NCR Planning Board
Asian Development Bank

Capacity Development of the National Capital Region Planning Board (NCRPB) – Component B

(TA No. 7055-IND)

Sewerage Master Plan of Hapur

January 2009

Abbreviations

ADB	:	Asian Development Bank
APs	:	Affected Persons
AS	:	Administrative Sanction
BMTPC	:	Building Materials Technology Promotion Council
BOD	:	Biochemical Oxygen Demand
BOOT	:	Build-Operate-Own-Transfer
BPL	:	Below Poverty Line
CBD	:	Central Business District
CHO	:	Chief Health Officer
CI	:	Cast Iron
CMA	:	Counter Magnet Areas
COD	:	Chemical Oxygen Demand
CPHEEO	:	Central Public Health & Environmental Engineering Organization
CRRI	:	Central Road Research Institute
CWPS	:	Clear Water Pumping Station
DA	:	Development Authority
DFR	:	Draft Final Report
DI	:	Ductile Iron
DMC	:	Developing Member Countries
DPR	:	Detailed Project Report
EAF	:	Environmental Assessment Framework.
EC	:	Environmental Clearance
EIA	:	Environmental Impact Assessment
EIL	:	Engineers India Limited
EIRR	:	Economic Internal Rate of Return
EMP	:	Environmental Management Plan
ENPV	:	Economic Net Present Value
FGD	:	Focus Group Discussions
FIAP	:	Financial Implementation Action Plan
FIRR	:	Financial Internal Rate of Return
GDA	:	Ghaziabad Development Authority
GNN	:	Ghaziabad Nagar Nigam
GoH	:	Government of Haryana
GoI	:	Government of India
GoUP	:	Government of Uttar Pradesh
GRP	:	Glass Reinforced Plastic
HDPE	:	High Density Polyethylene
HH	:	Household
HPDA	:	Hapur-Pilkhua Development Authority
HSCC	:	Hospital Services Consultancy Corporation
HUDA	:	Hapur Urban Development Authority
IA	:	Implementing Agencies
IDFC	:	Infrastructure Development Finance Corporation
IEE	:	Initial Environmental Examination
IL&FS	:	Infrastructure Leasing and Financial Services

IPDP	:	Indigenous People Development Plan
IPT	:	Intermediate Public Transport
IRC	:	Indian Road Congress
ISWM	:	Integrated Solid Waste Management
IT	:	Information Technology
JNNURM	:	Jawaharlal Nehru Urban Renewal Mission
JS	:	Journey Speed
KMPH	:	Kilometer per Hour
KV	:	Kilo Volts
KW	:	Kilo Watts
LA	:	Land Acquisition
LAO	:	Land Acquisition Officer
LCV	:	Light Commercial Vehicle
LFS	:	Land Fill Site
LPCD	:	Liters Per Capita per Day
MAV	:	Multi Axle Vehicle
MGD	:	Million Gallons per Day
MLD	:	Million Liters per Day
MoRTH	:	Ministry of Road Transport and Highways
MoUD	:	Ministry of Urban Development
MPN	:	Most Probable Number
NBCC	:	National Building Construction Corporation
NCR	:	National Capital Region
NCRPB	:	National Capital Region Planning Board
NCT	:	National Capital Territory
NEERI	:	National Environment Engineering Research Institute
NGO	:	Non-governmental Organizations
NH	:	National Highway
NHAI	:	National Highway Authority of India
NI	:	National Institutions
NPRR	:	National Policy on Resettlement and Rehabilitation
NTU	:	Neflo Turbidity Units
O & M	:	Operation and Maintenance
OHSR	:	Overhead Service Reservoir
PCU	:	Passenger Car Unit
PHED	:	Public Health Engineering Department
PMC	:	Project Management Consultant
PPP	:	Public Private Partnership
PSC	:	Pre-stressed Concrete
PSMG	:	Project Sanctioning and Monitoring Group
PWD WSSD	:	Public Works Department – Water Supply & Sanitation Department
R & R	:	Resettlement and Rehabilitations
RCC	:	Reinforced Cement Concrete
RF	:	Resettlement Framework
ROB	:	Road Over Bridge
RP	:	Resettlement Plan
RS	:	Running Speed

Rs.	:	Indian Rupees
RSDD	:	Regional Sustainable Development Department
RWPH	:	Raw Water Pump House
SADA	:	Special Area Development Authority
SAIL	:	Steel Authority of India Limited
SCADA	:	Supervisory Control and Data Acquisition
SFI	:	Sanitary & Food Inspector
SH	:	State Highway
SIA	:	Social Impact Assessment
SIEE	:	Summary Initial Environmental Examination
SOI	:	Survey of India
SOR	:	Schedule of Rates
SPS	:	Sewage Pumping Station
STP	:	Sewerage Treatment Plant
SWM	:	Solid Waste Management
TA	:	Technical Assistance
TNUDF	:	Tamil Nadu Urban Development Fund
TOR	:	Terms of Reference
TSS	:	Total Suspended Solids
TW	:	Two Wheeler
UFW	:	Unaccounted for Water
UIDSSMT	:	Urban Infrastructure Development in Small & Medium Towns
UIT	:	Urban Improvement Trust
ULB	:	Urban Local Body
UP	:	Uttar Pradesh
uPVC	:	Unplasticized Polyvinyl Chloride
WAPCOS	:	Water and Power Consultancy Services
WB	:	World Bank
WSP	:	Waste Stabilization Pond
WTP	:	Water Treatment Plant
ZSO	:	Zonal Sanitary Officer

Glossary of Terms

Aerated Lagoons: Like Waste Stabilization Pond (WSP), but with mechanical aeration. Oxygen requirement mostly from aeration and hence more complicated and higher O&M costs require less land than WSP.

*Activated Sludge Proces*s: 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 maintains 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 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 20ºC.

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.

Coli form Bacteria: Rod shaped bacteria from intestinal tract 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 receives and conveys 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.

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.

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

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.

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.

Methane: A colorless, odorless, combustible gas that is the principal by-product of anaerobic decomposition or organic matter in wastewater. Chemical formula is CH4.

Mixed Liquor 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 prepares wastewater influent for further treatment.

Pump Station: (see Lift Station)

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 conditions 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 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 are 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 poor quality effluent than processes such as ASP (NOTE: other anaerobic processes exist, but UASB is the most common at present).

Collection System Terminology

Manhole: An opening in a vessel or sewer to permit human entry. Also called man way.

Trunk Sewer: Trunk sewers are large sewers that are used to convey wastewater from main sewers to treatment or other disposal facilities or to pumping station.

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

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.

Pumping Main: Pumping mains are used to convey wastewater from pumping stations to treatment plants at higher elevations. They are also referred as rising mains or force mains.

Contents

List of Tables

List of Maps

I. INTRODUCTION

A. Background

1. The National Capital Region Planning Board, constituted in 1985 under the provisions of NCRPB Act, 1985, is a statutory body functioning under the Ministry of Urban Development, Government of India. NCRPB has a mandate to systematically develop the National Capital Region (NCR) of India. It is one of the functions of the Board to arrange and oversee the financing of selected development projects in the NCR through Central and State Plan funds and other sources of revenue.

2. On Government of India's request, Asian Development Bank (ADB) has formulated the technical assistance (TA) to enhance the capacities of National Capital Region Planning Board and its associated implementing agencies. The TA has been designed in three components: Component A relates to improving the business processes in NCRPB; Component B relates to improving the capacity of the implementing agencies in project identification, feasibility studies and preparing detailed engineering design; and Component C relates to urban planning and other activities.

3. ADB has appointed M/s Wilbur Smith Associates to perform consultancy services envisaged under Component B. In the context of this contract, the first deliverable – Inception Report, was submitted in October 2008.

4. This is the Interim Report prepared for the TA Component B, and is the second deliverable under the Contract. This was prepared by the WSA Team between October 2008 and January 2009.

B. Overview of this ADB TA

5. *Objectives*. The objective of this Technical Assistance (TA) is to strengthen the capacity at NCRPB, state-level NCR cells, and other implementing agencies in the area of planning for urban infrastructure and to impart necessary skills to conceive, design, develop, appraise and implement good quality infrastructure projects for planned development of NCR. The increased institutional capacity of the NCRPB and the implementing agencies will lead to effective and time scaling-up of urban infrastructure to (i) improve quality of basic urban services in the NCR; (ii) develop counter magnet towns; (iii) reduce in migration into Delhi and orderly development of NCR; and (iv) accelerate economic growth in the NCR.

6. The TA – Capacity Development of the NCRPB, Component B focuses on strengthening the capacities of NCRPB and implementing agencies relating to project feasibility studies and preparation, and detailed engineering design in the implementing agencies. Specifically this component B of the TA will support the project preparation efforts of the

implementing agencies by preparing demonstration feasibility studies that include all due diligence documentation required for processing of the project in accordance with best practices, including ADB's policies and guidelines.

7. *Scope of Work*. According to the terms of reference of the TA assignment, the following activities are envisaged in component B of the TA:

(i) Conduct technical, institutional, economic and financial feasibility analysis of identified subprojects in the six sample implementing agencies;
(ii) Conduct safeguards due diligence on the subprojects, including environmental assessment report and resettlement plan for all subprojects covered in the sample implementing agencies;
(iii) Prepare environmental assessment framework and resettlement framework; and
(iv) Develop a capacity building and policy reform program for the implementing agencies, including governance strengthening, institutional development and financial management.

8. Besides, this component of the TA will also:

(i) help in assessing the current practices and procedures of project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
(ii) support preparation of standard procedure manuals for project identification and preparation of detailed project reports including technical, financial, economic and social safeguard due diligence;
(iii) train the implementing agencies in the preparation of detailed project reports by using the sample subprojects, reports on deficiency of current practices and standard protocol manuals; and
(iv) help in developing a user-friendly web-page where different manuals and guidelines for preparation of DPRs will be made available for the implementing agencies.

C. About the Interim Report

9. The Interim Report is the second report/deliverable under the TA Component B, and was prepared between October 15, 2008 and January 16, 2009. During the Inception Stage, ADB/NCRPB in consultation with the implementing agencies and WSA Team has identified and finalized the sample implementing agencies and subprojects for preparation under this TA. Accordingly, it is proposed to produce model Detail Project Reports (DPR) in the following sectors: (i) Water Supply; (ii) Sewerage; (iii) Storm Water Drainage; (iv) Solid Waste Management, and (v) Traffic Planning

10. These model DPRs are proposed to be made available to the implementing agencies of the state governments so that they may replicate the methodology/approach in the future DPRs being prepared by them for obtaining finances from financial institutions including NCRPB. It is also proposed to develop appropriate tool kits for each of these sectors to facilitate preparation of DPRs.

11. It is proposed to produce DPR for water supply for Panipat town, Sewerage for Hapur town, Storm Water Drainage for Hapur and Sonipat towns, Solid Waste Management for Ghaziabad town and Traffic Planning for Ghaziabad town.

4. Following the approach developed for the TA assignment as presented in the Inception Report, the Team at this stage focused on preparation of Master Plan as a base for preparation of sample DPRs. These Plans are prepared keeping in view of the long terms requirements of the sample towns. The existing infrastructure systems have been studied assessed and issues in service delivery have been identified. A long term plan has been developed with the projected service demands and targets to be achieved; and various interventions and subprojects required to achieve the sector plan targets have been identified. In the next phase of this study, DPRs will be prepared for selected subproject components from the above long-term plans.

12. The Interim Report is organized in Four Volumes:

Volume I is the main Interim Report; summarizes the entire output produced till date under the TA Component B; provides a brief of all Sector Master Plans;

Volume II. Infrastructure Master Plans: this is compiled in five parts, each dealing with a separate sector, as given below:

A – Water Supply Master Plan of Panipat
B – Sewerage Master Plan of Hapur
C – Drainage Master Plan of Hapur
D – Solid Waste Management Master Plan of Ghaziabad
E – Existing Traffic & Transport Analysis of Ghaziabad

Volume III presents the results of the socio-economic base line survey conducted in three sample towns in three parts:

A – Ghaziabad
B – Panipat
C – Hapur

Volume IV. The proceedings of the Introductory Workshop organized on December 10, 2008, as part of training/workshop component of the TA is presented in this Volume.

13. This is **Volume II B: Sewerage Master Plan of Hapur**, of the Interim Report. This report is the first step in the direction of producing DPR for sewerage in Hapur Town. This report is organized into following eight (8) sections including this introductory section:

Section II presents an overview of sanitation and methodology for preparation of Sewerage Master Plan

Section III describes baseline profile of Hapur Town, this includes description of existing water supply system in Hapur;

Section IV Defines study area provide population forecast for the design year;;

Section V Describes existing sewerage system and deficiencies**;**

Section VI establishes planning and design criteria for preparation of master plan for sewerage system in Hapur Town;

Section VII provides in details the interventions proposed in the Master Plan; and

Section VIII provides the cost estimates and implementation phasing of the the proposed Sewerage Master Plan of Hapur.

II. SANITATION OVERVIEW AND METHODOLOGY

A. Urban Sanitation Overview

1. Millennium Development Goals

14. The Millennium Development Goals (MDGs) (Goal No.7) enjoin upon the signatory nations requiring them "to halving the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015'' and 100 percent access by 2025. This implies extending coverage to households which are presently without improved sanitation, and providing proper sanitation facilities in public places to make cities open-defecation free. Since the early 1990s, India has made good progress in developing water supply and sanitation (WSS) infrastructure in urban areas. According to the information given in the India Water Supply & Sanitation published by World Bank in 2006, if access to sewers and septic tanks was about 43 percent in 1990, the MDG target should be about 72 percent at the end of the 12th Plan; with an official figure of about 62 percent in 2001, India should be able to exceed the MDG target. The discussion of future estimates presented in this report, is based on the following targets for the end of the 12th Plan (2017): (i) sanitation coverage ratio: about 82 percent broken down as follows: about 52 percent connected to sewers, 30 percent to septic tanks, and an additional 16 percent to latrines. However, Government of India envisages providing access to water supply facilities and sewerage and on-site sanitation facilities to 100 percent of the urban population by the end of the 11th Five Year Plan.

2. Sanitation Crisis in South Asia

15. Every one of two South Asians is still forced the indignity of defecating in the open, or using other forms of unimproved sanitation. There is a high disparity in access and use of sanitation facilities across socio-economic groups. Considerable number of women, girl-children, urban and rural poor and other vulnerable groups especially suffer the indignity, inconvenience, loss of time and energy due to lack of proper sanitation. Poor sanitation and hygiene kills a large number of South Asian children every day, and frequent diseases also cause widespread mal-nutrition amongst children, stunting their physical and mental growth. Poor sanitation causes huge economic losses to households and nations, apart from imposing alarming health and environmental costs for communities.

16. The Third South Asian Conference on Sanitation (SACOSAN) "sanitation for dignity and health" held on 16-21 Nov 2008 at New Delhi committed to achieving national goals and the Millennium Development Goals on Sanitation in a time-bound manner and prioritise sanitation as a development intervention for health, dignity and security of all members of communities especially infants, girl-children, women, the elderly and vulnerable and that achieving sanitation for all will be an inclusive process, involving all stakeholders at all stages, especially local governments, community and grassroots groups. SACOSAN has also agreed on a roadmap for achieving sanitation goals.

3. Urban Sanitation in India

17. Third of India's urban population does not have access to adequate sanitation; the situation is even more grim with respect to the urban poor. To address this situation and building on earlier initiatives, the Government of India has formally approved the National Urban Sanitation Policy in 2008 which envisions the creation of totally sanitized cities and towns. The policy articulates awareness generation and behaviour change, open defecation free cities in which all urban dwellers have access to safe sanitation, integrated city wide sanitation planning and sanitary and safe disposal of urban wastes. In addition, the policy promotes community and local government participation in the planning, implementation and management of urban sanitation services. In urban sanitation too, the importance of sustainability is highlighted, specifically addressing the issue of 'willingness to charge' for services and the impact on environmental health.

18. According to the Census of 2001, 30.6 million urban households which form 35.49 percent of the urban households suffer inadequate access to sanitation facilities and more than 37 percent of the total human excreta generated in urban India is unsafely disposed. Out of these 30.6 million households, 12.04 million (7.87 percent) urban households do not have access to latrines and defecate in the open. 5.48 million (8.13 percent) urban households use community latrines and 13.4 million households (19.49 percent) use shared latrines. 12.47 million (18.5 percent) households do not have access to a drainage network. 26.8 million (39.8 percent) households are connected to open drains.

19. The status in respect of the urban poor is even worse. The percentage of notified and non-notified slums without latrines is 17 percent and 51 percent respectively. In respect of septic latrines the availability is 66 percent and 35 percent. In respect of underground sewerage, the availability is 30 percent and 15 percent respectively. 37 percent of the wastewater generated is let out into the environment untreated. Three-fourths of surface water resources are polluted and 60 percent of the pollution is due to sewage alone. Poor sanitation severely impacts public health, causes hardships and imposes huge medical expenditure, especially for the poor. The loss due to diseases caused by poor sanitation for children under 14 years alone in urban areas amounts to Rs. 5 billion at 2001 prices.

20. Information collected by CPHEEO, Ministry of Urban Development indicates that as on 31.03.07, about 63 percent of the urban population have got access to sewerage, low cost sanitation and septic tank facilities at present i.e. about 30 percent population have got access to sewerage and 33 percent have got access to low cost sanitation and septic tank facilities. The coverage figures mentioned above indicate accessibility only and the quality and quantity of the services may not be as per norms in some cases.

21. As per assessment made by the Central Pollution Control Board in Class I cities and Class-II towns during 2003-04, about 26,254 MLD of wastewater was generated in 921 Class I cities and Class II towns in India (housing more than 70 percent of urban population). The wastewater treatment capacity developed so far is about 7044 MLD – accounting for 27 percent of waste water generated in these two classes of urban centres. Most of the cities have only primary treatment facilities. Thus, the untreated and partially treated municipal wastewater finds its way into water sources leading to pollution.

4. Institutional and Policy Framework in India

22. Under the Constitution of India, water supply and sanitation is a State subject. Urban Local Bodies (ULBs) have the responsibility for planning, design, implementation, operation and maintenance of water supply and sanitation services in cities and towns. At the Central level, the Ministry of Urban Development is the nodal agency for formulation of policies, strategies and guidelines and assists the States by providing financial assistance for the development of urban water supply and sanitation schemes in cities and towns. The Central Public Health and Environmental Engineering Organization (CPHEEO) is the technical arm of the Ministry and assists in preparation of policy guidelines, technical manuals etc. related to urban water supply and sanitation.

23. To achieve 100 per cent population coverage for sewerage, sewage treatment and low cost sanitation facilities in urban areas during Eleventh Plan, the following steps have been identified:

(i) Install more plants to treat, recycle and reuse sewage.

(ii) Industrial and commercial establishments must reuse and recycle treated sewage to reduce fresh water demand.

(iii) ULBs should amend their by-laws to make it mandatory for all residents to connect their toilets to the existing sewerage system.

(iv) Fringe areas of cities and colonies of economically weaker sections and slum dwellers be covered with low cost sanitation facilities, either on individual household basis or community basis with "pay and use system" with adequate maintenance arrangements. Necessary penal clause to be enforced effectively to stop open defecation practice as well as indiscriminate throwing of garbage/litter in public places.

(v) Targeted subsidy may be given to urban poor for taking water supply/sewerage house service connections, metering, to and construction of toilets.

(vi) Comprehensive storm water drainage system should be developed in all cities and towns in order to avoid water logging during monsoon.

24. *National Urban Sanitation Policy*. The Government of India, in discussion with the States, constituted a National Urban Sanitation Task Force in 2005 comprising eminent policy makers, practitioners, experts and NGOs in order to take stock of the situation and formulate a policy to comprehensively deal with the challenges in urban sanitation in Indian cities. Based on the recommendations of this task force, a National Urban Sanitation Policy has been approved by the Government of India in October 2008. The main elements of the policy are discussed below.

25. *Policy Vision and Goals*. The vision of the policy is that all Indian cities and towns become totally sanitized, healthy and livable and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women. The policy articulates the following goals:

(i) Awareness Generation and Behavioral Change:

- Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions
- Promoting mechanisms to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices

(ii) Open Defecation Free Cities: The ultimate objective is that all urban dwellers will have access to and be able to use safe and hygienic sanitation facilities and arrangements so that no one defecates in the open. In order to achieve this goal, the following activities shall be undertaken:

- Promoting household access to safe sanitation facilities (including proper disposal arrangements)
- Promoting community-planned and managed toilets wherever necessary, for groups of households who have constraints of space, tenure or economic constraints in gaining access to individual facilities
- Adequate availability and 100 per cent upkeep and management of public sanitation facilities in all urban areas, to rid them of open defecation and environmental hazards

(iii) Integrated City Wide Sanitation. Re-orienting institutions and mainstreaming sanitation by

- Mainstreaming thinking, planning and implementing measures related to sanitation in all sectors and departmental domains as a cross-cutting issue, especially in all urban management endeavors
- Strengthening national, state, city and local institutions (public, private and community) to accord priority to sanitation provision, including planning, implementation and Operation & Maintenance (O&M) management
- Extending access to proper sanitation facilities for poor communities and other un-served settlements

(iv) Sanitary and Safe Disposal: 100 per cent of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed-of safely. In order to achieve this goal, the following activities shall be undertaken:

- Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them, wherever possible
- Promoting recycle and reuse of treated waste water for non-potable applications, wherever possible, will be encouraged
- Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.)
- Ensuring that all the human wastes are collected safely confined and disposed-off after treatment so as not to cause any hazard to public health or the environment

(v) Proper Operation and Maintenance of all Sanitary Installations:

- Promoting proper usage, regular upkeep and maintenance of household,

community and public sanitation facilities

- Strengthening Urban Local Bodies (ULBs) to provide or cause to provide, sustainable sanitation services delivery

B. Methodology for Preparation of Sewerage Master Plan

26. The following tasks have been performed during the planning of the proposed sewerage system

- Data Collection and Field Visits
- Review of adequacy of existing sewerage system
- Prepare contour map
- Population Projection and Sewage Flow Estimation
- Design of Sewage Collection System
- STP site identification, area required
- Phasing of construction of STP
- Capital cost and O & M costs

III. PROFILE OF HAPUR TOWN

A. Physical Features

27. Hapur Town is administratively part of Ghaziabad District in Uttar Pradesh State, and is an important town of National Capital Region. Geographically it is situated at 28^0 44' N latitude and 77^0 47' E Longitude (**Map 1**). It is well connected with important cities of country. National Highway 24 (Delhi-Lucknow-Muradabad Road) and National Highway 18 (Meerut-Bulandsahar Road) passes through Hapur city. The main Rail Line of Delhi-Lucknow-Howra also passes through Hapur Town. Hapur city is situated at about 54 Km east of Delhi, 32 Km from Meerut, 39 Km from Bulandsahar and 432 Km from the State Capital, Lucknow.

28. There are many stories around establishment and the name of Hapur. It is said that Hapur was established by King Harischandra. Some say, Shree Haridutt of Meerut/Bulandsahar established it and gave the name of Haripar. The word Hapar means garden and so the name of city is Hapur. In the 19^{th} century a French General name Pairan appointed by Marathas started distribution of financial assistance to retired and incapacitated persons. British used this city traditionally for many years to provide land to retired and incapacitated persons after clearing forest bushes. In the year 1805, Tahasildar of Hapur Ibrahim Ali saved and protected the town from an attack by Aamir Khan Pindary. During 1885 at the time of India's struggle for independence Walidad Khan of Malagarh planned invasion of this city but because of resistance of Jats of Bhadhona it was not successful.

29. The city was surrounded all around by a wall with five gates- Dehli, Meerut, Garh Mukteshwar, Kothy and Sikandra. However, now none of these exists except some remnants. Jama Masjid in the town was constructed in the year 1670 during the rule of Emperor Aurangazeb.

30. The population of Hapur Town as per census 2001 was 211,983. Hapur Municipality (Hapur Nagar Palika Parishad) was established in 1982. At present, the municipal area of Hapur is 1,401 ha (14 sq. km).

1. Climate

31. Typical humid subtropical climate of north India prevails in Hapur, with high variation between summer and winter temperatures and precipitation. Summer starts early April and peaks in May. Winters are from November to February/March. The average temperature ranges from a minimum of 1.8oC to a maximum of 44.9oC; occasional extremes may in the ranges of -0.6oC to 47oC. Predominant winds are from north, northwest and west, followed by east and southeast. Extreme temperatures have ranged from −0.6 °C (30.9 °F) to 47 °C (116.6 °F). Annual average rainfall of the town is 732 mm.

Map 1: Location of Hapur in NCR

2. Topography

32. The town has almost flat topography except a small portion in the south, which is a marginally higher than the general ground level. The general slope of the town is from north to south. The difference between the maximum and minimum ground levels is about 3 m - varies from 213 to 210 m above mean sea level. The depth of groundwater in the town varies from 9-12 m. The town is located in the catchment area of the Ganges River, the most important and perennial river of India, flowing at a distance of 30 km east of the town. River Kali, a tributary of River Ganges, flows in the eastern outskirts of the town in the north-south direction. Hapur Town drains into this Kali River. The general nature of the soil is sand mixed with clay.

B. Socio Economic Conditions

33. Hapur is an important commercial centre. It is an important town in NCR area, which is being developed to decongest National Capital Delhi by improving infrastructure in NCR towns with the aim of shifting some of the offices and establishments of Government of India. It is a big mandi of Grains, Gur, and Potato etc. Six big silos of grains owned by the Ministry of Food and Agriculture of the Government of India, exist in the town. Small to medium industries manufacturing sewing machines, motor spare parts, all type of agricultural machinery & equipments, oil expellers etc. have already developed in the town. Due to enormous growth of potatoes in the area around, there are many cold storages in the town. The town has all modern amenities like transportation, electricity, telephone – landline as well as mobile, water supply, sewerage etc. the town has many technical institutions, degree colleges, intermediate colleges, tehsil office, post office, fire station etc. For all the above-mentioned reasons and its strategically important location, Hapur is a fast developing town.

34. The main occupation of inhabitants is agriculture and agro based trade and business. Therefore, the people, specially farmers and traders are generally well to do. The importance of this town is steadily increasing. Economic conditions of the people are similar to those of any average Indian small town. There are double storied houses also in the town apart from single storied pucca & kuchcha houses.

35. *Urban Economy*. Hapur is an important centre for trade and commerce in western UP sub-region. The workforce participation rate is almost constant but the size of work force in the city has maintained its increasing trend as shown in the following table.

Table 1: Population and Workforce of Hapur

S.N.	Year	Population	Work Force	WFPR	Male Workers %
1	1971	71,266	18,123	0.25	96.7
2	1981	10,2837	26,585	0.26	95.5
3	1991	14,6591	36,648	0.25	94.0
3	2001	21,1983	72,983	0.34	93.0

Source: Master Plan 2005; Census of India 2001,

C. Water Supply System in Hapur

36. *History of water supply system*. The existing water supply in Hapur Town was first introduced in the year 1955 on the basis of the scheme prepared in the year 1952 – 53 at an estimated cost of Rs.1.15 million. The scheme was designed for population of 5,500 at the rate of water supply of 135 LPCD. With the increase in population and consequently greater demand of water, the water supply arrangements fell short of the requirements. Therefore, a water supply reorganization scheme was prepared by LSGED in the year 1971 – 72 at an estimated cost of Rs.2.74 million. In this scheme, the town was proposed to be divided into three water supply zones. The boundaries of zone II were fixed such that the existing tube wells and overhead tank were sufficient to meet out the water demand of this zone, even at the enhanced rate of water supply of 180 LPCD. Provision of 1350 KL capacity overhead tank and 3 no. tube wells was made for zone I. Similarly for zone III, 1250 KL capacity overhead tank and 3 no. tube wells had been proposed. The provision of reorganization of the distribution system in the zone I and zone II had also been made in this scheme.

37. *Present System*. At present about 60 percent population that is about 150,000, is covered with water supply. The present rate of water supply in the town is about 100 LPCD. There are 18 tube wells for water supply, about 40 percent are directly connected to distribution system and remaining are feeding in three areas, where water is supplied through over head reservoirs. At present water supply is one hour a day from 6 AM to 7 AM.

38. Ground water is available in sufficient quantity at shallow depth and as such is source of water supply. The ground water table depth is at 9-12 meter. The pumps on tube wells are of 30-60 HP. There are 5 overhead tanks (Total storage capacity 3,675 KL) spread in 5 water supply zones. In distribution system PVC pipes are laid. The chlorination is through liquid chlorine since last 10-15 years. All water connections are un-metered including commercial and industrial connections. The present water tax is being realized at the rate of 10 percent of annual rental value and water charges for domestic and non-domestic /commercial house connections are Rs. 50 and Rs. 75 per month respectively. In total there are 14,000 house water connections, 150 public stand posts, 810 hand pumps.

39. *Quality and quantity of Ground Water***.** Hapur is located in Central Gangetic Alluvium of quaternary age. The alluvium comprises of clay mixed kankar and fine and medium sand. The ground water in the area occurs under the unconfined to semi confined conditions. As per the subsurface configuration study of the nearby area, the saturated/tapped granular zones occur between the depth ranges of 70 - 100 meter below ground level. Yield of tube wells is 750-1,000 LPM. Depth of tube wells is about 110 meters. As per study and evaluation of chemical analysis results, it has been found that the formation water of upper and middle aquifer is potable. The chemical analysis results of the tube wells upto the depth of 110 meter below ground level indicate fresh/potable water.

40. *Institutional Arrangement for Water Supply.* Hapur Municipality is operating and maintaining the water supply system in the city. EE Project Diivision, UP Jal Nigam is in charge of all Water Supply and Sewerage capital works of Hapur and Bulandsahar towns.

41. *Projects under Consideration for Water Supply*. To meet the requirements of the year 2034-(projected population 425,331 for year 2034, 343,507 for year 2024 and 248,771 for year 2009), Reorganization scheme for water supply of Hapur City will has been prepared by UP Jal Nigam. The scheme covers whole of the habitated area of Hapur Municipal Corporation 1401 hectares. The scheme is estimated to cost Rs 324.5 million. The project proposes construction of new tube wells, over head tanks and pumping stations. Construction of new tube wells will be staggered in three stages; in first phase requirement of year 2009 will be met; in phase II, requirement of year 2024 will be met and in the 3rd phase ultimate requirement of the year 2034 will be met. It is proposed to supply water at the rate of135 LPCD and additional provision of 15 percent for losses in the system has been accounted. The project has been approved by GOI under UIDSSMT and is waiting for release of funds for start of works.

42. Existing and proposed water supply system is shown in **Map 2**.

Map 2: Existing and Proposed Water Supply System in Hapur

IV. TOWN PLANNING AND POPULATION FORECAST

A. Project Area

43. The present municipal corporation boundary extends to 1,401 hectares. The master plan 2005 boundary covers an area of 4,633 hectares. Recently 19 villages have been included and with these villages the area becomes 5,522 hectares. The UP NCR Cell has prepared existing land use map of Hapur in 2007 (**Map 3**). This has an area of 9,733 hectares. The boundaries of above three areas are shown in **Map 4**.

44. Project area has been taken corresponding to the land use plan of the master plan 2005 and recently extended area in view of the growth pattern of the city and in consultation with HPDA. This is because of the fact that actual growth of Hapur has been far less than that projected in the said master plan and regional plan 2001. The Population considered in Hapur Master Plan for year 2005 is 450,000 but actual census population in year 2001 was 211,983 and in year 2005 population may be about 230,377. The area under the Master Plan 2005 is 46 sq km but the habituated area at present is 14 sq. km. Moreover the projected population for year 2041 is 628,302. Thus the likely area habituated by year 2041 will be about 55 sq km which corresponds to the Master Plan area 2005 plus recently included villages.

45. The project horizon year is 2041 and as such sewerage system is required to be planned for area of city to which it will grow by the year 2041. Master plan of a city gives an idea of city as to how it will grow in future. However in case of Hapur the available Master Plan is for year 2005 and currently master plan for future is under preparation. Under the circumstances a judgment is required to ascertain likely extended area of city in the year 2041. The forecasted population for year 2041 can be accommodated in Current master plan area of 5,522 hectares with an average density of 114 persons per hectares. As such the project area for which this sewerage plan is being prepared is 5,522 hectares. The project area is delineated to include all area of Hapur Municipality, Master plan 2005 and recently included villages. Different areas are given in the following Table.

Table 2: Geographical Area of Hapur

S. No	Particulars	Area in ha
1	Municipal Area	1,401
2	Master Plan 2005 Area	4,633
3	Master Plan Area 2005 recently extended	5,522
4	Existing Land Use 2007	9,733

Map 3: Existing Land Use 2007

Map 4: Project Area Boundary

B. Hapur Master Plan 2005

46. The Government of Uttar Pradesh in 1978 declared the area falling under Hapur Municipality and 31 villages of Hapur and Meerut Tehsils as Hapur Viniyamit Area. Subsequently GOUP in 1993 extended area by including Pilkhua Municipal Area, Babugarh Nagar Punchayat and 51 villages. In 1998 Hapur Pilkhua Development Authority (HPDA) was created to implement Master Plan and area under Viniyamit Area. The Master Plan for Hapur for period 1979-2001 for target population of 200,000 was approved by GoUP in 1983. The regional plan NCR 2001 proposed population of Hapur in year 2001 as 450,000 and as such the Master Plan 2005 was modified considering population in the year 2005 of 450,000. Now the master plan for next 20 years is under preparation. The master plan proposes land use plan for the city with the intention of achieving balanced distribution of various land uses.

47. *Land Use*. In 1994, Hapur had residential as the major land use (49.71 percent) followed by traffic and transportation (23.95 percent). Industrial land use (5.09 percent) was not a dominant land use in 1994. Land use of 2005 as per the proposed Master Plan is shown in **Map 5**.

Table 3: Comparative Land Use Pattern as in 1994 and as proposed in 2005

S.No	Category	1994	2005
1	Residential	49.71	56.27
2	Commercial	11.20	3.81
3	Industrial	5.09	6.72
4	Govt-Semi Govt	1.08	1.14
5	Community Facility	0.92	2.07
6	Traffic & Transport	23.95	10.00
7	Recreation Open Spaces/Play Grounds/others	8.05	19.98
	Total	100	100

Source: Master Plan 2005

C. NCR Regional Plan

48. Regional Plan 2001 of NCR assigned population of 450,000 for Hapur in the year 2001. However actual population as per census 2001 of Hapur was 211,983. Thus the development was not as much as envisaged. The regional plan 2021 of NCR proposed six tier hierarchy of settlements, as given in the following Table.

Table 4: Proposed Six-tier Hierarchy of Settlements

S No	Hierarchical Level	Population Range
1	Metro Centre	1 million and above
2	Regional Centre	0.3 to 1 million
3	Sub-Regional Centre	50,000 to 0.3 million
4	Service Centre	10000 to 50000
5	Central Village	5000 to 10000
6	Basic Village	Below 5000

Source: NCR Regional Plan 2001

Map 5: Proposed Land Use as per Master Plan 2005

49. The Regional Plan also defined Central NCR (CNCR) and area of NCR except CNCR i.e. outside CNCR. Regional Plan 2021 proposed 7 metro centres and 11 regional centres. Regional Plan 2021 defined regional centre as, well established urban centre in the region, marked by highly specialized secondary and tertiary sector activities and providing job opportunities, which normally cannot be performed by other lower order centres. The regional centres will be developed for advanced industrial and other economic activities and will have concentration of administrative and higher order service functions, which are expected to exert an increasingly dynamic influence on attraction of investment and creation of conducive living and working environment. In Regional Plan 2021 Hapur-Pilkhua has been proposed as regional centre outside CNCR and population estimated is as follows: 300,000 in 2011 and 450,000 (2021)

D. Population Projections

50. The population of Hapur has increased from 146,591 to 211,983 during 1991-2001. The town is mainly developing on both sides of Bulandsahar road towards Bulandsahar in narrow width and along Delhi- Muradabad National Highway towards Muradabad. HPDA is developing all areas in south west direction lying between Bulandsahar road and NH 24. Census data of Hapur for year 1951to 2001 are given in the following Table.

Table 5: Population Growth of Hapur

Year	Population	Decadal Population Growth Rate (%)
1951	49,260	12.2
1961	55,248	29.0
1971	71,266	44.3
1981	102,837	42.2
1991	146,262	42.2
2001	211,983	44.9

Source: Census

51. Based on decadal populations, the future population has been projected in **Annexure 1** as per different prevalent methods such as arithmetical increase, Incremental increase, geometrical increase, graphical etc. Considering high growth proposed under regional plan geometrical increase method has been adopted for estimating future population as it gives more population than that by other methods. Moreover the population projected by geometrical increase method resemble closely to Regional Plan 2021 population projection. The regional plan projected population as available in the plan is combined for Hapur and Pilkhua, separate population projection for Hapur not given, as such exact match is not done. The projected population as adopted is given in the following Table.

Table 6: Projected Population of Hapur

Year	Projected Population	Decadal Population Growth Rate %
2001	211,983	
2011	278,143	31.2-
2021	364,951	31.2
2031	478,853	31.2
2041	628,302	31.2

Source: Analysis

52. *Projection of Population beyond Hapur Municipal Area and within Project Area*. The population of the area outside municipal boundary has been worked out by subtracting population residing in municipal area in 2041 from total population of Hapur of year 2041. On this basis the population density shall be as given in the following Table.

Table 7: Population Densities in Project Area

Location	Population year 2041	Area in ha	Population Density
Municipal Boundary	364,631	1,401	260
Area outside municipality but with in project area	263,671	4,121	64
Total Area	628,302	5,522	114

Source: Mater Plan

E. Projection of Ward Level Population

53. For Sewerage Planning it is most crucial to identify smaller sewerage zones covering the whole project area. For this purpose population of the sewerage zones is also required and this can be assessed if ward, the smallest unit of a ULB, is considered and hence the population of the wards needs to be projected for various design stages from 2011-41.

54. For projecting the ward population the available data is population of ward in year 2001Census. The population density in year 2001 has been calculated as area of ward is known. The population of Hapur as arrived by geometric increase for the year 2011, 2021, 2031 and 2041have been distributed in different wards as per assumed growth of each ward. Growth of wards will vary, the wards which are at peak density i.e. 700-800 persons per hectare will grow at a very slow pace but wards which are at minimum density at present will grow at maximum rate. Rate of growth has been adopted as per **Table 8**. Maximum density has been taken 800 persons/ hectare. Ward wise population for year 2011, 2021, 2031 and 2041 are given in **Annexure 2**.

Table 8: Assumed Decadal Growth in Population Density

Population Density Range	Decadal growth
persons/hectare	*%*
0-100	20
100-200	18
200-300	15
300-400	12
400-500	9
500-600	6
600-700	4
700-800	2

Source: Analysis

V. EXISTING SEWERAGE SYSTEM IN HAPUR

A. General

55. Sewerage system in city was developed by UP Jal Nigam during year 1972-1974. The map of existing sewerage system showing trunk mains, sewage pumping station and laterals is given in **Map 6**. The present sewerage system exists in about 30 percent area of the old town and is almost defunct. Municipal authorities maintaining the sewerage system informed that the existing sewers are choked and over-flowing in number of areas. The sewage flow is so less that at present pumping is done for 2 hours a day and that too with one pump operating against installation of four pumps. This also indicates that most of the sewers are choked or connected to drains.

B. Sewer Lines and Pumping

56. *Sewer Lines*. Existing sewer lines are of RCC (Reinforced Cement Concrete), with a minimum diameter of 150 mm (lateral sewers) to a maximum of 850 mm. Total length of sewer line is Hapur is about 15 km. Of the 27 wards, sewers were laid in 11 wards partly (ward no,s 9, and 12 to 22).There are four main/trunk sewers laid to convey sewage collected through laterals to the Sewage Pumping Station (SPS) and then to the sewage farm. Diameter of these sewers varies from 300 mm to 850 mm .

57. Most of the sewer lines are choked and are overflowing. Due to lack free flow in the system, most of the sewers are discharging sewage into open drains. Almost all of the open drains in the congested city area are carrying sewage. As a result, the total sewage reaches the sewage pumping station is very minimal. At present pumping is done for 2 hours a day with one pump operating against installed capacity of four pumps. The sewage reaching sewage pumping station is hardly 5-10 percent of design flow; which confirms that the existing sewerage system is almost defunct.

58. *Sewage Pumping Station*. As part of the system a Sewage Pumping Station was developed near Awas Vikas Colony (Ward 15), along Circular Road. The sewage that reaches SPS through trunk sewers is conveyed to Sewage Treatment Plant through pumping. There are four open clog turbine pumps of capacity 30 KW each. The electric motor is of 960 RPM rated 55 Amperes. The Mechanical and electrical equipments are in use for almost 30 years, and needs immediate replacement.

59. *Rising Main*. A raising main – of 450 mm diameter, partly of Cast Iron, and partly of RCC, was laid from SPS to a natural drain in the south of the town.

Map 6: Existing Sewerage System

C. Sewage Treatment Plant

60. The sewerage system in Hapur was developed without a sewage treatment facility. Sewage pumped from SPS is discharged directly into natural stream and used for irrigation in the surrounding agricultural fields without any treatment. There was a large demand for raw sewage from farmers, but due to urbanization, the farming activity has greatly been reduced, and at present there is no demand, and untreated sewage is disposed off directly. It was the practice of Hapur Municipality to sell the raw sewage to the farmers to generate some additional revenues.

61. Master plan 2005 has identified two sites for development of STP; however, these sites needs to acquired as they are under private ownership and are currently used for agriculture.

D. Institutional Arrangement

62. Sewerage system is maintained by Hapur Municipality. The capital works, rehabilitation, extension and up gradation in sewerage system is done by UP Jal Nigam. In Municipal Corporation, Assistant Engineer is in charge of the operation and maintenance of sewerage system.

E. Proposals for up gradation of Sewerage System

63. Earlier it was proposed to prepare sewerage scheme for Hapur under UIDSSMT. Accordingly UP Jal Nigam has done some work. Subsequently the state government took a decision to have sewerage schemes for District Head Quarter towns only in the first instance and accordingly the work of preparation of sewerage project was dropped by UP Jal Nigam. HPDA informed that they will take up the matter with the state government for giving relaxation in this regard looking to the fact that Hapur is under NCR and probably the only Non District HQ Town which has a Development Authority.

VI. PLANNING AND DESIGN CRITERIA

A. Preparation of Base Map for Planning

64. To prepare the maps for planning sewerage system in the Hapur Town following maps/data were used:

(i) Topographical map Sheet 53 H 14/I from Survey of India (SOI) (surveyed 1971-72), scale 1:25,000

(ii) Existing Land Use map 2007 obtained from NCR cell UP Gaziabad

(iii) Map of Hapur Municipal Area scale 1:4800 showing existing sewer lines proposed sewer lines and Wards, obtained from local municipal office, in hard copy

(iv) Water Supply Network Map obtained from UP Jal Nigam

(v) Master Plan Land Use Plan 2005

(vi) Zonal maps (all 4 zones) of Hapur from HPDA

(vii) Sector maps of Preet Vihar Phase I, Preet Vihar Phase II and Anand Vihar from HPDA

65. The details of above maps were integrated to prepare maps showing, River / pond / stream, cinema / petrol pump, Road / railway and school / college, Bridge / culvert / flyover, hospital / major nursing home, Major hotel / guest house, General land use with road / locality / landmark name, Police station / Chowky, Drains and outfalls, landmarks, Existing sewer network, proposed sewers, pumping station, Water supply network with municipal boundary and wards, Overhead tanks, GLRs etc. Contour map was prepared from levels given in water supply map. The contours available in Topographical map of Survey of India (SOI) have been integrated in this map. The contours and drains of Hapur are shown in **Map 7**.

B. Topographical Survey and Soil Investigations

66. Topographical survey will be undertaken now along trunk mains, outfall sewer, interceptors and laterals and drains. Contour survey of STP area shall be done. These surveys will be used to revalidate current proposals and further work on feasibility report and DPRs. Soil investigations and waste water characteristics shall also be found out.

C. Constraints and strategies for planning of sewerage

67. The area is sloping towards south and southwest. Topography of area is flat. This puts a constraint on collecting and carrying the sewage flows by gravity without pumping. The natural slope of the town will be followed while planning the sewer network in order to minimise pumping. Newly developing areas and areas anticipated to be developed would be considered in the planning. In narrow lanes, the sewers will be proposed in centre, so that houses on both sides of the road can be connected to it.

Map 7: Contour Map of Hapur

D. Sewer Connections

68. It was informed that about 75,000 people are covered with sewerage system. However no data is available with Hapur Municipality on sewer connections. But based on enquiry in different wards, about 70 percent of the houses of core area where sewer lines exist are connected. It is also true that provision of connections to all is impossible. In areas where economically weaker section population is predominant and in slum localities the percentage of connection is less. But in other areas, after completion of scheme much higher ratio is expected. The success of the scheme and higher connections is possible with effective awareness program supported by ULB. However for design purpose for safety, it is assumed that all the waste water produced will come into sewerage system.

E. Design of Sewage Collection System

69. The sewerage collection system will be designed based on the projected contributing population, factories, office buildings etc. Sewer alignments and diameters, manhole and junction sites, etc. will be designed using computer models.

F. Design Period

70. Design period of 30 years has been proposed for the Master Plan with base year as 2011 and design horizon year as 2041. Design period for various main components has been taken as given below-

Land Acquisition	-	30 years
Trunk, Main, Branch Sewer & Appurtenances	-	30 years
Pumping mains	-	30 years
Pumping Stations-Civil Work	-	30 years
Pumping Machinery	-	15 years
Sewage Treatment Plants	-	30 years

(The construction shall be in phased manner)

G. Flow in Sewers

71. Manning's formula has been used for design of sewers, assuming free flow in sewers. For pressure flow, the Hazen-William's formula has been used. Sewer network design has been done with the help of Manning's Formulae i.e.

Velocity V=[(1/n) x (R2/3S1/2)] (in m/s)

For Circular Sections

V = (1/n)(3.968 x 10-3D2/3S1/2)

Q = (1/n) (3.118 x 10-6D8/3S1/2)

Where, Q = discharge in lps; S = slope of hydraulic gradient; D =internal dia of

pipe line in mm; R = hydraulic radius in m; n = Manning's Coefficient of roughness

72. Coefficient of Roughness (n) in case of RCC S&S pipe is 0.011 for new pipes and 0.015 for old pipes. For uPVC pipe the value of (n) has been taken as 0.011.

H. Per capita sewage flow

73. The rate of water supply has been adopted as per the norms of CPHEEO manual as 135 lpcd at consumer end throughout the whole design period. 80 percent of the water supply has been considered as sewage flow into the sewerage system which works out 108 LPCD.In case of bulk consumers rate of water supply has been taken as per CPHEEO manual with a return factor of 80 percent or as per actual measured quantity of effluent.

I. Peak Factor

74. The peak factor is the ratio of maximum to average flow and depends upon contributory population. The same has been calculated from the Gifft formulae as given below-

F = 14/P^ (0.1667), where P is population

However, a maximum peak factor of 3 and minimum of 1.6 has been taken for estimation of sewage generation.

J. Ground water infiltration

75. Estimate of flow in sanitary sewers includes flows due to infiltration of ground water where the sewer has been proposed below the subsoil water level. However, where the groundwater level is much below the sewer line no infiltration is considered. Where the sub-soil level is high, infiltration rate of 5000 Lit./ Hectare / day has been adopted as per CPHEEO manual.

K. Velocity of flow and Depth of flow

76. The velocity of flow in sewers varies, as per the flow, which varies from hour to hour and also seasonally. For hydraulic design, the estimated peak flow is adopted. However it is to be ensured that a minimum velocity is developed in sewers during peak hours from the very beginning. At the same time the velocity should not be excessive to cause erosion of pipe material. Minimum velocity of 0.60 m/sec and a maximum velocity of 2.75 m /sec has been adopted which is as per CPHEEO manual. Sewers are designed on the assumption that although silting might occur at minimum flow, it would be flushed out during peak flows.

77. Sewers shall not be designed to run full. The maximum flow depth should be 0.8 full at ultimate peak flow for all pipe diameters.

L. Changes in Diameter and Direction

78. Sewers shall be designed to ensure that the energy gradient is a continuous smooth line,

thus transitions from larger to smaller diameters shall not be made. The crowns of sewers shall be kept continuous. In no case, the hydraulic flow line in the large sewers shall be higher than the incoming sewer. To avoid backing up, the crown of outgoing sewer shall not be higher than the crown of incoming sewer.

79. A manhole shall be provided at each change of direction and the sewer shall be in a straight line between two manholes. The channels in manholes at junctions and bends shall be smooth with gradual transitions to avoid turbulence and deposition of solids.

M. Minimum size of sewer

80. Minimum pipe diameter recommended in CPHEEO manual is 150 mm. Some states and ULBs have started adopting minimum diameter as 200 mm or even 250 mm. The logic is i) Maintenance of sewer system is generally not good and 150 mm dia sewer will chowk frequently and remain un attended for some time ii) Quality of construction in smaller size RCC main such as 150 mm is not good iii) The sewerage system is not totally closed one and undesired waste such as solid waste and drains finds way in sewerage, making smaller size sewer lines more prone to frequent choking iv) The cost of pipe line element is only about 15 percent of total project cost and increase in pipe size from minimum of 150 mm to minimum of 200 mm size will increase cost of project by 2 percent whereas flow capacity increases by more than 80 percent. Hapur is comparatively smaller town and as such it is proposed to have minimum size of 150 mm but at junction of two pipes and further downward at least 200 mm pipe will be used. This way use of 150 mm has been kept minimum and only at start of sewer system.

N. Pipe material

81. Reinforced Concrete, uPVC, HDPE and GRP are all suitable materials for gravity sewers. When using concrete or reinforced concrete, high density sulphur resistant cement should be used. These pipes are made of slag cement that contains fewer calcareous (CaOH2) particles than pipes made of Portland cement. These particles react with the sulphuric acid (created by bacterial dissipation of hydrogen sulphide) in sewers, causing the aforementioned crown corrosion. If this particular cement is not used, lifetime of concrete sewers cannot be expected more than 30 years.

82. The cost comparison of different types of pipes is done including cost of bedding and trench back fill material as these costs are substantial. On this basis RCC pipes are more cost effective and as such have been recommended. RCC NP3 pipes shall be used for depths up to 2-3 meter and below that RCC NP4 pipe shall be used. RCC Pipes shall be manufactured with sulphate resistant cement to minimize crown corrosion and increase life of pipe. In narrow and congested lanes without heavy traffic uPVC and HDPE pipes (6kg/sqcm pressure) are recommended.

O. Minimum cover

83. The minimum cover without protection has been proposed 1.00 m above the pipe. The

maximum depth of sewer pipe can be kept as per site conditions to minimize the number of pumping stations. Normally the same has been kept 8-10 m.

P. Bedding

84. Design of bedding shall be adopted as per CPHEEO manual and latest IS code. Four classes of beddings of A, B, C, and D are used for laying of sewers. Class A bedding may be either concrete cradle or concrete arch. Class B is bedding having a shaped bottom or compacted granular bedding with a carefully compacted backfill. Class C is an ordinary bedding having a shaped bottom or compacted granular bedding but with a lightly compacted backfill. Class D is one with flat bottom trench with no care being taken to secure compaction of backfill at the sides and immediately over the pipe.

Q. Manholes

85. Manholes are proposed at every change of alignment, gradient or diameter, at head of all sewers and at every junction of sewers. Manholes are usually constructed directly over the line of the sewer. They are circular, rectangular or square in shape. Manholes should be of such size that will allow necessary cleaning and inspection. The circular manholes have been proposed on all sewer lines Polyelastromer M S flats footrest has been provided for entry into manholes.

86. *Spacing and Depth*. For inspection, cleaning and testing of sewers, manholes shall be provided at every change of alignment, gradient, diameter, head of sewers and at junction of sewers. The spacing and the size of manholes are proposed as per CPHEEO manual as given in the below Table.

Table 9: Size and Spacing of Manholes

Sewer size	**Manhole spacing**
Sewer < 900 mm diameter	30 m
900 mm –1000mm diameter	75 m (from practical view point)
> 1000 mm diameter	100 m (from practical view point)
Depth of manhole	Manhole dimension
< 1.65 m	900 mm diameter
1.65 m – 2.30 m	1200 mm diameter
2.30 m-9.00m	1500 mm diameter
> 9.00m	1800 mm diameter

Source: CPHEEO Manual on Sewerage

87. *Covers and frames*. The size of manholes shall be such that there should be a clear opening of not less than 0.56m dia for entry. Steel Fibre Reinforced Concrete Covers (SFRC) conforming to IS 12592 has been proposed. Cover and frame (heavy duty HD-20 Grade designation) 560mm internal dia has been proposed.

88. *Drop Manholes*. As per CPHEEO manual Drop manhole to be provided when a sewer

connects with another sewer, where the difference in level between water lines (peak flow levels) of main line and the invert level of branch line is more than 600mm or a drop of more than 600mm is required to be given in the same line and it is uneconomical or impractical to arrange the connection within 600mm.

R. Flushing

89. In places where desired velocity (self cleaning) is not attainable in initial pipe sections, flushing by water tanker by a frequency of flushing at specified basis once in a day is to be considered. Flushing tanks are to be designed for 10 min. flow at a self cleansing velocity of 0.6 m/s.

S. Pumping Mains

90. Rising mains (pressure mains) shall be required to convey sewage from Sewage Pumping Stations to an inlet chamber of nearby sewer or Sewage Treatment Plants and will be designed according to the following considerations:

- A maximum velocity of 3.0 m/s at ultimate peak flow
- Where flows are expected to substantially increase between 2026 and 2041 the option of laying a duplicate line at a later stage will be investigated.
- Each pumping station will be provided with an on line flow meter.

91. *Design Formula*. Hydraulic design has been done using Hazen-Williams formula which is given below:

V = 4.567 X 10-3 CD0.63 S0.54 and

Q = 1.292 X 10-5 CD2.63 S0.54

Where, Q - Discharge in m^3/hr; V - Velocity of flow in m/sec; d - diameter of pipe in mm;

C - Hazen-Williams Co-efficient; S - Slope of Hydraulic Gradient;

'C' Value adopted used in the hydraulic design has been taken 140 for DI pipes with cement mortar lining inside.

92. *Duration of Pumping*. Considering the normal availability of electricity in the town 16 hours per day pumping has been considered.

93. *Minor losses for Fittings*. While calculating the head loss for flow of water through pipeline additional provision of 10 percent will be made over the theoretically calculated loss (using Hazen-Williams formula) to take account of the additional head losses for bends, tees, tapers, enlargers and valves etc. along the alignment of pumping main.

94. Pipe Material for Rising C.I. unlined pipes/PSC pipes have so far been used in pressure mains. The prevalent practice is to use ductile iron (D.I.) pipes with cement mortar lining/ zinc coated. Apart from superior metallurgical properties, D.I pipes with cement mortar lining / zinc coated possess numerous certain distinct advantages over CI unlined pipes. PSCs pipe are cheaper than other pipe materials but maintenance of PSC pipe especially replacement of pipe piece is very difficult, while replacement of pipe piece is very

convenient in case of DI pipes. The life of DI pipe is also longer than PSC pipes and it will work out economical in the long run. Therefore, DI pipe is generally recommended for rising main.

95. In this case DI pipe has been proposed for rising main for pumping station at south STP and East STP as length is quite less, Pump houses are proposed near to the respective STPs. However in case of existing pump house it is proposed to use existing pipe and extend it further by PSC pipe up to STP south.

T. Sewage Pumping Stations

96. At places, where depth of sewer becomes too deep and it is difficult to lay sewer at such depths, sewage-pumping station has been proposed to lift the sewage to nearby manhole or to the STP, from where it will flow by gravity. A number of pumps are provided in the pumping station which performs the lifting function through a pumping main.

97. *Screens*. All PS will be provided with Mat screens. Conventional mechanically raked screens are not proposed considering its problems in past.Manual screens have been proposed with each Mat screen for use in case of breakdown of Mat screen. It is also proposed to provide an overflow weir on the upstream side, to avoid overflow of the screen channel in case of sudden power failure. Drainage facility shall also be provided in the individual screen channels to empty these channels for maintenance purposes.

98. *Sump*. The sewer line will discharge the sewage into a wet well, designed for a hydraulic retention time of 5 minutes storage of ultimate peak discharge in a wet well, and 3.75 minutes for submersible pumps. The Sump design high water level will not exceed Invert level of lowest incoming pipe.

99. Types of Sewage Pumps. Non clog submersible pumps are proposed in all Pumping stations as per availability in the Indian market. All pumps of same capacity are to be provided. Pumping units are designed to handle suitably peak, average and low-flow from connected sewers.

100. Pump Configuration. Configurations of Sewage Pumps shall be as follows:

Where rising main is long-	Peak flow/2 pumps	- 3 no’s (1 standby)
Where rising main is short	peak flow/4 pumps	-5 no’s (1 standby)

U. Sewage Treatment Plants

101. For the provision of treatment plants distributed or decentralised STP should be considered. It should be noted that the financial analysis of STP options will compare the costs of decentralised works to centralised works with its associated longer rising mains. However, decentralised treatment is the preferred option. STPs capacity shall be designed for ultimate flow in the year 2041. The plant will be modular such that planning will be

for 2041 capacity but initially one module will be developed for year 2026 requirement or even less depending on techno economic criteria because sewer connectivity is at a low pace. The design of STP will be based on measured values of sewage strength with an assessment made of the sewage dilution due to natural flows in the drains.

102. Selection of Sewage Treatment Plant Site:

- Suitable location for the discharge of treated effluent
- Sufficient area for future expansion preferably for 30 years period
- Should be away from residential areas to avoid odour problems, 200m buffer plantation zone recommended
- All weather access for the trucks to remove sludge/screenings/grit, etc.
- Minimum land resettlement issues - Government owned land is preferred to avoid land acquisition problems.

103. Criteria for Evaluating the Sewage Treatment Technologies

- Capital and O & M costs
- Land Area Requirements;
- Need for Mechanical and Sophisticated Equipment;
- Level of Supervision Required for Operation and Maintenance;

104. Sewage Treatment Selection Criteria
- Minimum energy consumption
- Need to meet effluent standards;
- Should be simple to construct and operate and have a low O & M cost
- Final use of the treated effluent.

105. *Influent Quality*. As per analysis report of samples collected by TA consultants shall be used as influent quality in designs.

106. *Effluent Quality Standards*. The Government of India, appointed a committee of experts to look into various sewage treatment technologies and recommend water quality standards for rivers and treated wastewater and to suggest simple, efficient, cost effective, easily replicable and sustainable technology to be adopted.

Table 10: Effluent Disposal Stanadards

Parameters	**Standards for treated sewage effluents for irrigation / water bodies**
BOD (mg/l) (5 days 20ºC)	30
TSS (mg/l)	50
Faecal Coli form MPN/100 ml Desirable Maximum. Permissible	 1,000 10,000

Parameters	Standards for treated sewage effluents for irrigation / water bodies
COD	250
pH	5.5-9.0
Sulphides (mg/l as S)	2.0
Total Chromium (mg/l as Cr)	2.0

Source: CPHEEO Manual

107. *Land Requirement*. Requirement of land as per different methods of treatment is given below:

Activated Sludge/Trickling Filter	-	0.5 acre/MLD
Aerated Lagoon	-	1.2 acre/MLD
Stabilisation Pond	-	2.5 acre/MLD
UASB	-	0.42 acre/MLD
Extended Aeration	-	0.35 acre/MLD

108. *Low Cost Sanitation Options*. Community/Public toilets will be provided for slum sanitation and sewage generated from the toilet blocks is either to be treated by constructing septic tanks followed by soak pits in the areas where sewer line is not available and sufficient space is available for its construction or to be disposed into the nearby sewer line and treated at the treatment plant. Size of the toilet block shall be decided depending upon the size of community and space availability. 10 and 20 seated toilet blocks will be provided. These units will be properly designed as per SP 35 (S&T): 1987 and CPHEEO Manual according to the number of users. However community toilets will be provided where beneficiaries are ready to maintain and bear cost of maintenance. The norms for use of such toilets are 50 persons per seat; therefore the number of users for 10 seat complex shall be 500.

VII. INTERVENTIONS FOR MASTER PLAN

A. Sewerage Zones

109. Sewerage zones are based on the following criteria

(i) Utilization of topography of the town
(ii) Natural boundaries like rivers, canals/Drains and habitation Pattern
(iii) National Highways and Railways
(iv) Utilization of, existing sewerage network, Pumping stations, pumping mains
(v) Availability of land for pumping stations and STP
(vi) Permissible depth of outfall sewer, depth of subsoil water level, length of main/trunk sewer and pumping main etc

110. In Hapur the project area has been divided into 8 sewerage zones, named zone 1 to 8. The contour map shows that Meerut–Bulandsahar road is at contour of 213 m and area on west side of Meerut –Bulandsahar road drains towards east and south, lowest point being near proposed STP south which is at 210 m contour. The area on west of Meerut –Bulandsahar road is generally flat at contour of 213 m, but the lowest point is towards Tatarpur village where Kali river passes. The contour here is of 210 m. In the master plan 2005 two sites for STPs have been marked, one near Tatarpur village and on east side of city and is near to Kali River. Other site shown in the master plan is towards south near Chatoli village. These sites are suitable from engineering aspects as situated towards depression, low levels. The zone 1,2, 3, 5 and 8 will drain in STP south and zone 4,6, and 7 will drain in STP east. Proposed sewerage zones are shown in **Map 8**.

(i) Zone 1: It comprises of 9 sectors being developed by HPDA such as Preet Vihar, Anand Vihar etc and also encompasses some municipal area. Its area is 1280 hectares and shown **Map 9**.
(ii) Zone 2: The area covers the existing sewered area of Hapur. Area is 180 hectares
(iii) Zone 3 & Zone 4: The remaining area of Municipal Corporation which is not covered under zone 1 & 2 is placed under zone 3 & 4 such that western part which will drain in STP south is named zone 3 and other area named zone 4. Area of zone 3 is 500 hectares and area of zone 4 is 360 hectares
(iv) Zone 5 & zone 8: Out of the remaining area the southern part which is near to STP south is classified as zone 8 and North east part of city which is more near to STP south as compared to STP east has been classified as zone 5. The area of zone 5 is 910 hectares and area of zone 8 is 640 hectares
(v) Zone 6 and zone 7: The remaining area which is near to STP east has been classified as zone 6 and 7. NH 24 divides zone 6 and 7. Area of zone 6 is 1090 hectares and area of zone 7 is 640 hectares

Map 8: Proposed Sewerage Zones

Map 9:Sectors Under Development by HPDA in Hapur

111. Basis of zoning: The area which has natural slope towards south STP and near to south STP has been considered to drain in south STP and remaining area which is near to STP east is considered to drain in STP east. These two areas have been further sub divided as per existing system, municipal area to be covered on first priority and area being developed by HPDA which is also to be covered on priority. The other remaining area is not populated at present and not presently planned for development and as such has been considered separately and it has been further sub divided as per main physical boundaries such as rail line, NH, bye pass road.

B. Zone wise Population and flow generation

112. Further break up of zone no 1 such as sector 1 to 9 proposed by HPDA and different municipal wards falling under this zone are show in **Map 10**. Area of each ward coming under this zone has been worked out and also area of HPDA sectors 1 to 9 has been calculated. Some area of HPDA sectors and municipal areas are overlapping as such net area of HPDA sector has been considered and the overlapping area has been considered in municipal ward area. The density of particular ward and sectors as stated in population forecast has been used to find population and waste water generation in zone 1 for year 2011, 2021, 2031 and 2041 and shown in **Annexure 3**. Similar drawings have been prepared for zone 2, 3 and 4 showing areas of different wards falling under each of these zones and are presented in **Map 11**, **Map 12**, and **Map 13**. Population and waste water generation under zone 2, 3 and 4 has been calculated and detailed calculations are presented in **Annexure 4, 5 and 6** respectively for year 2011, 2021, 2031 and 2041. Detailed calculations of zone 5, 6,7 and 8 are given in **Annexure 7**.

C. Adequacy of Existing Sewerage System

113. The discharge capacities of the main trunk sewers have been calculated to establish if they have sufficient capacity for the peak flow for the horizon year 2041. The sewerage system has been designed such that existing sewers shall be apportioned flow as per their carrying capacity by diverting additional flow to newly proposed sewers. The adequacy of existing outfall sewer has been examined with respect to the flow generated from the apportioned area and it is found ok. However De silting and repair/replacement of damaged sewers and manholes would be required for most of the length. The existing pumping station shall be used under new system with discharge capacity same as designed earlier. The pump head will now increase corresponding to take flow up to new STP south. The mechanical and electrical equipment and installation will require total change as it has survived more than its life. The new pumps 4 no. 40 KW will replace existing pumps of 30 KW. The existing rising main 600 mm dia shall be used and Its length will be extended by 1300 mm dia PSCC pipe up to STP south. Existing sump and pump house building shall be used after repairs.

Map 10: Detailed Map of Zone 1 Showing Wards and Sectors

Map 11: Detailed Map of Zone 2 Showing Wards and Sectors

Map 12: Detailed Map of Zone 3 Showing Wards and Sectors

Map 13: Detailed Map of Zone 4 Showing Wards and Sectors

D. Proposed New Sewerage System

114. It is proposed to provide sewerage system to cater needs of project area. As per preliminary design the outfall sewer for zone 1 will be of 1000 mm, zone 3 shall be 1100 mm and zone 4 outfall shall be of 700 mm. The preliminary designs of outfall for zone 1, 2, 3 and 4 are given in **Annexure 8**. The designs will be modified and updated after engineering surveys during feasibility study. Lateral sewers at 125 meter per hectare have been taken. On this basis length will be about 650 KM in whole project area. RCC NP3 and NP4 pipes diameter 150 mm and 200 mm shall be used. PVC pipe 110 mm and 160 mm shall be used for making connections from house to sewer. The length of PVC pipe shall be approximately 410 Km. Interceptors, trunk mains and outfall sewer shall be RCC NP4/NP3 pipes; diameter shall be 250 mm -1100 mm. The length of interceptor, trunk main and outfall sewers shall be taken10 percent of the laterals i.e. about 65 Km. Road reinstatement has been taken 40 percent of total length of sewers considering laying of sewers on right of way but outside bituminous road as far as possible. Proposed sewerage system is shown in **Map 14**.

E. Sewage Pumping Stations, Sump and Rising main

115. For planning purposes, it is assumed that the maximum distance that can drain to an STP is about 4.00 km. Non clog Submersible pumping sets have been proposed. Two new pumping stations have been proposed one each for STP south and STP east and are to be located near to respective STPs. Minimum number of pumping stations has been proposed to save energy cost and make sewerage system more on gravity for reliability and less maintenance. However need of any additional pumping station if any shall be reassessed after engineering surveys. The preliminary designs of existing pumping station and proposed pumping stations are given in **Annexure 9**.

116. In phase 1, in SPS south five pumps of 40 KW each, (Pumps to be same size and equal to 4 nos. for peak flow with 1 no standby) and in SPS east 3 pumps of 20 KW each, (2 working & 1 no standby for peak flow) has been proposed. These pumps will meet the flow of year 2026. In phase 2, pumps provided under phase 1 will be replaced and additional pumps of 100 KW at SPS south and 95 KW at SPS east shall be provided to cater the flow for year 2041. The civil works shall be for 2041. The wet well storage shall be 3.75 minutes at peak flow. Rising main length is short and as such DI pipe has been proposed.

Map 14: Proposed Sewerage System of Hapur

F. Proposed Sewage Treatment Plant: Capacity

117. The sewage flow in different years from different zones is given in **Table 11**.

Table 11: STP capacity required for different zones

STP South					STP East				
Zone No.	**Flow in MLD**				**Zone No.**	**Flow in MLD**			
	2011	**2021**	**2031**	**2041**		**2011**	**2021**	**2031**	**2041**
1	5.3	7.1	9.5	12.5	4	3.9	4.6	5.4	6.4
2	6.6	7.3	8.1	9.0	6	1.0	2.7	4.8	7.8
3	10.7	12.4	14.3	16.5	7	0.6	1.6	2.8	4.6
5	0.9	2.2	4.0	6.5					
8	0.5	1.4	2.5	4.0					
Total	**24**	**30.4**	**38.4**	**48.5**	**Total**	**5.5**	**8.9**	**13.0**	**18.8**

Source: Analysis

118. Phase I is for zones 1, 2, 3 and 4 for which sewerage is to be provided on first priority. Phase II, III, IV and V are for zones 5, 6, 7 and 8 which are of second priority. In phase I, capacity required is given in the Table below.

Table 12: Capacity of STP required in Phase 1

Zone No.	**Flow in MLD for STP South**				**Zone No.**	**Flow in MLD for STP East**			
	2011	**2021**	**2031**	**2041**		**2011**	**2021**	**2031**	**2041**
1	5.3	7.1	9.5	12.5	4	3.9	4.6	5.4	6.4
2	6.6	7.3	8.1	9					
3	10.7	12.4	14.3	16.5					
Total	**22.6**	**26.8**	**31.9**	**38**	**Total**	**3.9**	**4.6**	**5.4**	**6.4**

Source: Analysis

119. Connectivity to sewer system is very slow and STPs generally does not receive the anticipated flow and remain unutilized. Therefore STPs have been proposed modular such that planning will be done for year 2041but construction will be in phases so that initially less capacity will be developed and subsequently capacity shall be added for optimum use and minimum investments. Accordingly STP South is proposed for 25 MLD capacities and STP East is proposed for 5 MLD capacities. This capacity will serve demand of phase 1for year 2020. It is proposed to further increase capacity of South STP by 24 MLD in phase 2 and to increase capacity of East STP by 14 MLD in phase 3.

G. Sewage Treatment Plant: Process

120. There are a number of treatment technologies that have been applied for sewage treatment in India under different schemes including Ganga Action Plan and other River Action Plans of NRCD. The treatment technologies for organic pollution load that have been used are mostly biological processes and have their own merits and demerits. The strategy for sewage treatment is to provide low cost treatment with a robust process that takes into account local conditions. The effluents from the STPs should confirm to the standards as presented in 5-3

Table 13: Effluent Standards

Discharge of Effluent	**BOD5**	**TSS**	**Faecal Coliforms**
Into the river	30 mg/l	50 mg/l	1,000 MPN1
On land for irrigation purposes	50 mg/l	50 mg/l	1,000 MPN1

Source: Effluent Standards

121. Waste stabilization pond consists of anaerobic ponds, aerobic ponds and maturation pond. WSP is a natural treatment process and does not consume energy in treatment process. Maintenance cost of WSP is less due to less mechanical parts. In view of poor resource availability in municipal corporation Hapur and rugged ness and less requirement of maintenance, WSP process has been proposed.

122. The land required for waste stabilization plant for year 2041 for STP south of 49 MLD at 1.25 hectares per MLD is 61 hectares. The requirement, for STP east of 19 MLD at 1.25 hectares per MLD is 24 hectares. The land required for Activated sludge process is 10 hectares for STP south and 4 hectares for STP east. The land location shown in master plan at both locations has agricultural use and it is fertile land. HPDA/ Municipal Corporation Hapur should proceed to acquire land as required for waste stabilization plant.

H. Water Reuse

123. The effluents after treatment in the respective STPs can be used for irrigation with faecal coli forms within the desired limits. Phosphates and nitrates are present in the effluent which is advantageous for irrigation. The treated water can also be used for industrial purposes, with further treatment as required. Considering approximately 10 percent as reduction in volume after treatment the minimum quantity of water available for reuse is given in **Table 14**.

Table 14: Quantity of Water Available for Reuse

Location of STP	**Water for Reuse (MLD)**		
	2011	**2026**	**2041**
STP South	20.3	26.0	43.7
South East	3.5	6.6	16.8

Source: CPHEEO Manual

124. *Potential for Irrigation*. The water requirement to irrigate depends on the type of crops that are to be cultivated, type of soil and the climatic conditions. The average quantity of water required per day will be 125 - 250 m3/ha during dry seasons. The total area that can be irrigated per day in Hapur is given in **Table 15**. In wetter periods of the year when only supplementary irrigation is required a greater area could be irrigated.

Table 15: Area for Irrigation

Location	**Area for Irrigation (ha)**		
	2011	**2026**	**2041**
STP South	102	130	219
South East	18	33	84

I. Institutional Set-up

125. At present Municipal Corporation Hapur is operating and maintaining sewerage system. The maintenance is under Juniour Engineer. Capital works are done by UP Jal Nigam. UP Jal Nigam is a competent organization. Municipal Corporation lacks managerial and technical capacity and shortage of financial resources to operate and maintain the sewerage system. The municipal corporation need to be strengthened to handle sewerage system professionally. The engineering department of corporation should be restructured such that at least Executive Engineer heads all engineering operations, supported by four Assistant Engineers, one assistant engineer will be in charge of sewerage operations that will be supported by 4 junior engineers dealing exclusively with sewerage. Municipal Corporation should be in charge of capital works also. However if required by them capital works can be got done from any other agency but Municipal Corporation should have capacity to over view the works.

J. Low Cost Sanitation

126. Experience of community toilets has not been good due to poor maintenance and after some time community toilets remain unutilized. Therefore community toilets shall be constructed only if beneficiaries can maintain and pay for use. Connection to sewerage system shall be encouraged. In slums also connection to sewerage system should be encouraged. Construction of toilets in all houses should be ensured to have city open defecation free Provision of Rs 200 lacs have been taken for low cost sanitation & equipment for maintenance. For sewer cleaning a high pressure water jetting machine will be required together with a suction tanker.

K. House Sewer Connections

127. Connection of waste to sewers: It is proposed to lay 110 mm/140 mm uPVC pipe under the project to connect sewage from house door to sewer man hole. This will ensure fast connectivity and avoid damage to manhole by unskilled people during connection.

L. Sustainability

128. Operation and maintenance cost should be recovered fully from beneficiaries so that proper maintenance is possible and scheme becomes sustainable.

VIII. COST ESTIMATES AND PHASING

A. Capital Cost

129. The item wise abstract of cost estimate is given at **Annexure 10**. The total estimated cost is Rs 2034.7 million. The main components and basis of estimation is given below

(i) Rehabilitation of Existing Sewerage System: The cost includes repair and desilting of sewers, repair and replacement of man holes and foot steps, extension of 600 mm diameter PSCC pipe 1300 m long rising main up to STP south, rehabilitation of sewage pumping station- providing 4pumps of 40 KW each and replacing all mechanical and electrical equipment and installation etc. The present pumps are of 30 KW, discharge of pumps will be same but pumping head will increase due to increased length as such pump KW will increase from 30 to 40 KW. Cost of pumping sets and other mechanical and electrical equipments have been estimated at Rs 10000 per KW. Existing sump and pump house building shall be used after repairs.

(ii) Laterals: Lateral sewers at 125 meter per hectare have been taken. On this basis length will be about 650 KM in whole project area. RCC NP3 and NP4 pipes diameter 150 mm and 200 mm shall be used. PVC pipe 110 mm and 160 mm shall be used for making connection from house to sewer. The length of PVC pipe shall be approximately 410 Km. Rate of RCC pipes including excavation, laying, road repair, bedding, man hole, has been taken at Rs 1500 per meter.

(iii) Interceptors, Trunk Mains and Outfall sewer: RCC NP4/NP3 pipes shall be used; diameter shall be 250 mm -1100 mm. The length of interceptor, trunk main and outfall sewers shall be taken10% of the laterals i.e. about 65 Km in length. Road reinstatement has been taken 40 % of total length of sewers considering laying of sewers on right of way but outside bituminous road as far as possible. Average rate for pipes 250-1100 mm pipe has been taken at Rs 5000 per meter.

(iv) Sewage Pumping Stations and Rising Mains: The estimate includes two no sewage pumping stations near STP south and STP east, wet wells and DI rising main. For planning purposes, it is assumed that the maximum distance that can drain to an STP is about 4.00 km. Non clog Submersible pumping sets have been proposed. In phase 1, in SPS south five pumps of 40 KW each, (Pumps to be same size and equal to 4 nos. for peak flow with 1 no standby) and in SPS east 3 pumps of 20 KW each, (2 working & 1 no standby for peak flow) has been proposed. These pumps will meet the flow of year 2026. Rate has been taken Rs 20000 per KW including civil works. In phase 2, pumps provided under phase 1 will be replaced and additional pumps of 100 KW at SPS south and 95 KW at SPS east shall be provided to cater the flow for year 2041. Rate of equipment and installation has been taken at Rs 10000 per KW as the civil works constructed in phase 1 will serve purpose of phase 2 also. The wet well storage shall be 3.75 minutes at peak flow

(v) Sewage Treatment Plant South and East: The total capacity of STP required for year 2041 will be 67 MLD. The construction shall be modular. Initially 25 MLD capacity shall be provided for STP south and 5 MLD for STP east. Subsequently in second phase capacity of STP south shall be further increased by 24 MLD. In third phase 14MLD capacity shall be additionally provided for STP east. The treatment process shall be waste stabilization pond consisting of anaerobic ponds, aerobic pond and maturation pond. The land required shall be 1.25 ha per MLD, i.e. 61 hectares for STP south & 24 hectares for STP east. The provision for land acquisition has been made in first phase at Rs 2.0 million per hectare. The unit cost for STPs has been taken at Rs 3.0 million per MLD

(vi) Low cost Sanitation & Equipment for maintenance: Provision of Rs 200 lacs have been taken for low cost sanitation & equipment for maintenance. For sewer cleaning a high pressure water jetting machine will be required together with a suction tanker.

(vii) Contingencies: The cost is based on current prevalent rates. The price contingency has not been taken. However provision of physical contingencies at 10%, Environmental mitigation at 1%, Social Interventions at 1%, Institutional Development Interventions at 1% & design and supervision at 5% has been provided.

130. Investment phasing has been done based on the following priority of interventions: (i) rehabilitation of existing system and land acquisition for STPs and pump houses; (ii) interceptors, trunk mains and outfall sewers for Zone 1; (iii) sewerage in Zone 2 & 3, and SPS; (iv) laterals in Zone 1; (v) STP South and East; (vi) sewerage in Zones 5 to 8. Priority among these will be as per development plan priority of HPDA. Accordingly, the total Master Plan investments are distributed in five Phases:

(i) Phase I: Rehabilitation of existing system in zone 4; land acquisition for STP and SPS; sewerage system in zone 1,2 and 3; STP at south and east with SPS;

(ii) Phase II to V: Sewerage system will be developed in Zone 5 to 8 covering a Zone in each Phase.

Table 16: Abstract Cost Estimates

S No	Item	Phase 1 2009-13	Phase 2 2014-18	Phase 3 2019-23	Phase 4 2024-28	Phase 5 2029-33	Grand Total
		Rs. Million					
1	Rehabilitation of existing system	19.8					19.8
2	Laterals New	375.9	170.6	204.4	120.0	105.0	975.9
3	Trunk Mains New	125.3	56.8	68.1	40.0	35.0	325.2
4	Sewage Pump House	4.7		4.5			9.2
5	STP	90.0	60.0	54.0			204
6	Land Acquisition	170.0					170
7	Low Cost Sanitation	20.0					20
8	Total	805.8	287.5	331.1	160.0	140.0	1,724.3
9	**With Contingencies**	**950.8**	**339.3**	**390.6**	**188.8**	**165.2**	**2,034.7**

Source: Analysis

Map 15: Phase-wise Sewerage System Proposals

B. Operation and Maintenance Cost

131. Operation and maintenance cost has been worked out as, sewers at 0.25 percent of capital cost, Mechanical and electrical equipment at 3 percent of capital cost, civil works at 1.5 percent of capital costs, STP for WSP at 0.5 percent of capital cost, energy cost for WSP at Rs 0.2 million per MLD, staff cost at Rs 1.1 million per STP and Rs 0.35 million per SPS has been taken. Energy cost for pumping has been taken considering pumping of average flow for 16 hours a day and energy cost at Rs 4 per KW. The cost in subsequent phases will increase by the amount stated in that phase ie at end of phase 5 the O & M cost will be Rs 25.6 million per annum (**Table 17**).

Table 17: Operation and Maintenance Cost

	Phase 1		**Phase 2**		**Phase 3**		**Phase 4**		**Phase 5**	
Item	**C**	**O&M**	**C**	**O&M**	**C**	**O&M**	**C**	**O&M**	**C**	**O&M**
Rehabilitation	17.8	0.09								
Sewers	501.2	1.25	227.5	0.57	272.6	0.68	160.0	0.4	140.0	0.35
M & E	4.7	0.141			4.55	0.14				
Staff		3.25								
SPS Energy old		1.87								
SPS Energy East		0.33			0.93					
SPS Energy South		1.87			1.24					
Civil SPS	3.0	0.05								
STP	90.0	0.45	60.0	0.3	54.0	0.27				
STP Energy		6.00		4.8		2.80				
Total		**15.29**		**5.67**		**3.89**		**0.4**		**0.35**

Source: Analysis

www.WilburSmith.com

WilburSmith
ASSOCIATES
#8, Second Floor, 80 Feet Road,
RT Nagar Bangalore Karnataka - 560 032. India
w +91.80. 3918.7500 f +91.80. 2363.4097