewater to Gaughat SPS.

Wastewater from one section of the unsewered part of the district flows westwards into a nala, which joins the Sasur Khaderi River. Another section drains into Ghaghar nala. Both Ghaghar Nala and Sasur Khaderi fall into Yamuna River.

(2) District E

Sewerage District E is the northwestern outlier of urban Allahabad. A southern channel of Ganga flows along its Northern boundary. It has no sewerage infrastructure at present.

4.1.2 Population

The present and estimated future population in Master Plan for District B is as follows:

Table 4.1 Population of District B

Year	Population within Municipal Area	Population outside Municipal Area	Floating Population	Total
2003	105,767	13,099	1,130	119,996
2015	159,412	20,337	1,784	181,533
2030	234,462	25,332	2,694	262,488

The present and estimated future population in Master Plan for District E is as follows:

Table 4.2 Population of District E

Year	Population within Municipal Area	Population outside Municipal Area	Floating Population	Total
2003	96,858	0	0	96,858
2015	153,819	0	0	153,819
2030	258,872	0	0	258,872

4.1.3 Present and Future Waste Water flows

The flows of District B as given in the Master Plan, are reproduced in Table 4.3.

Table 4.3 Present and Estimated Future Wastewater Flows by Sub-catchment in District B

District	Sub-Catch ment	Resident									Floating			Total		
		Inside of Municipality			Outside of Municipality			Total								
		2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030
District B	B-1	14.79	18.41	22.45	0.00	0.00	0.00	14.79	18.41	22.45	0.23	0.31	0.42	15.02	18.72	22.87
	B-2	6.89	9.49	13.89	0.00	0.00	0.00	6.89	9.49	13.89	0.00	0.00	0.00	6.89	9.49	13.89
	FSA 2	0.00	0.00	0.00	2.69	3.56	3.93	2.69	3.56	3.93	0.00	0.00	0.00	2.69	3.56	3.93
	Total	21.68	27.90	36.34	2.69	3.56	3.93	24.37	31.46	40.27	0.23	0.31	0.42	24.60	31.77	40.69

The flows of District E as given in the Master Plan, are reproduced in Table 4.4.

Table 4.4 Present and Estimated Future Wastewater Flows by Sub-catchment in District E

District	Sub-Catch ment	Resident									Floating			Total		
		Inside of Municipality			Outside of Municipality			Total								
		2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030	2003	2015	2030
District E	E-1	4.72	7.35	13.79	0.00	0.00	0.00	4.72	7.35	13.79	0.00	0.00	0.00	4.72	7.35	13.79
	E-2	2.37	3.23	4.94	0.00	0.00	0.00	2.37	3.23	4.94	0.00	0.00	0.00	2.37	3.23	4.94
	E-3	3.18	4.24	6.23	0.00	0.00	0.00	3.18	4.24	6.23	0.00	0.00	0.00	3.18	4.24	6.23
	E-4	4.89	5.95	7.37	0.00	0.00	0.00	4.89	5.95	7.37	0.00	0.00	0.00	4.89	5.95	7.37
	E-5	4.71	6.15	7.79	0.00	0.00	0.00	4.71	6.15	7.79	0.00	0.00	0.00	4.71	6.15	7.79
	Total	19.86	26.92	40.13	0.00	0.00	0.00	19.86	26.92	40.13	0.00	0.00	0.00	19.86	26.92	40.13

4.1.4 Existing and Proposed Sewerage Pattern

(1) District B

A small area lying north and west of Nurullah Road is sewered; the sewers carry the flow to Lukerganj SPS, the only existing SPS in the district. This SPS pumps the wastewater to an existing sewer laid along Saukat Ali Marg, the sewer carries the wastewater to Gaughat SPS. Wastewater from one section of the unsewered part of the district flows westwards into a nala, which joins the Sasur Khaderi River. Another section drains into Ghaghar nala. Both Ghaghar Nala and Sasur Khaderi fall into the Yamuna.

(2) District E

District E has no existing sewage collection or treatment facilities.

4.1.5 Proposed System

(1) District B

The proposed augmentation/ new construction measures, under priority projects, for this district are:

- Construction of new trunk sewers – 4.92 km.
- Construction of new Rising Mains – 7.9 km
- Construction of a new SPS to tap Ghaghar Nala - 94.2 mld in 2003, 92.9 mld in 2015, 94.17 mld in 2030.
- Construction of a new SPS at Sasur Khaderi - 32 mld in 2015, 57 mld in 2030.
- Construction of a new STP at Numaya Dahi – 50 mld capacity in 2015.
- Treated Effluent Channel from Numaya Dahi Sewage Treatment Plant to outfall into Yamuna, at Bisona Village

(2) District E

- Construction of a new STP at Ponghat – 10 mld capacity in 2015.
- Construction of a new STP at Kodara – 15 mld capacity in 2015, 30 mld capacity in 2030.

4.1.6 Cost Summary

Summary of cost of District B and E have been given in Table 4.5 and 4.6, respectively.

Table 4.5 Summary of Estimated Project Costs (District B)

Sr.	Item	Capital Costs (Million Rs.)	Annual O&M Costs (Million Rs.)
1	Branch Sewers		
	Sub-Total	**0.00**	**0.00**
2	Trunk Sewers - new		
2.1	Sasur Khaderi Pumping Station to Ghaghar Nala Pumping Station	8.98	0.04
2.2	Lukerganj Pumping Station to Ghaghar Nala Pumping Station	34.70	0.17
2.3	Ghaghar small nalas interceptor	6.30	0.03
	Sub-Total	**49.98**	**0.25**
3	Trunks sewers - replace		
	Sub-Total	**0.00**	**0.00**
4	Trunk sewers - rehab (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
5	Force Mains (itemize by facility)		
5.1	Sasur Khaderi Pumping Station to Ghaghar Nala Pumping Station	1.74	0.00
5.2	Ghaghar Nala Pumping Station to Numaya Dahi STP	68.60	0.17
	Sub-Total	**70.34**	**0.17**
6	Pumping Station - new (itemize by facility)		
6.1	Sasur Khaderi including Electrical Feeder	38.94	2.81
6.2	Ghaghar Nala	49.36	10.20
	Sub-Total	**88.30**	**13.02**
7	Pump Stations Improved (itemize by facility)		
7.1	Lukerganj	16.76	1.67
	Sub-Total	**16.76**	**1.67**
8	Treatment Plants - new (itemize by facility)		
8.1	Numaya Dahi including Electrical Feeder	327.92	3.74
	Sub-Total	**327.92**	**3.74**
9	Treatment Plants - improved		
	Sub-Total	**0.0**	**0.0**
10	**Direct Construction Costs (Total)**	**553.30**	**18.85**

Table 4.6 Summary of Estimated Project Costs (District E)

Sr.	Item	Capital Costs (Million Rs.)	Annual O&M Costs (Million Rs.)
1	Branch Sewers		
	Sub-Total	**0.00**	**0.00**
2	Trunk Sewers - new		
	Sub-Total	**0.00**	**0.00**
3	Trunks sewers - replace		
	Sub-Total	**0.00**	**0.00**
4	Trunk sewers - rehab (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
5	Force Mains (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
6	Pumping Station - new (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
7	Pump Stations Improved (itemize by facility)		
	Sub-Total	**0.00**	**0.00**
8	Treatment Plants - new (itemize by facility)		
8.1	Ponghat including Electrical Feeder	83.22	2.56
8.2	Kodara including Electrical Feeder	85.52	5.04
	Sub-Total	**168.74**	**7.60**
9	Treatment Plants - improved		
	Sub-Total	**0.0**	**0.0**
10	**Direct Construction Costs (Total)**	**168.74**	**7.60**

4.2 EXISTING SYSTEM DESCRIPTION

4.2.1 General

The existing sewerage system in District B is slightly developed and only a small area lying north and west of Nurullah Road is sewered and drains to Lukerganj SPS. Lukerganj SPS is situated near the boundary of district A and B. Presently the sewage from Lukerganj PS is discharged to the old existing sewer of 22” x 33” at Saukat Ali Marg, further to Gaughat PS in district A. This sewer is very old and at present in poor condition (Refer Sheet no. 83-87).

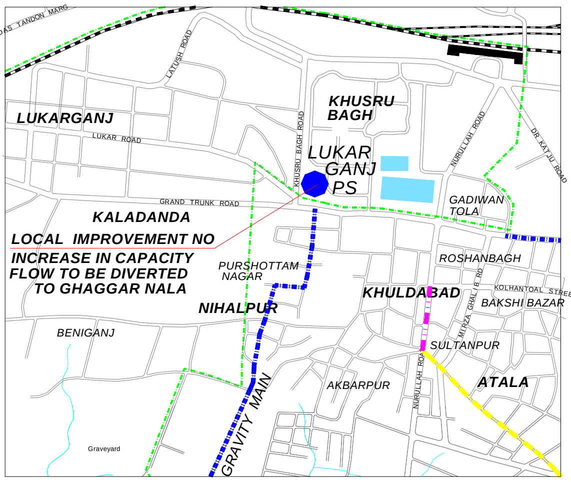
Since, entire wastewater of Allahabad converges towards the Gaughat SPS, result in overflow at Gaughat. Hence in master plan recommendations, it has been proposed that this sewage from Lukerganj PS will be diverted to Ghaghar Nala PS.

Some part of the district B, which is unsewered, discharges to west side in a nala that ultimately discharges to Sasur Khaderi River and some part discharges to Ghaghar Nala. Both of these nalas discharges finally to Yamuna. Presently existing facilities in District B are as:

- Trunk sewers -
- Lukerganj PS of 18.3 mld peak capacity.

4.2.2 Existing Pumping Station

(1) Lukerganj Pumping Station



Preamble

This pumping station is located in the District B, close to the boundary of dist A and B. It was commissioned in the year 1964 to handle the discharges from the 27´´ sewer catering to Lukerganj area. The Pumping Station discharges wastewater flow to the old 22´´ x 33´´ sewer on Shaukat Ali Marg. The discharge will be diverted to a new gravity sewer leading to Ghaghar Nala Pumping Station.

Presently it has an average pumping capacity of 9.2 mld and peak capacity of 18.3 mld with a 50 % derating factor.

Existing System and Status of E&M Equipment:

- Wet Sump

Table 4.7 Wet Sump of Lukerganj Pumping Station

Capacity (m^3)	Retention Time (Minutes)		Adequate	Additional Sump (m^3)
	Avg. flow in 2030	Peak flow in 2030		
44.5	3.5	1.7	No	82.5

- Pumps and Motors

Table 4.8 Pumps and Motors of Lukerganj Pumping Station

Disch. Capacity (lps)	Pumping Head (m)	Nos.	Pump Type	Pump Make	Motor capacity (kW)	Motor Type
105	7	2	VNC	MM	12.5	Sq. Cage TEFC
35.5	7	3	VNC	MM	5	Sq. Cage TEFC

TEFC – Totally Enclosed Fan Cooled
VNC – Vertical Non Clog

- Rising main- 600 mm dia, Length = 30 meter.

- Electrical System

Incoming Supply - The electric supply is taken from Over Head Distribution system of UPPCL at medium voltage of 415V from a nearby 250 kVA transformer.

1) LT Panel - One Incoming SFU and five outgoing feeders for operation of the five existing pumps , provided through protective switch gears.
2) Cables – PVC insulated and PVC sheathed armoured cable.
3) Starters - Star delta / ATS starters are provided for starting the pumps.
4) Transformer – Not applicable

The LT cable termination at transformer is completely damaged and to be remade immediately.

The details of the available equipment differ from those shown in the Master Plan.

Future Flows

The total installed capacity is 318 lps and the allowable pumping capacity with a 50% de- rating is 212. Anticipated peak flows from the catchment is of the order of:

- 104 lps in the year 2003
- 217 lps in the year 2015
- 423 lps in the year 2030

Inadequacies of the Existing System

The pumping station discharges wastewater flow to the old sewer on Shaukat Ali Marg, which is at present in poor condition and hydraulically overloaded. The present sump is considered inadequate for present and ultimate peak discharges. The other shortcomings are listed below:

- No Mechanical bar screen
- Electrical Panels are to be rewired
- Removal of screening is not done on regular basis
- Supply of Diesel is inadequate and irregular.

Rehabilitation / Upgradation Proposed

The allowable pumping capacity is sufficient to meet the present peak flow and that of the year 2015 but the ultimate peak flow exceeds the allowable pumping capacity in the year 2030.

Dedicated feeder from other source is proposed from nearby sub-station of UPPCL. The cost is taken separately.

Rehabilitation / Up gradation Measures:

- **Immediate**
  Install two mechanical bar screens (10 mm opening) of 0.75 m wide plus one manual standby and two manual coarse bar screens (40 mm size opening) of 1 m wide and 2 m. high to be installed at 45^0 with the horizontal plane. One set of conveyor belt is provided for removal of floating for disposal. It is proposed to add a wet sump of 82.5 m^3 capacity.
  Dedicated feeder shall be provided.

- **Pump Design for the year 2030**

Table 4.9 Pump Design for the year 2030 for Lukerganj SPS

Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
423	3	157	2	1	423	314	211.5	157	105.7	-
	2	109	1	1		109		109		109
Total	5					423		266		109

<u>Rehabilitation Cost</u>

The total cost for rehabilitation of Lukerganj SPS is Rs 16.76 million including dedicated electrical feeders. Civil cost is Rs. 5.00 million and E&M cost is Rs 8.36 million.

Table 4.10 Rehabilitation Cost of Lukerganj Pumping Station

	Amount (Thousand Rs.)
Civil	5,000
E & M	8,360
Electrical Feeder	3,400
Total	16,760

4.3 PROPOSED SEWAGE COLLECTION AND TREATMENT SYSTEM – DISTRICT B

4.3.1 Proposed System

- Construction of new trunk sewers – 4.92 km.
- Construction of new Rising Mains – 7.9 km
- Construction of a new SPS to tap Ghaghar Nala - 94.2 mld in 2003, 92.9 mld in 2015, 94.17 mld in 2030.
- Construction of a new SPS at Sasur Khaderi - 32 mld in 2015, 57 mld in 2030.
- Construction of a new STP at Numaya Dahi – 50 mld capacity in 2015.
- Treated Effluent Channel from Numaya Dahi Sewage Treatment Plant to outfall into Yamuna, at Bisona Village

Design Criteria for the facilities has been given in Section I, design and details are presented here, and drawings are attached in Volume-II.

4.3.2 Proposed Gravity Sewers

As part of master plan recommendations, certain routes and flows for proposed trunk sewer (gravity and rising mains) have been defined for District B. Summary of these have been shown in Key plan of proposed sewer for District B. Details of these gravity sewers are given below in brief:

Table 4.11 Proposed Gravity Sewers for District B

Pipe line No.	Node no.	Road	From	To	Peak Flow in 2030 (lps)	Dia. (mm)	Length (m)	Material	Installation Cost (Million Rs.)
1B	1-3	-	Lukerganj PS	Ghosh Girls Inter College	102	450	1,426	RCC	34.70
3B	3-5	-	Ghosh Girls Inter College	Karamat Ki Chowki	102	450	447	RCC	
5B	5-6	-	Karamat Ki Chowki	Ghaghar Nala PS	762	1000	1,157	RCC	
4B	4-5	-	Sasur Khaderi	Karamat Ki Chowki	660	900	713	RCC	8.98
6B	7-7C-7B-A-6	Interceptor for Nalas 1A, 1B and 1C near Ghaghar Nala	Nala 1C	Ghaghar Nala PS	21-178	350-800	1,178	RCC	6.30
Total							4,921		49.98

- **Alignment details of Pipe line 1B (node 1-3) (Ref. Sheet No. 15-17)**

General

Proposed sewer starts from node 1 (Lukerganj PS). Presently sewage pumped from Lukerganj SPS is being discharged to the existing sewer towards Gaughat pumping station (District A). As per the master plan recommendations, this sewage is to be rerouted towards Ghaghar Nala pumping station (District B). Rising main from Lukerganj SPS is to be diverted towards the proposed sewer out side the pumping station, which will carry sewage to Ghaghar Nala Raw Sewage Pumping Station.
Proposed sewer is from the Lukerganj PS (node 1) up to Ghosh Girls Inter College, near IOCL pipe line Corridor (node 3). The direction of travel is towards Ghaghar PS.

Constraints

Initial approx 200 m of the proposed sewer route is very congested. Since this sewer will be laid at a depth of only 2.0 to 3.0 m, there might not be much problem in laying the sewer; however, some additional safety measures are required to be taken while executing the work.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 102 lps. Diameter of the pipe is 450 mm and slope is 1 in 500.

- **Alignment details of Pipe line 2B (node 2-3) (Ref. Sheet No. 17)**

General

As per master plan a sewer had been proposed between node 2 and 3. On conducting a field survey, it was found that the route lay along a gas pipe line corridor and cannot be used for laying a trunk sewer.
A joint site inspection was held with JICA representatives and it was found that this sewer route was not feasible. At present, sewage of this area is being discharged into the nala, which flows towards Sasur Khaderi River. Hence as an alternative route it was decided that a separate pumping station should be installed at the downstream of this nala just before it falls into the Sasur Khaderi River.
This sewage is to be carried to the Numaya Dahi Sewage Treatment plant; it was not economical to provide a separate rising main up to the STP. Hence it was decided that this sewage can be carried to the trunk main towards Ghaghar nala.

- **Alignment details of Pipe line 3B (node 3-5) (Ref. Sheet No. 17-18)**

General

Proposed sewer starts from node 3 (Ghosh Girls Inter College) unto Karamat Ki Chowki (node 5) where another trunk sewer from Sasur Khaderi merges with it and ultimately flows towards Ghaghar Nala Pumping Station.

Constraints

Since this sewer has to discharge to another proposed gravity sewer at node 5 hence it has been designed accordingly.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 102 lps. Diameter of the pipe is 450 mm and slope is 1 in 500.

- **Alignment details of Pipe line 4B (node 4-5) (Ref. Sheet No. 20-21)**

General

As per the decision taken as in above paragraph, a detailed study was carried out by JICA Study Team and followed by detailed survey carried out by M/s STUP Consultants, it was found that a new Raw Sewage Pumping Station can be provided at the location as mentioned above and a trunk sewer is possible from Sasur Khaderi (node 4) up to Karamat ki Chowki (node 5), where it will discharge to the main trunk sewer from Luker ganj PS to Ghaghar Nala.

Rising main from this pumping station discharges the sewage at the main Numaya road near Sasur Khaderi Bridge.

Constraints

Since this sewer has to discharge to another proposed gravity sewer at node 5 hence it has been designed accordingly.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 660 lps. Diameter of the pipe is 900 mm and slope is 1 in 500.

- **Alignment details of Pipe line 5B (node 5-6) (Ref. Sheet No. 18-19)**

General

From node 5, the trunk main has been proposed up to Ghaghar Nala PS (node 6).

Constraints

There is an existing drain on one side of the road hence sewer has been proposed on other side of the road. The sewer also crosses the Ghaghar nala in this reach. After crossing Nurullah road chainage 2800 m, there are two water mains on both sides of the road up to Ghaghar Nala PS for a length of approx. 230 m. Moreover one rising main of 1000 mm diameter has to be laid up towards Numaya Dahi Sewage Treatment Plant. Hence shifting of these services is required so that proposed sewer and rising main can be laid.

Hydraulic Design

The sewer has been designed for a maximum peak flow of 762 lps. Diameter of the pipe is 1000 mm and slope is 1 in 500.

- **Alignment details of Pipe line 6B (node 7-7C-7B-7A-6) (Refer Sheet no. 22-23)**

General

The intercepting sewer has been proposed by diverting Nala 1C at Harshwardhan Nagar area towards Nala 1B further to Nala 1A and finally to Ghaghar Nala Raw Sewage Pumping Station.

Constraints

Invert level of Nala IC at proposed tapping point is 87.255 m, further down stream of the tapping point, there is steep slope in nala (Il 85.4 m) there for tapping has been done from up stream point. Further, there is some habitation at down stream area (plinth level approx. 86.50 m) and the sewage from these houses is to be diverted to the tapping point: hence IL of first manhole has been decided accordingly.

Since this alignment is a gas pipe line corridor for some distance there fore it is not possible to lay additional sewer hence proposed intercepting sewer will be laid in the existing nala and thus existing nala between ch. 0.00 (MH 1) and ch. 500.00 (MH 14) is to be converted into the sewer.
Another constraint is that the level of Nala 1A is very less and it is not possible to tap this nala at lower level (IL 80-78 m) and divert to Ghaghar Nala Pumping station (TWL of Stilling chamber 83.00 m) therefore it has been proposed to remodel these nalas (nala 1B and 1A) at higher level and then divert to Ghaghar Nala PS through intercepting sewer.

Hydraulic Design

Peak flow in these nalas has been taken from the table no. 7.1 of Master plan (drain 1A, 1B and 1C). Diameter of the pipe is 350 mm in initial stretches after that is increases as the flow increases and maximum dia. of the pipe is 800 mm.

Crossings

Details of road /nala crossings and railway crossing culverts are given in Table 4.12.

Table 4.12 Details of Road /Nala Crossings

	No. of Man-holes	**Nala Crossing**		**Road Crossing (Ordinary)**		**Road Crossing by Trenchless**		**Railway Crossing/ Culvert**	
		No.	**Total length (m)**	**No.**	**Total length (m)**	**No.**	**Total length (m)**	**No.**	**Total length, (m)**
Pipe Line 1B, 3B, and 5B	80	2	14	23	159	5	74	-	-
Pipe Line 4B	16	-	-	4	36	1	9	-	-

Material:

Material of the trunk sewer shall be RCC pipe of NP3 class made of Sulphate resisting Cement. Since most of the pipe line is along the main road hence NP3 pipe has been proposed. Wherever the pipe is to cross the road through trench less technology, RCC NP4 pipe has been proposed.

Bedding:

Two types of bedding have been mainly used for all proposed trunk sewers in district “B”. Trunk sewers up to 5 m depth have been proposed with Reinforced Cement Concrete bedding with 0.4% steel (RCCB) type “C” bedding, and trunk sewers up to 9 m depth have been provided with type “D” bedding i.e. Reinforced Concrete Arch (RCA) with 1% steel at top and granular material at bottom.

4.3.3 Rising Main(s)

(1) District B

All rising mains have been designed for design year 2030 and the design method is in accordance with the guidelines specified in CPHEEO manual for design of most economical size of rising main.

There will be three pumping stations in District B namely the existing Lukerganj and two proposed pumping stations at Ghaghar Nala and Sasur Khaderi.

There are three rising main (s) in District B under the study. Details of these are given in Table 4.13.

Table 4.13 Proposed Rising Mains for District B

Pipe line No.	From	To	Peak Flow in 2030	Dia. (mm)	Length (m)	Material	Installation Cost (Million Rs.)
7B (Existing)	Lukerganj PS	Receiving Chamber (node 1)	423	600	50	CI	0.00
8B	Sasur Khaderi PS	Receiving Chamber (node 4)	660	600	200	CI	1.74
9B	Ghaghar Nala PS	Numaya Dahi STP	1090	1000	7,700	PSC	68.60
Total					7,950		70.34

- **Rising Main from Luker Ganj Raw Sewage Pumping Station to Trunk Sewer 1B (node 1)/(7B) (Ref. Sheet no. 117, 15)**

General

As per Master Plan recommendations, presently the sewage that is being discharged to the trunk sewer towards Gaughat Raw Sewage Pumping Station is to be diverted towards Ghaghar Nala raw sewage pumping station. Therefore present rising main has to be diverted to the proposed sewer towards Ghaghar Nala out side the pump house premises.

Hydraulic Design

The required size is:

Diameter – 500 mm
Length – 30 m
Material - CI
Existing rising main – 600 mm

As per design, the required size of rising main is 500 mm however existing rising main is of 600 mm dia (material – CI).

Since the capacity and head of the pumps is sufficient to meet the flow requirement unto 2015 and pumps do not require any replacement there fore size of the rising main has been kept same as existing and no replacement is required. Only this has to be diverted to the proposed trunk sewer.
Invert level of the receiving manhole of this proposed sewer is 90.973 m (MH 2). Size of trunk sewer is 450 mm hence invert level of the rising main at termination point will be 91.4 m (above TWL in sewer).

- **Rising Main from Sasur Khaderi Raw Sewage Pumping Station to Trunk Sewer 4B(node 4)/(8B) (Ref. Sheet no.120-121 and 20)**

General

As described earlier, an additional pumping station at Sasur Khaderi is required. Rising main from this Raw Sewage Pumping Station will discharge to the receiving manhole of the trunk sewer near Sasur

Khaderi bridge ultimately flowing towards Ghaghar Nala.

Constraints

There is not any problem in this alignment except crossing of Numaya road.

Hydraulic Design

The required size is:

Diameter – 600 mm
Length – 200 m
Material – CI

Since total length of the rising main is very short (200 m) and most of the reach is within the plant premises. As per practice, all the piping within plant premises is considered of CI. Hence the material of rising main has been taken as CI.

Minimum cover for laying of the rising main has been considered as 1.5 m from the ground level. Invert level of the receiving manhole is 85.778 m. Diameter of trunk sewer is 900 mm. Hence invert level of the rising main at termination level will be 86.5 m.

- **Rising Main from Ghaghar Nala Raw Sewage Pumping Station to Numaya Dahi STP/(9B) (Ref. Sheet No. 41-53)**

General

As per master plan recommendations, a new pumping station is to be constructed at Ghaghar Nala to tap it. Sewage, which is coming to this nala and from trunk sewer of dist B, is to be pumped towards Numaya Dahi Sewage treatment plant.

From the pumping station rising main is to be laid on left side of the road. There are two water mains on both sides of the road from Ghaghar Nala PS for a length of approx. 230 m. hence right side water main (500 mm dia.) has to be shifted towards left side. After crossing the Nurullah road (ch. 200 m), rising main has been proposed on left side of the road up to Karamat Ki Chowki (ch. 1100 m). At this point, pipe line crosses the Numaya road after wards rising main has been proposed on right side of the road up to Numaya Dahi Sewage Treatment Plant. This reach is highly undulating and ground levels are varying between 87.0 m to 95.0 m.

Constraints

There are two main constraints in this point, one is crossing of Sasur Khaderi river and other is HT transmission lines, which have been taken care off.

Hydraulic Design

The required size is:

Diameter – 1000 mm
Length – 7,700 m
Material – PSC

Minimum cover for laying of the rising main has been considered as 1.5 m from the ground level.

Crossings

Details of road /nala crossings and railway crossing culverts are given in Table 4.14.

Table 4.14 Details of Road /Nala Crossings

	Nala Crossing		Road Crossing (Ordinary)		Road Crossing by Trenchless		Railway Crossing/ Culvert	
	No.	**Total length (m)**	**No.**	**Total length (m)**	**No.**	**Total length (m)**	**No.**	**Total length (m)**
Pipe Line 7B	-	-	-	-	-	-	-	-
Pipe Line 8B	-	-	1	6	-	-	-	-
Pipe Line 9B	3	95	15	75	2	18.00	-	-

Valves

Details of valves are given in Table 4.15.

Table 4.15 Details of Valves

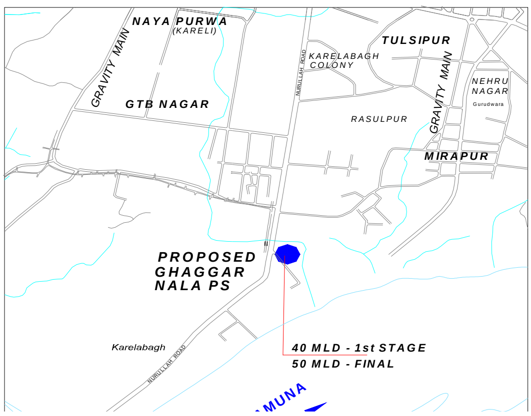
	Air Valve		Scour Valve		Isolation Valve	
	No.	**Size (mm)**	**No**	**Size (mm)**	**No.**	**Size (mm)**
Ghaghar Nala to Numaya Dahi Sewage Treatment Plant/(9B)	13	150	8	500	7	1000

Bedding

For all rising main(s) in District B, PCC bedding type “B” has been used.

4.3.4 Proposed Pumping Stations

(1) Ghaghar Nala SPS



LOCATION PLAN (NTS)

Preamble

The Ghaghar nala Pumping Station will be located near outfall of Ghaghar Nala at its left bank in District B (Ref Sheet No.124-127). This pumping station will be the main pumping station receiving all the wastewater from District B. This will receive wastewater from Lukerganj pumping station as well as from Sasur Khaderi PS, in addition to the command area.

Final Proposal

The wastewater from the nala is tapped and carried to Numaya Dahi Sewage Treatment Plant. Pumping station is proposed to be built on columns, i.e., elevated bar screen chambers/ channels to save lot of electrical energy in addition to civil cost of construction.

Projected wastewater flows from District B, including Ghaghar nala flow are as follows:

Total Design Flow

2015 : 44.5 mld (average), 89 mld (peak)
2030 : 47.1 mld (average), 94.2 mld (peak)

To meet the above requirement, 6 pumps have been proposed with following capacities:

273 lps, 37 m head - 6 Nos.

- Wet Sump designed for the year 2030.

Table 4.16 Wet Sump of Ghaghar Nala Pumping Station

Capacity (m^3)	Retention Time (Minutes)		Adequate
	Avg. flow	Peak flow	
327	10	5	yes

- Rising main 1000 mm, L = 7.7 Km to the proposed Numaya Dahi STP

The other equipment to be installed for successful operation are enumerated below:

- Mechanical:

1) Two no. of Mechanical bar screens (10 mm opening size) and conveyor system with one no. of manual standby screen
2) Two nos. of coarse bar manual screens
3) Sluice gates
4) Suction, Delivery lines, rising main with necessary valves and other accessories
5) 5 ton capacity HOT crane – 1 No.

- Electrical:

1) Incoming Supply – The electric supply will be taken from 11 kV , UPPCL power network opposite the road. The second feeder from the nearby sub station is proposed through an under ground cable. The cost is taken separately.
2) 11kV / 415 V, 1250 kVA transformers – 2 Nos.

3) 5 Panels HT vacuum circuit breakers
4) One DG set of 320 kVA
5) HT / LT cabling , bus trunk system , cable tray arrangement
6) LT panel with proper protection and metering arrangement
7) Squirrel cage TEFC motors of 150 kW capacity – 6 Nos.
8) Automatic power factor control (APFC) panel for power factor improvement
9) Necessary interlocks between transformer incomers and DG set
10) Interlocking arrangement for DG incomer and APFC panel
11) Complete earth protection system
12) Solid state level indicator for easy and smooth control over the motors' duty cycle.

Since it is a new proposal hence the wastewater shall be pumped to Numaya Dahi STP for treatment and its disposal.

Table 4.17 Pump Design for the Year 2015 and 2030

Year	Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
2015	1,075	6	273	4	2	1,075	1,092	537.5	546	268.	273
2030	1,090	6	273	4	2	1,090	1,092	545	546	272.5	273

Cost of Work

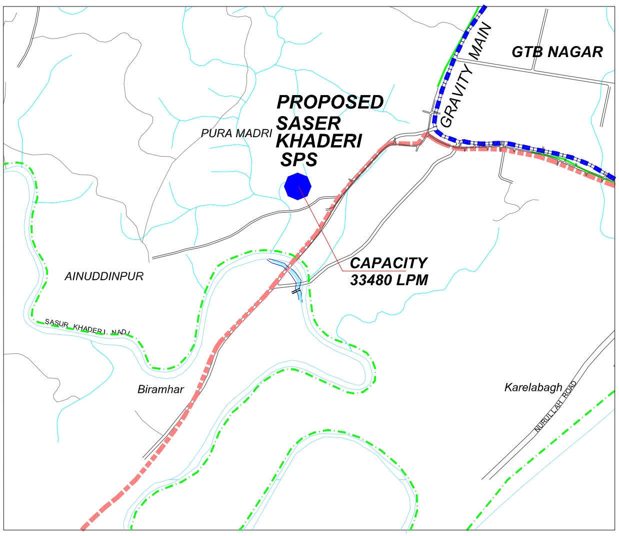
The total cost for construction is Rs 49.36 million including dedicated electrical feeders. Civil cost is Rs. 19.79 million and E&M cost is Rs 29.57 million.

Table 4.18 Rehabilitation Cost of Ghaghar Nala Pumping Station

	Amount (Thousand Rs.)
Civil	19,790
E & M	26,170
Electrical Feeder	3,400
Total	49,360

Rising Main	75,460
Land acquisition (1.0 ha)	960

(2) Sasur Khaderi SPS



LOCATION PLAN (N.T.S.)

Preamble

This pumping station will be situated in the District B (Ref Sheet No. 120-123). Raw Sewage Pumping Station has been proposed to tap the sewage flowing to the drains in District B, discharging towards Sasur Khaderi River and ultimately to Yamuna River. Pumping Station has been proposed at the up stream point where the nala merges with the Sasur Khaderi. This pumping station will also cater to the surrounding areas, which are expected to grow quickly.

Proposed pumping station will discharge the sewage at the receiving chamber of proposed trunk sewer 4B at Numaya Road. This sewer will carry the discharge to the trunk sewer at Karamat Ki Chowki and finally to Ghaghar Nala PS.

Final Proposal

Anticipated peak flow for proposed pumping station will be as below:

- 371 lps in the year 2015
- 660 lps in the year 2030

To meet the above requirement for year 2015, 6 pumps are proposed with following capacities:

93 lps, 17 m head - 6 Nos.

The other equipment to be installed for successful operation is enumerated below:

- **Mechanical :**

  1) Mechanical and manual bar screens with sluice gates and conveyor system
  2) Suction, Delivery lines, rising main with necessary valves and other accessories
  3) 2 ton capacity HOT crane – 1 No.

- **Electrical :**

1) Electrical power will be taken from nearby UPPCL distribution network at 415 V. The second feeder from the nearby station, through a pole mounted transformer of UPPCL, from the other sub-station.
2) One DG set of 63 kVA
3) LT cabling, bus trunk system, cable tray arrangement
4) LT panel with proper protection and metering arrangement
5) Squirrel cage TEFC motors of 23 kW capacity – 6 Nos.
6) Automatic power factor control (APFC) panel for power factor improvement
7) Necessary interlocks between transformer incomers and DG set
8) Interlocking arrangement for DG incomer and APFC panel
9) Complete earth protection system
10) Solid state level indicator for easy and smooth control over the motors' duty cycle.

Table 4.19 Pump Design for the Year 2015

Year	Anticipated Peak Discharge (lps)	No of Pumps	Capacity (lps)	Working	Stand by	Peak discharge Required (lps)	Peak discharge (lps) Available	Average discharge (lps) Required	Average discharge (lps) Available	Lean discharge (lps) Required	Lean discharge (lps) Available
2015	371	6	93	4	2	371	372	187.5	186	93.75	93
2030	660	6	165	4	2	660	660	330	330	165	165

Cost of Work

The total cost for construction is Rs 38.94 million including dedicated electrical feeders. Civil cost is Rs. 24.41 million and E&M cost is Rs 11.13 million.

Table 4.20 Construction Cost of Sasur Khaderi Pumping Station

	Amount (Thousand Rs.)
Civil	24,410
E & M	11,130
Electrical Feeder	3,400
Total	38,940
Rising Main	1,910
Land acquisition (1.0 ha)	960

4.3.3 Proposed Numaya Dahi STP

(1) Design Flow

The design flow as specified in the Master Plan is 50 mld for 2015, ultimate capacity remains same.

(2) Sitting of the STP

Two possible locations were identified in the Master Plan, for sitting the Numaya Dahi STP, ref photos attached below. These locations were studied by the consultants. Both the sites cover agricultural fields, hence resettlement issues are avoided, sufficient land is available for providing Waste Stabilisation Ponds at both sites. The site labeled Alternative I was finally chosen based on the following considerations:

- Two HT lines pass through Alternative II, this would interfere with STP layout design
- The treated effluent from the STP is to be discharged ultimately into the Yamuna. However, the discharge point would lie upstream of the raw water intake at Kareli Bagh from where Yamuna water is abstracted for supply of potable water to the main city, after conventional treatment. If the STP is located at site labeled Alternative II, the effluent can be discharged into either the Sasur Khaderi river, or the effluent channel can be routed to Karendha village. In either case, the outfall will be too near the Karelibagh Intake for the effluent to get dispersed into the River water. Hence, there is a strong possibility that the effluent could affect the raw water quality.
- Sitting the STP at site marked Alternative I, would enable disposal of treated effluent into Yamuna River at Bisona village. This location is approx. 25 km u/s of Karelibagh and hence, sufficient time will available for dispersion of the effluent into the river water.

This final site is located along the borders of Numaya, Dahi, Karendha and Sayyedpur villages.

Numaya Dahi STP site – Alternative I

Numaya Dahi STP site – Alternative II

(3) Raw Sewage Characteristics

The raw sewage characteristics fixed for Numaya Dahi STP are as follows:

Table 4.21 Raw Sewage Characteristics

Sr.	Parameter	Numaya Dahi STP	
		2015	2030
1.	Minimum Temperature, ^{o}C	20	20
2.	pH	6-8.5	6-8.5
3.	BOD_5, mg/l	112	225
4.	Total Suspended Solids, mg/l	200	400
5.	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$

(4) Treated Effluent Quality

Table 4.22 Treated Effluent Quality

Sr.	Parameter	Value (Irrigation Field/River)
1.	pH	5.5 – 9.0
2.	BOD_5, mg/l	< 30
3.	Total Suspended Solids, mg/l	< 50
4.	Faecal Coliform Count, MPN/100ml	<10,000

(5) Treated Effluent Disposal

The STP site is surrounded by agricultural land and hence, the treated effluent can be used for irrigation.

The balance effluent will be discharged into the Yamuna. The 3 alternatives studied for routing the effluent disposal channel are:

Table 4.23 Comparison of Alternative Routes for Treated Effluent Channel from Numaya Dahi STP to Yamuna River

Sr.	Parameter	Alt. 1 – Outfall at Karendha village	Alt. 2 – routing via fish pond near Dahi village	Alt. 3 – Outfall at Bisona village
1.	Re-use of Effluent for Irrigation	Possible	Possible	Possible
2.	Probability of re-contamination of treated effluent	Low	High, as raw sewage of adjoining villages is being discharged untreated into the fish pond	Low
3.	Capital Cost	Lowest	**Highest**	High
4.	Approx. distance, along the river stream from the Karelibagh raw water intake	**5 km, Not sufficient distance available for dispersion & dilution of effluent into the river water**	>30 km Sufficient distance available for dispersion & dilution of effluent into the river waters	25 km Sufficient distance available for dispersion & dilution of effluent into the river waters
	Conclusion	**Not recommended**	**Not recommended**	**Recommended**

Total length of the channel from STP site to outfall at Bisona works out to 3.82 km. The ground profile along the route alternates between ridges and depressions and the channel gets elevated 3-4 m above the ground in some stretches and dips 3m below the general ground level in others.

Wherever the channel is 1m or more below the ground, a box section has been provided to prevent cattle / other animals from falling into the water. To reduce the variation of channel levels from the ground levels, two different channel slopes have been used along the route. Additionally, a drop in invert levels has been proposed at Chainage 1.55. Inverted siphons have been provided to cross roads and other structures en-route.

Details of Channel have been given in Table 4.24.

Table 4.24 Details of Effluent Channel

Section	Type of Section	Chainage (km)	Length (m)	Slope	Size (m)
Section-1	Rectangular	0 to 1.55	1,550	1 in 868	1.8 m x 0.91 m (FB - 0.29m)
Section 2	Rectangular	1.55 to 3.82	22,722	1 in 2481	1.8 m x 1.2 m (FB - 0.30m)

(6) Treatment Technology

The STP will be based on Waste Stabilisation Ponds because it is possible to acquire enough land for this technology. Anaerobic, Facultative and Maturation Ponds have been provided in series to achieve the desired effluent quality.

(7) Design Methodology and Design

Design methodology is as per the 'Design Manual for Waste Stabilisation Ponds in India' authored by Duncan Mara. Process Flow diagram is given in Figure 4.1.

(8) Cost of Work

Table 4.25 Construction Cost of Numaya Dahi STP

	Amount (Thousand Rs.)
Civil	227,260
Effluent channel to Bisona	38,850
Channel for irrigation	29,550
E & M	11,360
Electrical Feeder	20,900
Total	327,920

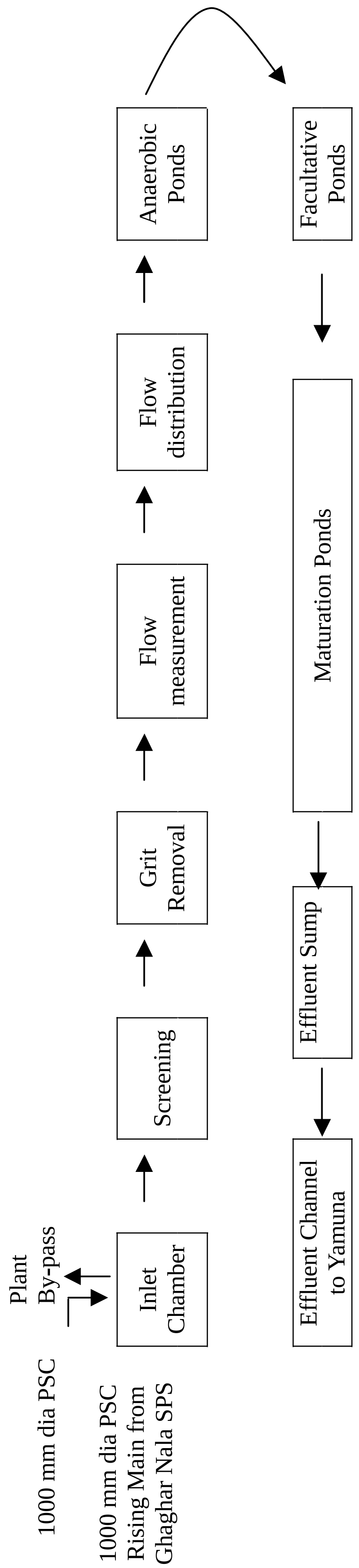


Figure 4.1 Process Flow Diagram of Numaya Dahi STP

4.4 PROPOSED SEWAGE COLLECTION AND TREATMENT SYSTEM - DISTRICT E

4.4.1 Proposed System

- Construction of a new STP at Ponghat – 10 mld capacity in 2015.
- Construction of a new STP at Kodara – 15 mld capacity in 2015, 30 mld capacity in 2030.

Design Criteria for the facilities has been given in Section I, design and details are presented here.

4.4.2 Proposed Ponghat STP

(1) Design Flow

The design flow as specified in the Master Plan is 10 mld for 2015, ultimate capacity remains same.

(2) Sitting of the STP

The STP has been located along the borders of Mariyadih and Ponghat. The area use is agricultural, no resettlement issues are involved. The STP site is located slightly u/s of the Ponghat's outfall into Ganga River.

A small sump with screening and pumping arrangements has been provided to tap the Ponghat Nala. The trunk sewer for the area, to be laid in future (and not included in the priority projects) can be joined into this chamber for pumping of sewage to the STP, as the STP has been located on a local plateau to avoid costly flood protection works.

(3) Raw Sewage Characteristics

The raw sewage characteristics fixed for Ponghat STP are as follows:

Table 4.26 Raw Sewage Characteristics

Sr.	Parameter	Value	
		2015	2030
1.	Minimum Temperature, ^{o}C	20	20
2.	pH	6-8.5	6-8.5
3.	BOD_5, mg/l	115	200
4.	Total Suspended Solids, mg/l	207	360
5.	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$

(4) Treated Effluent Quality

Table 4.27 Treated Effluent Quality

Sr.	Parameter	Value (Irrigation Field/River)
1.	pH	5.5 – 9.0
2.	BOD_5, mg/l	< 30
3.	Total Suspended Solids, mg/l	< 50
4.	Faecal Coliform Count, MPN/100ml	<10,000

(5) Treated Effluent Disposal

Treated effluent from Ponghat STP will be discharged back into the Nala, downstream of the tapping point. This STP will also be based on the pond technology and thus the effluent will be suitable for re-use as irrigation water in the fields adjoining the STP site.

(6) Treatment Technology

The STP will be based on Waste Stabilisation Ponds because it is possible to acquire enough land for this technology. Anaerobic, Facultative and Maturation Ponds have been provided in series to achieve the desired effluent quality.

(7) Design Methodology and Design

Design methodology is as per the 'Design Manual for Waste Stabilisation Ponds in India' authored by Duncan Mara. Process Flow diagram is given in Figure 4.2.

(8) Cost of Work

Table 4.28 Construction Cost of Ponghat STP

	Amount (Thousand Rs.)
Civil	67,200
Mechanical and Electrical	16,020
Total	83,220

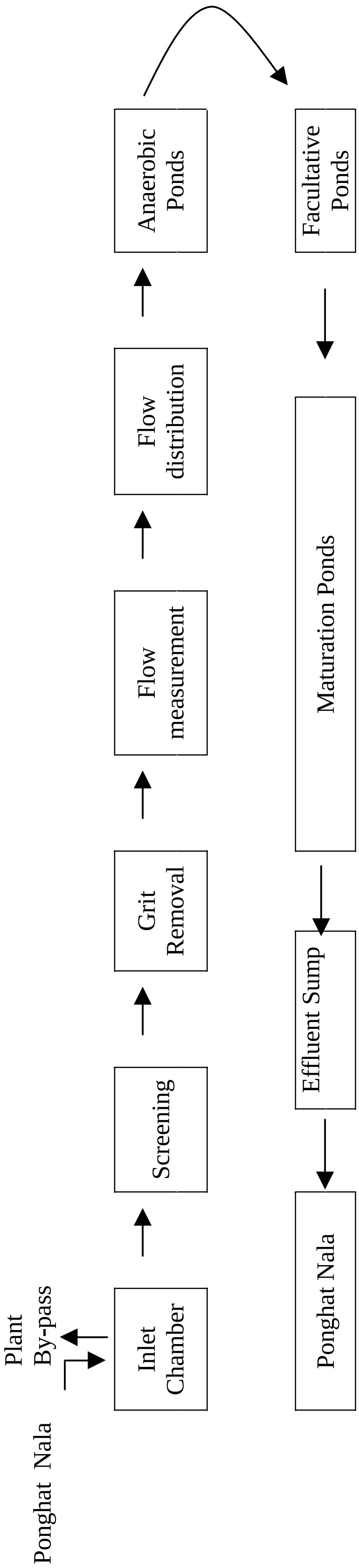


Figure 4.2 Process Flow Diagram of Ponghat STP

4.4.3 Proposed Kodara STP

(1) Design Flow

The design flow as specified in the MP is 15 mld for 2015, ultimate capacity 30 mld.

(2) Sitting of the STP

The STP has been located near the outfall of the Kodara Nala into Ganga River, near the Manoharpur village. A small temple of local significance (Mouni Baba Temple) and an adjacent well lie near the proposed STP site. This aspect has been studied and carefully considered while designing the layout of the STP. The boundary of the STP has been drawn up such that the temple and the well lie outside the proposed STP campus. Additionally, the site boundary has been pushed back from the ridge line to provide walking access to the temple.

<u>Tapping of Nalas</u>

Three Nalas flowing near the STP site are to be tapped; these are the Kodara Nala, the Nehru Nala and a third small Nala (ID not known) which bisects the STP site. The Kodara and Nehru Nalas are tapped via inlet chambers followed by screening arrangements; the flow is brought to the STP site via pipes laid below ground. The pipes will be provided with manholes @ 20m. The dry weather flow of the small Nala is tapped by a similar arrangement; the wet weather flow has to be diverted to the Nehru Nala, else the layout of the STP cannot be planned in the limited space available.

An earthen bund of 5 m height has been provided to enclose the STP site as a flood protection measure.

(3) Raw Sewage Characteristics

The raw sewage characteristics fixed for Kodara STP are as follows:

Table 4.29 Raw Sewage Characteristics

Sr.	Parameter	Value	
		2015	2030
1	Minimum Temperature, ^{o}C	20	20
2	pH	6-8.5	6-8.5
3	BOD_5, mg/l	115	200
4	Total Suspended Solids, mg/l	207	360
5	Faecal Coliform Count, MPN/100ml	$2x10^7$	$2x10^7$

(4) Treated Effluent Quality

Table 4.30 Treated Effluent Quality

Sr.	Parameter	Value (Irrigation Field/River)
1	pH	5.5 – 9.0
2	BOD_5, mg/l	< 30
3	Total Suspended Solids, mg/l	< 50
4	Faecal Coliform Count, MPN/100ml	<10,000

(5) Treated Effluent Disposal

Treated effluent from Kodara STP will be discharged into the Ganga channel. The effluent will flow by gravity except during the monsoon period when the water levels in the river rise, at which time the effluent will be pumped into Ganga River channel by submersible pumps.

(6) Treatment Technology

The treatment technology shall be UASB followed by Aerated lagoons of 1.7 days detention.

(7) Design Methodology and Design

Design methodology is as per standard textbooks. Process Flow diagram is given in Figure 4.3.

(8) Cost of Work

Table 4.31 Construction Cost of Kodara STP

	Amount (Thousand Rs.)
Civil	34,720
Embankment	26,850
Mechanical and Electrical	23,950
Total	85,520

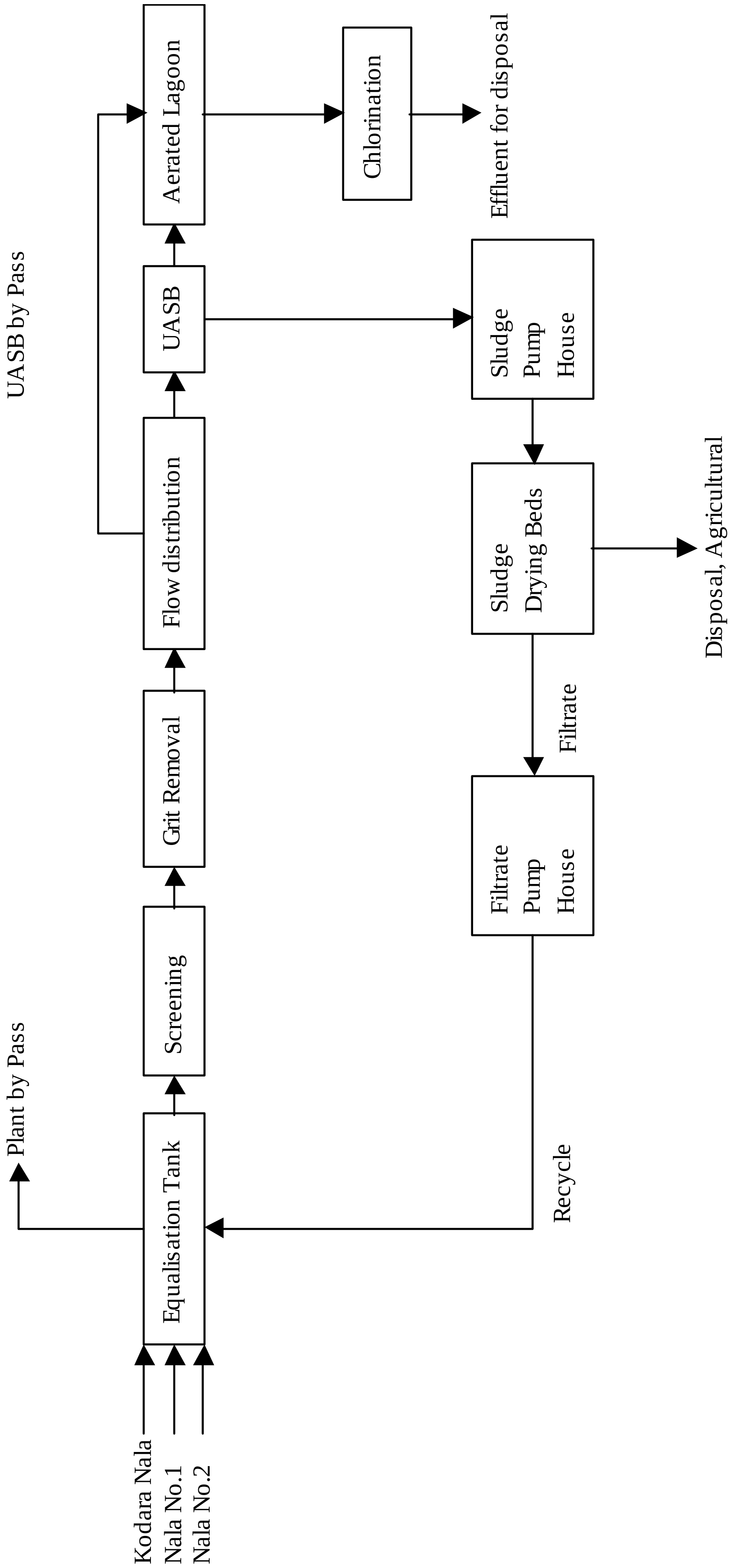


Figure 4.3 Process Flow Diagram for Kodara STP