FINAL REPORT

Asian Development Bank

National Capital Region Planning Board

Capacity Development of the
National Capital Region Planning Board
Package 2 Component B
TA No. 7055-IND

Volume I-A : Main Report

Detailed Project Report for
Water Supply System in Panipat

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ASSOCIATES

July 2010

NCR Planning Board
Asian Development Bank

Capacity Development of the National Capital Region Planning Board (NCRPB) – Component B (TA No. 7055-IND)

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Volume I-A: Detailed Project Report for Panipat Water Supply Main Report

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Abbreviations

ADB	:	Asian Development Bank
AS	:	Administrative Sanction
BHRA	:	British Hydraulics Research Association
BIS	:	Bureau of Indian Standards
BMTPC	:	Building Materials Technology Promotion Council
BOD	:	Biochemical Oxygen Demand
BPL	:	Below Poverty Line
BSNL	:	Bharat Sanchar Nigam Limited
BWSC	:	Bar-Wrapped Steel Cylinder
$CaCo_3$	:	Calcium Carbonate
CBD	:	Central Business District
CBIP	:	Central Board of Irrigation and Power
CETP	:	Common Effluent Treatment Plant
CGWA	:	Central Ground Water Authority
CGWB	:	Central Ground Water Board
CI	:	Cast Iron
CMA	:	Counter Magnet Areas
CM	:	Concrete Mix
COD	:	Chemical Oxygen Demand
CW	:	Clear Water
CWR	:	Clear Water Reservoir
CPHEEO	:	Central Public Health & Environmental Engineering Organization
CWPS	:	Clear Water Pumping Station
DA	:	Development Authority
DB	:	Decibels
DC	:	Direct Current
DFR	:	Draft Final Report
DI	:	Ductile Iron
DMA	:	District Metered Areas
DOL	:	Direct-On-Line
DPR	:	Detailed Project Report
ELCB	:	Earth Leakage Circuit Breaker
EOT	:	Electrically Operated Trolley
E & M	:	Erection & Maintenance
FPU	:	Final Polishing Unit
FR	:	Final Report
FSL	:	Full Supply Level
FS	:	Feasibility Study
GI	:	Galvanized Iron
GLR	:	Ground Level Reservoirs
GoH	:	Government of Haryana
GoI	:	Government of India
GDWQ	:	Guideline for Drinking Water Quality
GLSR	:	Ground Level Surface Reservoir
GRP	:	Glass Reinforced Plastic

GSS	:	Grid Sub-Station
G.T Road	:	Grand Trunk Road
HAFED	:	Haryana State Cooperative Supply and Marketing Federation
HDPE	:	High Density Polyethylene
HH	:	Household
HP	:	Horse Power
HSC	:	House Service Connection
HSIIDC	:	Haryana State Industrial Infrastructure Development Corporation
HT	:	High Tension
HUDA	:	Haryana Urban Development Authority
IA	:	Implementing Agencies
IEC	:	International Electro-Technical Commission
IPS	:	Intermediate Pumping Station
IS	:	Indian Standards
ITI	:	Industrial Training Institute
JE	:	Junior Engineer
JLN Canal	:	Jawahar Lal Nehru Canal
K	:	Conductivity
KL	:	Kilo Litres
KV	:	Kilo Volts
KVA	:	Kilo Volt Ampere
KW	:	Kilo Watts
LPCD	:	Liters Per Capita per Day
lpm	:	Litres per minute
lps	:	Litres per second
LV	:	Low Voltage
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Center
MCCB	:	Motor Control Center Board
MDG	:	Millennium Development Goals
MDPE	:	Medium Density Poly Ethylene
MGD	:	Million Gallons per Day
MCP	:	Municipal Council Panipat
mg/l	:	Milligrams per litre
ML	:	Million Litres
MLD	:	Million Litres per day
MPN	:	Most Probable Number
MS	:	Mild Steel
MVA	:	Mega Volt Amperes
MW	:	Million Watt
N/A	:	Not Available
NCR	:	National Capital Region
NCRPB	:	National Capital Region Planning Board
NCT	:	National Capital Territory
NEERI	:	National Environment Engineering Research Institute
NFL	:	National Fertilizer Limited
NGO	:	Non-governmental Organizations

NH	:	National Highway
NHAI	:	National Highway Authority of India
NPSH	:	Net Positive Suction Head
NRV	:	Non-return Valve
NRW	:	Non Revenue Water
NTU	:	Neflo Turbidity Units
O & M	:	Operation and Maintenance
OHSR	:	Overhead Service Reservoir
PC	:	Personal Computer
PCB	:	Pollution Control Board
PE	:	Poly Ethylene
PHED	:	Public Health Engineering Department
PLC	:	Programmable Logic Controllers
PPha	:	Persons Per Hectare
PPP	:	Public Private Partnership
PSC	:	Pre-stressed Concrete
PSP	:	Public Stand Posts
PVC	:	Poly-Vinyl Chloride
PWD	:	Public Works Department
PWD WSSD	:	Public Works Department – Water Supply & Sanitation Department
RCC	:	Reinforced Cement Concrete
RL	:	Reduced Level
Rs.	:	Indian Rupees
RUIDP	:	Rajasthan Urban Infrastructure Development Project
RWPH	:	Raw Water Pump House
RWPS	:	Raw Water Pumping Station
SBC	:	Soil Bearing Capacity
SCADA	:	Supervisory Control and Data Acquisition
SOI	:	Survey of India
SOR	:	Schedule of Rates
SPP	:	Single Phasing Presenter
SPS	:	Sewage Pumping Station
STP	:	Sewage Treatment Plant
SY	:	Specific Yield
T	:	Transmissivity
TA	:	Technical Assistance
TC	:	Thermocouple
TSS	:	Total Suspended Solids
TW	:	Tube Well
UASB	:	Upflow Anaerobic Sludge Blanket
UFW	:	Unaccounted for Water
ULB	:	Urban Local Body
US	:	United States
UV	:	Ultra Violet
uPVC	:	Unplasticized Polyvinyl Chloride
VCB	:	Vaccum Circuit Breaker
WB	:	World Bank

WJC	:	West Jamuna Canal
WSS	:	Water Supply & Sanitation
WTP	:	Water Treatment Plant
WWTP	:	Waste Water Treatment Plant
XLPE	:	Cross Linked Polyethene
YAP-I	:	Yamuna Action Plan - I

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Compendium Volumes

Besides this Volume I-A Main Report, the DPR for Water Supply System in Panipat has the following Volumes appended separately.

Volume I-B: Detailed Designs (Appendices D-1 to D-20)

Volume I-C: Detailed Specifications

Volume I-D: Detailed Estimate (Appendices E-1 to E-5)

Volume I-E: Detailed Network Drawings

Volume I-F: Financial & Economic Analysis

Volume I-G: Initial Environmental Examination

Volume I-H: Short Resettlement Plan

1. 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. The second deliverable –Interim Report comprising Master Plan for sewerage in Hapur, Master Plan for Water Supply for Panipat, Master Plan for Drainage for Hapur, Master Plan for Solid Waste management for Ghaziabad, Traffic and Transport analysis for Ghaziabad, Socio-Economic base line survey result in 3 sample project towns and proceedings of workshop 1 was submitted in January 2009. The four Master Plans as stated above are also made available on NCRPB web site for use of the implementing agencies.

4. The third deliverable Draft Final Report (DFR) comprising Detailed Project Report (DPR) for water supply in Panipat, DPR for sewerage in Hapur, DPR for drainage in Hapur, DPR for drainage in Sonipat, DPR for solid waste management in Ghaziabad, DPR for four selected transport components (Flyover, Road widening, Multi-level Parking and Bus Terminal) in Ghaziabad, and a Report on Capacity Building Activities were submitted.

5. Now, this is the Final Report (FR) and is the fourth and final deliverable. The comments/feedback on Draft Final Report received from ADB, NCRPB and respective implementing agencies were duly incorporated and final DPRs for components of Water Supply, Sewerage, Drainage, Solid Waste Management, and Transport are submitted as part of this Final Report. This is the Detailed Project Report for Water Supply System Improvement Project in Panipat

B. Overview of this ADB TA

6. *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.

7. 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.

8. *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.

9. 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 Final Report

10. At Interim Report stage of the TA, the Master Plans for Water Supply in Panipat, Sewerage system in Hapur, Drainage for Hapur and Municipal Solid Waste Management for Ghaziabad were prepared. The Master Plans provided 100 percent coverage of population and the area likely to be in planning horizon year 2031/2041. All works required up to planning horizon year were conceptualized, broadly designed and block cost was estimated. The Master Plans also provided phasing of investment such that under phase 1 works required to cover present spread of city were proposed.

11. At draft final report stage of the TA the Detailed Project Reports (DPRs) were prepared for Phase 1 works as suggested in the Master Plans. For preparation of DPRs, engineering surveys and investigations were conducted and various possible and feasible alternatives evaluated. Finally for the selected options the DPRs prepared with detailed designs, item wise detailed cost estimate, work specifications, implementation process and proposed implementation arrangements. Further, according to ADB procedures these DPRs in addition to technical analysis included institutional, financial and economic feasibility analysis and environmental and social safeguards due diligence – environmental assessment and resettlement plans.

12. The DPR's submitted as part of Draft Final Report was reviewed by the implementing agencies, NCRPB and the ADB. Now this Final Report comprising DPR's modified in light of comments of IA's is being submitted. The draft DPR for water supply in Panipat was reviewed by PHED Haryana. Detailed discussions were held with Superintending Engineer (Urban), Executive Engineer (Urban), Superintending Engineer (Karnal) and Executive Engineer Panipat. The comments made by PHED have been suitably incorporated in this Final Report.

13. These DPRs are proposed to be made available to the ULBs and other implementing agencies of the state governments as model DPRs so that they may replicate the methodology/approach in the future DPRs prepared by them for obtaining finances from the NCRPB

14. Organization of this Final Report. The Final Report of the TA Component B is organized in following Six Volumes:

Volume I: Detailed Project Report for Water Supply System in Panipat

Volume II: Detailed Project Report for Rehabilitation and Augmentation of Sewerage System in Hapur

Volume III: Detailed Project Report for Rehabilitation of Major Drains in Hapur

Volume IV: Detailed Project Report for Improvement of Solid Waste Management System in Ghaziabad

Volume V: Detailed Project Reports for Four Transport Components in Ghaziabad

Volume VI: Detailed Project Reports Rehabilitation of Drainage in Sonipat

Volume VII: Capacity Building Activities

D. Structure of this Volume I Report

15. This is Volume I of the FR and is the Detailed Project Report for Water Supply System Improvement in Panipat. This DPR is presented in **eight** sub-volumes (Volumes I-A to I-H) including this Main Report:

Volume I-A: Panipat Water Supply DPR Main Report:

Section 1 Introduction

Section 2 describes project rationale, and defines the scope and objectives of the DPR;

Section 3 presents sector review at national, state, regional and city levels and presents a brief of the Water Supply Master Plan of Panipat;

Section 4 provides profile of project town Panipat including future perspectives on land use, population etc;

Section 5 describes the existing Water Supply System in Panipat;

Section 6 describes the existing Sewerage System in Panipat;

Section 7 presents study approach and methodology including the zoning approach followed and various stages covered in the DPR preparation;

Section 8 establishes planning and design criteria for preparation of DPR for Water Supply system in Panipat Town;

Section 9 presents the Detailed Design of the proposed Water Supply system;

Section 10 provides Project cost estimates including operation and maintenance cost estimates;

Section 11 discusses operation and maintenance of the proposed system

Section 12 provided cost estimates

Volume I-B: Detailed Designs

Volume I-C: Detailed Specifications

Volume I-D: Detailed Estimates

Volume I-E: Detailed Network Drawings

Volume I-F: Economic & Financial Analysis

Volume I-G: Initial Environmental Examination

Volume I-H: Short Resettlement Plan

2. PROJECT RATIONALE, SCOPE & OBJECTIVES

A. Project Rationale

16. GOI through NCR Planning Board is trying to develop area around NCT of Delhi, called National Capital Region (NCR) by developing infrastructure facilities similar to those available in Delhi so that people migrating to Delhi could stay back in these places, people of Delhi may move out and thus decongest Delhi. Panipat town is part of NCR and situation of water supply is far from satisfactory. Water is supplied once in a day for limited period, quality of water is not as per standards everywhere, there are regular complaints of polluted water being supplied, water pressure at consumer end is inadequate and above all consumer satisfaction level is low. In view of these problems and on public demand, Hon'ble Chief minister of Haryana declared in a public meeting for providing Canal water after treatment to people of Panipat town and improve the whole system. In view of these facts and the goals set under MDG, this project for providing potable water on sustained basis with 100 percent coverage is required.

B. Scope

17. The DPR proposes to provide good potable water on continuous basis to Panipat town for its projected population for 2026. The project area to be benefited will be limited to that for which land use has been defined and development started and is contiguous with existing Municipal boundary. Some of the project components will be adequate for meeting projected water demand for 2041. Water will be drawn from the WJC canal passing through the town, will be treated and supplied through Zonal Service Reservoirs. Distribution system will be designed on zonal basis and will be extended to uncovered areas. 100 percent metering of all domestic, commercial and Industrial consumers will be done and attempt will be made to reduce UFW significantly.

C. Objectives

18. The ground water exploitation in Haryana state is almost 150 percent. The situation in Panipat district is still worse. Water table in Panipat city is depleting steeply for last decade. This is also deteriorating the ground water quality. Panipat water supply is presently solely dependent on ground water. In spite of easy availability of water, distribution system has not been planned and the extent of UFW is high. DPR will therefore attempt to reduce dependence on ground water, reduce UFW to the level of less than 15 percent as envisaged in CPHEEO Manual of Water Supply, make 100 percent coverage as per MDG agreed by GOI and supply potable water on 24x7 basis. Attempt will also be made to encourage Public Private Partnership (PPP) to achieve improved customer service, lower operational cost and better management.

3. WATER SUPPLY SECTOR REVIEW

A. Millennium Development Goals

19. 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): 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.

B. Urban Water Supply in India

20. Water has many uses and its efficient management covers a multitude of issues, including nearly all development sectors and most disciplines. This is because in all Asian countries, the highest priority is invariably given to domestic water use. With accelerating urbanization, management of the entire water cycle in an urban context has become a priority consideration. Urban water management consists of three fundamental, but interrelated, services. First is the provision to households of clean water that is drinkable without additional treatment. Second is the collection of wastewater from all households and from industrial and commercial sources, which thereafter requires proper treatment and disposal in an environment-friendly way. Third is the efficient disposal of storm water, especially during the monsoon seasons. Often, only the first, provision of drinking water, is considered, while the other two services receive inadequate attention. Furthermore, even for drinking water supply, the focus tends to be on quantity; quality issues receive much less attention. The importance of clean water supply and wastewater management became an important international issue following the United Nations Water Conference, held in Mar del Plata, Argentina, in March 1977. The Mar del Plata conference was the only meeting ever held on water at a high political level. This conference proposed that the decade of the 1980s be declared as the International Water Supply and Sanitation Decade, with the very ambitious objective of providing clean water and sanitation to every human being by the end of 1990. The proposal was subsequently approved unanimously by the United Nations General Assembly.

21. A retrospective analysis of that decade indicates that even though it did not reach its goals, it was a remarkably successful event. Because of the promulgation of the concept, hundreds of millions of people received accelerated access to water supply and sanitation, which may not have happened otherwise. Subsequently, the Millennium Development Goals (MDGs) incorporated part of the objectives of the water supply and sanitation decade. One of the goals is to reduce by half the number of people not having access to clean water, between 1990 and 2015. Improvement in sanitation is not a component of the MDGs. The Johannesburg Summit, in 2002, recommended an equivalent sanitation goal to reduce the number of people having no access to sanitation by half within the 1990–2015 periods. Considerable attention is now given by national and international institutions to the achievements of the MDG on water supply, and to the Johannesburg target on sanitation. However, in much of the global discussions during recent years, the focus has been almost exclusively on achieving the numerical targets; the real objectives and the philosophy behind the two targets are seldom discussed. When the idea of the International Water Supply and Sanitation Decade was first proposed, its objective was that everyone should have access to clean water that is drinkable without any additional treatment. Similarly, it was expected that access to sanitation, at least in the urban context, meant that wastewater would be collected from households and then properly treated for safe disposal to the environment. During the intervening years, somehow the philosophies behind these goals were lost, and the emphasis was transferred to the achievement of the numerical targets. For example, there has been limited discussion on the quality of the water supplied to urban households. The discussion has almost exclusively focused on provision of a certain quantum of water, irrespective of quality in terms of drinking. Consequently, in many urban centers, each household, or block of flats, now acts as a mini-utility

22. Water of indifferent quality is collected and stored in underground tanks and then pumped to overhead tanks. This water is then treated, sometimes even with membranes, before it can be consumed. Where the main utilities supply water intermittently (2–4 hours per day), the mini-utilities at the household level transform it to a 24-hour water supply, followed by treatment, at high economic costs. This certainly was not the thinking behind the supply goal of the water and sanitation decade. A similar anomaly exists with the sanitation goal as well. Waste water may now be collected from urban areas, but is mostly either not treated, or only receives partial treatment, before being discharged to rivers, lakes, or oceans. Thus, the contamination and health problems are simply shifted from the urban areas where the waste water originates, to other locations where fewer people may be affected. Because of this transfer of the problem from one location to another, rivers, lakes, and oceans in and around urban areas are now seriously contaminated. This is already having serious adverse health, social, economic, and environmental impacts. If the present unsatisfactory trends continue, in one or two decades, India is likely to face a crisis on water quality management that is unprecedented in human history. Thus, it is absolutely essential that new wastewater treatment facilities are constructed at a massive scale and are properly maintained, so that the water contamination problems can be progressively reduced. By diluting seriously the definition of access to clean water and considering sanitation only in a very restricted sense, we are mortgaging future in terms of water security. Such mindsets, including the tenor of the global water policy dialogue, have to change very significantly. If such an approach is taken as the MDG to formulate a target for access to wastewater treatment, it will mean that by 2015, we need to increase access to around 50–60 percent of the population, about four times that at present. This

will not be an easy task, and yet this must be the real target. Meeting that target is all the more worthwhile because investing in the water sector is investing in all the MDGs, not just Target 10 and the Johannesburg target on sanitation. Safe water supplies immediately improve people's health and save them time, which they can use to study or improve their livelihoods, so they can earn more, eat more nutritiously, and enjoy more healthy lives. Improved sanitation protects the poor from socially and physically degrading surroundings, health risks, and exposure to dangerous environmental conditions. It is easy to see how Rs.1 invested in the water sector turns into a benefit equivalent to Rs.6. All too often, though, the expectation and analysis of benefits from water supply and sanitation projects are limited to the most common intended result—better health.

23. Information collected by CPHEEO, Ministry of Urban Development indicates that as on 31.03.07, about 63 percent of the urban population has 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.

24. 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 centers. 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.

C. Institutional and Policy Framework in India

25. 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.

26. 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 is 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, and for 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.

27. No sensible person will argue with the fact that all human beings should have access to clean and drinkable water and proper wastewater management. When people do not have access to one or both of these services, the social, economic, and environmental costs are high, as is the overall cost to the national economy. The main issue is not the need for these services, which are now universally accepted, but rather how can these be provided to everyone cost-effectively, equitably, and promptly. In India intermittent water supply is at present the norm rather than an exception. Yet, problems associated with an intermittent water supply are well known. Among these are provision of contaminated water, wastage of water at all stages, need for bigger pipes in the network (thus higher economic cost) for water delivery in a short time, unreliable metering, high levels of corruption, and stress among the urban poor to obtain their supply each day. For most urban centers, at least those with populations of one million or more, there is no reason why a continuous water supply of a drinkable quality cannot be provided. The common excuse currently offered for the intermittent water supply is that there is not enough water to ensure a continuous supply. A quick review will indicate to any reasonably intelligent person that the professed reason has absolutely no scientific, technical, or economic validity. For example, supply may be intermittent, but during the short period the supply is available, most consumers withdraw enough water, which is then stored at the household level, to provide a continuous supply. If the supply were continuous, the households would use a similar amount of water, but spread over the entire day. Also, in most of the towns, more than 50 percent of water that enters the system never reaches its designated consumers due to leakages and poor management. The main reason for the current unacceptable situation is widespread mismanagement of the water utilities, as a result of which the utilities cannot be run professionally.

28. Haryana state has 78 towns with a total population of 7336967 souls. All the towns are covered with piped intermittent water supply. The status of water supply in different towns is as follows:

(i)	No. of towns with Service Level 135 lpcd or more	25
(ii)	No. of towns with Service Level >120<135 lpcd	34
(iii)	No. of towns with Service Level >70<120 lpcd	19

29. The status of coverage of towns with sewerage is as follows:

(i)	No. of towns with coverage >50%	46
(ii)	No. of towns with coverage <50%	20
(iii)	No. of towns without sewerage system	12

30. There are around 564209 consumer water connections in all the towns of the state. The total revenue realized last year from water supply operations was approximately Rs. 217.50 million and that from Sewerage operations was Rs. 64.50 million. Against this the O&M expenditure was around Rs.980 million (Rs.390m on O&M and Rs.590m on power charges). This gives a deficit of almost 70 percent. The main problems comprise of intermittent water supply resulting in in-adequate terminal pressures, contamination in distribution network, high amount of UFW and poor consumer satisfaction.

4. PROFILE OF PANIPAT TOWN

A. Physical Features

31. The existing town of Panipat is situated on National Highway No.1 (Delhi-Amritsar, G.T. Road) and is at a distance of about 85 km from Delhi, 34 km from Karnal (**Map 4-1**), It is situated between 76º 38' west to 77º 09' west longitudes and between 29º 10' north to 29º 31' north latitudes. The town is the head quarter of Panipat district. It is the point of convergence of roads from Delhi, Gohana, Karnal, and Asandh, in Haryana and Kairana from Uttar Pradesh. It is also a Railway Junction. The Delhi- Ambala Railway line, which runs parallel to the G.T. Road, divides the city into two parts. On the western side, across the Railway line is the Industrial area and the Model Town. The old town of Panipat lies on the eastern side.

32. The three sides of Panipat district touch other districts of Haryana - Karnal in the north, Jind in the west and Sonipat in the south. Panipat borders Uttar Pradesh across Yamuna in the east. The character of the old town has remained much the same over time. However, the planned sectors developed by Haryana Urban Development Authority (HUDA) have grown and gained importance. The HUDA areas have grown substantially and now represent almost 26 percent of the overall urban population.

33. Panipat enjoys a pride place in the long and chequered history of India. Panipat was one of the five cities (prasthas) founded by the Pandav brothers during the times of the Mahabharata; its historic name being Panduprastha. It has witnessed the three famous Battles of Panipat in the years 1526, 1556 and 1761. The First Battle of Panipat was fought on 21 April 1526 between Ibrahim Lodhi, Sultan of Delhi, and the Zaheeruddin Babur. Babur's force of twelve thousand soldiers defeated Ibrahim's much larger force of over one lakh soldiers. Babur founded the Mughal Empire in India.

34. The Second Battle of Panipat was fought on 5 November 1556 between the Mughal general Bairam Khan Shaibani, regent for the young Emperor Akbar, and Hemu, courtier and general of Isa Khan Suri, Islam Shah Suri brother in law who murdered Islam Shah's young son and usurped the throne of Delhi won by Sher Shah Suri from the Mughal Emperor Humayun. Hemu was struck down by an arrow in the eye and his army fled. He was beheaded and the Mughal comeback in India was complete.

35. The Third Battle of Panipat was fought in 1761 between the Afghan king Ahmad Shah Abdali and the Marathas under Sadashivrao Bhau of Pune. Ahmad Shah won decisively. British soldiers captured and took over the town while establishing the cantonment at Karnal. The famous Urdu shayar Maulana Hali was born in Panipat. The main places of attraction are the grave of Ibrahim Lodhi, Kabuli Bagh, Devi Mandir, Kala Amb, Salar Gunj Gate, and the tomb of the thirteenth century sufi saint Bu Ali Shah Qalandartau.

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Location of Panipat

Legend

- NCR
- State Boundary
- District Boundary
- District Hq.
- Counter Magnet Areas
- River / Stream

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

Drawn: Roopa	Checked: SKG
Date: April 2010	Approved: NSS
Scale: NTS	

Map 4 - 1

36. Panipat is popularly known as 'The City of Handlooms' because the industrial activities in this town primarily consist of textiles with handloom. Panipat is a city of textiles and carpets. It is the biggest centre for quality blankets and carpets in India and has a handloom weaving industry. The "Achar Pachranga" is a well known Indian pickle produced since 1925. The company was brought to Panipat in 1947 after the partition of India. Panipat also have heavy industries, with a refinery of the Indian Oil Corporation, a National Thermal Power Corporation Power Plant and a National Fertilizers Limited Plant. Some salient features of industry in Panipat are:

(i) Three major public sector projects: the Indian Oil Corporation oil refinery, the National Fertilizers Limited plant and the Thermal Power Station.

(ii) Biggest centre in the country for producing shoddy (recycled) yarn, and a large consumer of rags for reprocessing.

(iii) Biggest centre in the country for producing low priced blankets, a traditional supplier of barrack blankets to the armed forces.

(iv) Biggest centre in the country engaged in export of cotton durries, made-ups, throws and mats.

(v) Samalkha, a small town near Panipat, is known for foundry work and supply of agricultural machinery to neighboring Uttar Pradesh.

(vi) Relatively high wages compared to the Indian national average - a worker earns Rs.130/- to 170/- per day on Handloom Power loom.

(vii) The town has infrastructure such as rail, road and inland container depots well suited to industry and export.

37. As of 2001 India census, Panipat district had a population of 967,449. Males constitute 55 percent of the population and females 45 percent. Panipat has an average literacy rate of 69 percent, higher than the national average of 59.5 percent: male literacy is 73 percent, and female literacy is 64 percent. In Panipat district, 14 percent of the population is under 6 years of age. The population of Panipat Town as per census 2001 was 261740. Panipat Municipality was established in 1986. At present, the municipal area of Panipat is about 2000 ha (20sq. km).

B. Climate

38. Typical humid subtropical climate of north India prevails in Panipat, 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 1.8^{o}C to a maximum of 44.9^{o}C; occasional extremes may in the ranges of 0.6^{o}C to 47^{o}C. 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.

C. Topography

39. The town has almost flat topography except a small portion in the east, which is a marginally higher than the general ground level. The general slope of the town is towards South-west. The difference between the maximum and minimum ground levels is about 21 m - varies from 235 to 256 m above mean sea level. The depth of groundwater in the town varies from 23 to 40 m. The town is located in the catchment area of the Yamuna River, one of the most important and perennial river of India, flowing at a distance of 19 km east of the town. The general nature of the soil is sand mixed with clay. The town has a major drain (Panipat drain) passing through the heart of the city. An extensive system of canals and drains cuts across Panipat town. Sewage from the un sewered areas of the town as well as treated effluent from the WWTPs is discharged into the Panipat drain, Nohra drain and the Panipat drain and finally entering river Yamuna.

D. Socio Economic Conditions

40. Panipat 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. Panipat is popularly known as 'THE CITY OF HANDLOOM' because the industrial activities in this town primarily consist of textiles with handloom. It is the biggest centre for quality blankets and carpets in India and has a handloom weaving industry. The "Achar Pachranga" is a well known Indian pickle produced since 1925. The company was brought to Panipat in 1947 after the partition of India. Panipat also has heavy industries, with a refinery of the Indian Oil Corporation, a Thermal Power Plant of National Thermal Power Corporation and a Fertilizer Plant of National Fertilizers Limited.

41. The main occupation of inhabitants is agriculture and agro based trade and manufacture of textiles, carpets and Pachranga Achar and their trading. Therefore, the people are generally well to do. The importance of this town is steadily increasing. There are mostly double storeyed houses in the town apart from single storied pucca houses. Areas developed by HUDA (Haryana Urban Development Authority) are well planned and has very good houses and shopping areas and complexes.

42. *Urban Economy*. Panipat is an important centre for trade and commerce in Haryana. The occupational structure of town as per Census 2001 is presented in the **Table 4-1**.Workforce is predominantly engaged in industrial sector, followed by trade and commerce and service sectors.

Table 4-1: Workforce of Panipat

Occupational Sector	1971	1981	1991	2001
	%	%	%	%
Primary Sector	9.78	7.37	5.30	4.00
Industry	32.79	36.39	39.70	40.00

Occupational Sector	1971	1981	1991	2001
	%	%	%	%
Construction	2.55	2.89	3.10	4.00
Trade and commerce	25.95	25.14	24.60	20.00
Transport and communication	5.95	5.36	4.80	12.00
Other services	22.98	22.85	22.50	20.00
Percentage to total population	26.80	30.40	30.00	32.00

Source: Master Plan 2005; Census of India 2001.

E. Land Use and Growth Pattern: Existing Land Use

43. The existing town of Panipat has expanded on both sides of GT Road. The old settlement is on an elevated tract of land, which once upon a time was a fortified town. The features of historical importance of the town are Lodhi Tomb, Devi Mandir and Tomb of Saint Qualendar. River Yamuna flows at a distance at about 16 km from the town in the east.

44. The wholesale grain market named Gaushala Mandi and Gandhi Mandi are situated on G.T. Road. A temporary wholesale fruit and vegetable market is situated on Sanoli Road, whereas a new vegetable market with modern amenities has already been constructed by the Urban Improvement Trust Panipat on the same road to meet with the future needs of the town. A new grain-market constructed with World Bank assistance stands developed over an area of 42 hectares on G.T. Road.

45. Recently Hali Park, a recreational complex named after the famous Urdu Poet "Khawaja Altaf Hussain Hali" has been developed on an area of 11.6 hectares near the industrial area. This complex consists of a children park, a rose garden, fountain, streams and a lake with boating and fishing facilities. Besides this, a stadium has also been constructed on an area of 2.8 Hectares in the Model Town. A tourist complex in an area of 2 Hectares has been constructed by the Tourism Department in a triangular tract on G.T. Road, towards the north of Civil Hospital.

46. Panipat Thermal Power Plant with a capacity of 660 MW constructed on Assandh Road is one of the biggest thermal plants in the country. In addition to above, Panipat is the main distribution centre of electricity produced at Bhakra Nangal Project. Hence the town is likely to attract more projects of national importance in future.

47. The Haryana Urban Development Authority (HUDA) has acquired approximately 1230 hectares of land for development of residential and industrial areas. The development works are under progress. A well-planned Transport Nagar on G.T. Road is a redeeming feature, which has eased the parking congestion in the town to some extent and will provide the facilities at one place once all workshops of the town are shifted to the Transport Nagar. The living environment of the town is likely to improve considerably after the development of industrial sector–29 Part II, as it has the capacity to accommodate all the fiber-dying units scattered presently in and around the town including its residential areas.

48. In order to channelize the development in planned manner and to control the sprawling haphazard piecemeal growth, the state government declared 6740 hectares area around municipal limits of the town in year 1971 as controlled area and 22800 hectares area as additional controlled areas– II and III in the year 1982 under section 4 (I) (a) of the Punjab Scheduled Roads and Controlled areas Restriction of Unregulated Development Act-1963 (Punjab Act 41 of 1963), vide Notification No. 10165-VDP-71/3884, dated the 10th September, 1971 and 10 DP-82/3163, dated the 23rd February 1982 published in the Haryana Government Gazette dated the 24th January 1984 vide Notification No.3591-2TCP/83 dated the 26th October 1983.

F. Development Concept

49. Since Panipat is to be seen as a regional centre for Haryana sub-region of National Capital Region, therefore, there is a need to intensify the development efforts by providing sufficient regional level infrastructural facilities so that it may not only hold back the out-migration but also capture the Delhi-bound migration. Efforts for the same have already been started with the help of public-sector development agencies.

50. Although Panipat has been growing along National Highway-I on a linear pattern, there is a marked twist in favor of East and marginally on the West. Therefore, the axis for development is likely to be in line with natural axis of growth i.e. eastward. The new town is to be developed not as an urban extension of the existing town but as a separate entity in itself. Predominant wind direction i.e. Northwest to Southeast direction and availability of transportation network are the guiding factors for location of major land uses i.e. industry and whole sale trade etc.

51. The municipal limits of the town cover an area of about 2000 hectares. The planning within the existing town is conspicuously absent, except few residential colonies like Model Town, Housing Board colony, and a few pockets developed under town-planning-schemes and planned industrial area.

52. According to the development plan prepared for the town by the state Town Planning Department, estimated population of about 1.75 lakh would be adjusted within old municipal limits. The final development plan provides for the remaining 5.25 lakh (for 2021) to be accommodated in the extended municipal area and controlled area. The town density has been taken as 115 persons per hectare in the final development plan.

53. Since the town is situated on both sides of the Grand Trunk Road, it will generate high criss-cross traffic. The road system has been so proposed in the final development plan that the eastern V-2 Road, along with the inner spine V-2 road can serve as a through high-speed traffic road. V-2 road in the east can serve as an outer ring road. The city centre has been proposed along the inner V-2 road in view of its central location. Further keeping in view the prevailing wind direction the area for industrial use has been proposed mainly towards south duly separated by sufficient wide green buffer from residential area except for some area in west for expansion of the existing industrial area contiguous to the existing town. The land use proposed in the final development plan is given in **Table 4-2**

Table 4-2: Proposed Land Use of Panipat 2021

Land use	Area within municipal limits	Area within extended municipal limits	Area within controlled area	Total area	% of total area
	ha	*ha*	*ha*	*ha*	*%*
Residential	400	300	2,282	2,982	42.53
Commercial	115	50	97	262	3.74
Industrial	262	293	1,135	1,690	24.10
Transport and Communication	42	-	475	517	7.37
Public utilities	44	--	173	217	3.10
Public and semi public	105	8	180	293	4.18
Open Spaces	88	-	485	573	8.18
Special Zone			477	477	6.80
Total	1,056	651	53,04	7,011	100.00

Source: Development Plan 2021

54. The phasing of development proposed in the Final development plan is given in **Table 4-3**

Table 4-3 : Phasing of Development as per Final Development Plan

S.No.	Period	Sector to be Developed	Departmental Activities to be taken up
1	2001-05	(i) Industrial Sector 29-II	
		(ii) Shifting of Dairies	Milk Dairies will be shifted to the site identified at Jatal Road, Panipat.
2	2005-11	(i) Residential Sectors 19, 36, 37, 38, 39 & 40.	(i) Construction of V-2 Road (Eastern Peripheral Road.
		(ii) Industrial Sectors-28 & 30	(ii) Construction of Canal based Water Supply System by P.W.D, Public Health Department.
		(iii) District Center in Sector-13 and 38	(iii) Construction of Common Effluent Treatment Plant.
3	2011-16	(i) Residential Sectors 19-A, 23, 27 & 31	(i) Construction of V-1 Road (Western Peripheral Road)
		(ii) Commercial Sector 22	
		(iii) Public & Semi Public Sector 20 & 21.	
		(iv) Industrial Sectors 32, 33 & 34	
4	2016-21	Rest of the proposal in the development plan	

Source: Development Plan 2021 approved by Haryana Town and Country Planning Department

5. WATER SUPPLY SYSTEM IN PANIPAT

A. General

55. There are two water and wastewater service providers in Panipat town for non-industrial users. These are the Public Works Department (Water Supply and Sanitation department) (PWD-WSSD) and the Haryana Urban Development Authority (HUDA). These agencies provide all the basic services pertaining to water supply and sewerage facilities in Panipat town. PWD-WSSD is a state government department and is primarily responsible for providing water supply and sewerage services within the municipal boundaries. Their responsibilities include providing piped water supply and sewerage facilities to the residents of the area. The existing water supply system is depicted in **Map 5-1.** Location of tube wells in municipal area is given in **Map 5-2.**

56. The PWD-WSSD has informed approximately 27,303 water connections in their service area. There are smaller but undetermined number of unauthorized connections. Using an average of six persons per connection, the population officially connected to the water supply system is approximately 163,818. The population in the PWDWSSD service area was documented at 282,714 in 2006. This implies that 58 percent of the population is connected legally to the water supply system. However, a number of consumers located on the outskirts of the PWD-WSSD service area have been reported to be using personal hand pumps as their main source because of low residual pressure in distribution system at those locations. Due to an unequal distribution of water, per capita water supply in some areas could be less as compared to the targeted per capita rate. It is not unusual for people in wealthier areas to use personal tube wells as a supplemental source of water, especially to meet non-potable needs for cattle bathing, filling coolers, washing vehicles, gardening etc.

57. HUDA is an autonomous government body and functions as the land developer in Haryana. HUDA is the second largest service provider in Panipat and is responsible for providing services only to areas developed by it. The areas under HUDA are divided into "Sectors". HUDA has separate water works and a wastewater collection system. However, wastewater from HUDA areas is currently being discharged into PWD-WSSD sewers and treated at the existing 35 MLD Sewage Treatment Plant (STP) in Panipat. HUDA has released about 4818 water connections in the HUDA service area.

B. Source of water

58. Tube wells have traditionally been the main source of water in Panipat. However, there is now an attempt to tap the surface water sources. The existing tube wells are demonstrating a marked decrease in yield and deteriorating water quality according to PWD-WSSD and the Ground Water cell of the state Agriculture Department. At few places, the ground water quality has become un-potable. Accordingly, the existing water sources are unable to meet the peak summer season demand of the residents. Extensive ground water usage for domestic as well as commercial & Industrial use was observed to be a common

phenomenon in the town. The level of the water table is reported to be sharply depleting during last 5 years, resulting in declining yield from existing tube wells. The main water supply sources in the town are listed in **Table 5-1.**

Table 5-1 : Main Water Supply Sources of Panipat

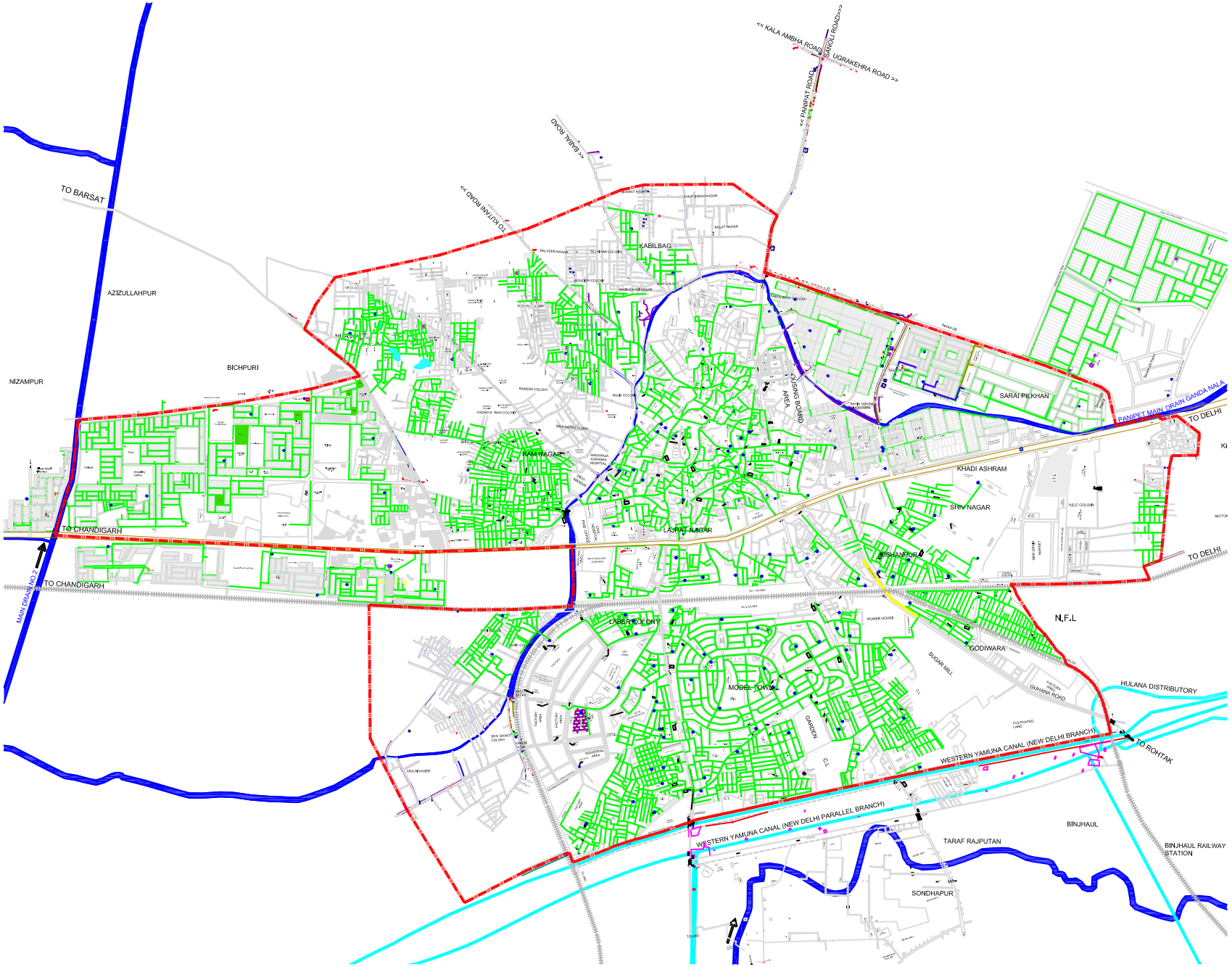
S. No	Existing water works	No, of Tube Wells	Location	O&M By	Water Production
1	Tube Wells in PWDWSSD (Within Municipal area)	115	Various locations	PWD-WSSD	56.31 MLD
2	Tube Wells in HUDA Sectors	41	Various locations	HUDA	15.66 MLD
3	Tube Wells in PWD WSSD areas around Panipat (outside Municipal area)	39	Various locations	PWD-WSSD	9.07 MLD
	Total installed Water Works Capacity	**195**			**81.05 MLD**

HUDA – Haryana Urban Development Authority; PWD WSSD – Public Works Department – Water Supply & Sanitation Department

Source: PWD WSSD

59. The total estimated quantity of water delivered to the distribution system of PWD-WSSD and HUDA by this tube well based supply is 81.05 MLD. Allowances have been made for groundwater usage and leakage to estimate the quantity of potable water used by consumers in the area. A leakage factor of 40 percent has also been applied to the total quantity of water delivered into the distribution system. Thus, the total estimated quantity of water used by consumers is 48.63 MLD. This gives a service level of around 100 lpcd for the present estimated population of 4.86 lakh. Industries are estimated to be using 40MLD water from their own bore wells to meet their requirement.

60. A statement giving location of existing tube wells in municipal area belonging to PWD (WSSD) is given in **Appendix 1-A**. A statement giving location of tube wells in Panipat urban agglomerate but outside municipal limits belonging to PWD (WSSD) is given in **Appendix 1-B.** A statement giving location of tube wells in HUDA area belonging to HUDA is given in **Appendix 1-C.** Details of some of the tube wells giving strata, depth, discharge etc is given in **Appendix 1-D.**



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Existing Water Supply System in Panipat

Legend

- DPR Project Boundary
- National Highway
- Other Roads
- Railway Line
- Canal
- Drain
- Hand Pump
- Culvert
- Manhole
- Transformer
- Electricpole
- Lamppost
- Telephonepole
- GPS
- TBM
- Tree
- OFC
- Ditch
- Building
- Tube Well

Overlay Legend

- Existing Pipe Line

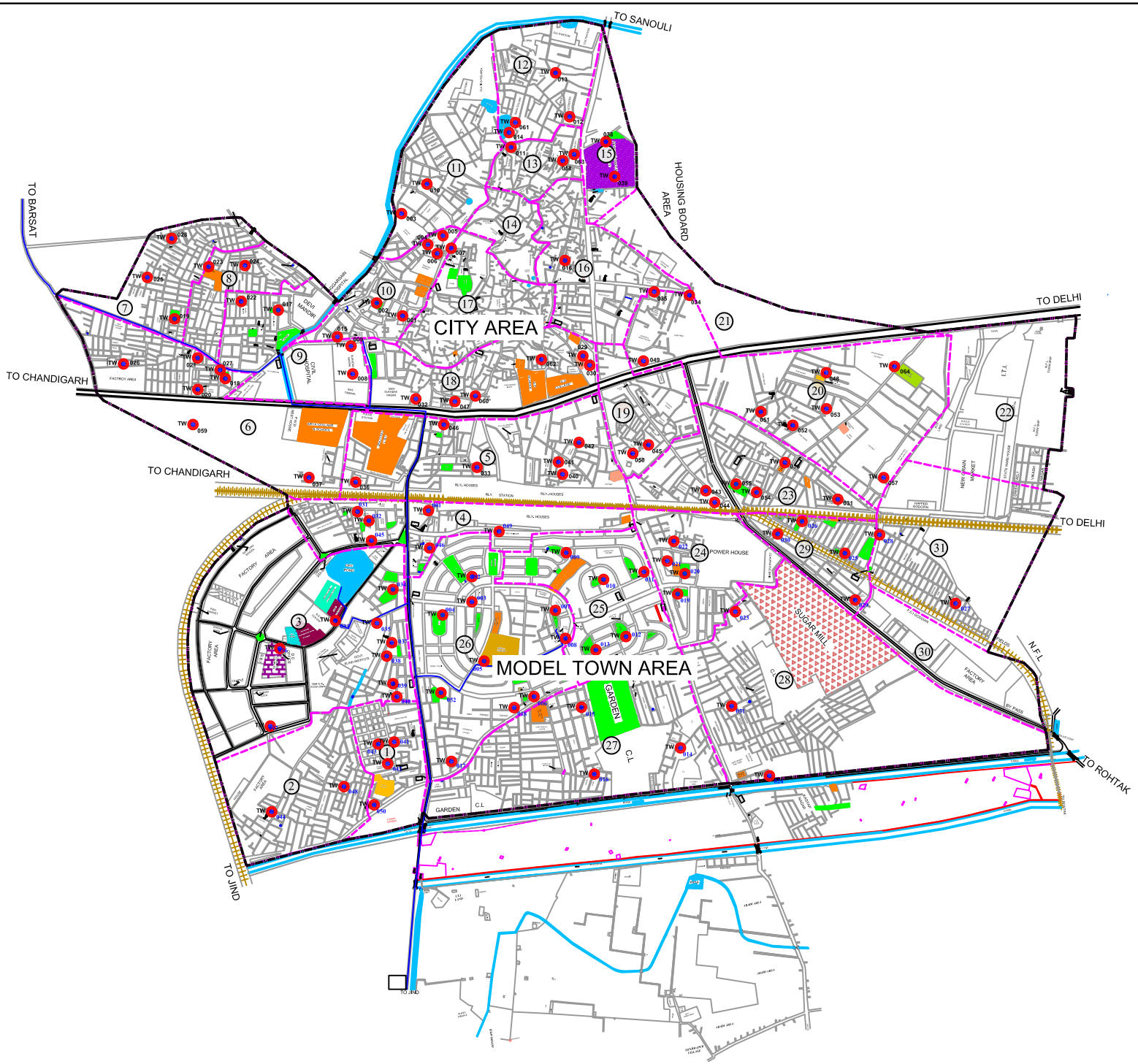
Client
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn: SK | Checked: NSS
Date: April 2010 | Approved: NSS

Scale: 0 400 800 1200 1600 Meters

Map 5 - 1



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Location of Tube wells in Panipat Municipal Area

Legend

- Municipal Boundary
- Ward Boundary
- 20 Ward Number
- Major Roads
- Other Roads
- Railway Line
- Cart Track
- House settlement
- Temple
- Water Course

Overlay Legend

- TW Tube Well
- 050 Tube Well Number for City Portion
- 050 Tube Well Number for Model Town

Source:
PHED Panipat, Haryana

Client

Asian Development Bank
National Capital Region Planning Board

Consultant

Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date: April 2010	Approved: NSS
Scale: NTS	

Map 5 - 2

61. PWD-WSSD supplies water directly from the tube wells into the distribution network. Disinfection of water is done on-line by using a new compound named 'Twin-Oxide'. The tube wells are operated for 8 to 12 hours daily. However, the consumer end pressures are generally low. In the old city area, which is thickly populated, water from the tube wells is first collected in a ground level reservoir and then pumped into the distribution network. Water is then supplied to consumers by making zones, zone wise for 2 hours daily. There are 115 tube wells of PWD (WSSD) in the municipal area and 39 tube wells in the surrounding areas of municipal area in the urban agglomerate being served by PWD (WSSD) as per list given above. Details of some of tube wells constructed regarding lithology, well assembly, initial capacity and draw down etc is placed at **Appendix 1-D** Condition of a few tube wells is depicted below:

62. HUDA has a sectoral approach. It has constructed a set of tube wells in each sector. Water is collected in a CWR in each sector and then boosted into the distribution network after disinfection. HUDA has also constructed few OHSRs but the same are defunct and the general practice is to boost water directly to distribution system. As population in HUDA area is quite less compared to projected population, there is generally no pressure problem, but as load increases, the system will get into strain. There are in all 41 tube wells in HUDA area as per list given in **Appendix 1-C**.

63. HUDA is executing a project to supply raw water to Industries from the Delhi Link Channel canal through a dedicated pipeline. This is likely to take care of the projected water demand of industries in HUDA industrial sectors.

64. Distribution and Storage: The distribution system in PWD (WSS) area is generally laid on ad hoc basis. There are no defined zones for supply of water. All tube wells are directly connected to distribution pipe lines. Compared to this, in areas served by HUDA, distribution system has been laid on sectoral basis and water is first pumped to a clear water reservoir and then boosted to the distribution system. OHSRs have been constructed in some cases but are not being used. The total length of distribution system has been reported to be around 285 km and comprises of mainly AC pressure pipes and in some cases of CI and PVC pipes. As the pressures in distribution system are generally low, there are very few cases of pipe bursting.

65. There are no public stand posts and Hand Pumps provided by the service providers in the town. However, many unauthorized PSPs are reported to exist.

66. The details of Service Reservoirs in the town are given in **Table 5-2**: However most of these over head reservoirs are not in use and water is being supplied directly by boosting.

Table 5-2: Details of Service Reservoirs

S No	Location	Capacity	Staging (m
		lakh litres	*m*
	Overhead Service Reservoirs		
1	Salar Ganj Gate	4.5	15
2	Krishanpura	3.5	15
3	Bosaram Chowk Model Town	3.5	15
4	Lal Tanki Model Town	1.5	10
5	Sector-11	4.5	20
6	Sector-12	4.5	20
7	Sector-29 Part I	4.5	20
	Ground-level/Underground Reservoirs		
1	Quilla Booster	11.5	-
2	Ward no. 10	2.0	-
3	Sector-11	31.5	-
4	Sector-12	31.5	-

67. Following are the boosting stations in the town to boost water to the distribution system:

68. *Quilla Booster***.** One number of 75 HP pump (which generally operate) and one 40 HP with one 35 HP as stand by pump are installed. This booster supplies water to different areas in Quilla area by making small sub zones as the area is thickly populated and elevation is higher compared to other areas. Booster stations in Sectors 11 and 12 are provided with one 50 HP capacity each.

69. *O&M Expenditure*. The O&M expenditure incurred during last 4 years for Panipat Water Supply by Panipat Division of PWD (WSS) under various sub heads is given below in **Table 5-3**

Table 5-3 : O & M Expenditure of Panipat Division, PWD (WSS)

S.No.	Sub Head	2004-05	2005-06	2006-07	2007-08
		Rs. Million			
1	Daily Wagers pay	0.61	0.1	0.07	0.09
2	Repair & Consumables	3.08	3.01	4.89	9.86
3	Local & other expenditure	2.25	1.95	3.08	6.79
4	Energy Charges	22.09	32.61	24.50	36.78
	Total	**28.02**	**37.66**	**32.55**	**53.51**

70. *Revenue System*. There is no metering system for water produced or for water supplied in PWD (WSSD) area. Domestic water connections are all on flat rate basis. Recently metered connections have been started for commercial consumers. In absence of metering of production and distribution water, there is no system of estimating losses in distribution system. It has been reported that there are large number of un-authorized water connections. The general pattern of leakage losses in other water supply projects of similar nature and size has been reported to be around 40 percent and accordingly distribution losses have been assumed to be around 40 percent for Panipat town.

71.. The status of water connections in PWD (WSSD) area as on November 1, 2008, was as follows:

(i)	Domestic flat rate (15mm)	27,083
(ii)	Commercial Metered (25mm)	220

72. The department charges a connection fee of Rs1,000 for a new connection. The present tariff is Rs.25 per month for single tap connections and Rs.48 per month for two tap connections. The revenue collected during last three years in Panipat Town is given in **Table 5-4**.

Table 5-4: Revenue Assessment and Collected

Year	Assessment		Collection	
	Water Supply	**Sewerage**	**Water Supply**	**Sewerage**
	Rs. Million			
2005-06	12.88	0.37	5.79	0.14
2006-07	15.96	0.42	8.32	0.63
2007-08	18.40	0.76	11.03	0.91
2008-09(Up to Oct 2008)	NA	NA	2.05	0.10

Source: PWD – WSSD

73. In HUDA area there are reported to be 5258 domestic, 59 commercial and 591 commercial connections. HUDA gives only metered connections. The present tariff is Rs.4 per KL for domestic plot sizes above 150 square yards including all commercial and industrial consumers and Rs.3 per KL for smaller domestic plots.

74. Organization Structure: PWD (WSS) is a state government department responsible for all water supply and sanitation related activities in the state both in urban and rural areas. The department is headed by a Minister and a Secretary. The organization setup of the department in the state is placed at **Appendix 2**. It is evident from the organization structure that there are two Executive Engineers in Panipat town. One Executive Engineer is in-charge of city water supply and some village water supply schemes in Panipat district. The second Executive Engineer is in charge of Sewerage system of the town and remaining rural water supply schemes.

75. Executive Engineer in-charge of City water supply is assisted by 3 Sub Divisional Officers (SDO) with following staff with respective jurisdiction:

(i) SDO-I: In-charge of water supply in old city area and water supply to 30 villages; assisted by 3 Junior Engineers (JE)

(ii) SDO- II: In-charge of Divisional Stores and water supply to 40 villages and also Public Health amenities in government buildings in Panipat town; assisted by 4 Junior Engineers.

(iii) SDO-IV: In-charge of water supply in Model Town area and in 30 villages.

76. Following **Table 5-5** gives the present operational staff strength at Panipat water supply system:

Table 5-5: Operational Staff Strength

S.No.	Name of Post	City Area		Model Town area		Total
		Regular	*Temp.*	*Regular*	*Temp.*	
1	P.O.Grade-I	3	-	4	-	7
2	P.O.Grade-II	42	-	51	-	93
3	Fitter Grade-I	1	-	1	-	2
4	Fitter Coolie	6	-	4	-	10
5	Fitter Grade-II	2	-	-	-	2
6	Petrol man/Oilman	1	-	-	-	1
7	Keyman	6	-	-	-	6
8	Mech. Foreman	-	-	-	-	-
9	Mech. Fitter	1	-	1	-	2
10	Mech. Fitter Helper	1	-	-	-	1
11	Electrician Grade-II	1	-	-	-	1
12	Electrician Helper	1	-	-	-	1
13	MCC	83	2	40	2	127
14	Tax Collector	-	-	1	-	1
15	Ele. Chargeman	1	-	1	-	2
16	Meter Reader	1	-	-	-	1
17	Bill Clerk	2	-	2	-	4
18	Bill Distributor	-	-	-	2	2
19	Sewerman	14	-	1	-	15
20	Masson	-	-	1	-	1
21	Carpenter	-	-	1	-	1
22	Diesel Mechanic	1	-	-	-	1
23	Beldar	2	-	-	-	2
	TOTAL	**169**	**2**	**108**	**4**	**283**

77. *Industrial Water Supply*. The old industrial area receives water supply from PWD-WSSD. The industrial area in Panipat is maintained by HSIIDC and HUDA. Major Industries in Panipat are weaving and dyeing units. Textile dyeing is the main Industry in Panipat. There are 451 small scale and large dyeing units scattered all over town. Some industries distributed spatially across the town use PWD-WSSD water supply, others use unregulated bore wells for their process water requirements. PWD (WSSD) estimated that Industries are using 40MLD water from their own tube wells to meet their requirement. Most of these industries are discharging their effluent into public sewers and drains. Data obtained from the local PCB office show the wastewater discharge of these industries is 34 MLD. The modes of disposal of industrial effluent are land application, PWD-WSSD sewers and septic tanks and at times in ground through deep bore wells without any treatment. Following photographs depict condition of drains on account of industrial effluents.

Photograph 1 and 2: Condition of Open Drains in Panipat Old Industrial Area

78. It has been proposed that dyeing units shall be relocated to Sector 29 Part II, and a CETP of 42 MLD shall be constructed in two phases of 21 MLD each. The treated effluent from CETP shall be taken to Panipat Drain. This under-construction CETP will reduce the load on existing sewerage scheme.

C. Water Supply Analysis

79. *Use of groundwater for domestic / commercial / industrial purposes*. The water supply system of Panipat town has not been given any comprehensive look for improvement during past. The approach seems to have been mostly ad-hoc. Construction of additional tube wells to meet increased demand or construction of new tube wells as replacement against failed tube wells has been the practice. Similarly extension of pipe lines in newly developed areas has been done. There is no defined zoning of distribution system. Whenever there is any complaint of low pressure, laying additional pipe line or a new pipe line of bigger size seems to be the practice.

80. In addition to this, there has been sharp growth of population on the fringe of municipal boundary. As there is no check on this growth in rural area on urban pattern, due to non development in formal urban area and fast economic growth in the municipal township, PWD(WSSD) has provided partial water supply in such areas by constructing tube wells and laying skeleton distribution system. This was good from the point of view of providing immediate relief but has resulted in non-development of proper system for water distribution, release of regular water connections and putting the required sewer network in place.

81. As ground water is available at reasonable depth and tube well construction is not a problem, industrial water demand is mostly met through privately owned tube wells. This however, creates a problem on sewerage front because effluent discharge from the industries is either put into the sewers or in open drains. The discharge of open drains is also connected to sewers at many places. Thus there is excess flow into the sewers on one hand and quality of sewage also become worst as the industries discharge their effluent untreated. This is putting excessive load on the STPs resulting in poor quality of effluent being discharged into the Panipat drain from the sewage treatment plants.

82. The water supply system of Panipat is facing several problems at present. A low level of service in terms of low per capita water supply rate, short hours of supply, insufficient terminal pressure in the outlying areas, and non-uniform spatial supply rate are among these problems. Most of the unauthorized colonies do not receive municipal water supply. These problems affect the water consumption patterns in the following ways:

(i) Those colonies not receiving municipal water supply use ground water extensively to meet drinking and non-drinking needs of water.

(ii) Areas connected to the municipal water supply system but located at the tail of service area, use ground water to supplement the municipal supply due to low rate of supply and low terminal pressure.

(iii) Small household industries and commercial enterprises (dying, dairies, hotels, nursing homes, and hospitals) continue to rely heavily on ground water to meet their demands.

6. EXISTING SEWERAGE SYSTEM IN PANIPAT

A. General

83. More than 197 km of sewers varying in sizes from 150 mm to 1800 mm are being operated and maintained by PWD (WSSD) and HUDA in Panipat town. There are 3,729 sewer connections in the town, which indicates that not even 10 percent population is connected to the sewerage system. Most of this network was laid under Yamuna Action Plan I. There are 2 sewage main pumping stations and one intermediate pumping station which pump sewage into two STPs of 10 and 35MLD capacities. The effluent from the treatment plants is discharged into Panipat drain, which ultimately meets river Yamuna. In addition to this, sewerage system has been provided by HUDA in its own colonies called sectors. However, HUDA has not constructed any STPs so far and is thus discharging its sewage into the STPs of PWD (WSSD).**Map 6-1** and **Map 6-2** respectively show existing sewerage zones and the existing sewerage system.

B. Existing Sewage Pumping Stations

84. The town is divided into 2 sewerage zones for wastewater management. It has been observed that pressure gauges are not working for almost all the pumping stations. Lifting devices, automation and level switches also require repairs. Mechanical screens are not working. Manual screens are inadequate and allow plastics and other floating material to enter the wet wells. **Table 6-1** is a comparison of the estimated maximum capacity of each pumping station with estimated peak flows, including estimated infiltration but not including potential storm water inflow, for 2011 population estimates.

Table 6-1: Comparison of Existing Pumping Capacity and Total Estimated Flow

Pumping Station Name	Estimated Peaked Capacity (Present)	Estimated 2011 Peak Flow
	MLD	*MLD*
Master Pumping Station for 10 MLD STP,Zone I	20	31
Master Pumping Station at 35 MLD STP, Zone II	70	77
Intermediate Pumping Station Hali Park, Zone I	9.6	8

Source: Analysis

C. Existing Sewage Treatment Plants

85. **Table 6-2** depicts comparison of the estimated maximum capacity of each STP with estimated average flows, not including potential storm water inflow, for 2011 population estimates.

Table 6-2: Comparison of Existing STP Capacity and Total Estimated Flow

Sewage Treatment Plant Name	Maximum Installed Capacity(Present)	Estimated 2011 Average Flow*
	MLD	*MLD*
10 MLD UASB sewage Treatment Plant	10	10*
35 MLD UASB sewage Treatment Plant	35	27*
TOTAL	45	37

*Estimated average flows (without industrial wastewater). However, industrial waste finding its way to the treatment plant is substantial and causing overloading of the same resulting in poor quality of effluent coming out from Sewage Treatment Plants.

86. *35 MLD STP*. The 35 MLD capacity STP, based on UASB technology, is located at Village Siwah and was constructed under YAP I. The treated wastewater is discharged into Panipat Drain which eventually meets the river Yamuna. The main treatment units of the plant are an inlet chamber with mechanically cleaned bar screens, grit channels, the UASB reactor and the final polishing unit (FPU). A biogas holder is also provided for collection of biogas which can be either flared or utilized in a dual fuel engine. The sludge from the UASB reactor goes to the sludge dewatering beds for drying before it is sold as agricultural manure. A summary of the observations are given below:

(i) The wastewater coming to the STP is of different colors at different times of the day indicating a very high presence of influents from the dyeing industry.

(ii) The average incoming flow to the plant has reached 31 MLD. It is in excess of the design flow of 35 MLD during some parts of the year.

(iii) The removal of pollutants in the UASB is as follows: These are lower than what was assumed in the design.

- COD: 34%
- BOD: 63%
- TSS: 71%

(iv) The removal of pollutants in the FPU seems to be overstated especially for a one day pond. In fact, the FPU is operating more like an anaerobic/facultative pond rather than as an oxidation pond.

(v) Poor performance of the screening facilities, especially the mechanical screens, is one of basic reason for the poor performance of the plant.

(vi) The FPU, as a secondary treatment facility after the UASB, seems to be inadequate to achieve the desired treatment standards.

87. *10 MLD STP*. The 10 MLD STP, based on UASB technology, located on Jatal Road near the Western Jamuna Canal, was commissioned in 2001, under YAP I. The treated wastewater is discharged into the Nohra drain. The main treatment units of the plant are an inlet chamber with mechanically cleaned bar screens, grit channels, the UASB reactor and the final polishing unit (FPU). A biogas holder is also provided for collection of biogas which can be either flared or utilized in a dual fuel engine. The sludge from the UASB reactor goes to the sludge dewatering beds for drying before it is sold as agricultural manure. Main observations are:

(i) The removal of pollutants in the UASB is reported to be:
    - COD 35%
    - BOD 64%
    - TSS 76%

(ii) The maintenance of electrical and mechanical equipment is minimal.

(iii) The laboratory testing facilities at the site need to be improved.

(iv) The FPU, as a secondary treatment facility after the UASB, is inadequately sized to deliver the expected treatment standards.

(i) The removal of pollutants in the UASB is reported to be:
    - COD 35%
    - BOD 64%
    - TSS 76%

(ii) The maintenance of electrical and mechanical equipment is minimal.

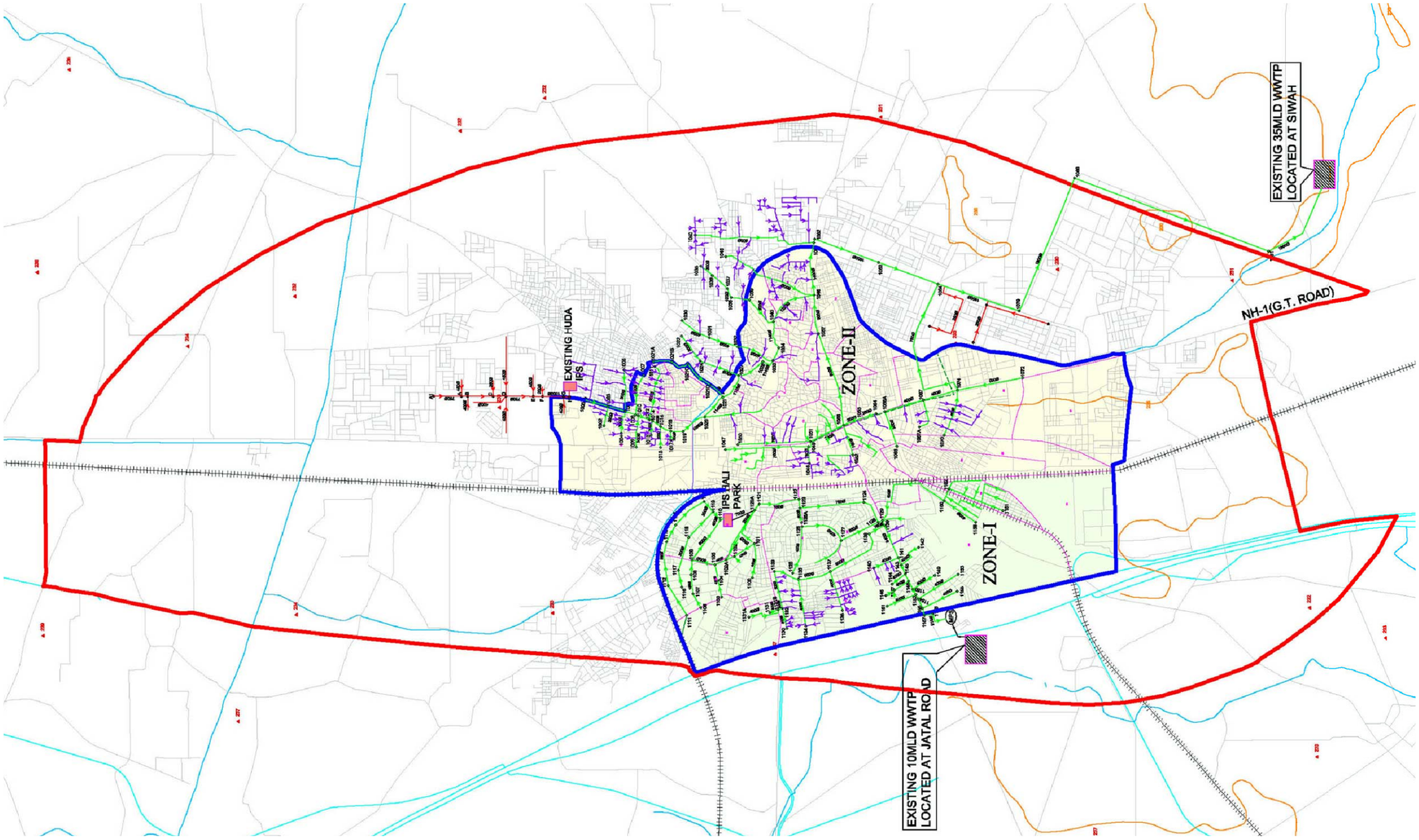
(iii) The laboratory testing facilities at the site need to be improved.

(iv) The FPU, as a secondary treatment facility after the UASB, is inadequately sized to deliver the expected treatment standards.

88. Each element of the existing sewerage infrastructure has been evaluated while preparing Sewerage Master Plan under Yamuna Action Plan II during 2006. **Map 6-3** shows Sewerage Master Plan of Panipat.

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Sewerage Zones
Panipat



LEGEND:-

1. PWD-WSSD SEWERS
2. PWD-WSSD LATERALS
3. RISING MAIN
4. EXISTING HUDA SEWERS
5. STORM WATER DRAIN
6. MUNICIPAL AREA
7. ROAD
8. DRAIN
9. CANAL
10. WARDS
11. WARD NO. 21
12. RAILWAY LINE
13. SEWERS DIA FOR EX. 300mmØ
14. NODE NO. ⊕1079
15. CONTOURS 235
16. SPOT HEIGHT ▲231
17. EXISTING MPS LOCATION
18. EXISTING WWTP & MPS LOCATIONS
19. ZONE-I
20. ZONE-II
21. INTER CONNECTION
22. EXISTING IPS

Client

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National Capital Region Planning Board

Consultant

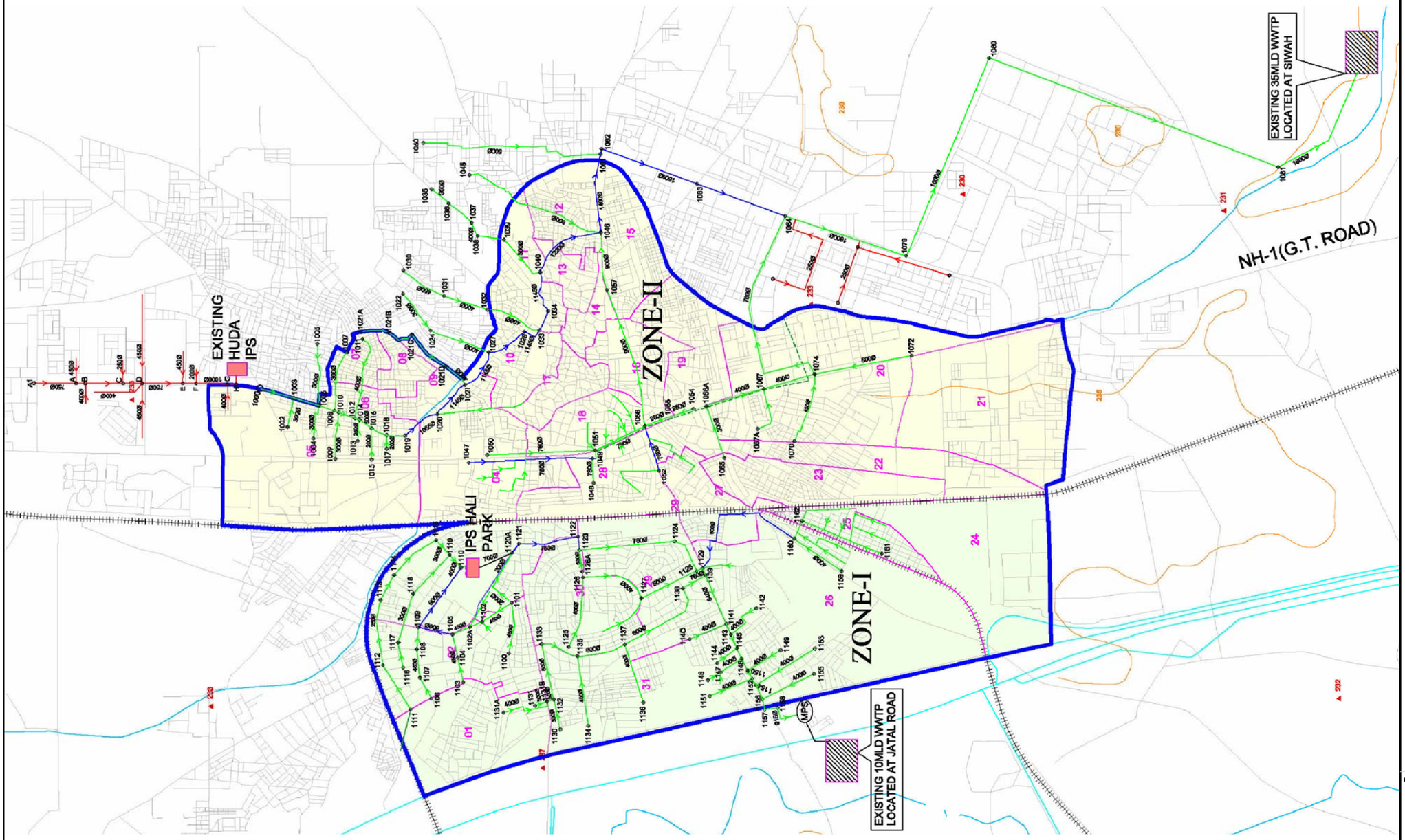
Wilbur Smith Associates

Drawn:SK	Checked: NSS
Date:April 2010	Approved: NSS
Scale: NTS	

Map 6 - 1

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Existing Sewerage System in Panipat



LEGEND:-

1. PWD-WSSD SEWERS
2. SEWERS IDENTIFIED FOR CCTV INSPECTION + DE-SILTATION
3. RISING MAIN
4. HUDA EXISTING SEWERS
5. STORM WATER DRAIN
6. MUNICIPAL AREA
7. ROAD
8. DRAIN
9. CANAL
10. WARDS
11. WARD NO. 21
12. RAILWAY LINE
13. SEWERS DIA FOR EX. 300mmØ
14. NODE NO. 1079
15. CONTOURS 235
16. SPOT HEIGHT ▲ 231
17. EXISTING MPS LOCATION
18. EXISTING WWTP & MPS LOCATIONS
19. ZONE-I
20. ZONE-II
21. EXISTING IPS

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Wilbur Smith Associates

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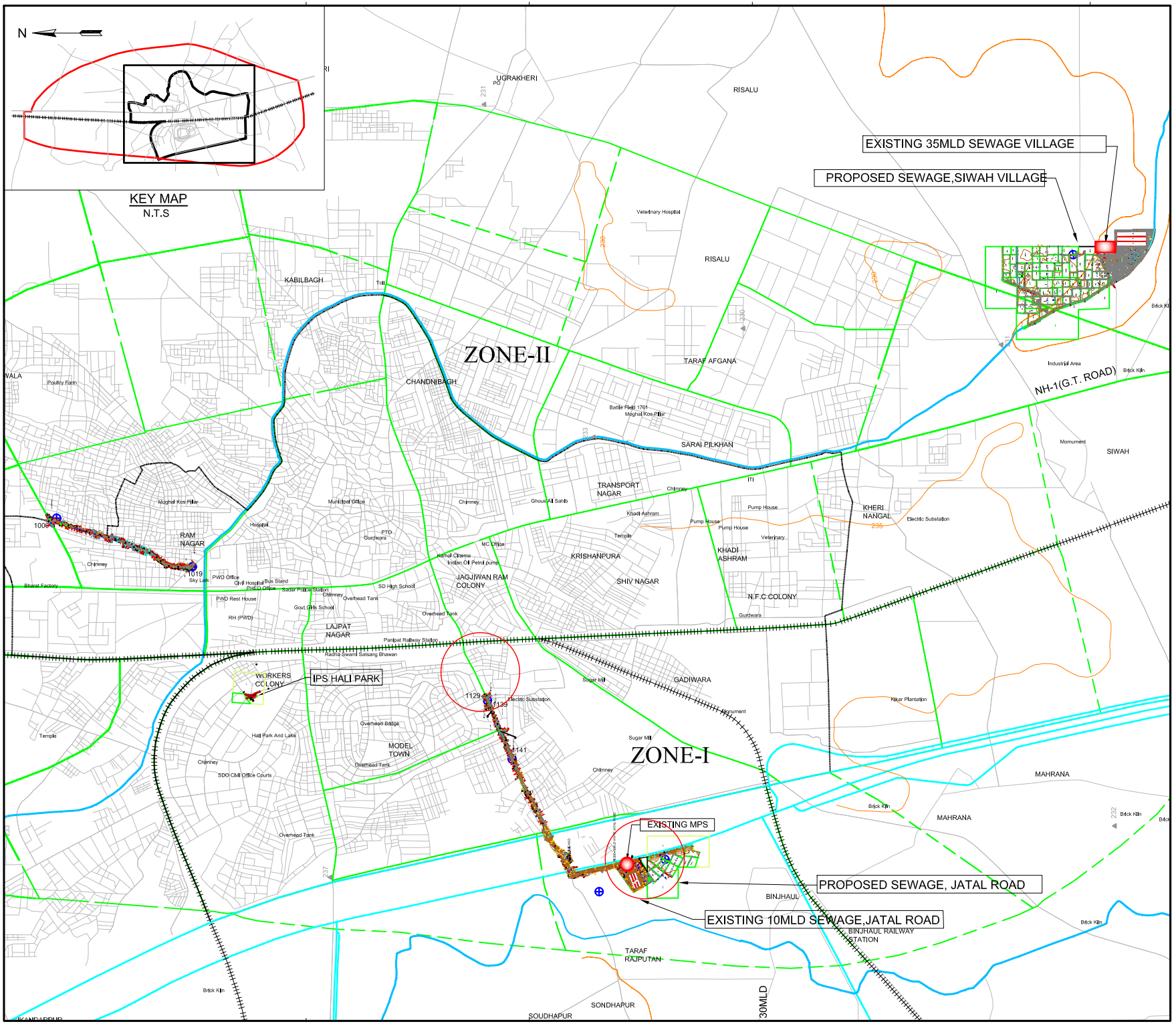
Scale: NTS	

Map 6-2



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Sewerage Master Plan
Panipat

Client:
Asian Development Bank
National Capital Region Planning Board

Prepared By:
Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date : April 2010	Approved:NSS

Scale: 0 0.5 1 Km

Map 6 - 3

7. STUDY APPROACH

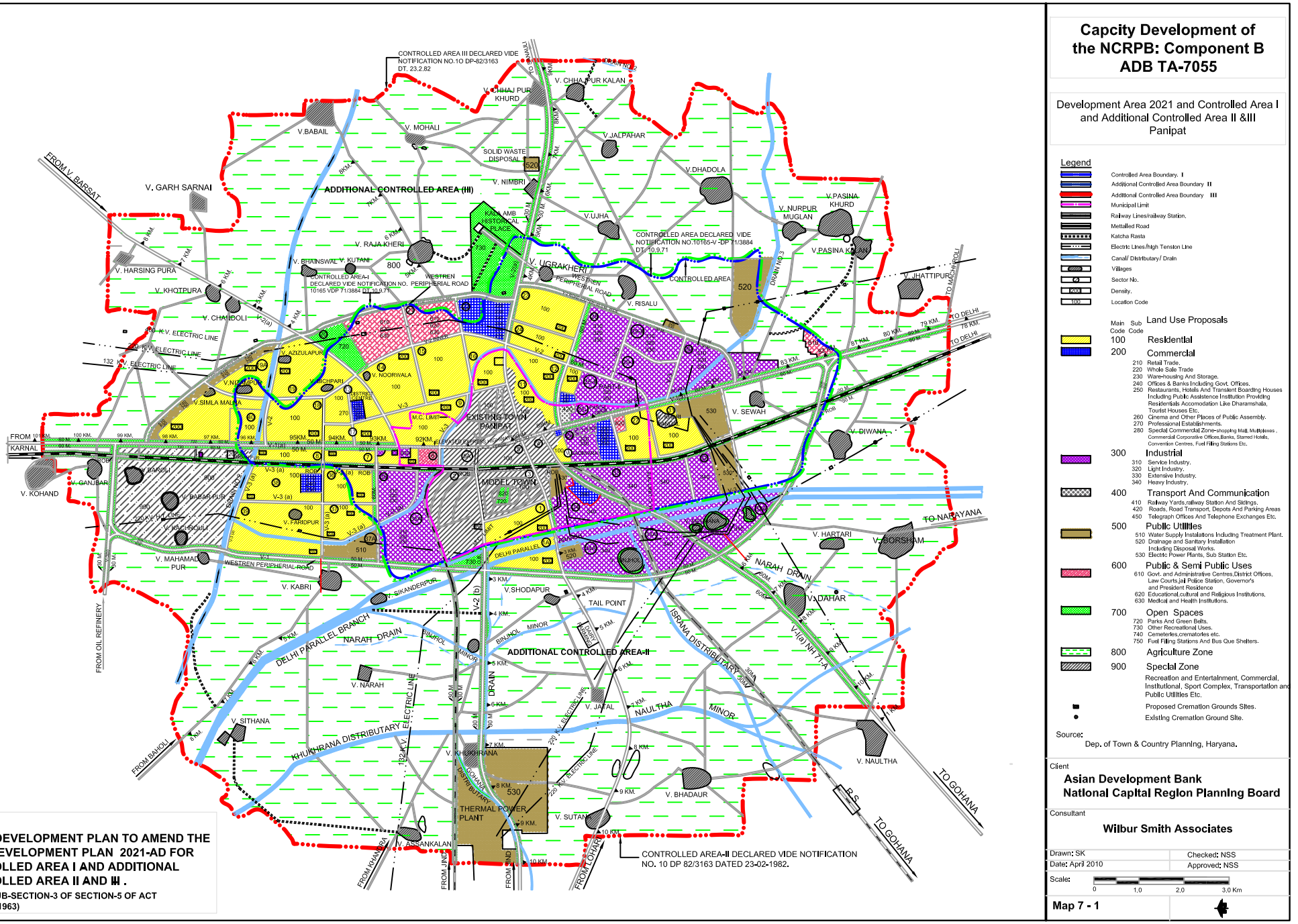
A. Project Area

89. The present municipal council boundary extends to 1,707 hectares. In order to channelize the development in planned manner and to control the sprawling haphazard piecemeal growth, the government declared 6,740 hectares area around municipal limits of the town in year 1971 as controlled area and 22,800 hectares area as additional controlled areas– II and III in the year 1982 under section 4 (I) (a) of the Punjab Scheduled Roads and Controlled areas Restriction of Unregulated Development Act-1963 (Punjab Act 41 of 1963), vide Notification No. 10165-VDP-71/3884, dated the 10th September, 1971 and 10 DP-82/3163, dated the 23rd February 1982 published in the Haryana Government Gazette dated the 24th January 1984 vide Notification No.3591-2TCP/83 dated the 26th October 1983. The Development plan 2021 notified by the Hayana Town and country planning department in 2006 covers an area of 8,065 hectares. The boundaries of above three areas are shown in **Map 7-1.** This is the project area for Water Supply Master Plan.

90. Within this study area is the urbanisable area (area for which land use has been defined as per the current Town Development Plan) for which population projections were developed for the year 2041. This study area, covering approximately 8065 hectares, is comprised of (a) the municipal area, and (b) the sectors outside the municipal area as per the Town Development Plan. As the land use pattern of area outside the development plan has not been defined, the same was not considered for the master plan. This is also in consonance with the area adopted in the Master Plan prepared for Sewerage for Panipat under Yamuna Action Plan II.

91. The project horizon year is 2041 and as such water supply 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. The forecasted population for year 2041 can be accommodated in Current master plan 2021 area of 8,065 hectares with an average density of 115 persons per hectare.

92. The Project area for the DPR has been taken out of the master plan area proposed which has already developed in a contiguous manner. It covers the existing municipal area **Map 7-2,** sectors already developed by HUDA and villages forming part of HUDA sectors. A map showing project area for DPR is given in **Map 7-3**. It covers an area of 3,321Ha.



Note:

DRAFT DEVELOPMENT PLAN TO AMEND THE FINAL DEVELOPMENT PLAN 2021-AD FOR CONTROLLED AREA I AND ADDITIONAL CONTROLLED AREA II AND III .

(UNDER SUB-SECTION-3 OF SECTION-5 OF ACT NO. 41 OF 1963)

Capcity Development of the NCRPB: Component B ADB TA-7055

Development Area 2021 and Controlled Area I and Additional Controlled Area II &III Panipat

Legend

- Controlled Area Boundary. I
- Additional Controlled Area Boundary II
- Additional Controlled Area Boundary III
- Municipal Limit
- Railway Lines/railway Station.
- Metalled Road
- Katcha Rasta
- Electric Lines/high Tension Line
- Canal/ Distributary/ Drain
- Villages
- Sector No.
- Density.
- Location Code

Main Code	Sub Code	Land Use Proposals
100		Residential
200		Commercial
	210	Retail Trade.
	220	Whole Sale Trade
	230	Ware-housing And Storage.
	240	Offices & Banks Including Govt. Offices.
	250	Restaurants, Hotels And Transient Boarding Houses Including Public Assistence Institution Providing Residentials Accomodation Like Dharamshala, Tourist Houses Etc.
	260	Cinema and Other Places of Public Assembly.
	270	Professional Establishments.
	280	Special Commercial Zone-shopping Mall, Multiplexes , Commercial Corporative Offices,Banks, Starred Hotels, Convention Centres, Fuel Filling Stations Etc.
300		Industrial
	310	Service Industry.
	320	Light Industry.
	330	Extensive Industry.
	340	Heavy Industry.
400		Transport And Communication
	410	Railway Yards,railway Station And Sidings.
	420	Roads, Road Transport, Depots And Parking Areas
	450	Telegraph Offices And Telephone Exchanges Etc.
500		Public Utilities
	510	Water Supply Installations Including Treatment Plant.
	520	Drainage and Sanitary Installation Including Disposal Works.
	530	Electric Power Plants, Sub Station Etc.
600		Public & Semi Public Uses
	610	Govt. and Administrative Centres,District Offices, Law Courts,Jail Police Station, Governor's and President Residence
	620	Educational,cultural and Religious Institutions.
	630	Medical and Health Institutions.
700		Open Spaces
	720	Parks And Green Belts.
	730	Other Recreational Uses.
	740	Cemeteries,crematories etc.
	750	Fuel Filling Stations And Bus Que Shelters.
800		Agriculture Zone
900		Special Zone
		Recreation and Entertainment, Commercial, Institutional, Sport Complex, Transportation and Public Utilities Etc.
		Proposed Cremation Grounds Sites.
		Existing Cremation Ground Site.

Source:
Dep. of Town & Country Planning, Haryana.

Client
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date: April 2010	Approved: NSS

Scale: 0 1.0 2.0 3.0 Km

Map 7 - 1

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Municipal Area Showing Ward Boundaries
Panipat

Legend

- Municipal Boundary
- Ward Boundary
- 20 Ward Number
- Major Roads
- Other Roads
- Railway Line
- Cart Track
- House settlement
- Tube Well
- Temple
- Water Course

Source:
PHED Panipat, Haryana

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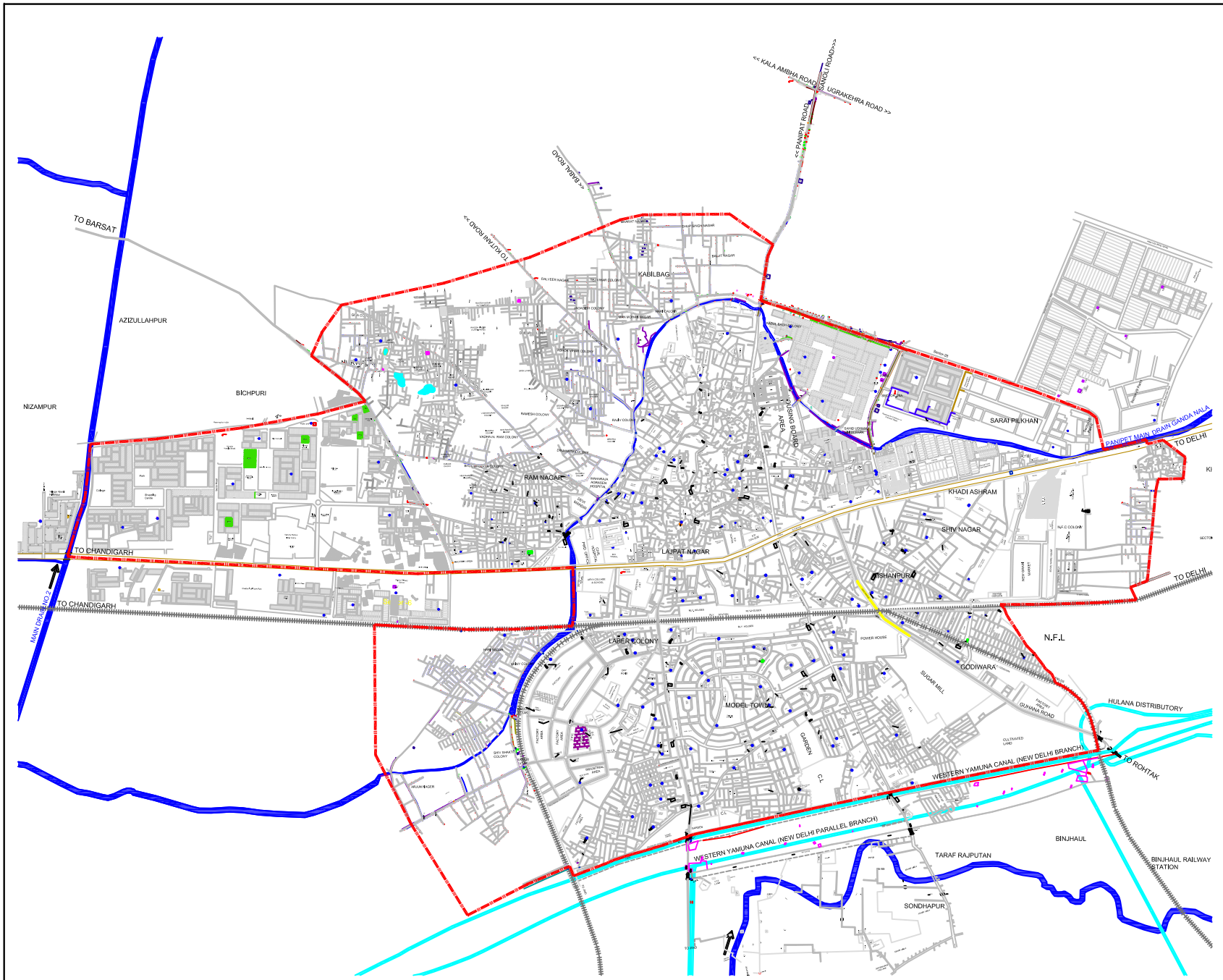
Date: April 2010	Approved: NSS
Scale: NTS	

Map 7 - 2



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Base Map Showing Project Area for DPR Panipat

Legend

- DPR Project Boundary
- National Highway
- Other Roads
- Railway Line
- Canal
- Drain
- Hand Pump
- Culvert
- Manhole
- Transformer
- Electricpole
- Lamppost
- Telephonepole
- GPS
- TBM
- Tree
- OFC
- Ditch
- Building
- Tube Well

Overlay Legend

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Date: April 2010 | Approved: NSS

Scale: 0 400 800 1200 1600 Meters

Map 7 - 3

B. Development Plans

93. The Development Plan of the town of Panipat and the NCR Regional Plan -2021 are a few of the critical drivers for developing the growth projections for the Water Supply Master Plan. The key highlights of these guiding documents are outlined below:

94. Development Plan 2021: The Development Plan of a town is a vision document of the town prepared by the Town and Country Planning department of the state government. The proposed land use given in the Development plan is given in **Table 7-1**. The key highlights of this guiding document are:

(i) The projections are based on "induced growth" estimations and no mathematical method has been used for establishing population projections.

(ii) At a growth rate of 43 percent and 40 percent, the Development Plan projects a population of 506,866 for the year 2011 and 709,612 for the year 2021.

(iii) The planned development density in the residential pockets is in the range of 125 to 300 ppha.

(iv) An average planned development density for the town is 115 person per ha across the entire Panipat town development area.

(v) The Plan focuses on developing the town as an industrial hub, with the provision of 25.1 percent of total area to be developed as Industrial land use and with 42 percent of the total workforce engaged in industrial activities by 2021.

(vi) The expected direction for development of the town is towards north and northeast.

(vii) The Plan proposes 40 sectors in and around existing Panipat town to be developed per designated land use.

Table 7-1: Land Use Proposed in Development Plan 2021

S.No.	Land use	Area within municipal limits in Hectares	Area within extended municipal limits in Hectares	Area within controlled area in hectares	Total area in hectares	% of total area
1	Residential	400	300	2282	2982	42.53
2	Commercial	115	50	97	262	3.74
3	Industrial	262	293	1135	1690	24.10
4	Transport and Communication	42	--	475	517	7.37
5	Public utilities	44	--	173	217	3.10
6	Public and semi public	105	8	180	293	4.18
7	Open Spaces	88	--	485	573	8.18
8	Special Zone			477	477	6.80
	Total	**1,056**	**651**	**5,304**	**7011**	**100.00**

95. Regional Plan 2021: The Regional Plan has been prepared by the National Capital Region Planning Board to bring about balanced and organized growth in the National Capital Region and to reduce pressure on Delhi.

(i) At a growth rate of 41 percent and 40 percent, the Regional Plan projects a population of 500,000 (in the year 2011) and 700,000 (in the year 2021).

(ii) The town is designated as "Regional Center", marked by specialized secondary and tertiary sector activities.

(iii) The Plan proposes strengthening and widening of the Rohtak-Gohana-Panipat National Highway No.71A.

(iv) The Plan proposes construction of a Rapid Rail Transit System between Sonepat-Panipat during 2011 – 2021.

96. Population density of 150 to 200 per Hectare prescribed in Regional Plan 2021 approved by NCR Planning Board for towns with a population of 10 to 50 lakh.

C. Population Projections

97. Population projections for decennial intervals were developed using mathematical methods using the past data available from census data. Other inputs into the projections were the 2021 Town Development Plan and the 2021 NCR Regional Development Plan. The mathematical methods were used as the basis for establishing a best fit with the published town development plans, with the intent of selecting a method which is appropriate to compute future decennial projections.

98. The population projections for the project area were then finalized in consultation with key town planners, experienced professionals, representatives of Urban Local Bodies (ULB), District Town Planning Office, PWD (WSS) and NCR Planning Board and rationalized using the growth rate method to arrive at the final recommendations of population projections. Having finalized the projected populations by decadal intervals based on census years, estimates were interpolated for the intermediate decadal Years – 2021, 2031 and 2041. Field verifications were done to understand the current development scenario on the ground and examine relative growth between the last census in 2001 and the current development scenario (in 2008). A better appreciation of the accelerated rate of growth and the spatial pattern of urbanization was obtained from this dataset.

D. Overall Population Projections

99. Different mathematical methods were used to ascertain the possible population growths and assess indicative population projections for the town by using these methods (arithmetical, incremental and exponential) as given in **Table 7-2** Considering the prospects of expansion of the economic base of the town due to the industrial activity and the growth driven by the increasing industrial base of the town, the incremental growth were assessed to mathematically best fit the population growth established by the Development plan approved by Haryana Town & country planning Department and the

NCR PB Regional Plan 2021, using 2001 census data as the base. Sewerage master plan has considered a decadal growth rate that resembles population growth as per incremental increase method. These have been marginally adjusted and adopted here.

Table 7-2: Population Projections based on Growth Models

Year	Development Plan-2021	Arithmetic increase	Incremental increase	Exponential Method	Growth Rate by Incremental Method	Growth Rate Allocated	Projected Population as per allocated growth
2001	3,54,148*						
2011	5,06,866 (43%)	442,864	499,438	566,637	41.0 %	41.34 %	500,543
2021	7,09,612 (40%)	531,580	701,302	906,619	40.4 %	42.87 %	715,105
2031	-	620,296	959,740	1,450,590	36.9 %	33.33 %	953,484
2041	-	709,012	1,274,752	2,320,944	32.8 %	28.33 %	1,270,597

* Census 2001

Note: The data represented in the parentheses represents the revised projection as per the Development Plan Notification dated February 14, 2006

$ Growth rates have been marginally adjusted as adopted in Sewerage Master Plan, Panipat

Source: Census of India, Regional Plan-2021 of National Capital Region and Development Plan – 2021 of Haryana Town & country planning Department.

100. Based on interactions with local officials, field reconnaissance, assessment of current population, and the infrastructure development in Panipat Town, it was perceived that the growth rate over the past 7 years (from 2001 to 2008) had been perceptibly higher than the estimated 40 percent. Given this ground reality, the growth rates assessed by incremental growth method appeared to be slightly on the lower side and Panipat was estimated to have the growth potential to grow at a rate marginally higher than that estimated by the NCR Plan and the Town Development Plan. With the increasing urban densities and patterns of surrounding urbanization, the growth rates for subsequent decadal intervals, 2031 and 2041, are anticipated to decline and lower growth rates were forecast using guidance from the mathematical models as well as the induced growth rate analysis.

101. Subsequent to projecting the population for the town and its distribution within the sectors, and wards, the aggregated totals were re-computed to fine tune the growth rates of the town, resulting in the final overall population projections for Panipat. These projections form the basis of the distribution within the currently defined wards and sectors, which have a limited capacity to accommodate the increasing population.

E. Population Projections within Municipal Limits

102. The municipal limits of Panipat are comprised of 31 wards. Assessed based on the 2001 census demographics, the development density of these wards varies from about 36 ppha to 542 ppha. In this broad range, the higher densities are associated with the older parts of

the town which have densified over the decades. In the absence of spatial information correlating ward geographies between the past and present it becomes impracticable to assess the relative growth differentials and create an explicit relationship between increasing density and declining growth rates. However assessed as a whole, the data from 1981 to 2001, a time period with unchanged municipal extents, reflects an inversely proportional reduction in the growth rate (from 56 percent to 37 percent) as population densities increased (from 69 ppha to 132 ppha). Other factors that are an influence are evidently the increasing development outside of the municipal limits that become evident in Panipat from field work, indicating growth directions shifting from municipal to other HUDA sectors and private developers. While part of the municipal area is encompassed by the sectors which have planned development, a substantive part of the municipal extent is reflective of an urban development landscape that is relatively unplanned with organic growth of small lots and old building stock. The building bylaws for the town do not provide for any significant direction of increased development density in such unplanned areas permitting increased densification within the municipal limits while regulating only the planned sectoral developments.

103. As compared to other towns, the extensive industrial activity in the town, especially in the informal sector, has resulted in a high population density on average across the municipal limits. The population density for the decadal interval ending 2001 is consequently at about 132 ppha. Preparing estimates of population within municipal areas based on field reconnaissance, information provided by officials from PWD WSSD, municipal officials etc. has already exceeded the average planned development density for Panipat anticipated at 115 ppha, the municipal area in 2001 and 2008 has already exceeded these population density levels. Although it is not possible to specify a saturation level for the municipal extent, the unplanned residential areas can be expected to achieve densities upward of 300 ppha, and those of planned areas within the municipal limits being between 150 and 300 ppha. Considering the pressures for affordable housing, the slum clusters within the town (generating high base densities in some wards at over 500 ppha) the average development density of Panipat can be anticipated to be upwards of 200 ppha.

F. Population Projections in Sectors outside Municipal Limits

104. The development extent of 6,078 ha outside of the municipal limits represents an area of about 3 times that of the municipal extent itself, distributed over 40 sectors. As per current assessments, this area already has a base population of 185,862 persons, with an average density of 31 ppha.

105. The development plan proposes an increase in the industrial land use, an increased residential development density (ranging from 150 – 300 ppha) and the active participation of the private sector in developing the residential areas. The average development density of this area, as per the development plan, is expected to be about 115 ppha.

G. Population Distribution

106. The town has been studied with respect to its administrative divisions, wards and sectors, for the purpose of allocation and distribution of the population. The 31 wards form part of the municipal area. The area outside the municipal limits form part of the planned urban development is categorized into sectors and the areas of villages forming part of study area. The portions of sectors that are part of wards, or fall within the municipal limits have been addressed for the projection purpose under the category of wards. The area of the sectors outside of the municipal limits has been addressed under the sectors category.

H. Determinants of Population Distribution

107. Growth drivers are the parameters which act as a catalyst to the growth of the city. These are the phenomena that attract or repel the population to a particular area, thereby resulting the spread and growth of an urban area in a particular direction. Growth catalysts influencing Panipat are:

(i) Panipat as a Regional Centre: Designated as a regional centre under the Regional Plan-2021 of National Capital Region (NCR Plan), marked by highly specialized secondary and tertiary sector activities. As a Regional Centre, the town will be developed for advanced industrial and other economic activities. These are expected to exert an increasingly dynamic influence on attraction of investment and creation of healthy living and working environment. The industrial impetus coupled with the improvement of infrastructure will generate employment opportunities and is expected to be a major driver for population growth.

(ii) Transport catalyst: The proposals for improvement and development of the road network between Panipat and other important towns of the region like Gohana, Rohtak and Sonepat will provide development impetus to Panipat. A Rapid Rail Corridor has also been proposed to be developed between Panipat-Sonepat. Wider roads in the 'to-be developed' town and reduced congestion of the inner town will also enhance the town's development.

(iii) Employment catalyst: Industrial development being carried out in and around an urban area functions as catalyst to the population growth of the town. Industrial activity generates employment, further attracting an influx of population. This is likely to be among the key drivers for growth in Panipat. Over 1722 hectares of land area (25 percent) has been allocated for industrial development.

108. Growth Deterrents influencing Panipat are:

(i) Man-Made Barriers: Panipat drain, which crosses the town, has limited the growth towards the east and inhibits development to some extent. The canal on the west also acts as a deterrent.

(ii) Property Barriers: The National Fertilizer Ltd. Township and Thermal Power Plant act as deterrents to the development of the town in the southern side.

I. Field Information

109. As a result of the limitations of not being able to specifically ascribe a growth rate to each ward based on ward-specific past data, it was necessary to assess the development potential of each municipal ward, and build up its potential increase in population through careful analysis of the available data and field-based review of the urban morphology of the municipal extents.

110. Panipat has a complex mix of residential, informal industries, slums, and planned development. The municipal limits are well inhabited, with some areas having very high population densities, the areas under the urban extent have also been growing very rapidly. The areas along the highways and the existing municipal limits has grown rapidly, however areas set further back and relatively less accessible from NH-1 are now beginning to gather development momentum. In the old town areas, commercial activity and daily use shopping is interspersed within the urban fabric with the frontage of buildings conventionally being used for such activity. Added to this, industrial activity seems to be generally pervasive through a large extent of Panipat and current efforts to move textile dyeing units to a specific industrial area are meeting with limited success as the smaller, informal units are difficult to close down and move to this designated area.

J. Population Computation for Project Specific Years

111. Consequent to the allocation of the population for the decennial years, 2011, 2021, 2031 and 2041, population has been interpolated for the Project Horizon year 2026. The summation of the project populations computed for the municipal area and the planned urban development area represent our project service area population. A summary of these numbers is presented in **Table 7-3**

Table 7-3: Population Projections for Project Horizon Years

Year	Population in Municipal Area	Population in Urban Areas	Population In the Project Area	Average Population Density
	No,s	*No,s*	*No,s*	*Persons/ha*
2011	308,574	191,969	500,543	62
2026	374,649	430,390	805,039	100
2041	500,017	717,488	1,270,597	151

Source: Analysis

112. Master Plan prepared for Panipat water supply envisaged dividing the town in 32 Zones. Distribution of population zone wise and Horizon year wise is presented in **Appendix 3-A and 3-B.** As mentioned above, study area for preparation of DPR is limited to the area within the master plan area, which has already developed and which is contiguous **(Map 7-3).** This DPR area comprises of 18 Zones. Distribution of population Horizon year wise for each zone in DPR area is presented in **Table 7-4**.

Table 7-4: Distribution of population Zone wise in DPR area for the Horizon years

Zonal Population, Panipat. (DPR)							
Zones	**Wards**	**Population 2011**		**Population 2026**		**Population 2041**	
		Ward wise	**Zone**	**Ward wise**	**Zone**	**Ward wise**	**Zone**
1	W-31	14,895	17,000	22,532	25,532	34,085	38,360
	W-29p	2,105		3,000		4,275	
2	W-3p	4,211	17,635	6,000	25,135	8,549	35,814
	W-29p	5,912		8,431		12,013	
	W-30	7,512		10,704		15,252	
3	W-2	8,899	16,679	11,588	22,673	15,089	30,884
	W-3p	7,780		11,085		15,795	
4	W-1	17,247	17,247	20,414	20,414	24,163	24,163
5	W-26	9,150	24,059	10,598	27,290	12,275	31,046
	W-25	8,968		10,387		12,031	
	W24p	1,980		2,305		2,700	
	W-27p	3,961		4,000		4,040	
6	S-35	1,442	11,585	3,208	22,089	3,494	32,316
	S-35A	10,143		18,881		28,822	
7	W-8p	992	26,570	992	36,608	992	57,853
	W-6	7,708		7,708		7,708	
	W-7	8,321		8,321		8,321	
	W-5p	8,749		18,627		39,632	
	W-9p	800		960		1,200	
8	W-28	8,261	13,876	11,777	19,777	16,790	28,189
	W-4p	5,615		8,000		11,399	
9	W-9p	6,836	31,361	8,618	33,609	10,814	36,309
	W-10	8,176		8,516		8,870	
	W-14p	6,760		6,790		6,843	
	W-17	9,589		9,685		9,782	
10	W-11	11,084	35,560	11,544	37,482	12,023	39,539
	W-12	9,091		9,468		9,861	
	W-13	6,812		6,880		6,949	
	W-14p	752		797		820	
	W-15	7,821		8,793		9,886	
11	W-18	8,558	19,113	9,622	23,091	10,818	27,764
	W-16p	5,195		5,831		6,063	
	W-4p	5,360		7,638		10,883	
12	W-16p	5,194	20,452	4,990	25,927	5,208	34,847
	W-19p	6,625		10,937		18,056	
	W-20p	8,633		10,000		11,583	
13	W-27p	6,880	22,039	6,949	26,417	7,018	32,550
	W-22p	4,820		6,000		7,469	
	W-23	7,310		8,468		9,809	

Zonal Population, Panipat. (DPR)							
Zones	**Wards**	**Population 2011**		**Population 2026**		**Population 2041**	
		Ward wise	**Zone**	**Ward wise**	**Zone**	**Ward wise**	**Zone**
	W-19p	3,029		5,000		8,254	
14	W-21	6,378	17,190	15,835	28,624	39,316	54,461
	W-22p	3,082		3,836		4,775	
	W-20p	7,730		8,953		10,370	
15	S-17	2,710	15,847	6,169	35,750	11,190	64,084
	S-18	6,608		16,291		30,962	
	S-13	6,529		13,290		21,932	
16	S-15	16,973	21,050	17,365	26,717	29,472	43,048
	S-16	4,077		9,352		13,576	
17	W-8p	5,000	29,043	5,000	31,670	5,000	53,007
	S-14	14,413		16,406		29,531	
	S-9	9,630		10,264		18,476	
18	S-25p	3,000	12,877	6,153	30,349	9,230	46,480
	S-12	6,352		15,333		21,296	
	S-24	3,525		8,863		15,954	
Total		**369,183**	**369,183**	**499,154**	**499,154**	**710,714**	**710,714**

W denotes ward S denotes sector

8. DESIGN CRITERIA

A. Introduction

113. The objective of a public protected water supply system is to supply safe and clean water in adequate quantity, conveniently and as economically as possible on sustainable basis. Engineering decisions are required to specify the area and population to be served, the design period, the per capita rate of water supply, other water needs in the area, the nature and location of facilities to be provided, the utilization of centralized or multiple points of treatment facilities and points of water supply intake and waste water disposal. Optimization may call for planning for a number of phases relating to plant capacity and the degree of treatment to be provided by determining the capacities for several units, working out capital cost required, interest charges, and period of repayment of loan, water tax and water rate. The assumptions/guide lines adopted mainly relate to Per capita water supply, design period, population forecast, measurement of flow, water treatment, specifications of materials, water quality standards etc. The main design criteria adopted are described in following sections.

B. Population Forecast

114. The design population will be estimated with due regard to all factors governing future growth and development of the project area in the industrial, commercial, educational, social and administrative spheres. Special factors causing sudden emigration or influx of population shall also be foreseen to the extent possible. A judgment based on these factors would help in selecting the most suitable method of deriving the probable trend of the population growth in the areas of the project town from out of the following mathematical methods.

(i) Arithmetical Increase Method
(ii) Incremental Increase Method
(iii) Geometric Increase Method

115. In addition to above, population has been assigned in the Regional Plan for 2021 approved by the National Capital Region Planning Board for Panipat and also assessment for population increase has been made in the development plan approved by the state government for the year 2021. These forecasts will also influence our population projections for the design year. The design period for the project will be 30 years. Taking base year as 2011, the master plan is proposed to be designed for 2041. Population forecast will be made for 2041 with interpolation for mid year 2026 and decadal years of 2011, 2021 and 2031.

C. Per Capita Water Supply

116. Piped water supplies for communities should provide adequately for the following as applicable:

(i) Domestic needs such as drinking, cooking, bathing, washing, flushing of toilets, gardening and individual air conditioning.
(ii) Institutional needs.
(iii) Public purposes such as street washing or street watering, flushing of sewers, watering of public parks.
(iv) Industrial and commercial uses including central air conditioning.
(v) Fire fighting
(vi) Requirement for livestock; and
(vii) Minimum possible UFW

117. Looking to the size and type of the township with sewerage system, CPHEEO manual recommends a per capita supply of 135 lpcd. This is exclusive of Unaccounted For Water (UFW) and supply to major Industrial, commercial and Institutional establishments which may require bulk supplies. As ground water is easily available at reasonable depths in adequate quantity for local requirements and also the fact that a major canal is passing through the town, it is assumed that any bulk requirement of water for major industry/commercial/institutional establishment will be met by the establishment itself and no provision for the same is being made. As has been mentioned earlier, in absence of metering of bulk water production and water supplied to consumers, it is not possible to realistically estimate UFW in the system. Looking to present status of the distribution system and previous experience it is presumed that present level of UFW is around 40 percent. The CPHEEO manual on water supply recommends a maximum of 15 percent as UFW in water supply system. In view of this, proposals envisage taking appropriate action to reduce the UFW and bring down the same to the level of 15 percent.

118. The Regional Plan 2021 approved by NCRPB provides for a water supply rate of 200 lpcd in the urban areas (with a population above 1 lakh) of NCR. This includes the requirement of water of major industries/commercial/institutional establishments.

119. In view of the recommendations of CPHEEO water demand for design purpose has been considered as 135 lpcd at consumer end and UFW as 15 percent. This makes per capita gross water supply of 160 lpcd. Water requirement of major industries, commercial establishments and institutions with bulk requirement will be met by themselves and as such not considered here.

D. Terminal Pressure Requirement

120. CPHEEO manual on water supply recommends that piped water supplies should be designed on continuous 24 hours basis to distribute water to consumers at adequate pressure at all points. The terminal pressure at ferrule point is specified as 7m for direct supply in single storey buildings, 12m for 2 storeyed buildings and 17m for 3 storeyed buildings in the above manual. Continuous 24 hours water supply is ideal on following grounds amongst others:

(i) It provides the most economical project design and best utilization of resources.
(ii) It ensures that there is no intrusion of pollution in the distribution system thus ensuring quality of water distributed.
(iii) It provides high level of consumer satisfaction.
(iv) It saves from substantial indirect costs on local storages and purification/disinfections equipments to be provided at consumer end by the consumers.

121. In view of above it is assumed that continuous 24 hours water supply shall be provided with a minimum terminal pressure of 12m as buildings are mostly single story and 2 storeyed.

E. Design Period for different elements of Water Supply system:

122. Based on the recommendations in the CPHEEO Manual on water supply, following design periods have been adopted for different components of water supply system:

(i)	Water Treatment Plant	15 years
(ii)	Canal Outlet	30 years
(iii)	Raw and Clear Water main pipe lines	30 years
(iv)	Distribution system	30 years
(v)	Clear water ground/over-head tanks	15 years
(vi)	Pump house buildings	30 years
(vii)	Pumping equipment (E&M)	15 years

123. As per manual on water supply, the design period for pump house buildings is normally 30 years. In the present case, construction of treatment plant is being proposed in two units, one for the present and one of same capacity at the end of 15 years. The future WTP will be complete with RWPS, CWR and CWPS. Accordingly, it is proposed that RWPS, CWR and CWPS in phase I will be constructed for the flows required for 2026, which can be upgraded for the flows required for 2041 by just change of Electro-Mechanical equipment. The distribution system and pumping main shall be designed to cater water demand of 30 years. These pipes will be laid through congested and city roads where laying pipelines again after 15 years is difficult, as such design period of 30 years has been adopted.

F. Water Quality Standards

124. The water quality standards specified in the CPHEEO Manual on water supply for Physical, chemical and Bacteriological quality will be followed. As recommended in the manual Filtration with disinfection will be proposed as the new source of water is proposed to be canal water. Water quality standards given in the CPHEEO manual are given at **Appendix 4**.

G. Power Supply

125. It is proposed to take power supply for the main raw and clear water pumping stations on 33 KV directly from the 132 KV GSS. In view of this it is assumed that power will generally be available on continuous basis (24 hours). However to account for system breakdowns and have some margin for reliability, the raw water pumping and clear water pumping in the trunk main is assumed as 23 hours daily.

9. PLANNING FOR WATER SUPPLY SYSTEM

A. Water Supply Analysis

126. Water supply to Panipat town is presently based totally on ground water. PWD (WSSD) through its 115 tube wells in municipal area and 39 tube wells in area outside municipal limits but within urban agglomerate and HUDA through its 41 tube wells in sectors provide water supply to all domestic and commercial consumers. Industries and many private individuals have large number of private tube wells to meet their water requirement. There is no survey data available to allow assess the actual number of such private tube wells in the town. Details of drilling data and well assembly data of departmental tube wells as provided by Executive Engineer, PHED Panipat are placed at **Appendix 1-D**.

127. Central Ground Water Board has carried out detailed study of the ground water status in Haryana state. According to this report Panipat district has very good ground water potential. The area is occupied by quaternary alluvium-sand, silt, kankar and gravel which constitute potential water bearing zones. Physio-graphically, the district is characterized by two distinct features, the upland plain and the flood plain of river Yamuna. The depth to water table varies from 2 m to 33 m. The water table depth is shallow in the southwestern parts of the district and in the flood plain areas of river Yamuna. Deeper water table condition occurs in northern, eastern, central and southern area, where, in general, depth to water table is in between 10 m to 20 m. The water table has declined during the past decades all over the district. When compared with the 10 years depth to water table average (May 93 – May 2003), the water table has declined by 0 – 2 m all over the district.

128. In alluvium, potential fresh water aquifer zones exist down to 460 m depth. Shallow tube wells tapping aquifer zones within 20 m to 40 m depth yield 500 LPM to 900 LPM for moderate draw down. A number of cavity wells also exist in the district. Detailed test drilling has established occurrence of three distinct aquifer groups down to 450 m depth in Upper Yamuna basin which largely includes Panipat District.

129. Aquifer group-I, which occurs under unconfined conditions, extends from water table to 50 m – 150 m depth. Tube wells tapping this aquifer group yield 2100 LPM to 2660 LPM for 5 m to 6 m of drawdown. Transmissivity (T) values of 1850 m2/day and 1950 m2/day, Lateral Hydraulic Conductivity (k) values of 17 m/day and 40 m/day and Specific Yield (SY) values of 7 percent and 24 percent characteristics of this aquifer group-I.

130. Aquifer group-II occurs under semi-confined / confined conditions and in the depth range of 160 m to 250 m. A test well located at Chhajpur tapping this aquifer group in the depth range of 163 m to 252 m yielded 1,740 LPM for about 15 m of drawdown. The aquifer characteristics determined are given in **Table 9-1**

Table 9-1 : Aquifer Group II Properties

S. No	Aquifer Properties	Value
1	Tranmissivity (T)	350 m2/day
2	Permeability (K)	3.95 m/day
3	Storativity (S)	1.0×10^{-3}
4	Vertical Hydraulic Conductivity	3.10×10^{-3} m/day

Source: Groundwater Cell, Agricultural Department, GoH

131. Aquifer group-III occurs in the depth range of 286 m to 366 m at Dadlana site and is under confined conditions. A test well tapping this aquifer group yielded 600 LPM for about 20 m of drawdown Aquifer characteristics determined are given in **Table 9-2**

Table 9-2: Aquifer Group III Properties

S. No	Aquifer Properties	Value
1	Transmissivity (T)	390 m2/day
2	Permeability (K)	4.90 m/day

Source: Groundwater Cell, Agricultural Department, GoH

132. The flood plains of river Yamuna are underlain by highly potential freshwater un-confined aquifer group down to 150 m depth. It is, further, underlain by fresh water semi-confined and confined aquifer groups down to 450 m depth. It is considered feasible to dewater and refill the unconfined aquifer group underlying the Yamuna flood plain. Keeping in view that large quantity of surface water flows out of the district through river Yamuna, recharging the dewatered flood plain aquifer system can be attempted. However, it requires enormous efforts in land acquisition for artificial recharge and enforcement of proper water management and is likely to be operationally expensive on account of 19 km distance and lift involved.

133. The status of ground water recharge and withdrawal in Haryana state, district wise is given in the table placed at **Appendix 5**. The status of ground water in different blocks of Panipat district is given in the **Table 9-3**.

Table 9-3 : Status of ground water development in Panipat District

District/ Assessment Unit	Stage of Ground Water Development	Is there a significant decline of pre-monsoon water table levels	Is there a significant decline of post-monsoon water table levels	Categorization for future ground water development
	(%)	*(Yes/No)*	*(Yes/ No)*	*safe/ semi-critical/ critical / over-exploited*
Bapoli	186	Yes	Yes	Over-Exploited
Israna	160	Yes	Yes	Over-Exploited
Madlauda	128	Yes	Yes	Over-Exploited
Panipat	137	Yes	Yes	Over-Exploited
Samalkha	181	Yes	Yes	Over-Exploited

Total	**156**	**Yes**	**Yes-**	Over-Exploited

Source: Groundwater Cell, Agricultural Department, GoH

134. The following graph shows the fluctuation of water level from June 1974 to June 2007 in different blocks of Panipat district as recorded by the ground water cell of the state Agricultural Department. Detailed block wise water level data is presented in **Table 9-4**.

Figure 9-1: Fluctuations in Groundwater Level (1974-2007) in Panipat District

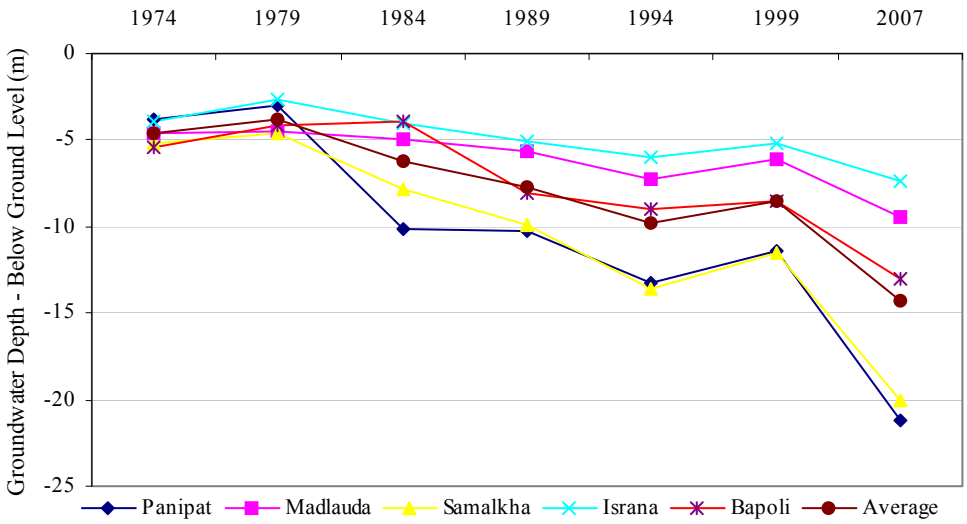


Table 9-4 : Fluctuations in Groundwater Level (1974-2007) in Panipat District

Year	**Panipat**		**Madlauda**		**Samalkha**		**Israna**		**Bapoli**		**Average**	
	Level	*fluct*	*Level*	*fluct*	*Level*	*Fluct*	*Level*	*fluct*	*Level*	*fluct*	*Level*	*fluct*
	M											
June 1974	3.81	-	4.57	-	5.16	-	3.87	-	5.39	-	4.56	-
June 1979	3.04	0.77	4.45	0.12	4.66	0.50	2.64	1.23	4.14	1.25	3.79	0.77
June 1984	10.18	-6.37	4.99	-0.42	7.79	-2.63	4.04	-0.17	3.95	1.44	6.19	-1.63
June 1989	10.2	-6.39	5.59	-1.02	9.86	-4.70	5.08	-1.21	8.02	-2.63	7.75	-3.19
June 1994	13.29	-9.48	7.25	-2.68	13.55	-8.39	6.04	-2.17	9.03	-3.64	9.83	-5.27
June 1999	11.35	-7.54	6.09	-1.52	11.49	-6.33	5.19	-1.32	8.53	-3.14	8.53	-3.97
June 2007	21.2	-17.39	9.49	-4.92	20.09	-14.93	7.43	-3.56	13.01	-7.62	14.24	-9.68
Avg fluct/yr	-	-0.52	-	-0.15	-	-0.45	-	0.11	-	-0.23	0	-0.29

Avg fluct/yr – Average yearly fluctuation in water level between 1974-2007; fluct – fluctuation in groundwater level considering 1974 as base year; negative (-) sign indicates decline

Source: Groundwater Cell, Agricultural Department, Government of Haryana

135. It is evident from the table above that there is an average depletion in ground water table of 9.68m for the Panipat district as a whole and 17.39m for Panipat block during the period under reference. The situation of ground water depletion is still worse in and around Panipat town. The table also reveals that during the period 1999 to 2007, drop in water table in Panipat block on an average is 9.85m. The PWD (WSSD), which operates more than 150 tube wells in and around Panipat town has reported a drop of more than 5m in water table and deterioration in water quality during last 5 years. It has also been reported by the department that rate of failure of tube wells and reduction in their

discharge is becoming alarming. A statement showing results of water quality analysis of various tube wells from time to time is placed at **Appendix 6.**

136. Central Ground Water Board, which has been appointed as designated authority for regulation of ground water by the Hon'ble Supreme court, has recommended to the Chief Secretary, GOH that "In order to preserve and protect the ground water resources from further depletion, it is considered necessary to regulate the indiscriminate construction of bore-wells and over development of ground water in "Bapoli, Isarna, Madlauda and Panipat Blocks of Panipat district" vide letter dated 5th March 2007. This letter has been issued in terms of mandate given to CGWA constituted by GOI under section 3(3) of the Environment (Protection) Act 1986. This is based on the assessment made by CGWB that the above blocks have become over exploited.

B. Water Source Selection

137. The above discussion reveals that the ground water status in and around Panipat town is over exploited and in critical stage. There is little control on ground water exploitation. The present rate of over exploitation is likely to result in permanent damage to the aquifer. It is also evident that ground water use for drinking purposes cannot be relied upon on long term basis without effective and substantial recharge of ground water. The rate of failure of existing tube wells and reduction in their yield is resulting in continuous requirement of additional annual investment in construction of new tube wells and keeping the operational and supervising staff in a panic state. In addition to this there is deterioration in ground water quality also on account of over drawl of water and also pollution due to untreated effluent from textile industries. The untreated industrial effluent normally flows in open drains/nallas percolating into ground and at times some industries pump the effluent directly into ground through abandoned bore wells. It would therefore be appropriate to reduce dependence on ground water for drinking water requirement gradually and switch over to some alternative source.

138. There are following two alternative sources available for water supply: (i) Yamuna river flowing 19 km from Panipat; and (ii) Delhi Carrier Link Channel Canal (Also popularly called WJC Canal) passing through the town Panipat along with the 'Delhi parallel Canal'. The feasibility of these two sources is discussed below:

1. Yamuna River

139. Yamuna River passes from a point which is about 19 km from Panipat towards Haridwar. This is the only river which passes through Panipat district. The flow into the river during rainy season is substantial which recharges the banks. However, Panipat drain, which carries sullage water, effluent from the Sewage Treatment Plants and

other waste water including industrial waste ultimately discharges into Yamuna River.

140. The banks of River Yamuna have very good ground water potential and provides an opportunity to meet drinking water requirement of Panipat town on sustainable basis looking to the average flood discharge passing by constructing a battery of tube wells on the river bank. However, bringing water from Yamuna River will involve pumping of water through additional pumping head (bed level of Yamuna River near Saloni-Karana bridge is 226m and general ground level in Panipat town is 237m). This is on account of static lift as well as frictional losses in pumping main of approximately 19 km in length.

141. Comparison of these two alternatives in terms of initial investment and yearly energy cost are worked out and presented in **Appendix 7A & 7B**. In case of Yamuna River source, the capital cost will increase by Rs 52.75 crore. The pumping head of water from River Yamuna to CWPS will be 27.7 meters but the pumping head for Canal option from RWPS sump to CWPS will be average 7 m as such energy cost in case of water from Yamuna River will increase by Rs 0.864 million per year.

142. The other disadvantages are with regard to threat to battery of tube wells during floods, non availability of water from the well field during flood period due to approach problem and creating a new operational point which will be 19 km away which will require additional logistics and man power.

2. Delhi Carrier Link Channel

143. Delhi Carrier Link Channel and Delhi Parallel canal are passing through the town. They take off from the Munakh head regulator. Water comes at Munakh head through two canals namely WJC canal and Munakh canal. From this regulator, in addition to 'Delhi Carrier Link Channel' and 'Delhi parallel canal', two more canals take off. They are Hansi Branch (7,000 cusecs) and Gohana distributary (321 cusecs).

The capacity of Delhi Carrier Link Channel is reported to be 2,823 cusecs with a slope of 0.20 percent and Delhi Parallel Branch with a capacity of 5,545 cusecs and a slope of 0.20 percent. These two canals again meet at Khubdu head regulator. From this regulator two canals takeoff namely 'Delhi Parallel Branch' and JLN Canal.

144. The Delhi Parallel Branch is a dedicated canal to supply raw water to NCT of Delhi. However, the Link channel provides for the requirement of JLN Canal and also requirement of raw water of NCT of Delhi during maintenance of 'Delhi parallel branch'.

145. The water requirement of Panipat Town for the projected population for 2041 works out to be around 100 cusecs. This requirement of raw water can be met out of the present flows through the Link canal. As the canal is passing through the town, it would be desirable to make use of the available resource. The quality of raw water of the canals is fairly good. It was informed that water quality is generally good except during the rainy season.

146. Raw water received through the 'Delhi Parallel Branch' is treated at 'Hyderpur Water Treatment Plant' in NCT of Delhi. The plant was visited and it was informed by the local Chemist that turbidity of raw water is normally very low and limited to 50NTU. The maximum turbidity is observed during rainy season which goes up to 6000NTU for one or two days in a year. The turbidity level is between 300 and 500 NTU for about 3 to 4 months period during a year. **Appendix 8** gives Raw Water quality at Hyderpur. As regards availability of water in the canal, it was informed that water in the canal is available round the year on 24x7 basis. They have made no provision for raw water storage on this account.

147. JLN Canal, which takes off from Khubdu head is also source of drinking water supply scheme for Rohtak town. This scheme was also visited and it was reported that turbidity level here is also similar to those reported at Hyderpur plant of NCT Delhi. However, regarding availability of water in the canal, it was informed that the canal runs in rotation and accordingly they have provided for raw water storage tanks for a requirement of 8 days. They have taken additional outlet from a nearby canal to meet with any exigency of non availability of water in JLN Canal.

148. Looking to above background it is evident that good quality raw water in adequate quantity is available in the Delhi Link Channel and Delhi parallel branch canals, which pass through the town. Looking to the proximity of the canals to the town, quality and quantity of raw water availability and dependability of canal flows, this looks to be a good feasible source for supply of water to Panipat town. It may be pointed out that HUDA is already executing a project to supply canal raw water to industries in HUDA area by laying a pipe line from the above canal.

3. Final Selection

149. In view of above discussion, it is evident that taking Delhi Link Channel canal as a source of raw water for Panipat Water Supply system will be desirable on following grounds amongst others:

(i) The dependability of local ground water has greatly reduced and it has come under over exploited zone.

(ii) The quality of ground water is deteriorating continuously making it unfit for human consumption in many areas.

(iii) The availability of raw water in the Link channel and in Delhi parallel canal all the year round on 24x7 basis is ensured.

(iv) The quality of raw water in the canal is good and treatable. This canal water is

already a source for many towns and villages including NCT of Delhi.

(v) The canals are passing through Panipat town only, thus pumping from long distance is not involved. The canals are located above the ground level, thereby facilitating lower pumping head and also reducing chances of any external pollution.

(vi) This is an economical solution than bringing water from Yamuna river as it involves pumping through a much lower head and O&M requirement including logistics requirements will be much less.

(vii) There is a strong public demand for providing drinking water from the canal. Honorable Chief Minister of Haryana has therefore announced in a public meeting his commitment to provide treated canal water to Panipat town on 20th January 2008 (a copy of announcement placed at **Appendix 9**).

150. It would however, require formal approval from the Irrigation Department for allocation of required quantity of water including sanction of outlet of required size. It would be desirable that canal out let is provided from each of the two canals so that water is available round the year even during closure of one of the canals for repairs or otherwise. The above issues were discussed with the Executive Engineer, Irrigation Department, Panipat wherein he informed that required quantity of water can be provided subject to approval by the government. He also informed that work of construction of outlets will be executed by his department on deposition of required amount by the PWD (WSSD). He also informed that crossing of canal by pipe line will also require permission of Irrigation department and the work in the canal portion will be executed by Irrigation Department at the cost of requesting department. Executive Engineer PWD (WSSD) has requested the EE Irrigation department, Panipat vide his letter no.29143 dated December 31, 2008 (copy placed at **Appendix 10** for allocation of water and sanction of outlet from the canals. Senior Town Planner has recommended to the Director Country and Town planning for permission for selected land for WTP to change land use (**Appendix 11).**

C. Preparation of Base Map for Planning

151. To prepare the maps for planning Water Supply system in Panipat 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) Development Plan 2021 obtained from Town and Country Planning Department, Hayana

(iii) Map of Panipat Municipal Area on AutoCAD showing existing water supply pipe lines, Tube Wells and Wards, obtained from local PWD (WSS), in soft copy

(iv) Existing Sewerage Network Map and sewerage master plan maps obtained from PWD (WSS)

(v) Hard copy of maps of some discrete colonies not included in the auto CAD map and map of some outside colonies recently got surveyed by PWD (WSS), Panipat.

(vii) Sector maps of HUDA area obtained from Executive Engineer, HUDA, Panipat.

152.. The details of above maps were integrated to prepare map 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 / Chowk, Drains and outfalls, landmarks, Existing water supply network, proposed water supply pipe lines, pumping station with municipal boundary and wards, Overhead tanks, GLRs etc.

1. Topographical Survey and Soil Investigations

153. Topographical survey was undertaken for the part of areas for which survey map was not available and along proposed pumping main. These surveys have been used to develop the city map used for current proposals and further work on feasibility report and DPR. However, map developed by integration of many maps and part survey work undertaken may not be fully accurate but is fairly adequate to process present proposals. Local PWD (WSS) also provided copies of water test reports and drilling data available with them. Water quality test was also got carried out for some water samples of ground water to conform its suitability for drinking.

D. Water Supply Zones

154. There are no defined water supply Zones in Panipat town. Water is supplied from each tube well to some area which it can feed. In the old town area, water from a group of tube wells is first collected in one underground clear water reservoir and then pumped into the distribution system directly. As it is not possible to supply water to entire area in one go, the area is divided into a number of zones and water is supplied to each zone for 2 hours daily spread over from early morning to late in the evening. The distribution system thus lacks proper design. The tail end pressures are generally low and there are complaints of in-adequate supply during summers from tail end consumers. There are 3 Over Head Service Reservoirs (OHSR) in the town but they are not in service.

155. It would be appropriate to divide the town in number of zones so that water can be supplied with adequate pressure and properly monitored for the purpose of UFW, adequate supply and water quality monitoring. As a matter of standard practice, each zone will have an OHSR with storage capacity adequate to take care of variation in demand during the day and staging to ensure defined minimum terminal pressures. It would be endeavored to keep the size of each zone to accommodate a projected population of around 25000 souls (For 2026). As per CPHEEO manual on water supply the capacity of OHSR is to be designed for 15 years requirement. Accordingly, zone size is being determined taking into consideration the projected population for 2026. However, the distribution system will be designed for 30 years so that additional storage can be provided at the end of 15 years period.

156. The existing population distribution and the projected population distribution for 2026 have been studied along with visit to different areas of the town. The major considerations have been the railway lines, National high way and the higher areas in the old town portion. As per Water Supply Master Plan the master plan area has been divided in 32 Zones. **Map 9-1** shows the distribution zones proposed for Master Plan area, while **Map**

9-2 shows 18 of 32 water supply zones taken up for this DPR preparation.

157. *ZONE – 1***.** This ZONE will be located between Asandh Road, Jatal Road, Delhi Parallel Canal and the road connecting Asandh road and Jatal road along Guru Teg Bahadur Park, Irrigation Office and Kamalia Bhawan Old & New. The zone comprises of Ward-31 and part of Ward-29 and mainly covers Friends Colony, Guru Teg Bahadur Park, Irrigation Office, New Krishna Nagar, Sawan Park, New Model town, Anand Nagar, Factory area, Rajput Colony, Virat Nagar, Latif Garden, Agrasain colony, Kartar Shah Nagar, Shanti Nagar etc.

158. *ZONE – 2***.** This ZONE has Delhi-Chandigarh railway line on its eastern side, Jatal Road on south side, Asandh Road on north side and road connecting Asandh road and Jatal road along Guru Teg Bahadur Park, Irrigation Office and Kamalia Bhawan Old & New (Zone 1 boundary) on western side. The zone comprises of Ward no.-30 and parts of Ward nos.-3&29 and mainly covers Model town, Hero Park, Sadanand Park, Tegore Park, Gandhi Colony, Shivaji Stadium area, Shakuntala Mandir area, Government Girls High School etc.

159. *ZONE – 3***.**This ZONE has Jind railway line on northern side, Delhi-Chandigarh railway line on eastern side, Pachranga Bazar road on western side and road from Bunkar Kendra joining Asandh Road on southern side. The zone comprises of Ward no.-2 and part of Ward no.3 and mainly comprises of Bagh colony, Government Blind Institute, Yodhog Vihar, Hotel Management Institute, Narayan Farm, Head Post Office, Sima cinema, Adarsha nagar, Railway Colony, Virvar Colony, New Khadi colony, BSNL Colony, Fire Station Court complex, Business center, Zila Samaj kalian office, Factory area etc.

160. *ZONE – 4***.** This ZONE has Jind railway line on northern side, Refinery bypass road on western side and Asandh Road on southern side. On the eastern side it has road starting from Bunkar Kendra on Asandh Road and joining Jind railway line along Lonod state road. The zone comprises of Ward no.-1 and mainly comprises of Gaurav chowk, Batra Colony, Factory area, Janak Garden, Purewal Colony, Basant Nagar, Diwan Garden, Canal Camp, Forest office, Aryan agar, Baba Bharti Mandir area, Sewing Center, Kishore garden etc.

161.. *ZONE – 5***.** This ZONE has Delhi-Chandigarh railway line up to HAFED on its eastern side and Jatal road on its northern side. It has Delhi parallel canal on its west side and NFL factory on its south side. The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Shakti Nagar, 8 Marla pulli, Nand Colony, Satkar Nagar, R.K.Puram, Saini Pura, Hari singh Factory, Mukhija Nagar, Bansi Colony, Kranti Nagar, Navyug High School, Azad nagar, Sanjay colony, Raj nagar, Sugar Mill etc.

162. *ZONE – 6***.** The Zone has Panipat – Jind railway line on its south, Delhi – Chandigarh railway line in east, Delhi parallel canal on west and Kabdi village on its north side. The ZONE comprises of Sectors 35 & 35A and mainly comprises of Hari nagar, Saini Colony, Shiv Shakti Colony, Kabdi Fatak area, Kaccha Fatak area etc.

163. *ZONE – 7*. The Zone has Barsat Road on its north, Nala on its south, GT road on its west and road leading from Devi Mandir to Bhawana Clinic to Barsat road on its east side. The ZONE comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Tehsil Camp area, Ram Nagar, Patel Nagar, Prakash Nagar, Nehru Nagar, Subhash colony, Green park, Sudheer nagar, Vishnu colony, Rajan Park etc. and parts of villages Bichhpadi and Noorwala.

164. *ZONE – 8*. This ZONE has Delhi-Chandigarh railway line on its western side, Nala and Mini Secretriat on northern side, Jatal road on south side and GT road on eastern side. It joins Jatal road and GT road on Sanjay Crossing. The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Prahlad Nagar, Geeta Colony & New Geeta colony, Devil al shopping Complex, Agrawal Mandi, Mahaveer Nagar, Paliwal Nagar, Railway Staff Colony, Arya college, PWD Rest house, Labour Court office, Bishan Swarup colony(Old & New), Mal godown road, Railway Station road, bank Colony etc.

165. *ZONE – 9***.** This ZONE has Nala from Ibrahim Lodhi tomb to Devi mandir to Agrasain hospital on its north side, has west side starting from Ibrahim Lodhi Tomb on Tehseel road to Salar ganj Gate to Inshar chowk to Amar bhawan Chowk to Sethi chowk to Sanauli Road in front of Gangapuri road start, has Sanauli road up to Bhim Guda chowk on south side and has road from Bhim Guda Chowk to Arjun halwai chowk to Master Somnath Rana ki Baithak to Kalu Tudi to Kallundhar Chowk to Veer Bhawan Chungi to Kaptan Nagar and up to Old Housing Board colony on east side. The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Veerji Patang wali Gali, Khara Pani (Wardno.7), Kumhar Mohalla, Valmiki Basti (Ward no.8), Lal Masjid (Ward no.8), Rajputana Mohalla, Quilla area, Ram lila ground, Power House, Library, Club, Devi Murthi Colony, MIG Colony, jain Mohalla, Mahajan Mohalla, Dev Nagar, Kaystha Mohalla, Mai ji ki colony, Old HB colony, Roshan mahal, Gul mandi bazaar, Ram mandir area, Unchi Gali, Khail bazaar, Gyan Halwai hatta, Bajaj Bazar, Water Works Office etc.

166. *ZONE – 10***.** This ZONE has Sanoli Road on south side, Nala on north and east side and boundary of Zone 9 on its west side.The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Kaptan Nagar, Bhima Guda, Raj Colony, Chandni Bagh, Rajiv Colony, Kumhar basti, New Jaganath Vihar, Chawla Colony, saini Colony, Saini Mohalla, Mohar Singh chowk, Mahaveer Mandir, Mastana Chowk, raj Colony etc.

167. *ZONE – 11*. This ZONE has GT Road (Bus stand to Sanjay Crossing) on western side, Nala on the north side, Sanauli road on the south and has east side starting from Ibrahim Lodhi Tomb on Tehseel road to Salar ganj Gate to Inshar chowk to Amar bhawan Chowk to Sethi chowk to Sanauli Road in front of Gangapuri road start. The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Veternary Hospital, Sarver Mohalla, Pachranga Bazaar, Palika Bazar, Kachahari Road, Kotla, Inshar bazaar, Balmiki basti, Prem mandir road, Old Hospital road, Ravidas road, Ram mandir gali, Sukhdev Nagar, New Sukhdev Nagar etc.

168. *ZONE – 12*. This ZONE has GT Road on west side, Sanoli Road on northern side, and Nala on its south and Zonal boundary of Zone 10 on its east side. The zone comprises of

Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Vegetable & Fruit Market, Adarsh nagar, Rishi Colony, Kataria Nagar, New Kataria Nagar, Swastik Road Colony, Deha Basti etc.

169. *ZONE – 13***.** This ZONE has Delhi-Chandigarh railway line on its western side, Jatal road on northern side, GT road on eastern side (from Sanjay crossing to Gohana road) and extends up to Gohana road near Vishwakarma mandir and Khanna road (near Agrasen Colony) ending at Kachhi Phatak railway crossing on southern side. The zone comprises of Ward nos.-25&26 and part of Ward no.-27 and mainly comprises of Balmiki Basti, Ramlila ground, Kumhar Mohalla, Shastri Colony, Khatik basti, Ravidas nagar, Jagjivan ram colony, Koli colony, Agrawal mandir, Kishan pura, Durga mandir, Sanjay park etc.

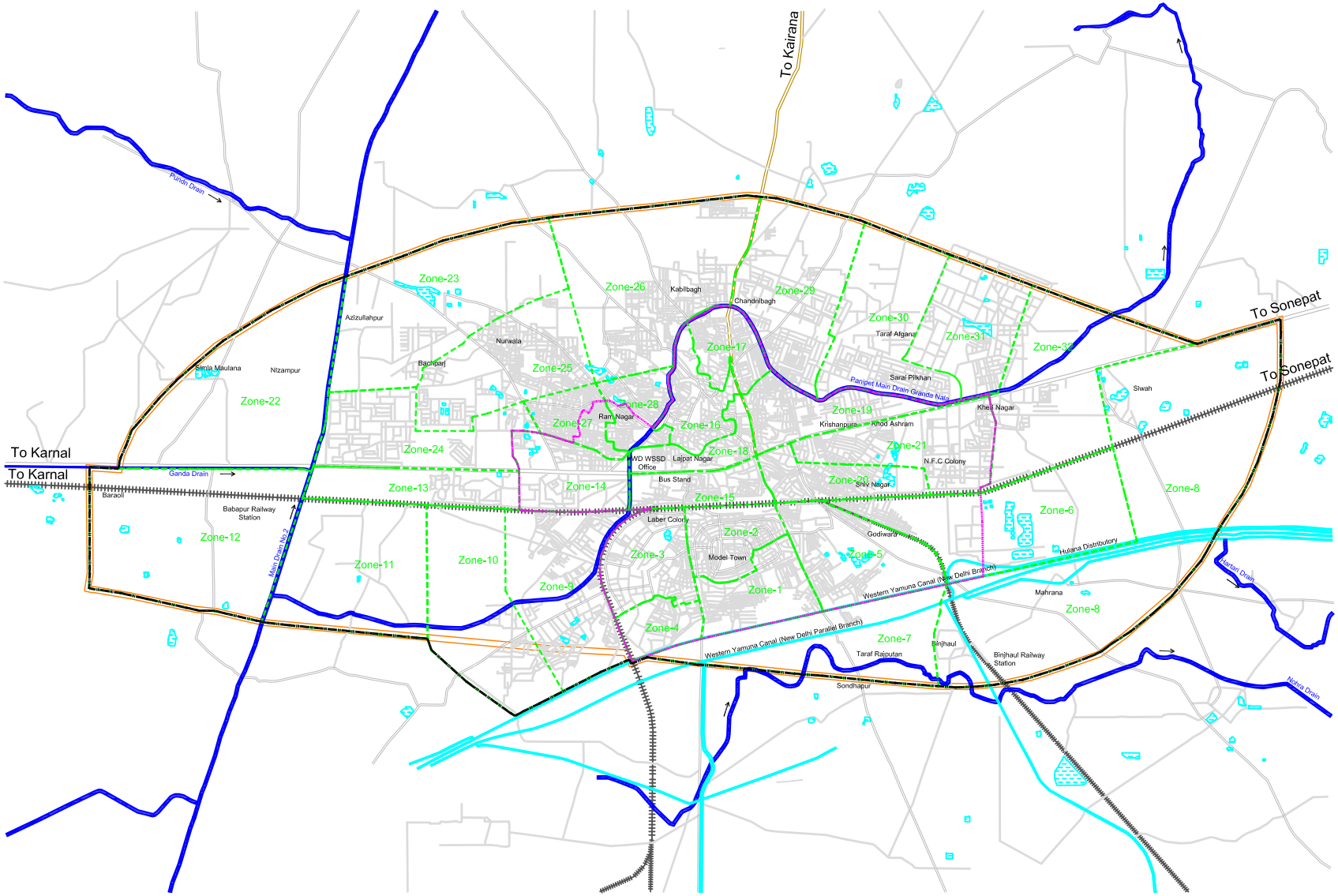
170. *ZONE – 14***.** This Zone has Gohana Road on its north, Khanna road on North-West, GT road on east, Delhi Railway line on west and outer limit of Khedli Nangal village and Vikas Nagar on its south side.The zone comprises of Shiv Nagar, Khadi Ashram, Krishna Nagar, Gandhi Mandir, Ganpati colony, ITI, New Grain Mandi, Khedi Nangal Village and Vikas Nagar but excludes NFL Township.

171. *ZONE – 15***.** This Zone has outer Nala on its north, GT road on west, Barsat road on south and Bichpudi village on the east. The zone comprises of comprises of Sectors 13, 18 and 17 and some colonies of Bichhpudi village.

172. *ZONE – 16***.** This Zone has boundary of Zone 17 on its north-west, Nala on West, Babel village on east, and Sanauli road on its south side.The zone comprises of Baljit nagar, Dhup singh nagar, Bharat nagar, Hari colony, Manmohan Nagar, The vihar, Dalveer nagar, Dabar Colony, Ashok vihar colony, Mahadeev Colony, Pahalwan chowk and part of Noorwala village.

173. *ZONE – 17***.** This Zone has Devi mandir - Barsat Road 33 ft. road on its west, Barsat road on north, Nala on south and boundary of Zone 16 on its west side.The zone comprises of Noorwala village, Parshuram chowk, Vjay nagar, Noorwala colony, Moti colony, Geeta Colony, Jasbeer ColonyDeshraj Colony, Dinanath Colony, Ramesh colony, Vadhawa Ram Colony, Nagpal Colony etc.

174. *Zone -18***.** The Zone has Nala on its west and north side touching GT road on west side and Sanouli road on north side. It has sector road between sector 24 and 26 on its east side running through south side.The Zone comprises of Sectors 11, 12, 24 and Part IIA of sector 25 outside municipal area beyond Nala.



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Water Supply Zones in Panipat Master Plan Ares (32 Nos)

Legend

- Study Area Boundary
- Municpal Boundary
- Proposed Road
- National Highway
- State Highway
- Major Roads
- Other Roads
- Railway Line
- Canal
- Drain
- Ponds and Lakes

Overlay Legend

- Zone Boundary
- Zone-16 Zone Number

Client

Asian Development Bank
National Capital Region Planning Board

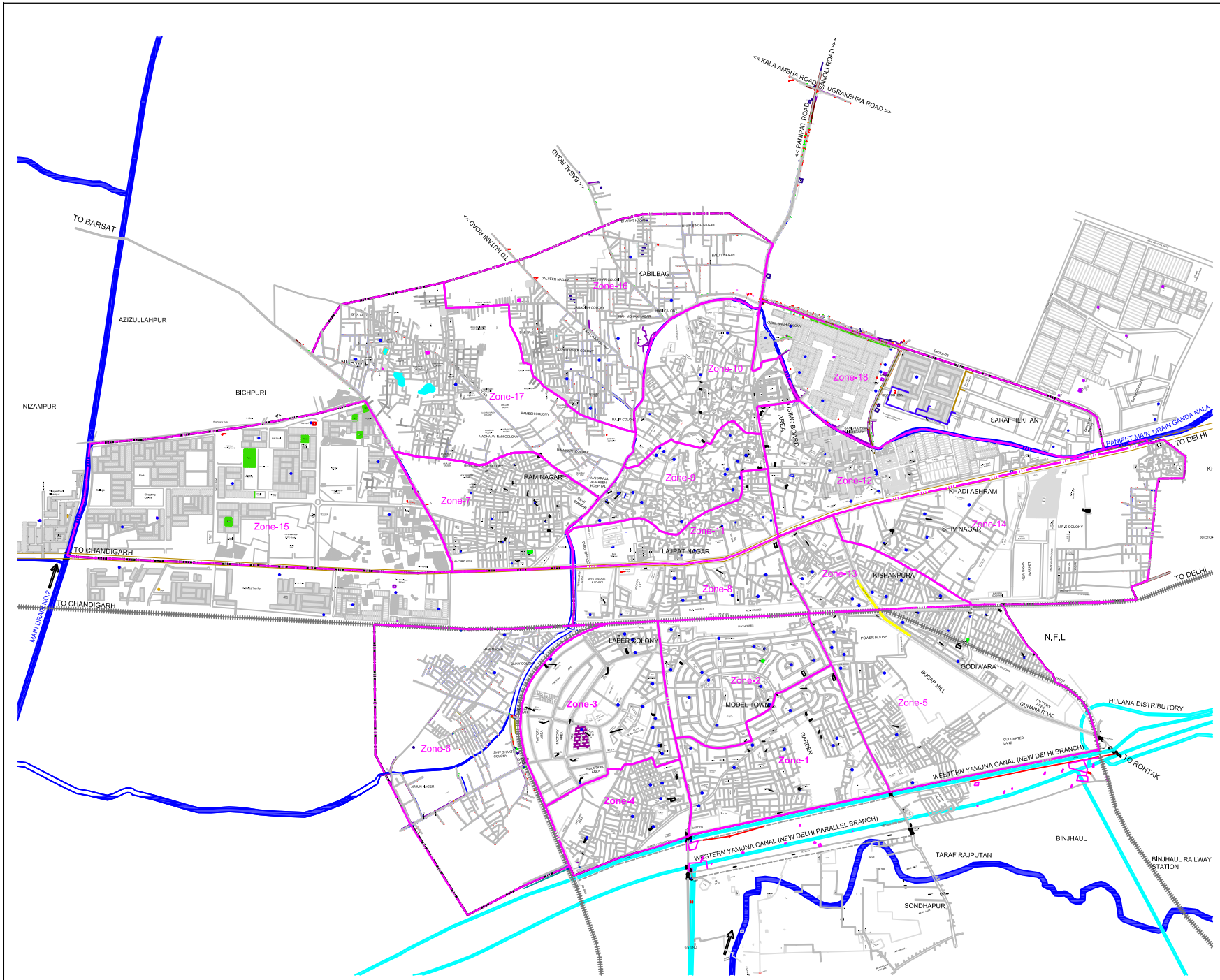
Consultant

Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date: April 2010	Approved: NSS

Scale: -400 0 400 800 1200 1600 Metres

Map 9-1



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Water Supply Zones in (18 Nos) for DPR Preparation

Legend

- DPR Project Boundary
- National Highway
- Other Roads
- Railway Line
- Canal
- Drain
- Hand Pump
- Culvert
- Manhole
- Transformer
- Electricpole
- Lamppost
- Telephonepole
- GPS
- TBM
- Tree
- OFC
- Ditch
- Building
- Tube Well

Overlay Legend

- Zone Boundary
- Zone-14 — Zone Number

Client
Aslan Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates

Drawn: SK | Checked: NSS
Date: April 2010 | Approved: NSS

Scale: 0 400 800 1200 1600 Meters

Map 9-2

E. Water Demand Forecast

175. As per Regional Plan 2021 of NCRPB, the rate of water supply (liters per capita in the NCR area is to be taken as follows:

(i) Urban
- NCT Delhi: 225 lpcd
- Towns (Population 1 lakh and above): 200 lpcd
- Town (Population below 1 lakh): 135 lpcd

(ii) Rural
- Spot source 70 lpcd
- Pipe supply 100 lpcd

(iii) Unaccounted for Water (UFW) should be reduced to 15 percent.

176. Panipat town comes under the category of towns with population more than 1 lakh and according as per above norms, the rate of water supply comes to 200 lpcd.

177. As per Manual of Water supply issued by CPHEEO, rate of water supply for all towns having sewerage system shall be 135 lpcd exclusive of UFW. It has been envisaged in the manual that losses in the distribution system should be limited to 15 percent. The manual also provides that the above requirement shall include demand of water of routine industries, commercial establishments and other institutions. However, the manual specifies that in case water demand of major industries, hospitals, institutions, fire fighting etc. is substantial, the same shall be taken separately.

178. In case of Panipat town, the canal is flowing through the town (Canal network of Haryana is shown in **Appendix 12**) and water requirement of industries is being taken care of by a separate raw water pipe line being executed by HUDA. There are no major Hospitals or other institutions having substantial water requirement. Executive Engineer PWD (WSSD), Panipat has informed that he has not received any such request for future planning also. Thus we may not take any separate provision for major industries, hospitals and institutions. Even if any such demand is created in future, the same can be met from ground water or canal water. The requirement of water for firefighting is highly intermittent and can be met from ground water and canal water.

179. It would therefore be appropriate to adopt the rate of water supply prescribed by CPHEEO i.e. 135 lpcd exclusive of 15 percent UFW. The water supply is therefore being designed for a gross demand based on 160 lpcd. However, during initial period i.e. in 2011 the UFW will continue to be around 40 percent, which is proposed to be gradually reduced to 15% percent over a period of time but latest by 2026. Accordingly water demand for 2011 is based on a UFW level of 40 percent and that for 2026 and 2041 with UFW level at 15 percent. The water demand has been calculated zone wise (**Appendix 3A & 3B**) for the years 2011, 2026 and 2041 and the total demand of Master Plan Area comprising of 32 distribution zones is given below:

(i) Water requirement for 2011 112.5 MLD

(ii) Water requirement for 2026 130 MLD

(iii) Water requirement for 2041 196 MLD

180. This is the gross water demand to be produced from the clear water pumping station. There will be losses in the Water Treatment Plant, which are 5 percent as per CPHEEO manual of water supply. This puts the total requirement of raw water from the canal at 206 MLD (85 Cusecs) for the design year 2041. As stated earlier, PWD (WSSD) has requested the Irrigation Department, Panipat for allocation of 100 cusecs of water for Panipat water supply.

181. As mentioned earlier, only the areas which have fully developed or have substantially developed have been considered for the Project area for present DPR. Following 18 Zones out of the total 32 zones are proposed to be taken up for detailed design of water supply system. The **Table 9-5** gives details of these selected 18 zones like population and water demand for different intermediate years (Water demand of 32 zones as per master plan are placed at **Appendix 3B**).

Table 9-5: Zone wise Population and Water Demand in different Years

Zone no.	Population			Water Demand (MLD)		
	2011	2026	2041	2011	2026	2041
1	17,000	25,532	38,360	2.72	4.09	6.14
2	17,635	25,135	35,814	2.82	4.02	5.73
3	16,679	22,673	30,884	2.67	3.63	4.94
4	17,247	20,414	24,163	2.76	3.27	3.87
5	24,059	27,290	31,046	3.85	4.37	4.97
6	11,585	22,089	32,316	1.85	3.53	5.17
7	26,570	36,608	57,853	4.25	5.86	9.26
8	13,876	19,777	28,189	2.22	3.16	4.51
9	31,361	33,609	36,309	5.02	5.38	5.81
10	35,560	37,482	39,539	5.69	6.00	6.33
11	19,113	23,091	27,764	3.06	3.69	4.44
12	20,452	25,927	34,847	3.27	4.15	5.58
13	22,039	26,417	32,550	3.53	4.23	5.21
14	17,190	28,624	54,461	2.75	4.58	8.71
15	15,847	35,750	64,084	2.54	5.72	10.25
16	21,050	26,717	43,048	3.37	4.27	6.89
17	29,043	31,670	53,007	4.65	5.07	8.48
18	12,877	30,349	46,480	2.06	4.86	7.44
TOTAL	**369,183**	**499,154**	**710,714**	**59.07**	**79.86**	**113.71**

182. The remaining population which is residing outside the project area but within the Master Plan area as scattered or at far away locations will continue to be served with TW water supply, as being practiced presently.

10. DETAILED DESIGNS

A. Overview

183. Bulk water supply normally refers to the process starting from water production (raw water abstraction and treatment), to bulk transmission and zonal reservoirs. For the design, implementation and operation and maintenance convenience, bulk water supply and distribution to consumers are separately designed and presented in the following sections.

B. Bulk Water Supply

184. For bulk water supply, turn-key approach (design, construction and operation for a specific fixed period) is suggested for implementation of bulk water supply. Bulk water supply system components include: Canal Intake, Raw Water Pumping Station (RWPS), WTP, Clear Water Pumping Station (CWPS), Pumping main pipe line and Overhead Service Reservoirs (OHSRs). Under this approach the performance requirements and suggested layout are specified. The contractor finalizes the layout and carries out the complete design and construction, supply, testing and installation including all associated civil works and mechanical and electrical works. Detailed designs have been prepared for pumping main pipeline, which the Contractor will execute the works as specified. The contractor carries out the operation and maintenance of the Pumping Stations, WTP and pipe line with OHSRs for a period of Five years after successful commissioning of the system and also imparts training to the staff before handing over the system back at the end of O&M contract period.

185. Based on the raw water characteristics and the treated water requirements and pumping requirements specified, the bidders will offer on turnkey basis the most appropriate and properly proven technology for the proposed WTP. The raw water quality will be defined in the specifications in terms of maximum for the range of parameters measured. The clarified and treated water quality requirements will be specified with reference to CPHEEO Manual on Water Supply and Treatment. These are generally consistent with WHO Standards for drinking water. Work will be defined in terms of unit processes that are required which could include pre-chlorination, alum addition, flash mixing, flocculation and clarification, filtration, disinfection and recirculation of filter backwash / clariflocculator sludge.

186. Process design criteria will be specified for minimum number of process units, acceptable hydraulic loading, chemical dosing rates etc. Successful bidder will undertake detailed design and will guarantee process performance. The loss of water in terms of sludge and backwash water will not exceed 3 per cent of the raw water to be treated. The plant shall be capable of catering to occasional hydraulic overload of 20 percent. The design of the water treatment plant will be based on 23 hrs working per day. The planning of the entire WTP premises shall be done for 100Mld of treated water output.

1. Scope of Work

187. All designs shall generally confirm to the 'Manual of Water Supply' of CHPEEO and other standard design practices. The design period adopted for the Water Supply system is 30 years for pumping main and distribution system and 15 years for pumping machinery and OHSRs. Execution period has been taken as 36 months.

188. This project, envisages drawing water from the inlet channel to be constructed by state Irrigation Department from the WJC Canal and Delhi parallel link Canal under this project. The inlet canal will terminate into the raw water sump, with pump house near sump. The Raw Water Pump House (RWPH) will have pumps (4W+2S). Water shall be pumped into Inlet Chamber of the Water Treatment Plant. The WTP of 100 MLD capacity will be a Rapid Gravity Sand Filter. The treatment plant may either have simple clarification or clarification through Tube Settlers. WTP shall have arrangement for Pre-Chlorination, Alum Dosing, flash mixing, flocculation, Clarification, filtration, Post-Chlorination, Wash Water Re-circulation and Sludge disposal systems. Treated clear water will be stored in underground reservoir adequate for 2 hour storage. A pump house will be constructed adjoining the CWR to house Pump sets (2W+1S).

189. Water shall be pumped to 18 Zonal Over Head Service Reservoirs (OHSR) through a ring pumping main pipe line (900mm to 300mm sizes). Water shall be distributed from these zonal reservoirs to the distribution networks of each zone which will be improved/ extended as per network design done. In order to reduce UFW (Un accounted For Water), service pipe line of all existing consumers will be replaced with new saddle pieces, ferrules and MDPE pipes. All consumers will be provided with water meters. Bulk water meters will be provided for each OHSR and one at the delivery pipe of CWPS to record actual water produced, distributed and billed. The whole system of water production and storage up to OHSRs is proposed to be controlled through SCADA for economy and effective monitoring of water supply.

2. General Arrangement of Components

190. The foundation of intake sump and pump house building requires careful consideration. All dead load of the structure including weight transmitted by over head traveling crane & superimposed loads are transferred to the soil on which the structure rests. The safe bearing capacity of the soil has been taken as 10 MT/ m2 at foundation level. However, actual SBC test should be carried out before undertaking design and construction. Foundation will be designed for entire structure dead load & machinery dynamic load.

191. The layout of the pump house will not only give a neat and pleasant appearance but will also result in ease of operation & maintenance. The building of the pump house will offer an attractive look which arouses public faith & confidence in the water supply scheme. The building shall be very well lighted and ventilated. The height of roof shall be sufficient to accommodate the functioning of over head crane. The door openings shall be large enough so that machinery can be taken in & out without difficulty. Loading & unloading facility directly from truck on the loading & unloading floor is provided. Door openings are located at middle of the loading & unloading bay.

192. The floor of the pump house will be properly sloped to drain off water when floors are washed or when there is water through a leaking joint inside the pump house. Care is taken to avoid water entering the electrical equipments. The cables from switch boards to motors should run in cable trays which will be covered properly. Power distribution board will be so located that unnecessary long length of cables is avoided. The entire area of the WTP/pumping stations shall be provided with adequate external electrification. A lightning arrester shall be provided at the top of the roof of pumping station. A detailed description and arrangements of various components are given in the following sections.

3. Inlet Canal

193. The inlet canal from the WJC canal and Delhi parallel Canal will terminate into the raw water sump as shown in the drawing so as to ensure a laminar flow for each pump. The inlet canal together with two outlets from the two canals will be designed and constructed by Irrigation Department of Haryana government, who owns the canals. However, the cost of construction of outlets and the Inlet Canal will be provided for in the cost estimates.

4. Raw Water Sump and Raw Water Pumping Station (RWPS)

194. The capacity of sump shall be minimum 2 minutes pumping capacity. The maximum water level will correspond to FSL of Inlet Canal and the floor level will be such that it provides required submergence for pumps for turbulence free pumping. The free board shall be minimum 500 mm from the soffit of the roof beams. One manhole frame and cover and aluminum ladder shall be provided for access into the sump.

195. Design of Raw Water Pumping Station (RWPS) and Sump is given in **Appendix D-1**[1] **and D 8** (**Volume I-B: Detailed Designs**). **Appendix D-1** gives details and works out duty conditions i.e. average pumping head of 7 m and discharge 105 MLD in 23 hours **Appendix D-2** gives specific speed for different options - Vertical Turbine Pump or Horizontal Split Casing Pump; single stage or multi stage pumping; single or more working pumps, and motor rpm of 500/1000/1500. As per American National Standard Institute New Jersey the specific speed should be 2000 to 3000 for attaining optimum efficiency. The calculations done in **Appendix D-2** give best possible specific speed of 3378.7 for vertical turbine pump at 500 rpm, 4 working and with single stage.

196. The second best option is 3 working vertical turbine pumps at 500 rpm and single stage where the specific speed is 3901.38. In market pump with duty conditions corresponding to 4 working combination is not available as such 3 working 2 stand bye, single stage at 500 rpm VT pump seems good from efficiency and minimum energy consumption criteria. However option of type of pump will be left upon contractor such that if efficiency quoted is less than his bid will be loaded by capitalized cost of extra energy consumed. **Appendix**

[1] All Appendices related to Design are compiled in a separate **Volume I-B: Detailed Designs**. All design related appendices are captioned as D-1, D-2…, where D indicates "Design". Similarly, all Estimate related appendixes are in **Volume III-D Detailed Estimates**; and are captioned as E-1, E-2.... . Specification of various items and work are provided in **Volume I-C: Detailed Specifications.**

D-3 gives suitability of design with respect to suction specific speed. **Appendix D-4** gives maximum attainable efficiency in the chosen combination of 82 to 88 percent. Considering 82 percent pump efficiency on safe side and motor efficiency of 94 percent (energy efficient motors) the combined efficiency is taken as 77 percent.

Appendix D-5 also works out capitalized cost of extra energy cost of Rs 78083 for each 1 percent drop in efficiency and it is proposed to load the bid of contractor by this much amount for quoting less efficiency per single percentage. **Appendix D-5** gives moor rating of 45 KW for each motor. **Appendix D-6** gives column pipe of 600 mm dia and 6 mm thickness. **Appendix D-8** gives crane capacity of 2000 kg.

197. The pump house will be constructed in RCC M30 (Design mix.) framed structure with brick partition wall. A loading / unloading bay of 4.0 m clear width shall be provided at one end of the pump house. This bay will also be used for maintenance purposes and accommodating store and toilet. Pumping Station shall have enough space to accommodate the pumps of required capacity to lift 105 MLD of raw water to the Inlet Chamber of WTP, motors, NRVs, BF Valves, Sluice Valves and electrical switch gear. It shall have a loading unloading bay, store and toilet. The size of the pump house shall be 14X5m overall. It shall house a manually operated crane of sufficient capacity for movement of equipments. The bottom of the raw water sump will be designed for uplift pressure. The Electric panels and capacitors shall be mounted on the pump floor. A continuous corbel shall be provided for mounting of rails for manually operated traveling crane. The sump portion or wet well of the pump house shall be designed as per the norms specified by US Hydraulic Institute Standards and CPHEEO manual. Baffle walls shall be provided between the pumps for better hydraulic performance. Delivery pipes of pumps shall be joined to a common manifold. Necessary supports, thrust blocks and end blocks shall be provided for delivery pipes, valves and manifold. The different levels of the structures shall be as follows:

FSL of Sump	236.5m RL
Bottom of Sump	233.5m RL
Invert of inlet Channel	235.5m RL

198. The raw water sump shall be hydraulically tested as per standards of water retaining structures.

5. *Clear Water Reservoir and Clear Water Pumping Station*

199. The capacity of CWR shall be equal to 2 hours output of WTP. Accordingly, CWR has been proposed with a capacity of 10000 cum capacity with 5m water column. CWR shall be in two compartments. A sump shall be provided adjoining the CWR having minimum 2 minutes pumping capacity. The maximum water level will correspond to the FSL of clear water channel/pipe of WTP and the floor level in sump will be such that it provides required submergence for pumps for turbulence free pumping. The free board shall be minimum 500 mm from the soffit of the roof beams. One manhole frame and cover and aluminum ladder shall be provided for access into the sump. Adequate ventilation and access arrangement shall be provided to each compartment of the CWR.

200. Design of Clear water pumping station is given in **Appendix D-9 to D-14**. **Appendix D-9** gives details and works out duty conditions i.e. average pumping head of 48 m and discharge 100 MLD in 23 hours. **Appendix D-10** gives specific speed for different options about vertical turbine pump or Horizontal split Casing pump, one stage or more stage pumping, one or more working pumps and motor rpm of 500/1000/1500. As per American National Standard Institute New Jersey the specific speed should be 2,000 to 3,000 for attaining optimum efficiency. The calculations done in **Appendix D-10** give best possible specific speed of 2,200.86 for vertical pump at 1000 rpm, 2 working and with single stage. The second best option is 2 working horizontal split casing pumps at 1500 rpm and single stage where the specific speed is 2,334.36. Thus we get almost equally good specific speed in vertical turbine and for horizontal split casing pumps. However option of type of pump will be left upon contractor such that if efficiency quoted is less than his bid will be loaded by capitalized cost of extra energy consumed. **Appendix D-11** gives suitability of design with respect to suction specific speed. **Appendix D-12** gives maximum attainable efficiency in the chosen combination of at least 88 percent. Considering motor efficiency of 94 percent (energy efficient motors) the combined efficiency is taken as 82.72 percent.

201. **Appendix D-12** also works out capitalized cost of extra energy cost of Rs 735,597 for each 1 percent drop in efficiency and it is proposed to load the bid of contractor by this much amount for quoting less efficiency per single percentage. **Appendix D-13** gives motor rating of 380 KW for each motor. **Appendix D-14** gives crane capacity of 5000 kg.

202. The pump house will be constructed in RCC M30 (Design mix.) framed structure with brick partition wall. A loading / unloading bay of 4.0 m clear width shall be provided at one end of the pump house. This bay will also be used for maintenance purposes and accommodating store and toilet. Pumping Station shall have enough space to accommodate the pumps of required capacity to lift 100 MLD of treated clear water to the OHSRs, motors, NRVs, BF Valves, Sluice Valves and electrical switch gear. It shall have a loading unloading bay, store and toilet. The size of the pump house shall be 14x7m overall. It shall house an EOT crane of sufficient capacity for movement of equipments. The bottom of the clear water sump will be designed for uplift pressure. The Electric panels and capacitors shall be mounted on the pump floor. A continuous corbel shall be provided for mounting of rails for manually operated traveling crane. The sump portion or wet well of the pump house shall be designed as per the norms specified by US Hydraulic Institute Standards and CPHEEO manual. Baffle walls shall be provided between the pumps for better hydraulic performance. Delivery pipes of pumps shall be joined to a common manifold. Necessary supports, thrust blocks and end blocks shall be provided for delivery pipes, valves and manifold. In case of HSC centrifugal pumps, the pump floor will be provided such that the pumps always get a positive suction. A control room shall be provided to house SCADA equipment and the operation and supervision staff. The different levels of the structures are as follows:

FSL of CW Sump	236.0m RL
Bottom of Sump	230.0m RL

6. Water Treatment Plant

203. System Planning Criteria for Water Treatment Plant: CPHEEO manual on water supply allows a loss between 3 and 5 percent during water treatment. WTP is proposed to handle 105 MLD of raw water to produce 100 MLD of treated water based on 23 hours operation. as, electricity is likely to be available for around 23 hours daily. Moreover, it will be ensured that loss of water during treatment does not exceed 3 percent of raw water pumped. Details of the quality of typical raw water samples were obtained from Hyderpur WTP at Delhi which draws raw water from the same canal around 70 km downstream and is placed at **Appendix 8**. It is observed that the turbidity ranges from 10 NTU to 400 NTU during most part of the year with a maximum of 5000 NTU in rainy season. pH varies from 6.9 to 8.0 and alkalinity varies from 60 to 400 mg/lit. The other parameters are expected to be within the recommended range of CPHEEO Standards. The water quality requirements as per CPHEEO Standards are reproduced in **Appendix 4**. Considering raw water quality data, the conventional Rapid Sand Filtration of Water Treatment Process can be adopted for Proposed WTP.

Detailed Description of the WTP Units

204. The treatment works will treat 105 MLD raw water taken from West Jamuna Canal/Delhi link parallel Canal running on either side of the proposed WTP and will deliver 100 MLD of treated water. The treatment works will comprise of following process units:

(i) Inlet Chamber
(ii) Pre-chlorination
(iii) Parshall Flume
(iv) Alum dosing
(v) Flash mixing
(vi) Distribution Chamber to Clarifiers
(vii) Flocculation and clarification,
(viii) Filtration
(ix) Disinfection using chlorination
(x) Clear water Reservoir Sludge and waste water disposal

205. *Treatment Plant Options and Land Required*. Capacity of the plant in first phase is 100 MLD and another unit of 100 MLD shall be constructed in year 2026 to meet requirement of year 2041. This DPR includes cost of one unit of 100 MLD but the land shall be taken for both phases. Here three options have been considered.

(i) Option-1 is Conventional Water Treatment plant (WTP) with rapid gravity filters with 4 Clarifies as per design criteria and norms given in Water Supply Manual of CPHEEO. Design of Option-1 is given in **Appendix D-15**. General arrangement of

various units for this option is given in **Map 10-1** and schematic sectional diagram is presented in **Error! Reference source not found.**. Land required for this option is 6.5 Hectares.

(ii) Option-2 is similar plant with 2 clarifiers. Design of Option-2 is given in **Appendix D-16**. The General arrangement for this option is given in **Map 10-4** and the land required is 4 Hectares.

(iii) Option-3 is high rate filters and tube settlers for high rate clarification. Design of Option-1 is given in **Appendix D-17**. The general arrangement for this option is given in **Map 10-5**. The land requirement is 3 hectares.

206. It is recommended to adopt third option as new proven technologies are available in India where WTPs have been constructed with high surface loading rates in filters and clarifiers. Thus contractors should be given option to use appropriate surface loadings. The limitations are that they should have constructed plants with those high rates and should be under operation for say at least 2 years. Also, the contractor who constructs this plant should run it for at least 5 years and guarantee the performance output quality and quantity on completion of plant during trial runs and also during operation. In the contract suitable penalties should be provided on failure to meet performance guarantees.

207. The high rate filters and clarifiers will need less land and civil structures will also be of lesser size that will reduce carbon foot print and as such recommended here. The land requirement in case of high rate WTP option is 3 hectare but here in DPR it is proposed to have 4 hectares to accommodate centralized training centre or office etc. The land includes provision for CWPS, RWPS, chemical storage and storage of waste water, its recirculation and thickening etc. The land also has option to provide second phase of 100 MLD Plant which is also shown in Maps in dotted lines.

208. *Limiting levels for WTP*. The schematic hydraulic flow diagram of WTP is shown in **Error! Reference source not found.**.

Table 10-1: Details of Hydraulic Levels

Units	Hydraulic Levels (m)
Top water level at raw water inlet chamber	240.10
FSL of Clear Water Reservoir	236.00
LWL of Clear Water Reservoir	232.00

209. *Inlet chamber***.** Raw water will be first received in the inlet Chamber from the Raw Water Pumping Station. The proposed size of the chamber will be 3.5x3.5x4.5m with a volume of 55 m^3 and will be constructed in RCC.

210. *Inlet Channel and Flow***.** Measurement: The inlet channel will start from the inlet chamber. The inlet channel will be constructed in R.C.C. For access, a 0.9 m wide walkway will be provided at top of the channel, along its full length. At a suitable place along the length of the channel, a Parshall flume shall be provided to measure the quantity of raw water. An

Ultrasonic type open channel flow measuring system will be provided at the flume to measure the rate of flow. The flow rate measured by this flow meter along with integrated flow will be displayed on the Annunciator panel. The flume has to be designed according to the recommendations of IS: 6063. All components of the flow meter will be of non-corrosive material.

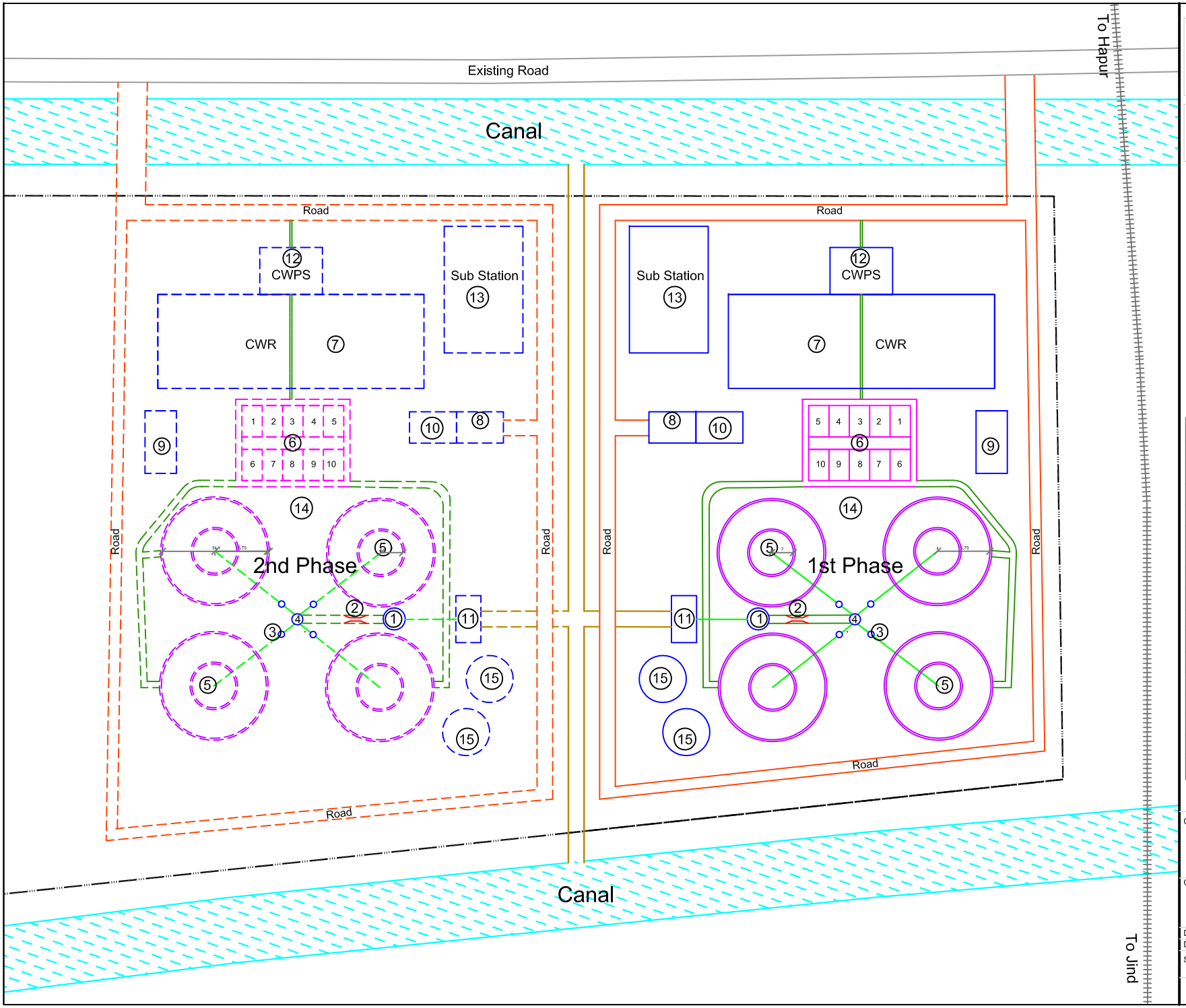
211. Parameters:

(i)	Rated Flow Capacity	: 4,350 cum/hour plus 20% overloading.
(ii)	Measuring range between	: 1000 and 7500 m^3/hr.
(iii)	Measuring accuracy between	: +/-2 %
(iv)	Free Board	: 30 cm

212. Flow measurement devices at following locations are proposed in the WTP along with their types as follows:

Table 10-2: Details of flow Meters and its locations

S. No.	Location of Flow Measurement	Type of Flow Meter
1	Raw Water Inlet	Ultrasonic open channel flow measuring system
2	Back Wash Water	Electronic Magnetic Flow Meter
3	Clear Water	Full Bore EMF meter



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Layout Plan of Conventional WTP with Four Clarifiers (Option 1)

Legend

- Existing Canal
- Existing Road
- Railway Line
- WTP Boundary
- Proposed Channel
- Proposed Road

S. No	Description	Size
1	Inlet Chamber - 1 No.	3.5m Ø
2	Pharshall Flume - 1 No.	1 No.
3	Flash Mixer - 4 Nos.	2.25m Ø
4	Distribution Chamber - 1 No	3.5m Ø
5	Clarifiers - 4 Nos	34m Ø
6	Filters - 10 Nos	10.7mx7m
7	Clear Water Reservoir - 1 No	85.0mx30.0m
8	Cholination Building	15.0mx10.0m
9	Office Building Cum Laboratory - 1 No	10.0mx20.0m
10	Alum Storage	20mx12.5m
11	Raw Water Pumping Station - 1 No.	-
12	Clear Water Pumping Station - 1 No	-
13	Electrical Substation - 1 No.	-
14	Waste Back Wash Storage Tank	2 Nos.
15	Waste Wash Tank - 1 No.	-
16	Area	6.14 Hect.

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

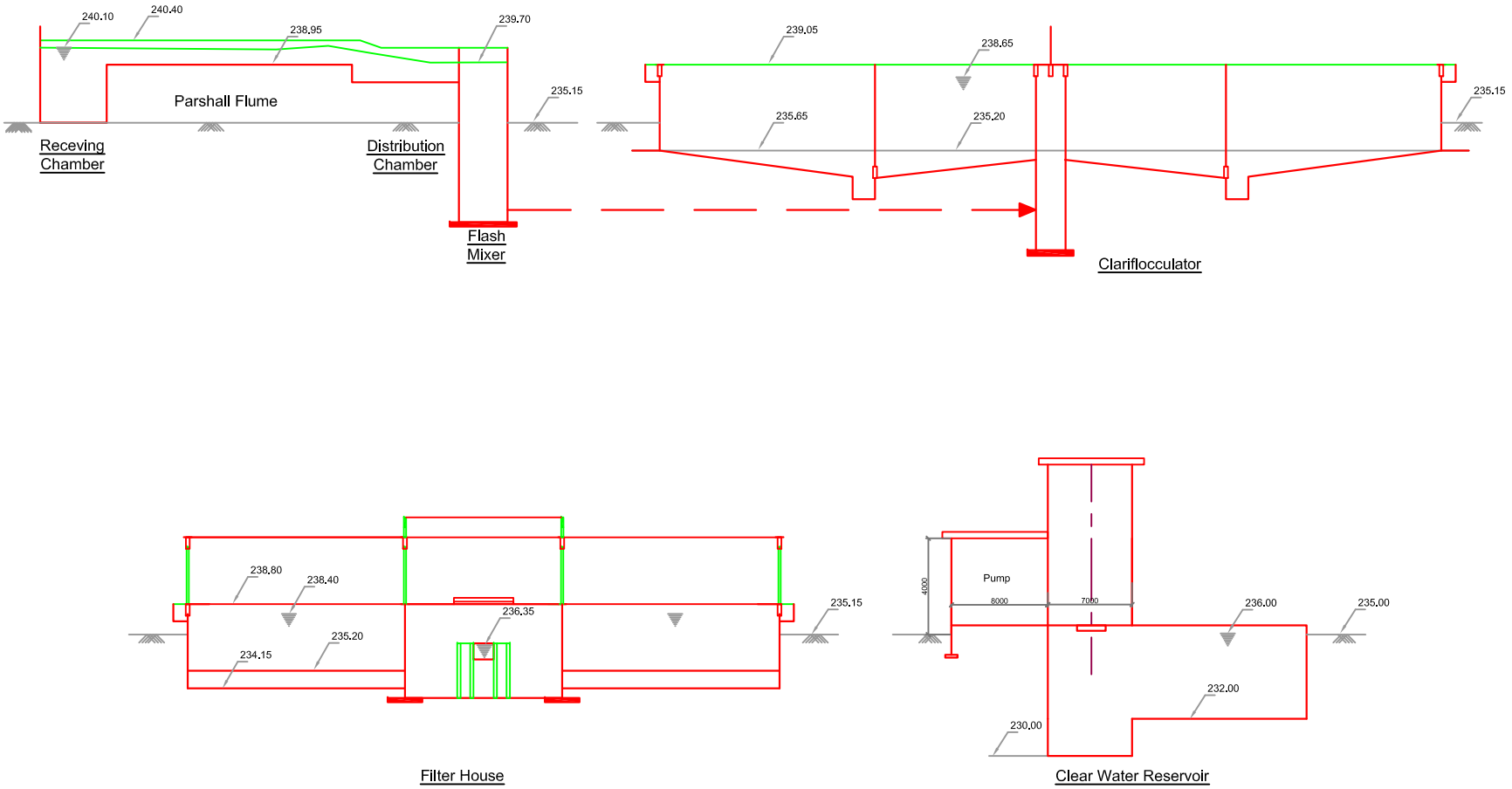
Drawn: SK | Checked: NSS
Date: April 2010 | Approved: NSS

Scale: 0 15 30 45 60 Meters

Map 10-1

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Schematic Sectional Diagram of WTP



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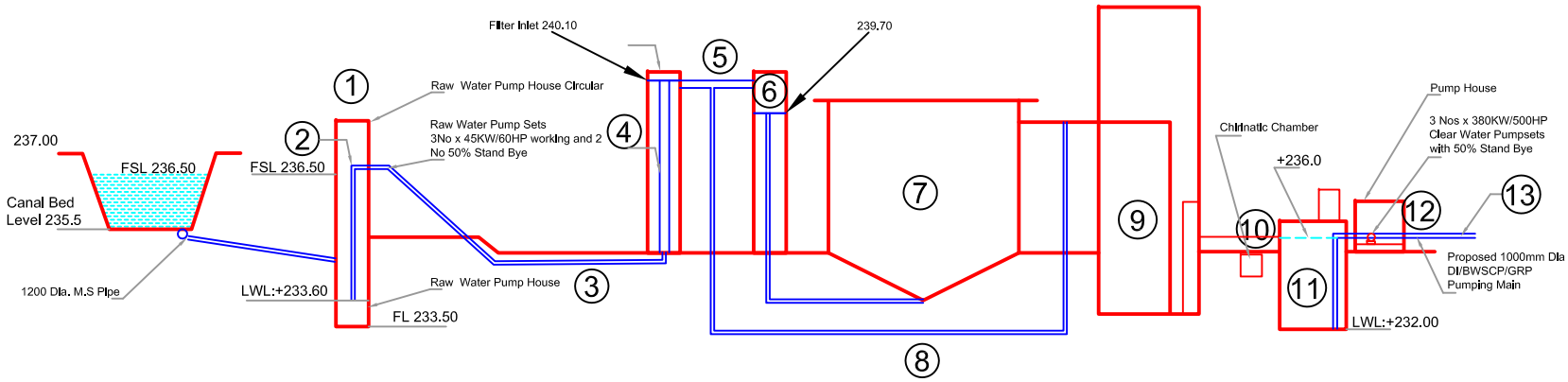
Scale: NTS	

Map 10-2

Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Hydraulic Flow Diagram of WTP (Option 1)



1. Intake Well Cum. Pump Houses
2. Raw Water Pumpsets 3 Nos.
3. Raw Water Pumping Main 800mm Dia 100m Pipe Line
4. Inlet Chamber
5. Parshalflume Channel
6. Flash Mixer 4 meters
7. Clariflocculator 4 Nos
8. Bypass Channel
9. Filter House, Chemical House, Wash Water Tank
10. Clear Water Channel with Chlorine Contaor Chamber
11. Clear Water Reservoir
12. Clear Water Pump Station with Pumpsets 3 Nos
13. Clear Water Pumping Main 1000 Dia MS/DI/BWSCP/GRP

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National Capital Region Planning Board

Consultant:
WIlbur Smlth Assoclates

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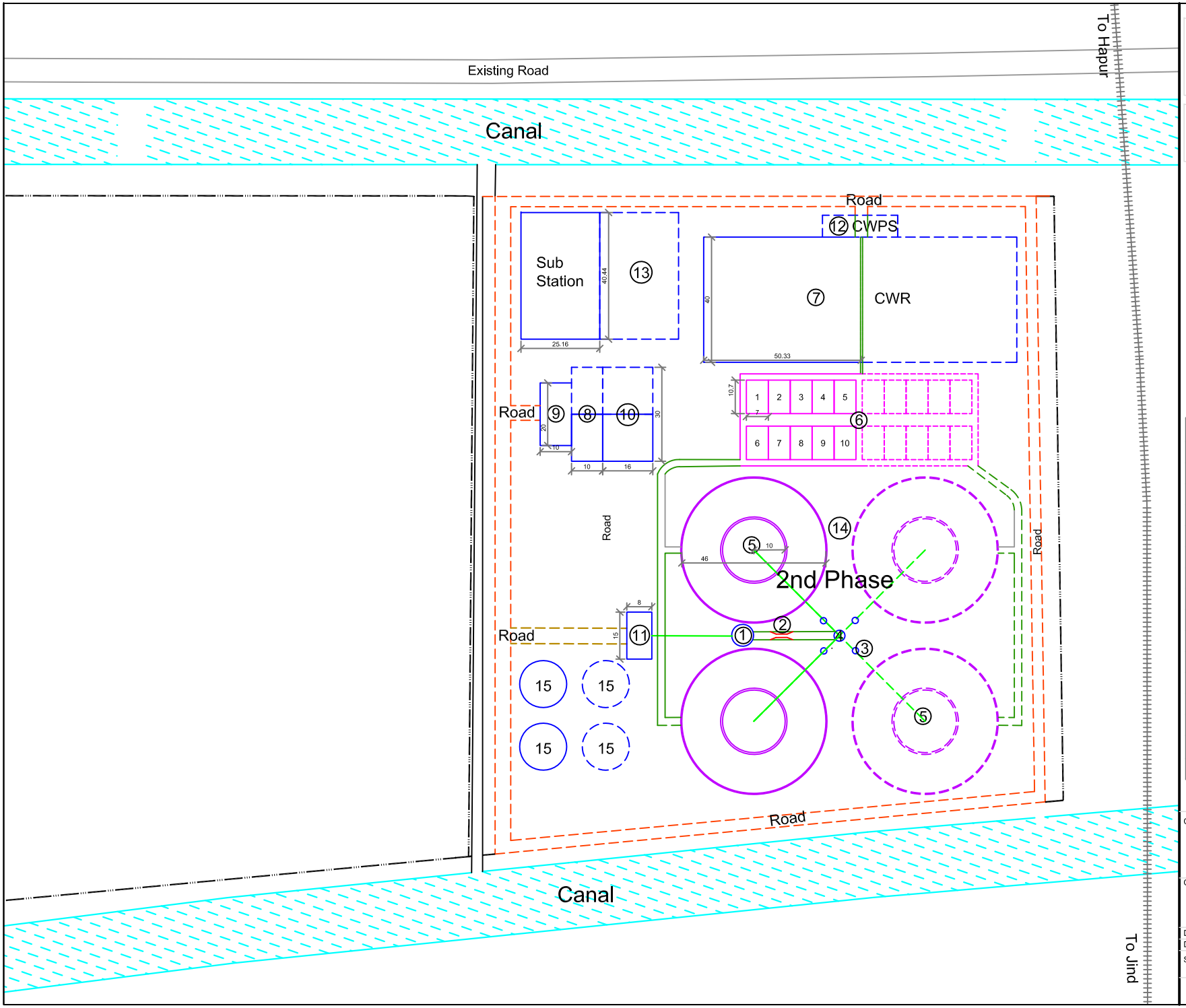
Date: April 2010	Approved: NSS
Scale: NTS	

Map 10-3



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat

Layout Plan of Conventional WTP with Two Clarifiers (Option -2)

Legend

- Existing Canal
- Existing Road
- Railway Line
- WTP Boundary
- Proposed Channel
- Proposed Road
- Future Plant

S. No	Description	Size
1	Inlet Chamber - 1 No.	3.5m Ø
2	Pharshall Flume - 1 No.	1 No.
3	Flash Mixer - 2 Nos.	3.15m Ø
4	Distribution Chamber - 1 No	3.5m Ø
5	Clarifiers - 2 Nos	46.7m Ø
6	Filters - 10 Nos	10.0mx6.5m
7	Clear Water Reservoir - 1 No	50mx40m
8	Cholination Building	15.0mx10.0m
9	Office Building Cum Laboratory - 1 No	10.0mx20.0m
10	Alum Storage	15.0mx16.0m
11	Raw Water Pumping Station - 1 No.	-
12	Clear Water Pumping Station - 1 No	-
13	Electrical Substation - 1 No.	-
14	Back Wash Tank - 1 No.	-
15	Waste Back Wash Storage Tank - 1 No.	-
16	Area	4 Hectares

Client:

Asian Development Bank
National Capital Region Planning Board

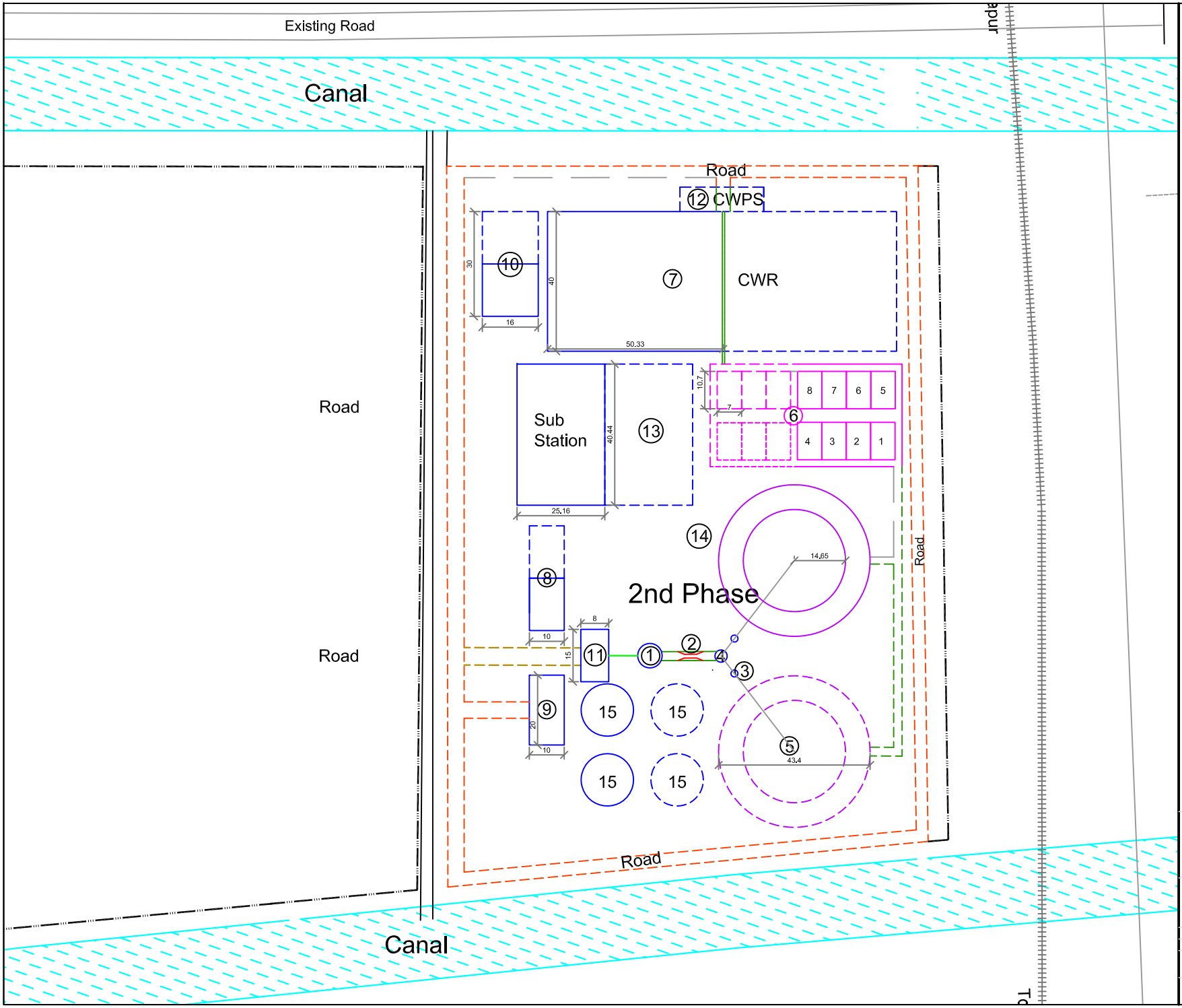
Consultant:

Wilbur Smith Associates

Drawn: SK | Checked: NSS
Date:April 2010 | Approved: NSS

Scale: 0 15 30 45 60 Meters

Map 10-4



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Layout Plan of Water Teatment Plant
High Rate Clarifiers & Filters

Legend

- Existing Canal
- Existing Road
- Railway Line
- WTP Boundary
- Proposed Channel
- Proposed Road
- Future Plant

S. No	Description	Size
1	Inlet Chamber - 1 No.	3.5m Ø
2	Pharshall Flume - 1 No.	1 No.
3	Flash Mixer - 1 Nos.	3.15m Ø
4	Distribution Chamber - 1 No	3.5m Ø
5	Clarifiers - 1 Nos	43.4m Ø
6	Filters - 8 Nos	10.0mx6.5m
7	Clear Water Reservoir - 1 No	50mx40m
8	Cholination Building	15.0mx10.0m
9	Office Building Cum Laboratory - 1 No	10.0mx20.0m
10	Alum Storage	15.0mx16.0m
11	Raw Water Pumping Station - 1 No.	-
12	Clear Water Pumping Station - 1 No	-
13	Electrical Substation - 1 No.	-
14	Back Wash Tank - 1 No.	-
15	Waste Back Wash Storage Tank - 1 No.	-
16	Area	4 Hectares

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

Drawn: SK | Checked: NSS
Date: Dec.2009 | Approved: NSS

Scale: 0 15 30 45 60 Meters

Map 10-5

213. *Distribution Chamber***.** The distribution chamber will receive water from inlet channel. The distribution chamber will have an arrangement for equal distribution of water to flash mixers. It shall be constructed in RCC. For access, a 0.9 m wide walkway shall be provided at top.

214. Parameters:

(i) Rated Flow Capacity : 4,350 cum/hour + 15% overloading.

(ii) Free Board : 300 mm

(iii) Provide 3.5 m dia. X 3.5m deep distribution chamber

215. *Alum Dosing and Flash Mixer***.** The Flash Mixers will be of reinforced cement concrete. The outlets from flash mixers will be provided with electrically operated sluice gates. The free board shall be at least 50 cm. The flash mixer will be equipped with an impeller type high speed mixer. The driving motor of suitable capacity and other accessories will be totally enclosed but easily accessible for maintenance. The shaft with the impeller will be freely suspended from the driving gear mounted on a platform on top of the chamber. Thrust or guide bearing will be located above the liquid level. The impeller will be of stainless steel-316.The outlet of the flash mixer will lead directly to the clariflocculator. For longer stretches, socket and spigot DI pipes with rubber ring (Tyton) joints may be used. The scour chamber of flash mixer will be connected to the drainage system by means of a wall duct and a gate valve.

Design Flow	4,350/4 = 1087.5 cum/hr
Distribution Chamber	
Detention period	45 second (Minimum)
Mixing chamber	
Detention Period:	30 to 60 sec.
Free Board	500 mm

216. A walkway with hand railing shall be provided around the top of the flash mixer and shall be accessible from the ground level by a staircase.

Material of construction

Shaft	-	SS 431
Paddles	-	SS
Drain Valve	-	Electrically operated

Drive motors to be provided with local push button control also. Provide 4 Flash Mixers of 2.25 m dia with 3.5m depth in RCC.

217. *Clariflocculator*. After flash mixing of raw water with the coagulant, it will be carried to clariflocculator. Two most used alternatives are available amongst others:

(i) Concentric inner flocculation tank and outer settling tank

(ii) Tube settlers for faster and more effective settling of flocks

218. In case of normal clarifloccualators, the clarification zone reservoir is huge on account of lower loading of 35 to 50m/day allowed. In case of tube settlers, the surface loading allowed ranges from 120 to 160m/day. This reduces the requirement of quantum of civil construction substantially when using tube settlers. However, additional investment is required for providing tube settlers. It is therefore proposed to keep both options acceptable based on economics at the time of bidding.

219. The circular RCC Clariflocculator will be 4/2 in numbers and will have a central area for coagulation and flocculation and outer area for settling. They will have a peripheral weir with vertically adjustable V-notch SS 316 weir blades for uniform surface withdrawal of the clarified water. The blades shall be fixed with stainless steel anchors, nuts and washers. The flocculation zone and the sedimentation zone will be separated by a circular isolation wall. All inlets, outlets passages of water shall be designed and arranged for a steady and uniform flow without undue turbulence to avoid disintegration. The freeboard shall be at least 50 cm.

220. A bridge with peripheral on-board drive with steel wheels travelling on the steel billets on the peripheral wall will be provided with:

(i) Central platform for the installation of the stirrers and their drives and for the local control panel;

(ii) Paddle stirrers/agitators for slow mixing of the incoming raw water in the central unit;

(iii) A radial scraper system with bottom scraper blades, suspended on the bridge.

221. The hydraulic equipment will comprise of:

(i) The inlet pipe from the distribution chamber feeding into the central flocculation part;

(ii) Sludge outlet pipe with an electrically driven valve for intermittent operation according to an adjustable timer;

(iii) A drain pipe with electrically operated sluice valve for complete emptying of the unit;

(iv) Discharge pipe from the sludge outlet and the drainage outlet to the adjoining drain;

(v) A constant bleeding arrangement for de-sludging shall be provided to enable observation of the sludge quality; and

(vi) A discharge pipe/channel from the peripheral collecting channel to the main channel leading to the filters.

222. The electrical equipment will comprise of:

(i) Incoming cable with slip ring contacts for the on-board power supply and the supply of all motors;
(ii) On-board panel for all operations of the unit with connections to the main control room for indication of the status of the unit components;
(iii) Adjustable drives for the flocculator stirrers;
(iv) Adjustable drive for the bridge;
(v) Emergency stop buttons at the centre and at the outer side of the bridge lighting;
(vi) An access to be provided to the bridge from the peripheral walkway of width not less than 90 cm with a railing.

223. The operation of the bridge and the clariflocculator units shall be as follows:

(i) Manual start and stop from the local control panel and also from the central control panel; and
(ii) The sludge withdrawal valve shall be of electrically operated type. The frequency of the sludge valve can also be adjusted manually through push buttons according to the raw water inflow.

224. *Rotating Scraper Bridge and accessories*. The scrapers, flocculator blades and the rotating/ bridge will generally be manufactured in steel, painted and protected. All steel members of the bridge shall be painted with epoxy paint; hand rails shall be galvanized. The rotating bridge structure will have a walkway with a minimum effective width of 90 cm which shall be surfaced with M.S. chequered plates, painted black.

225. *Flocculation zone.* The electric motor driven flocculator shall consist of MS flocculator paddles, fixed to a SS 431 shaft with guide bearings and guide brackets suitable for under water use. The paddle area shall be at least 10 percent of the sectional area of the flocculator zone. The drive mechanism will consist of motor with reduction gear.

226. *Motors, starters and control***.** The electrical supply to bridge or flocculator driving motors will be taken through a multi ring - slip-ring collector unit mounted in a fully water proof enclosure. The unit shall be fitted at the centre of rotation of each bridge and will be complete with all necessary support brackets, anti-rotation device. A suitable means of lubrication shall be provided. The slip ring assembly will be mounted above the top level of the tank walls. Sufficient rings will be included to cover the motor supply and any ancillary circuits. Bridge drive and flocculator motors will be of squirrel cage type, protected and shall be rated 25 percent above design duty.

227. All cables will be connected to a termination box at the wall of the Clariflocculator. Cables from the termination box will go to the main control panel. The bridge drive and the flocculator will be controlled from an outdoor panel installed in the central part of the bridge. The drive status indicating lamps shall be provided on the Main Control Panel.

Table 10-3: Design Parameters

Design flow		4,350 cum/hr
Flocculation Zone :		
	Detention Time	20 to 40 min.
	Velocity Gradient	10 to 75 S-1
	Paddle Area	10 to 25% of vertical section
Clarifier :		
	Detention time	2 to 2.5 hrs.
	Surface Loading	<1.67 cum./sq.m./ hr
	Weir Loading	< 12.50 cum./m./hr
	Depth at outer edge	2.5 to 5.0 m
Scraper Bridge :		
	Time for one rev.	30 to 40 min.

228. *Bypass of the Clariflocculator, Collecting Channel, Overflow***.** Bypass arrangement by connecting the distribution chamber directly to the collecting channel leading to the filters shall be provided. The bypass may be used during periods of very good raw water quality with minimum of turbidity and suspended solids or during maintenance of clariflocculators for direct loading of the filters. The bypass will be regulated through an electrically operated sluice gate.

229. An overflow will be provided at the collecting channel to avoid uncontrolled flooding of the plant. The overflow will be diverted to drain. The weir of the overflow will be designed for the design flow plus overload in a manner that the upstream head does not exceed the freeboard of the channels and treatment units. The weir plate shall be adjustable. Free board of the collecting channel should be 50 cm. Provide – 4 nos. Clarifiers 34 m dia x 3 m deep with inner flocculator tank of 14m diax3.5m deep. Launder shall be provided on the outer periphery of clarifier tank 600mmx600mm.

230. Tube Settler Clarifiers: In case of Clarifiers with Tube Settlers, design of flocculator remains the same. The change takes place only in the clarifier zone. Here by use of tube settlers, higher rate of surface loading could be achieved, thereby substantially reducing the surface area and the volume of clarifier. There can be two arrangements for placing tube settlers in place. In one arrangement, rectangular tanks with hopper bottom are provided with tube settlers of one meter height. A free board of 500 mm with a sludge zone of one meter below the tube settlers is normally provided. The TS are preferably placed at an angle of 60º. The surface loading allowed varies from 120 to 160 m/day. Design for tube settler clarifier is given in **Appendix D-17**. In an alternative arrangement the TS are placed in a circular tank around the flocculation tank. This is very commonly practiced while rehabilitating existing WTP with conventional clariflocculators.

231. Filter beds and inlet channels: The filter beds shall be supplied clarified or by-passed raw water from secondary channels through a main channel coming from the clariflocculators. The filters shall be of declining rate of flow type. All filters shall be identical in internal dimensions. The top level of the filters is so maintained as to avoid overflow in the filter area. The filters shall be open to sky. Sluice Gates shall be used for the isolation of each filter in case of backwash or maintenance. These will be electrically operated from the filter control consoles.

232. The water level on the filter bed during filtration will not be controlled. It will serve as the indicator for the filter loss. The filter influent shall enter below low water level of filters. Filters will be cleaned when the water has reached that upper level. There shall be proper arrangement to avoid free falling water which may destroy the sand surface in case of a low water level in the filters just after cleaning.

233. Filtration will be by gravity, downwards through a bed of filter sand supported by a layer of suitably graded filter gravel. The filter sand will consist of hard, durable grains of silica and shall have a specific gravity of not less than 2.5. All grains of sand shall preferably be water worn. The filter gravel shall consist of hard; preferably rounded stones with a specific gravity not less than 2.5, shall be free from clay, sand, loam and organic impurities of any kind and shall not disintegrate with the action of water and backwashing. The supporting media depths shall be such as to ensure adequate and uniform distribution of wash water and air after leaving the orifices with the minimum risk of mixing sand with the gravel of the supporting media.

234. The filter media (sand and gravel) shall conform to IS: 8419 (part I) amended up to date. The sand media shall have an effective size ranging between 0.45mm to 0.70mm and a uniformity coefficient of 1.3 to 1.7. Filter sand when immersed in 40 percent hydrochloric acid for 24 hours, the soluble matter shall not be more than 5 percent by weight. It shall not contain more than 1.5 percent of calcium and magnesium calculated as CaCO3. Ignition loss should not exceed 0.7 percent of the weight. The solubility of supporting gravels in 40 percent hydrochloric acid after 24 hours shall not exceed 10 percent for 10 mm or larger size gravel and 5 percent for smaller than 10 mm size.

235. All filter media shall be supplied in polythene bags. Suitable care should be taken to protect the media from spillage or contamination. Storage on site shall only be in an approved area, well drained and free of mud and silt. The filter media shall be carefully placed in the filter beds and shall not be dropped or dumped or machine handled so as to be detrimental to the floor media, nozzles or sealant etc.

236. The under drain system will be a pipe grid type consisting of a central pipe/channel with lateral system of PE pipes having perforations or nozzles. The laterals will have staggered orifices for water on the underside of the pipe. Air orifices will be at the topmost point in the pipe laterals. Alternatively, nozzles shall be provided in the pipes for collecting filtered water and also for discharging air for scouring the filter media and water for backwashing. The third alternative shall be providing a false bottom floor with nozzles. All the three types of under drainage system shall conform to IS: 8419 (Part 2). The under drain system shall be designed to provide uniform draw-off of filtered water and uniform distribution of wash water and air over the whole area of the filter. Particular provisions have to be made for the handling of the high air velocities at the inlet zone of the manifold.

237. Each filter will have central and lateral wash water trough which will be connected with adequate slope to the wash water outlet to prevent deposits of silt. The filter backwash water will ultimately be discharged to recycling reservoirs.

Table 10-4: Design Parameters

Filters :		
	Design flow	4350 cum/hr
	Filtration rate	4.8-6.0m3/m2/h
	Water column	1.5-2 m
	Free board	0.5m
	Loss of head	Not more than 2.00 m
	Filter beds Size	10.7 m x (3.50x2) m
	Filter Beds Nos.	10
Filter media :		
	Depth of sand bed	600 – 900 mm
	Effective size of sand particles	0.45 - 0.7 mm
	Uniformity coefficient of sand	1.3 – 1.7
	Depth of gravel layer	> 450 mm

238. *Filter operation gallery and pipe gallery***.** Each filter will be provided with necessary electrically driven valves/gates having control through push buttons provided on the filter operating console and also centrally. The valves will have provision for manual override to cater for power failure. Following valves/ gates will be at least provided:

(i) Filtered water outlet valves
(ii) Backwash water inlet valves
(iii) Backwash air inlet valves
(iv) Backwash water outlet
(v) Raw water inlet gate
(vi) Drainage of the filter valve

239. In line type Full Bore Electro Magnetic flow meter, flow transmitter with local display and a regulation valve will be provided in the backwash water pipe coming from the reservoir. There will be a locking arrangement in regulation valve which can be locked after adjustment of flow. The flow (m^3/h) shall be transmitted to an electronic digital meter of suitable size so that it is visible and readable from each filter operating console.

240. The washing cycle of the filter will be automatically set and could be operated from central console. Alternative manual step by step control should also be provided. Before backwashing, the filter water level has to be lowered to its minimum in order to avoid wastage. The back wash water outlet and the evacuation outlet will directly drain into an open channel in front of all the filters. This channel will lead to a chamber which is connected to the drainage system.

241. *Backwash***.** Filters are to be backwashed once the head loss through the filters reaches 1.8 to 2.00 m to prevent the breakthrough and consequent deterioration in the quality of the filtered water. However, when number of filters in the plant is high, generally the filters are backwashed once in 24 hours for ease of operation. The rate of backwash will be 36 m3/m2/hr and rate of air scour will be about 36-45 m3/m2/hr. A positive displacement blower with 100 percent standby will deliver air required for air scouring of sand prior to

back washing. A back wash water tank of capacity sufficient to cater to back wash of one filter bed in case of single bed system (two beds in case of twin bed system) and also for supplying water to Alum tanks and other requirements of the plant will be provided. A separate elevated storage reservoir is considered for this purpose. Filters will be backwashed by air wash followed by water wash.

242. *Backwash pumps***.** Two Submersible pump sets (2W+1S) 1090 cum/hr capacity each will be provided in the clear water channel and will be designed to fill the back wash water tank fully in not more than 90 min.

(i) The system will include the following:
(ii) Electrically actuated automatically operated, valves for delivery pipes;
(iii) Pressure gauges with stop cock at suction and delivery of the pumps;
(iv) Spring loaded non return valves in the delivery pipes;
(v) Mechanical and electronic water level indicator of the sump;
(vi) Low level switch in the sump for automatic stoppage of the pumps;
(vii) Low level float switch in the back wash water pump for automatic starting of the back wash pumps; and
(viii) Velocity in delivery pipe shall be limited to 2 m /sec.

243. *Blowers***.** The blowers for the air delivery for scour of the filter beds shall be provided and blower capacity will be adequate for both beds of twin bed system and for single bed in case of single bed system. Each unit will be provided with a suction air filter and silencer, pressure relief valve and delivery non-return valve. A non-return valve also will be provided on common air main to each battery of filter. The air pipe to the filter will be laid with an apex above the maximum water level of the filters and a vacuum breaker at the point to avoid backflow and siphoning of water. Pressure gauges with stop cock at the pressure side of the compressors will also be provided. The air piping connecting the blowers to the filters will be laid on the ring main principle. There will be a provision for the release of air from the system at the end of the scour before backwash commences.

Table 10-5: Design Parameters

Configuration	1W+1S 3,300 cum/hr capacity of each
Vol. of free air	600 to 900 l./min/sq. m.
Air pressure at under drain	0.35 Kg./sq cm.
Speed	< 1000 rpm
Air velocity in pipe and valves	< 25 m./sec.
Noise level	< 85 DB

244. The status of all backwash pumps and blowers will be indicated at the main control panel of the treatment plant. The status of the blowers will be indicated on the filter control consoles also.

245. *Backwash tank***.** The backwash tank will be of reinforced concrete. A separate elevated back wash tank with required staging will be constructed. The capacity of the tank will be

sufficient to provide for quantity of water required for backwashing of one filter bed (for single bed system) considering rate of backwashing as 600 l/sq.m for a period of 5 minutes (double this in case of twin bed system) + 8 hrs water requirement for chemical dosing other than chlorination + 10 percent extra for other utilities over the dead storage. The chlorination pumping will be done from the clear water channel by the side of backwash pumps. The back wash tank will have a free board of 30 cm. but not less than the size of overflow pipe. The elevation of the reservoir shall be fixed according to the requirement of the backwash. It shall also provide for the following:

(i) Inlet pipe & backwash pipe (outlet);
(ii) Branch for the supply of the chemical house;
(iii) Gate valve in the outlet pipe;
(iv) Overflow pipe (which shall be of dia at least equal to the inlet pipe) back to the filtered -water channel;
(v) Washout with gate valve;
(vi) Top level switch (stop pumps, signal to control panel of pumps);
(vii) Intermediate (75 percent tank full) level switch (start pumps, signal to control panel of pumps) (Adequate water-yes, signal to each filter console);
(viii) Low level (70 percent tank full) switch (signal to filter consoles; backwash impossible); and
(ix) External wall mounted water level indicator (Float and board type).

246. The reservoir will be provided with access to the roof, a mild steel epoxy painted cover, a galvanized steel ladder for access to the reservoir and two mild steel or CI ventilation pipes DN 200 with cowls and wire mesh.

247. *Chemical House, Chlorine House for chlorination and office building***.** The average dose of chlorine for pre-chlorination will be about 5mg/l and that for post-chlorination will be about 2 mg/l. Vacuum type chlorinators shall be provided with 100 percent standby arrangement. Pre-chlorination will be effected in the inlet chamber of the WTP and the final chlorination will be carried out in the filtered water channel. The chlorination plant will comprise a container store area, chlorinator, container store, vehicular access, mechanical container handling facility and a chlorine neutralization pit with a lime slurry feeder. All safety features and equipment shall be provided to meet with any accidental eventuality.

248. Chemical house for alum storage (for 7 days), handling, solution preparation tanks and alum dosing tanks will be provided. There will be additional storage house of 250 sq.m area for storing the alum sufficient to run plant for the period of 3 months.

249. A chlorine house for chlorination will be constructed comprising of a tonner store room (for empty as well as full), chlorinators, motive water pump rooms, vehicular access, mechanical container handling facility and neutralization pit. The container store area and chlorinator room will be made in house and provided with continuous forced ventilation system as well as provided with facility for isolation in the event of major chlorine leakages. Safety equipment

will be provided to the plant operators in the chemical house as well as in the chlorine house. The visible and audible alarm facilities also to be provided in the event of chlorine gas leak. A separate office building cum laboratory shall also be provided.

Table 10-6: Details of Chlorine dosage

Medium	Maximum dose	Solution	feeding capacity	solution tanks *	Storage
Alum	60 mg/l	8%	1+1	3	(7 days)
Chlorine (pre-chlorination)	5mg/l		1+1 working and one standby total 3Nos		Tonners for 30 days
Chlorine (post-chlorination)	2 mg/l				

250. *Clear Water Reservoir***.** Filtered water will be conveyed through a pipe/closed channel and a chlorine contact chamber to the clear water reservoir (CWR). A ground level Clear water storage tank of 10000 cum capacity (two hour storage for 100 MLD) shall be provided. The reservoir will be of reinforced concrete construction and will be in two parts to facilitate cleaning and maintenance of the tanks. The FSL of the tank shall be 236.0m with water depth of 5.00 m. The shape of CWR shall be rectangular and it shall be covered with RCC flat roof.

251. Disposal of clarifier sludge and filter back wash water: It is proposed to provide a recirculation system for wash water. For this purpose, wash water will be collected in two open tanks, with a storage capacity of one day wash water in each tank. These tanks may be used alternately. The settled water will be pumped back into the Inlet chamber. One submersible pump will be installed in each tank and one submersible pump will be kept stand by. Sludge from these tanks and also from the clarifier will be taken to a sludge tank. Two sludge pumps will be provided in the sludge tank to pump out sludge to the open field. In the first phase it is proposed to spread the sludge on open field and in next phase in 2026, mechanical equipment/system will be provided for sludge drying and disposal.

252. Process Control and Water Quality Monitoring System: The plant inflow and out flow will be measured with the help of ultrasonic flow meters. The quality monitoring system for the plant will comprise online measurement of Turbidity, pH, alkalinity and residual chlorine. Iron and Aluminum will be monitored periodically manually. A laboratory with sufficient equipment as per CPHEEO manual will be provided.

253. All interconnecting pipes shall be of Ductile Iron, chemical dosing pipes shall be of PE pipes and the drain and sludge pipes shall be RCC. Inter connecting channels shall be designed for flow under gravity with sufficient free board. The interconnecting channels shall be smooth finished.

254. The plant will be designed with a fully automatic system. Full plant with all operations shall be possible from single console in the control room with SCADA. In each case facilities will be provided to permit these automatic controls to be overridden and the system to be manually controlled.

255. Compound Wall: A compound wall of 230 mm thick second class B.B masonry CM (1:4) shall be provided all around the WTP premises. The height of wall shall be minimum 2 m. Suitable footing and coping shall be provided for compound wall along with pillars and expansion joints at safe intervals. M.S. gate of minimum 7.00 m width shall be provided for Compound wall at suitable location to have access to WTP premises. Internal Bituminous Macadam Roads to connect all units from main entrance shall be provided.

256. Street lighting, storm water drains within WTP premises shall also be provided. Landscaping for the plant shall be done. Plantation shall be undertaken in the campus.

Electricity Supply

257. The WTP will receive 415V power supply from Main LV switchboard located in CWPS. Main supply will be received at 33 KV from Electricity Company up to the 33x6.6KV cum 6.6X0.4KV substation to be constructed in the premises of WTP. The 415 V supply cable will then go to the main control panel in CWPS, from where power distribution will be done to RWPS, WTP and ancillary units. The Main LV switchboard for WTP shall supply power to following units:

(i) Compressors
(ii) Alum Agitator
(iii) Flash Mixture
(iv) Back Wash Pumps
(v) Air Blowers
(vi) Hoist Panel
(vii) Instrumentation Panel
(viii) Lighting Distribution Board
(ix) Clariflocculator panel
(x) Any other equipment/system required for WTP.

Process Design Criteria for Main WTP Units

258. Design criteria for the various water treatment plant units will be as given below:

Table 10-7: WTP Design Criteria

Inlet Chamber		
	Rated Flow Capacity	4,350 cum/hour plus 20% Overloading
	Detention Time	30 seconds
Parshall Flume		
	Flow Capacity	4,350 cum/hour
	Flow measurement system	Ultrasonic flow measuring system
Flash Mixers		
	Rated Flow Capacity	4,350 cum/hour plus 20% overloading
	Detention Time	30 seconds

Clariflocculator		
	Rated Flow Capacity	4,350 cum/hour
	Flocculation Zone :	
	• Detention Time	20 to 40 min.
	• Velocity Gradient	10 to 75 S^{-1}
	• Paddle Area	10 to 25% of vertical section
	Clarifier	
	• Detention time	2 to 2.5 hrs.
	• Surface Loading	<1.67 cum./sq.m./ hr.
	• Weir Loading	< 12.50 cum./m./hr.
	• Depth at outer edge	2.5 to 5.0 m.
	Scraper Bridge :	
	• Time for one rev.	30 to 40 min.
Rapid Sand Filter		
	Rated Flow Capacity	4350 cum/hour
	Filters	
	• Filtration rate	4.8-6.0$m^3/m^2/h$
	• Water column	1.5-2 m
	• Free board	0.5m
	• Loss of head	Not more than 2.00 m
	Filter media	
	• Depth of sand bed	60 - 90 cm
	• Effective size of sand particles	0.45 - 0.7 mm
	• Uniformity coefficient of sand	1.3 - 1.7
	• Depth of gravel layer	> 45 cm
	Chlorination	
	Type	pressure feed
	Chlorine Dosing	
	At inlet chamber	5 mg/l - average continuous dosing*
	At Filter outlet channel	2 mg/l - average continuous dosing*

*Dosing shall be worked out after Chlorine Demand Test

Mechanical Aspects

259. Design Criteria

(i) 100 percent standby shall be provided for each of the following units:

- Filter back wash pump
- Air blower
- Chlorinator
- Alum mixer
- Drain pump, if any

(ii) Positive suction shall be provided for priming of dry pit pumps.

(iii) Submergence of suction piping / vertical turbine pump / submersible pump shall be as per the pump manufacturer's recommendation but not less than 25 percent higher than that recommended by BHRA

(iv) All filter operations shall be automatic

(v) Filter back wash operation shall also be fully automatic

(vi) Electric hoisting shall be provided for handling chlorine tonners

(vii) All safety equipments such as emergency fan, safety shower, eye wash fountain, artificial breathing apparatus etc. shall be provided. Chlorine leak detector shall also be provided in chlorination room and tonner room.

(viii) Clear space for operation and maintenance shall be provided around back wash pumps and air blowers.

(ix) Portable fire extinguishers shall be provided as per TAC regulations.

Electrical Aspect

260. The first part of this section covers brief description of the proposed electrical system for the proposed WTP. The second part of this section covers "Design Criteria" for the electrical equipment/system.

Electrical System

261. The WTP will receive 415V Power Supply from Main LV switchboard located in CWPS through a cable. The main LV switchboard for WTP shall be installed in Machine room or any other suitable location in WTP building. The switchboard will have an incoming feeder with MCCB and outgoing feeders with MCCBs for supply to various design loads such as for clariflocculator, alum agitators, flash mixers, back wash pumps, compressors, lighting, etc. Necessary metering, protections and indications will be provided on the switchboard. The lighting system will be controlled by a lighting panels installed in respective plant areas, which will be fed from the main LV switchboard.

262. The earthing system for the complete plant will be based on IS: 3043: Code of practice for Safety Earthing. 1100 V grade, PVC insulated, armored cables will be used to for power distribution and control purposes. Local Start/Stop push button stations will be provided near those motors which are not controlled from a local console/panel.

Design Criteria

263. The Design Criteria described below is to be followed by the contractor and covers the electrical equipment/system required for the WTP.

264. Estimation of Load: The following assumptions are made to arrive at the maximum electrical demand.

Load Factor

(i)	Main motors	: 0.9
(ii)	Auxiliary load	: 0.9 (valve actuators, crane, etc.)
iii)	Lighting load	: 1.0

Diversity Factor		
(i)	Main motors	: 1.0
(ii)	Auxiliary load	: Max.1.5 (Based on working Pattern of load)
(iii)	Lighting load	: 1.0
Power factor of Motors		: As per the Manufacturers Catalogue
Efficiency of Motors		: As per the Manufacturer's Catalogue

265. Equipment: All the indoor electrical equipment will be rated and designed for 50° C ambient temperatures, while all the outdoor electrical equipment will be rated and sized for 55° C design ambient temperatures.

266. The capacity of the transformers will be calculated based on the total simultaneous maximum demand (calculated based on the load factors and diversity factors given above) plus 10 percent contingency. A transformer with the next higher standard rating recommended in the Indian Standards will be selected.

267. All the power cables will be sized based on the continuous current rating of the load, permissible voltage drop and short circuit current rating. The voltage drop will be limited to 2.5 percent at rated equipment current rating. The rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, type of laying, depth of laying, etc. will also be considered for cable sizing.

268. **Illumination:** The illumination levels to be considered for the design of lighting system for various areas are as follow.

Area		Illumination level (Lux)
Office		300
Indoor Plant Area		250
All other indoor areas		150
Outdoor plant areas		50
Other outdoor areas and roads		10
Maintenance Factor	- outdoor area	0.6
	- Indoor areas	0.7

269. **Earthing:** The material of earthing conductor laid above ground or buried in concrete will be galvanized steel, while that of the conductor buried in soil will be mild steel. The size of the earthing conductor will be designed as per the Indian Standards. The value of fault current will be calculated based on the transformer capacity, its impedance and the main supply system fault level. Fault current withstand time for sizing of earth conductor will be taken as three seconds. While sizing the buried earth conductor, a corrosion allowance of at least 20 percent will be taken. Main earthing conductors outside and inside the building will be planned in such a manner that the equipment are connected to the earthing system

by two connections in a reliable manner.

270. *Protections*.

The following protections will be provided on the main LV switchboard. Thermal overload and short circuit protection features on MCCBs and MCBs for all feeders.

Overload protection by thermal (bimetal) relays with single phasing presenter (SPP) for contactors for motor feeders

271. *Metering***.** The following metering will be provided.

Incomer

(i) Ammeter with selector switch
(ii) Voltmeter with selector switch
(iii) Kilowatt meter
(iv) Power factor meter
(v) Kilowatt-hour meter
(b) Outgoing Feeders for Main Motors
(i) Ammeter with selector switch

272. *Indicating Lamps***.** The following indications will be provided.

Incomer

(i) Supply 'ON' (Red, Yellow & Blue)

Motor Feeders

(i) Motor 'ON', 'OFF' & 'Trip' indications (Red, Green & Amber)

273. *General***.** The LV switchboard is proposed with 'Form-4' enclosure as per the Indian Standards. All indoor boards/panels and motors are proposed with a degree of protection of IP 54, while all outdoor equipment will be with a degree of protection of IP55. The method of starting of motors will be 'Direct-On-Line' (DOL) for motors with rating up to and including 5 kW, while 'Star-Delta' starting will be used for motor rating above 5 kW. LV power cables will be with stranded aluminum conductor, PVC insulation, extruded inner and outer sheaths and galvanized flat/wire armoring. Control cables will be with stranded copper conductor, PVC insulation, extruded inner and outer sheaths and galvanized flat/wire armoring.

274. Decorative type fluorescent lamp lighting fixtures will be used in the office/ conference room, while industrial type fluorescent lamp lighting fixtures will be used in other indoor areas. Where adequate mounting height is available in indoor plant areas, low/medium bay HPSV fixtures are proposed. For outdoor areas including roads, floodlight/street lighting

fixtures with HPSV lamps are proposed, as applicable. All the electrical equipment, accessories and systems will conform to the latest editions of the Indian Standards or other equivalent international standards.

7. Pumping main pipe line

275. The requirement of water for the year 2026 has been worked out as 80 MLD and for the year 2041 as 113.71 MLD from this system in the present DPR area, Covering 18 distribution zones (Table 19) The pipe line will be a ring main emanating from the CWPS up to a point where Asandh Road crosses the canal near Panipat town and then bifurcates in two directions, one through the Asandh Road and the other through Jatal Road, ultimately meeting on Sanauli road. From in between points, branch lines will take off to the 18 OHSRs. Pumping (rising) main system alignment and location of OHSR is shown in **Map 10-6**. Topographical survey map of pumping main and Over Head Service Reservoir sites was undertaken and given in **Map 10-7**. Net work analysis has been carried out for the complete pumping main pipe line through following two processes:

(i) Using Loop software of World Bank; (ii) Economical Design of each section of pipe line as specified in Manual of Water Supply issued by CPHEEO, GOI.

276. The design using loop software is given in **Appendix D-18.** The design as per capitalized cost table given in CPHEEO manual has been worked out for each of 32 pipe stretches between different nodes and is placed at **Appendix D-19.** The design is based on 30 years as design period as specified in the CPHEEO manual. After analyzing the two results, pipe sizes adopted for different sections are given in **Table 10-8 and Table 10-9**.

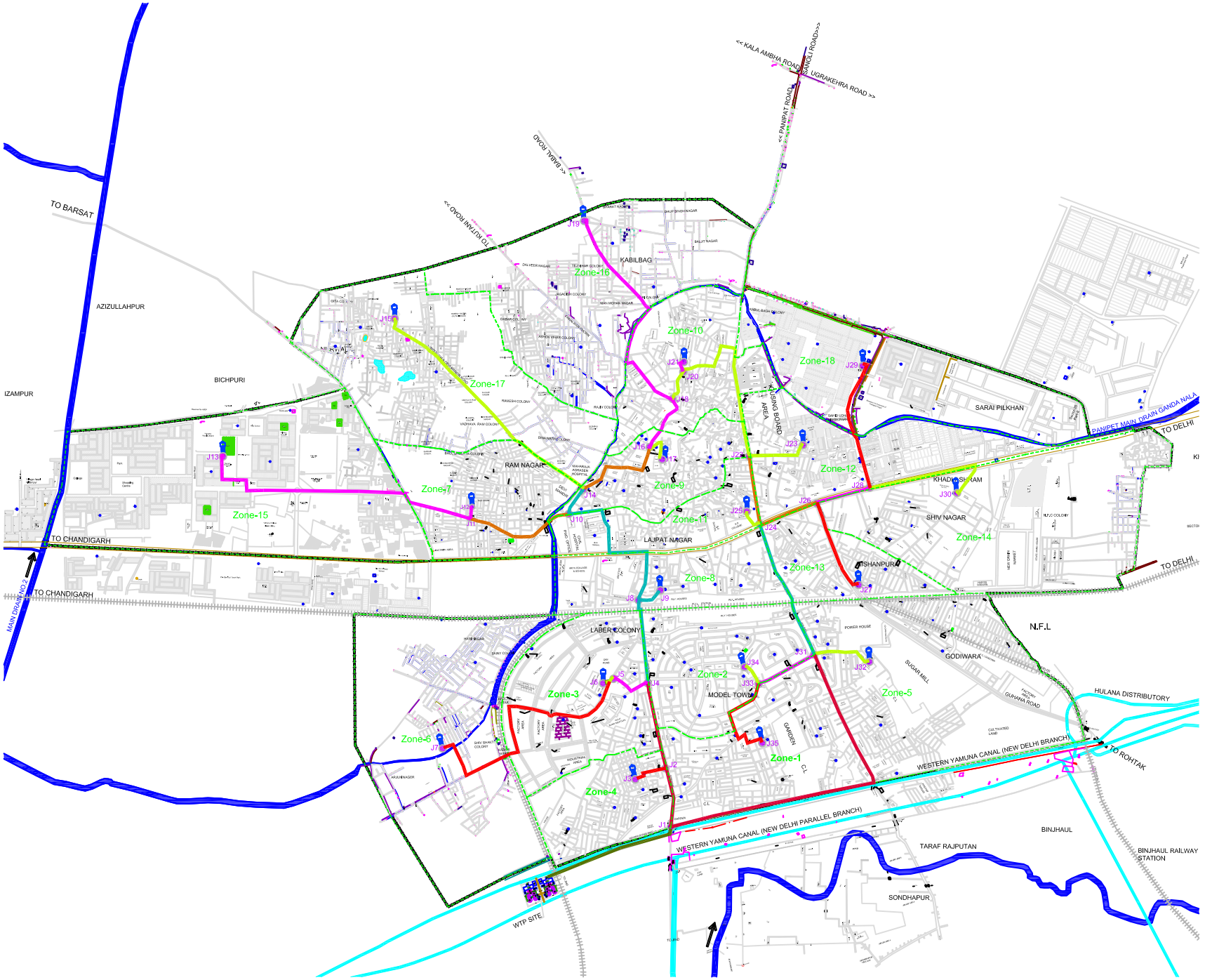
Table 10-8 : Rising Main Pipe Diameter

From	To	Pipe Dia in mm			Pipe Ending at zone reservoir	Length in meters
		Design As per Loop	Design as per Manual	Adopted		
WTP	J1	900	900	900		1,199
J1	J2	900	700	800		522
J2	J3	300	250	300	ZONE 4	301
J2	J4	900	700	700		785
J4	J5	450	400	400		430
J5	J6	350	250	350	ZONE 3	35
J5	J7	350	250	300	ZONE 6	2,394
J4	J8	800	700	700		744
J8	J9	350	250	350	ZONE 8	217
J8	J10	800	600	700		1,457
J10	J11	600	400	500		978
J11	J12	450	400	400	ZONE 7	110
J11	J13	450	300	400	ZONE 15	2,052
J10	J14	600	500	600		267
J14	J15	400	300	350	ZONE 17	2,316
JJ14	J16	500	400	400		818
J16	J17	350	250	350	ZONE 9	265

From	To	Pipe Dia in mm			Pipe Ending at zone reservoir	Length in meters
		Design As per Loop	Design as per Manual	Adopted		
J16	J18	450	300	400		532
J18	J19	400	300	300	ZONE 16	1,716
J18	J20	350	300	350		394
J20	J21	400	400	400	ZONE 10	110
J22	J20	250	400	350		1,574
J22	J23	350	250	350	ZONE 12	548
J24	J22	400	400	500		599
J24	J25	350	250	350	ZONE 11	199
J24	J26	600	400	500		545
J26	J27	350	300	300	ZONE 13	853
J26	J28	500	400	400		489
J28	J29	400	300	300	ZONE 18	1,210
J28	J30	450	300	350	ZONE 14	1,278
J31	J24	700	600	700		1,278
JJ31	J32	350	300	350	ZONE 5	523
J31	J33	500	400	400		560
J33	J34	350	250	350	ZONE 2	100
J33	J35	350	250	300	ZONE 1	945
J1	J31	800	700	700		3,096
					Total	31,439

Table 10-9 : Rising Main – Diameter-wise Length of Pipe

Dia	As per loop	As per WS Manual	Adopted/as per estimate
900	2,506	1,199	1,199
800	5,297	-	522
700	1,278	5,147	7,360
600	1,790	2,735	267
500	1,867	267	2,122
450	4,402	-	-
400	5,951	6,213	5,101
350	6,473	-	7,449
300	301	10,874	7,419



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Rising Main Alignment and OHSRs

Legend

- DPR Project Boundary
- National Highway
- Other Roads
- Railway Line
- Canal
- Drain
- Hand Pump
- Culvert
- Manhole
- Transformer
- Electricpole
- Lamppost
- Telephonepole
- GPS
- TBM
- Tree
- OFC
- Ditch
- Building
- Tube Well

Overlay Legend

- Overhead Service Reservoir (OHSR)
- Zone Boundary
- Zone-14 — Zone Number
- Node
- J35 — Node Number
- 1000 mm Dia Pipe
- 800 mm Dia Pipe
- 700 mm Dia Pipe
- 600 mm Dia Pipe
- 500 mm Dia Pipe
- 400 mm Dia Pipe
- 350 mm Dia Pipe
- 300 mm Dia Pipe

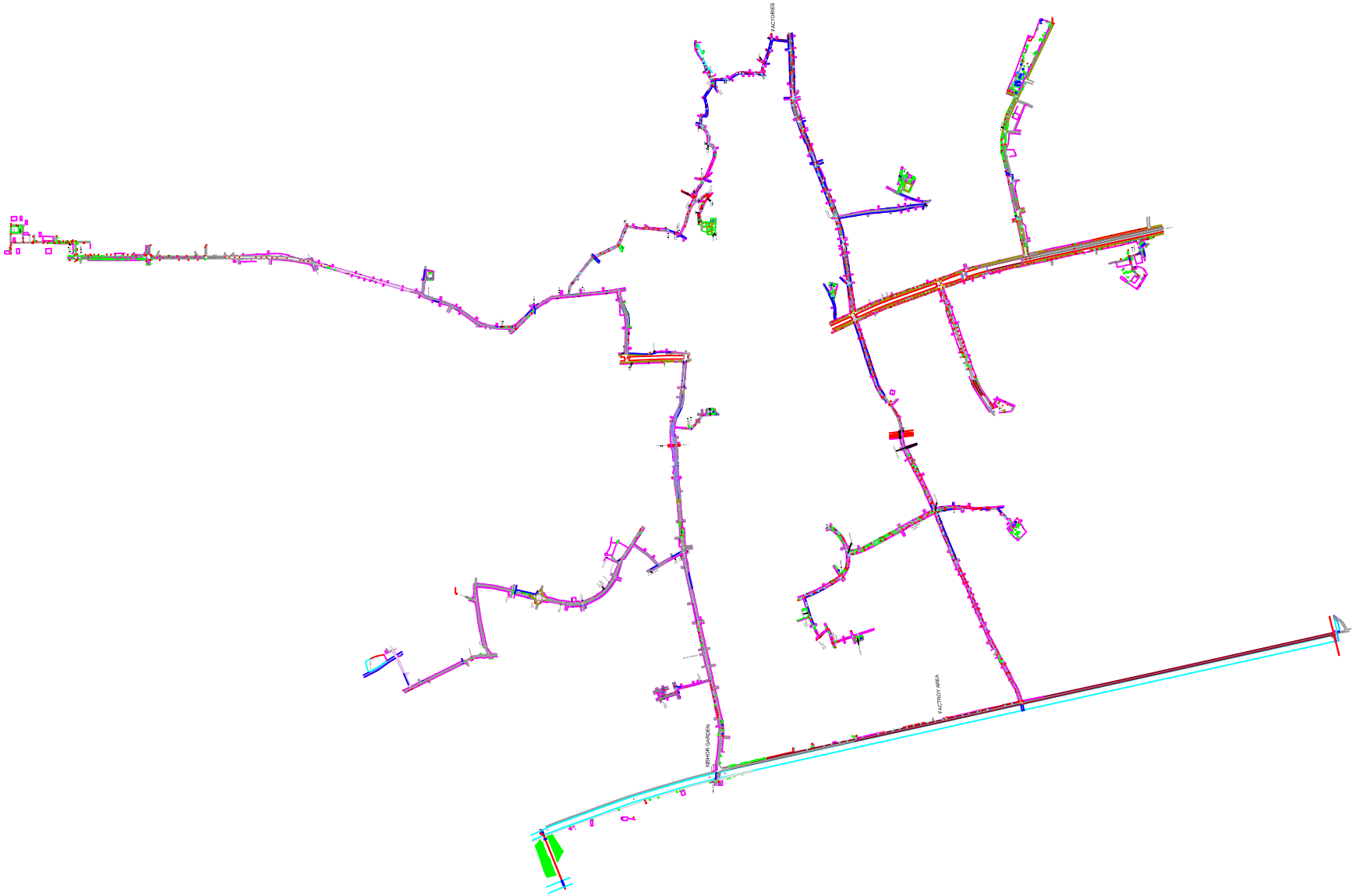
Client:
Aslan Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date: April 2010	Approved: NSS

Scale: 0 400 800 1200 1600 Meters

Map 10-6



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Topgraphic Map of Rising Main & OHSR Sites

Legend

- Road
- Drain
- Railway Track
- Divider
- Footpath
- Fencing
- Building
- Boundary
- Habitation
- Shops
- Gate
- Park
- Pump House
- Water Pipe
- Canal
- Bore
- Hand Pump
- Culvert
- Manhole
- Transformer
- Electricpole
- Lamppost
- Telephonepole
- Gps
- Tbm
- Tree
- Ofc
- Pond
- Water Tank
- Water Walv
- Box
- Retaining Wall
- Well
- Sign Post

Client:
Asian Development Bank
National Capital Region Planning Board

Consultant:
Wilbur Smith Associates

Drawn: SK	Checked: NSS
Date: April 2010	Approved: NSS

Scale: 0 250 500 750 1000 Meters

Map 10-7

277. It is proposed to provide one air valve of 100mm size on the delivery header outside the CWPS. No provision has been made for additional air valves because pumping line will be connected to 18 over head tanks all the time. Air Valve shall be connected through isolation valves (S.V.) of same size class PN 10.It is proposed to provide one Butterfly Valve 1000mm size (class PN 10) immediately after header outside the CWPS and one Butterfly Valve of respective size on each branch line for isolation purpose. All Butterfly valves shall be connected to pipe line through dismantling joint to facilitate removal for repair/replacement. It is also proposed to provide four scour valves, at points where pipe line passes near the Nala to facilitate emptying of pipe line, whenever required. The scour valves shall be 150mm size class PN 10.

278. All Butterfly Valves and Scour Valves shall be provided with RCC Chambers. As air valve will be located within CWPS/WTP premises, no chamber is proposed for the same. Thrust blocks shall be provided at all locations where pipe line takes a turn of 5 degrees or more. A cover of minimum 1 m shall be provided in the entire length except where pipe line is taken above ground.

Pipe Material Selection

279. The selection process of pipe material for the trunk mains and distribution system will comprise the following four stages.

(i) Technical Selection
(ii) Operational Consideration
(iii) Structural design
(iv) Economic consideration

280. The materials available for selection are:

(i) Ductile iron
(ii) Mild Steel
(iii) Cast Iron
(iv) Bar Wrapped Steel Cylinder Concrete
(v) Pre Stressed Concrete
(vi) Glass fiber reinforced
(vii) Asbestos Cement
(viii) HDPE
(ix) PVC
(x) MDPE

281. Experience of use of GRP pipe as trunk main is limited in India. This pipe material is however being used extensively in USA. There are risks of overstrain due to subsidence and ground movement. However, during recent past use of GRP pipes has increased fast,

particularly in bigger sizes. One of the advantages in using this pipe material is the fact that the pipe line will pass through heavily in habituated area and people will have tendency to take water connection from pumping main but it will be difficult to take connection without major shut down of the pipe line. Again, experience of Pre Stressed Concrete pipe in India is not encouraging. Jointing of PSC pipes need high skill. Joints are also relatively inflexible and use of such pipe in trunk main may lead to excessive leakage at a later stage. It has also other limitation such as heavy weight, slow progress of work, difficulty in leakage detection etc. Hence, materials e.g. BWSC, cast iron, ductile iron, mild steel, GRP, HDPE, PVC and MDPE are technically desirable in the materials selected for the evaluation. The major advantages and limitations of BWRC, ductile iron, cast iron, GRP and steel pipes are shown in the **Table 10-10**

Table 10-10 : Advantages and Limitations of Selected Pipe Materials

Pipe Material	Advantage	Limitation
Ductile Iron	Strength and toughness Resistance to pressure fatigue Ease of jointing. Flexible joints tolerate some deflection Well established method of repair Easy location and leak detection Imported bedding not required	Not good for aggressive soils Requires protection against internal and external corrosion Potential rise in pH while conveying soft water Corrosion protection system at risk in certain soils Corrosion protection system susceptible to impact and accidental damage Susceptible to attack by stray currents
Cast Iron	Long life can be used in slightly aggressive soil. Easy jointing Well established method of repair	Heavy and difficult to transport Due to brittleness they break or crack easily
Steel	Strength and Toughness Resistance to pressure fatigue Ease of jointing Can be welded to form leak free and load resistant system Flexible joints tolerate some deflection Impermeable to organic contaminants Well established method of repair Easy location and leak detection Can be produced to any diameter and pressure rating	Not good in aggressive soils Requires protection against internal and external corrosion Potential rise in pH conveying soft water. Corrosion protection system susceptible to impact and accidental damage. Welded joints require special equipment and framing Cathode protection system requires regular maintenance. Susceptible to attack by stray currents The walled pipes with large diameter to thickness ratio rely on support from soil. Thin walled pipes jointed with mechanical fittings may suffer breakage.
Bar Wrapped Steel Cylinder	Longevity Strength Corrosion Resistance Durability Economical Easy location and leak detection Can be produced to large diameters and pressure rating	Pipes have to be tailor made. Accordingly close monitoring of quality control of raw material and finished product required. Laying and jointing has to be under skilled supervision. Handling of pipes during transportation requires care to avoid damage to mortar cover. The weld joints are to be covered with special cement mortar require special attention.
Glass	Longevity	Pipes have to be tailor made. Accordingly close

Pipe Material	Advantage	Limitation
Reinforced Pipes	Strength Corrosion Resistance Durability Economical Can be produced to large diameters and pressure rating	monitoring of quality control of raw material and finished product required. Laying and jointing has to be under skilled supervision. Back filling and bedding is to be done carefully to prevent deflection due to subsidence and ground movement

282. For operation and maintenance of pipelines in the selected materials, PHED is familiar and experienced. They already have trained manpower and a strategy of maintenance for steel, Ductile Iron and cast iron pipes. However, they have less experience in operation and maintenance of GRP pipes. Structurally, all the materials mentioned above will be able to withstand the expected internal water pressure and external loading.

283. For final selection of the appropriate pipe material an economic comparison has been made amongst the selected ones for equivalent working pressure of water. It has been found that the cost differential between cast iron and ductile iron pipe is low. Cast iron pipe is marginally costlier than ductile iron by about (5 percent). It is also observed that for large diameter, steel pipes are cheaper than ductile iron and cast iron pipe by more than 30 percent. Cost differential between ductile iron and steel pipe for small diameter pipe (300 mm) is less of about 5 percent. BWSC and GRP pipes are cheaper compared to steel pipes of same diameter and pressure rating by as much as 20 to 30 percent. A final selection of pipe material will depend on actual cost comparison for a particular situation of pipe size, length and pressure requirement. In case of Distribution system, it is proposed to use HDPE pipe as the same provides a cost effective solution with long life, easy installation and practically little leakage loss. MDPE pipe will be used for providing service connections to consumers. In case of rising main DI K7 pipe has been proposed.

Mechanical Works

(i) Specific speed of the pump shall be in the range of 2,000 to 3,000

(ii) Suction specific speed at available NPSH shall be in the range of 8,500

8. RWPS Pumps

284. A Raw Water Pumping Station is planned for pumping 105 MLD raw water to WTP inlet chamber through a 50 m long 800 mm Dia. rising main pipe line. (Considering 23 Hrs. pumping) Configuration of 3W+2SB has been adopted. Details are given in **Appendix D-1**. The pump selection has been made with above criteria; refer **Appendix D-2 and D-3**. It has been found that 4 VT pumps with 1 stage with 500 rpm (Synchronous speed 3378.7) gives a solution for best efficiency. Provided minimum submergence is being provided. However this combination is not marketed as such adopt second best option of 3 W +2SB. Thus provide 3W+2S pump sets. Discharge for each pump shall be 423 LPS; head will be 7 m, efficiency of pump 82 percent (Refer **Appendix D-4**) and efficiency of motor taken as 94 percent (High efficiency motors available are proposed). Motor KW for each motor shall be 45, refer **Appendix D-5**. If some bidder offers lower efficiency then evaluation and bid comparison should be made by loading Rs 78083(capitalized power cost) per point of lower efficiency quoted, refer **Appendix D-4** for calculations. The pump shall conform to IS 1710 – 1989 Specification for vertical turbine pump and IS 5120–1992 Technical Requirements for Roto-dynamic Special Purpose pumps and tested to class 3 of IS: 9137-1978 Code for acceptance tests for Centrifugal, mixed flow and axial flow pumps

285. *Suction Bell mouth and Column Assembly.* A flanged bell mouth shall be provided at inlet to bowl assembly to admit flow at low velocity for vortex free operation. Considering design velocity at entrance of bell mouth as 1.2 m/s the diameter of suction bell mouth shall be 800 mm. Diameter of column pipe shall be 600 mm and thickness of column pipe shall be 6 mm as worked out in **Appendix D-6** as per IS 3589 for steel pipe. The column pipe shall be flanged. All column pipes shall be of 1.5 m length except for makeup piece. Length of column assembly shall be 7.5 m approximately.

286. *Impeller Shaft and Line Shaft.* The Impeller shaft and line shaft shall be circular in section of stainless steel AISI 410/416. Shaft diameter shall be based on speed, power transmitted, axial thrust and corrosion allowance. Diameter of line shaft shall be same as that of impeller shaft. The combination of shaft diameter and bearing spacing shall be such that first critical speed is at least 25 percent above the operating speed. Shaft coupling shall be screwed or muff type coupling. However, the bearing spacing for line shaft shall not be more than 1.5 m. Length of each line shaft shall be 1.5 m or less.

287. *Valves and Pipe work.* Considering velocity of 2 m/s, Size of individual delivery pipe shall be 450 mm. Individual delivery pipes, dismantling joint, NRV, Butterfly valves and Sluice Valves shall be of 450 mm. An Air Valve 80mm size shall be provided immediately after the pump discharge Tee. Dual Plat check valve shall be positioned near the pump. The Butterfly valve shall be operated by electromechanical actuator. Rating of NRV and butterfly valve shall be PN 10. A manually operated sluice valve of same size and class PN 10 shall be provided after the electrically operated butterfly valve in the delivery of pump to allow repair/replacement of butterfly valve. A Dismantling Joint shall be provided between NRV and the Butterfly valve to facilitate repair/replacement of valves. Considering design velocity of 2 m/sec the common manifold shall be of 800 mm dia and shall be located outside the pump house. M S Dished end shall be provided on one end of

common manifold.

288. *Lifting Equipment: Manually operated Crane.* Crane capacity is determined on the basis of maximum weight of pump (i.e. weight of Bowl and column assembly plus weight of Discharge Head) or motor to be lifted whichever is higher and safety margin. The crane capacity shall be 2,000 kg, refer **Appendix D-8.** The crane shall be longitudinal, single girder, electrically operated travelling crane. The crane shall have all the three movements' i.e. hoisting, longitudinal travel and cross travel through electrical actuation. The crane shall be suitable for lifting material from loading unloading bay i.e. 10 m clear lift.

289. *Dewatering pump***.** The Wet Well may require to be cleaned intermittently. Water in Wet Well would be dewatered up to the minimum water level by running VT pumps. Further emptying of the Wet Well would be by means of a portable or installed submersible mono block pump with a discharging capacity of 36 cum / hr and 8 m head. The submersible pump discharge would be led to the RWR. The pump shall dewater suction pit size 12*6* 2 m, refer **Appendix D-7**, of CWR in 2 hrs.

9. CWPS Pumps

290. A clear water pumping station is planned for pumping 100 MLD clear water to the 18 OHSR through 300-900mm pumping main pipe line (Considering 23 hours pumping). Different options for pump choice such as turbine/horizontal light, RPM, stages etc. have been considered in **Appendix D-10**. Submergence requirement has been worked out in **Appendix D-11**. It has been found that 2 VT pumps (working) with 1 stage with 1000 rpm (Synchronous speed) gives a solution for best efficiency (Specific speed 2,200.86) provided minimum submergence is being provided. Also double suction horizontal split casing pump 2 no. working, one stage, 1500 RPM give specific speed of 2334.36 as such it also gives optimum efficiency. As such for this application turbine pump & HIC pumps are equally suitable from optimum efficiency consideration 50 percent speed by pump sets are proposed. This being turnkey contract choice of turbine or HSC pump will be left on contractor to provide least cost solution available in market after considering capitalized cost of energy consumption also

291. *BKW Absorbed and Motor Rating***.** Maximum efficiency attainable is 88percent for pumps, refer **Appendix D-12**. Motor efficiency for efficient motors has been taken as 94 percent. Discharge of each pump shall be 604 LPS and head shall be 48 m. Motor rating as worked out in **Appendix D-13** is 380 KW. If some bidder offers lower efficiency then evaluation and bid comparison should be made by loading Rs 735597 (capitalized power cost) per point of lower efficiency quoted, refer **Appendix D-12** for calculations. The pump shall conform to IS 1710 – 1989 Specification for vertical turbine pump and IS 5120–1992 Technical Requirements for Roto-dynamic Special Purpose pumps and tested to class 3 of IS: 9137-1978 Code for acceptance tests for Centrifugal, mixed flow and axial flow pumps.

292. *Suction Bell mouth and Column Assembly***.** A flanged bell mouth shall be provided at inlet to bowl assembly to admit flow at low velocity for vortex free operation. Considering entrance velocity of 1.2 m/sec, Diameter of suction bell mouth shall be 800 mm. Diameter

of column pipe shall be 600 mm and thickness 6 mm as per IS 3589 for steel pipe. The column pipe shall be flanged. All column pipes shall be of 1.5 m length except for makeup piece.

293. *Impeller Shaft and Line Shaft***.** The Impeller shaft and line shaft shall be circular in section of stainless steel AISI 410/416. Shaft diameter shall be based on speed, power transmitted, axial thrust and corrosion allowance. Diameter of line shaft shall be same as that of impeller shaft. The combination of shaft diameter and bearing spacing shall be such that first critical speed is at least 25 percent above the operating speed. Shaft coupling shall be screwed or muff type coupling. However, the bearing spacing for line shaft shall not be more than 1.5 m. Length of each line shaft shall be 1.5 m or less.

294. *Valves and Pipe work***.** Considering optimum velocity for sizing of the delivery piping and valves, 2.0 m/s, the size of individual delivery pipe shall be 600 mm. Individual delivery pipe, dismantling joint, NRV, Butterfly valves and Sluice Valves shall be of 600 mm. An Air Valve 80mm size shall be provided immediately after the pump discharge Tee. Dual Plat check valve shall be positioned near the pump. The Butterfly valve shall be operated by electromechanical actuator. Rating of NRV and butterfly valve shall be PN 10. A manually operated sluice valve of same size and class PN 10 shall be provided after the electrically operated butterfly valve in the delivery of pump to allow repair/replacement of butterfly valve. A Dismantling Joint shall be provided between NRV and the Butterfly valve to facilitate repair/replacement of valves. Common delivery Manifold shall be 800 mm dia on the basis of velocity of 2m/sec. M S Dished end shall be provided on one end of common manifold.

295. *Lifting Equipment: EOT Crane Capacity***.** Crane capacity is determined on the basis of maximum weight of pump (i.e. weight of Bowl and column assembly plus weight of Discharge Head) or motor to be lifted whichever is higher and safety margin. The capacity of crane shall be 5000 kg, refer **Appendix D-14**. The crane shall be longitudinal, single girder, electrically operated travelling crane. The crane shall have all the three movements' i.e. hoisting, longitudinal travel and cross travel through electrical actuation. The crane shall be suitable for lifting material from loading unloading bay i.e. 10 m clear lift.

296. *Portable Fire Extinguishers***.** To fight incidences of accidental fires, portable fire extinguishers of CO_2 type 4.5 kg capacity, 4 nos. are to be provided in the pump house. Placement of these equipments shall have easy access.

10. Overhead Service Reservoirs

297. At present there are only 4 service reservoirs and these are not used. The water is supplied directly from tube wells which are connected to the distribution system. The capacity of existing reservoirs is grossly inadequate. It is proposed to supply water through service reservoirs. This is to take care of variation in water demand over the 24 hours. The pumping into reservoirs can be at constant flow rate and withdrawal from reservoirs can be as per fluctuating water demand. In case of pumping directly into the distribution system, the pumping head will vary due to variation in demand and as such the pump does not operate at peak efficiency point resulting in more energy cost. Also at peak demand

time the flow in distribution system is less than the demand and as such pressures are not sustained.

298. Water from Clear Water Reservoir will be pumped to OHSRs through the ring pumping main for further distribution. Eighteen Service Reservoirs will be constructed in 18 zones. One of these will be located on hill top and as such will be constructed on ground without staging. All other 17 reservoirs shall be on 20 meter staging. Staging of 20 meter gives overall cost effective design as increase in staging will increase pumping cost and will also increase cost of construction of reservoirs. Due to increase in staging reduction in cost in distribution system does not compensate the additional cost as most of the pipe sizes proposed are of minimum diameter and would remain so even if extra head is available. Moreover extra head increase percentage losses due to leakages and NRW. Suitable sites for all SRs were identified and finalized considering the availability of land, radial distribution system and centralized location in the zone, elevation and accessibility and feasibility of laying pumping main to the OHSR. One of the main considerations was to identify government-owned sites to avoid land acquisition.

299. Capacity of reservoirs has been taken as 33 percent of demand in the year 2026. The 33 percent capacity takes care of variation in demand and constant inflow rate. The design period for capacity of reservoirs has been kept 15 years to economize cost of service reservoirs. After 15 years one more reservoir will be constructed in each distribution zone or alternatively the distribution zone will be bifurcated in 2 zones such that one zone will be supplied water from the existing reservoir and other zone will be supplied water from new service reservoir.

Table 10-11: Details of Proposed OHSRs

Zone No	**Demand (2026)**	**Storage Required**	**Capacity Proposed**	**Staging Height**	**OHSR Location**	**Land Ownership**
	ML	*ML*	*ML*	*m*		
Zone 1	4.09	1.35	1.50	20	Virat Nagar	Government
Zone 2	4.02	1.33	1.50	20	Model Town	Government
Zone 3	3.63	1.20	1.25	20	Ali Park	Government
Zone 4	3.27	1.08	1.25	20	Canal Camp	Government
Zone 5	4.37	1.44	1.50	20	Satkartar Colony	Government
Zone 6	3.53	1.16	1.25	20	Kabri Road	Private land
Zone 7	5.86	1.93	2.00	20	Ram Nagar	Government
Zone 8	3.16	1.04	1.00	GL	Geeta Colony	Government
Zone 9	5.38	1.77	1.75	20	Gandhi Park	Government
Zone 10	6	1.98	2.00	20	Chawla Colony	Government
Zone 11	3.69	1.22	1.25	20	Veterinary Hospital	Government
Zone 12	4.15	1.37	1.50	20	Housing Board	Government
Zone 13	4.23	1.39	1.50	20	Sanjay Park	Government
Zone 14	4.58	1.51	1.50	20	Khadi Ashram	Government
Zone 15	5.72	1.89	2.00	20	Housing Board	Government
Zone 16	4.27	1.41	1.50	20	Bharat Nagar	Government

Zone No	Demand (2026)	Storage Required	Capacity Proposed	Staging Height	OHSR Location	Land Ownership
Zone 17	5.07	1.67	1.75	20	Moti Colony	Government
Zone 18	4.86	1.60	1.75	20	Kabulbag Colony	Government
Total	**79.88**	**26.36**	**27.55**			

11. Instrumentation, Automation SCADA

300. It is proposed to provide a SCADA system in the CWPS control room with access to Raw Water Pump House, CWPS, WTP and OHSRs including distribution system. This will make the total system controllable from one point. Haryana PHED is already exposed to SCADA for WTP at Rohtak. Thus it will be appropriate to extend the scope of SCADA to OHSRs. Control of distribution system through SCADA may be taken up at a later date when operational staff becomes friendly with the new system. This will reduce the requirement of additional man power for operating new assets. This will improve performance of the equipment and other assets being provided and make water supply more reliable with water quality being ensured. With the introduction of remote reading water meters and installation of bulk meters, it would be possible to control losses in the system, issue water bills accurately and in time. It would be possible to take timely action for disconnecting water supply to defaulting consumers or take other measures prescribed.

301. In water supply, instrumentation is carried out for monitoring various parameters of water as well as other parameters. Amongst these parameters are flow, pressure, level, temperature, turbidity, PH, chlorine residual, vibration, electrical voltages, current, power factor etc. In addition to these some of controlling elements such as switches viz., level switch, pressure switch, flow switch etc are used.

302. This instrumentation system is useful to coordinate various stages & their Components of water supply system by way of various control elements in the system. In the case of Pumping stations following benefits can be accrued by way of automation.

(i) Hydraulic monitoring & control.
(ii) Electrical parameter monitoring
(iii) Equipment i.e. Pump monitoring.
(iv) Emergency response for stopping pumping, i.e. earthquake line burst etc.
(v) Minimization of energy cost
(vi) Aid to man power.
(vii) Online efficiency monitoring
(viii) Other benefits such as logging, reporting, preventive maintenance, safety etc.
(ix) Human errors are minimized
(x) Rate of flow and total flow monitoring

303. In respect of WTP, total operation of the plant can be made from the control desk, like filter wash, de-sludging, chlorination, chemical dosing regulation etc. In addition to this,

online measurement of turbidity, residual chlorine and other parameters will have salutary effect on water quality assurance.

304. The control system is based on the use of Programmable Logic Controllers (PLCs). The modes of controls are.

(i) Auto
(ii) Semi auto
(iii) Manual

305. It is also that suggested to have PC based Supervisory Control and Data Acquisition system. However if it is required to be operated from long distance by way of using any medium of communication it is classified as central SCADA. In the present case SCADA will also control level in OHSRs by sensing water level in them and operating inlet valves of OHSR remotely. It will also record meter readings of bulk meters installed near OHSR and outside CWPS in addition to raw water flow through WTP.

306. *Design Considerations***.** Each instrumentation system shall be designed, manufactured and installed to achieve the following basic requirements.

(i) To maintain highest standards of availability, reliability, accuracy and to give clear warnings of any deterioration in performance.
(ii) To Suit the abilities of staff who will use and service the system.
(iii) To measure, indicate process, store and control the relevant parameters as specified.
(iv) To give clear warnings of dangerous and abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assess the safety of O & M personnel and plant, to collect & store data as required.
(v) To derive, present and utilize such additional data to facilitate most efficient operation and routine maintenance of the plant.
(vi) To suit environment at site.

307. *Automation***.** The following criteria shall govern the design requirements of the necessary components, sub systems and the whole hardware and software of automation/local SCADA system.

(i) Fail safe Design
(ii) System Availability
(iii) Equipment Reliability
(iv) Expandability/Flexibility
(v) User Friendly
(vi) Fault monitoring and diagnostic capability.
(vii) Redundancy.

308. The above requirements are elaborated further as follows:-

Fail Safe: The hardware and software modules, subsystems and total system shall be designed so as to be fail-safe. The system shall be designed such that loss of Power supply shall not result in any control action i.e. status quo shall be maintained.

System Availability: System shall be designed with extensive self diagnostics and troubleshooting features.

Expandability / flexibility: The system shall be expandable with respect to all subsystems in order to allow growth of the controlled system network i.e.

- Addition of controllers
- Addition of Operation interface equipment
- Increase of communication capability on data equipment bus and Communication
- Connection to additional computer systems.
- Addition of I/O System.
- The System Supplied shall be easily configurable to allow changes at site. All software functional modules shall be reconfigurable without requiring hardware additions or modification.

User friendly: The System shall be provided with built in help functions and be operator friendly for easy man-machine Communication. It shall be possible for an Operation / Maintenance Engineer to program the system for any complex application easily without employing a trained programmer, debugging aid shall be provided for software testing.

Fault monitoring and diagnosis capability:

- All equipment and system shall have a self checking and diagnosing capability for internal faults
- Signaling and indication of faults at card level shall include common alarms and Individual alarms

Redundancy: Redundancy of the system is proposed at control room by way of keeping hot standby.

309. All the signals from the instruments will be terminated at PLC. PLC will be provided in the instrumentation control panel near MCC panel (motor control centre panel). PLC will be requiring Operator inter face unit. From the MCC the pumps can be operated manually. The safety of the pump can be observed by way of using various parameters which are as follows.

(i) Electrical parameters i.e. under voltage, overload current.
(ii) Level in sump very low
(iii) High winding temperature
(iv) Not opening the discharge valve
(v) Any other electrical faults
(vi) Not switching more than one pump at a time.
(vii) Pressure on pump discharge

310. The PLC is programmed as per the philosophy of pump operation and required safety for automation purpose.

SCADA

311. The PLC will be connected to PC in pumping station cabin where minimum electrical interference will be there. The system can be operated either through its work station or through PC in control cabin. Similarly the same can be operated in auto-mode/ semi auto-mode. The following features will be provided on PC:-

(i) Dynamic information on PLC panel in pump room.
(ii) Generating bar-charts, trends, logs, report, mimic diagrams etc

312. Changing the color, flash the variables, annunciate audible chimes and equipment symbols to indicate alarm, change of status and certain predefined operating conditions. Alarm conditions shall be displayed in red color. There shall be reserved space for display on the screen. Should an older incident be on display and a new alarm occurs, the most recent page shall appear automatically. The alarm messages shall be printed in strict chronological order irrespective of type of alarm on the printer. Alarm acknowledgement shall be there on operator's key board. Very frequently occurring alarms shall be ignored by way of carrying out changes in the software. All return to normal messages shall be removed by pressing alarm reset push button on keyboard. Bad inputs shall be displayed on screen in area reserved for adequate messages. Any software and hardware faults detected by self diagnostic checks shall be displayed on the screen. Selected alarm messages on processing of acceptance and specified keys shall automatically bring out relevant mimic diagrams on the screen without having to select them. The alarm display list for analog and digital inputs shall contain type of alarm (minor or major) time of occurrence point no., point description, alarm type e.g. Lo, Lo-Lo, Hi, Hi- Hi, alarm limit value, the point description shall be displayed in bold characters on alarm screen.

The display list of individual analogue and digital inputs shall contain the following data

(i) Point number
(ii) Point description
(iii) Current value in engineering units for analogue and current contact status (open close etc.) for digital inputs:
(iv) Sensor / transducer for number
(v) Current alarm status
(vi) Alarm limits for analogue only.
(vii) The time will be displayed in a reserved space on the screen.
(viii) The System will store data for selected analogue parameter and will be able to generate the display trend plots.
(ix) Alarms which are returned to normal should be logged separately in 'Event' list. Event will be printed in chronological order.

313. The System can provide for composing the summaries of points with similar status. On the Operators command summary of existing alarms, 'Bad point' summary, summary of alarm limit changes for the day, summary of automation system faults including associated Power supply faults can be displayed or printed. The system shall be provided with extensive security features to prevent unauthorized access to the system.

314. *Logs and Report*. All alarms and abnormal system conditions can be recorded on the printer. The application software can generate the Periodic logs, shift report, daily report, monthly report, automation system fault log, equipment service log reports in the required formats.

315. *Alarm Annunciator***.** It is essential to provide alarm annunciator in pumping room. In view of this microprocessor based alarm annunciator shall be provided for generating audio visual alarms for each abnormal condition in the pumping room. The following alarms shall be provided on the alarm annunciator. For digital signals which have to be wired to alarm annunciator as well as to PLC, multiplication relays (with minimum 2 No + 2NC potential free contacts) shall be provided for multiplying the digital signals. Potential free contacts of the multiplication relays shall be wired to the alarm enunciator and to the PLC Alarms.

316. Pump tripped on overload (for each Pump)

(i) Pump bearing/motor winding/motor bearing temperature High/very High (common group alarm for each pump motor set)
(ii) Low level in sump
(iii) PLC trouble
(iv) Emergency stop operated
(v) Battery and battery charger trouble
(vi) UPS for SCADA system trouble
(vii) Water quality trouble
(viii) The above alarms are indicative and may vary as per actual requirement.

317. *Instrument power supply cables and instrumentation signal cables*. For digital signals and power supply to instruments – 600V grade multi-core cables, multi-stranded high conductivity annealed 1.0sq.mm stranded tinned copper conductor, extruded PVC insulated, with aluminum Mylar tape, a TC drain wire run continuously in contact with aluminum tape, inner sheathed with extruded PVC, armored with galvanized steel wire overall sheathed with extruded PVC.

318. For analogue signals and signals from temperature sensor 600 V annealed, tinned, high conductivity 1.0 sq. mm stranded copper conductor extruded PVC insulated two/three cores twisted into pair/triad, laid up collectively, individual pair/triad shielded and overall shielded with aluminum Mylar tape, ATC drain wire run continuously in contact with aluminum side of the tape, inner sheathed with extruded PVC, armored with galvanized

steel wire, overall sheathed with extruded PVC.

319. *Protection against surges.* Outdoor installed instruments viz., flow meters will be protected against indirect lightning stroke and other surges by providing lightning protection units at both ends of the signal cable. Indoor installed instruments will be protected by surge protection devices. Protection of field instruments: Field instruments will be protected against physical damage, rain, theft etc.

12. Power supply & Electrical Works

320. The voltage for control system and power supply for the instrumentation and control equipment shall be 24V DC. The 24V DC shall be derived from 230V AC from LV switchboard of the pumping station using rectifier/DC power supply system and having a battery backup. The DC power supply system shall consist of battery and battery charger and shall supply DC power to the control system without interruption in case of failure of mains power supply. On line uninterruptible power supply (UPS) system with one hour back up time at full load for the local PC based SCADA system will be provided. Regular supply of 230V, single phase shall also be made available for general purpose.

321. *Earthing.* A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated on to this bus. This bus will be connected to an electronic pit.

Proposed Electrical Works

322. The electric load comprises of 3 numbers 380 KW motors (2W+1S) and 5nos. 45 KW (3W+2S) as main load and auxiliary load of air compressor, valve actuators, dewatering pump, EOT crane, pump house, WTP and campus lighting, Battery Chargers etc. A 33 KV power line will be erected by Electricity Department from the nearest 132 KV GSS about 6 KM away. An electric substation of 33/6.6 KV with auxiliary substation of 33/0.4 KV will be constructed near CWPS. The substation will have Two 1.5 MVA main and two 315 KVA auxiliary transformers.

323. As per CPHEEO manual on Water Supply, electric motors of 250 KW and above should be of HT type of 3.3 or 6.6 KV. In the present case, motor rating is 380 KW. It is proposed to go for 6.6 KV motors for main pumps in CWPS and LT motors for RWPS pumps and all auxiliary load in CWPS and LT motors WTP.

324. It is proposed to take the outgoing cables from the secondary terminals of 33x6.6kv transformer to MCC incoming in CWPS and cable form secondary terminal from 33x0.4kv transformer to MCC LT panel in RWPS. LT supply to both WTP and CWPS will be taken from RWPS LT panel.

325. *6.6kV MCC.* A 6.6kV MCC is suggested at MCC room in Clear Water Pumping Station to cater power supply for 375 KW H.T motors. The MCC consists of 2nos of 6.6kV, 400A

VCB as incomers along with a bus coupler of same capacity. The incomers are connected to the secondary of the main transformer with suitable sized 6.6kV XLPE cable. The MCC shall be provided with 3Nos of 6.6kV 400A VCB out going feeders for H.T motors. Under normal condition bus coupler shall be kept in open condition and incomers will be feeding bus number 1 and 2 separately. In case of a failure of any transformer, corresponding incomer is open and bus coupler is closed so that total pumping load will be fed by single healthy transformer.

326. *H.T Motor Starting***.** The fault level calculation of suggested electrical system has been carried out; the fault level at 400 KW motor terminals works out to approximately 34.6 MVA. If we go for a DOL starting the starting MVA works out to 3.33 and voltage dip at the time of starting works out to 13.5 percent while with soft starter the starting MVA is 1.67 and voltage dip at the time of starting works out to 9 percent. The maximum limit of dip is 15 percent. For DOL starting, the dip is very close to maximum limit hence Soft starter option is being proposed. It is further proposed to provide one Soft Starter for a group of 2 motors and one for the remaining one motor to economize.

327. *Capacitor Banks.* For 6.6 kV motors it is proposed to install 80 KVAR fixed capacitors banks across motor terminals. The power factor value at each motor terminal is proposed to be increased to 0.98 with this intervention.

328. *Cables and Cable Carrier System.* XLPE insulated aluminum armored cable shall be provided for all 6.6kV loads, incomer of MCC etc.PVC insulated aluminum armored cable shall be provided for all LT power loads. Copper cables shall be used for all cable sizes up to and including 6 sq mm. Built up trench shall be provided for laying of cables outside the pumping station building and those inside shall be laid on cable trays of ladder type or perforated type supported on MS angles.

329. *H.T. Cable Design.* H.T. cable sizes shall be based on actual current, derating factor and fault current for 1 sec. Derating factor for 45° c ambient temperature = 0.9

Table 10-12: Details of Load Descriptions

S. No.	Load Description	Rating	Full load current Amps	Current D.F.	Cable size Sq.mm	Cable runs
1	Transformer to MCC 6.6 KV	800 KW	70	80	3c x 70	1
2	MCC to 6.6 KV Motor	400 KW	35	40	3c x70	1
3	MCC to 6.6 KV Capacitors	80 KVAR	20	22	3c x 70	1

330. *L.T. Cable Design.* All out going distribution feeders shall be SDFs of appropriate rating. All motor starter feeders for motors up to and including 5.5 KW shall have DOL starters and motors above 5.5 KW shall have star delta starters. The selection of SDFs, HRC back-up protection, contactor rating and over load relay range shall be as per type – II co-ordination chart recommended by manufacturer.

Derating factors : 0.9 for 2 cables in a tray touching each other.
: 0.9 for 45^{o}C ambient temperature.
: Overall derating factor = **0.81.**

Table 10-13: Details of electrical items

S. No.		Rating KW	Full load current IL	Current/ derating factor	Cable size	Cable runs	Cable type	Length in meters
1.	Air compressor	10	15	31	3C x 10	1 x 2	AYFY	30
2.	EOT Crane	5	8	31	3C x 4	1	AYFY	15
3.	Valve actuators	1.2	2	3.0	3 x 2.5	1 x 3	YWY	30
4.	Lighting DB	10	15	23	4 x 10	1	AYFY	30
5.	Other unaccounted load.	5	11	16.6	4 x 6	1	YWY	-

331. For Raw Water Pumping Station, the pump configuration has been taken as 3W+2S VT pumps of 45KW each. The Derating factor will remain as 0.81 as mentioned above. The load details and cable size selection will be as follows:

Table 10-14: Details of electrical items

S. No.	Load Description	Rating KW	Full load current IL	Current/ derating factor	Cable size	Cable runs	Cable type	Length in meters
1.	5 VT Pump	45	80	100	3C x 70	1 x 2	AYFY	10
2.	EOT Crane	5	8	31	3C x 4	1	AYFY	15
3.	Valve actuators	1.2	3	3.0	3 x 2.5	1 x 3	YWY	30
4.	Ventilation Load	2	3	5	4 x 10	1	AYFY	30
5.	Lighting DB	10	15	23	4 x 10	1	AYFY	30
6.	Other unaccounted load.	5	11	16.6	4 x 6	1	YWY	-

332. Starting will be done through Star Delta Starters. A LT panel with 2 incoming cables and 5 outgoing cables will be provided. Capacitors 10 KVAR each will be installed parallel to the all the motor terminals.

333. Battery and Battery Charger with D.C Distribution Boards Closing Coils, Tripping Coils, Annunciation Windows, Indicating Lamps, Auxiliary relays of 6.6kV MCC shall be operated on 48V DC supply. 15 Ampere Hour Battery with Battery charger and D.C distribution Board shall be provided at RWPS.

334. *Lighting System*. Lighting panels are provided at RWPS and CWPS with 63A MCB

incomer and 10A single phase MCB outgoings. At the incomer of lighting panel shall be provided 100mA ELCBs.

General Design Criteria

335. All electrical equipment will be rated for 50°C designed ambient temperatures. The installation will generally conform to Indian Standards / IEC.

The following assumptions shall be made to arrive at the load:

Load Factor

(i)	Main motor	:	0.9
(ii)	Auxiliary load, gate valve motors, etc.	:	0.9
(iii)	Lighting load	:	1.0

Diversity Factor

(i)	Main motor	:	1.0
(ii)	Auxiliary load, gate valve motors, etc.	:	1.5
(iii)	Lighting load	:	1.2

Power factor of MV/LV Motors shall be as per manufacturer's catalogue

Efficiency of MV/LV Motors shall be as per manufacturer's catalogue

336. Energy efficient, high performance motors are proposed for main pump motors for optimum utilization of energy.

337. *Protections***.** The following protections are proposed for switchboard, motors and other plant feeders.

6.6 KV MCC Incomer Feeders

(i) IDMT over current, Instantaneous over current and Instantaneous earth fault protection

Main Motor Feeders

(i) Breaker controlled with electronic comprehensive motor protection relay consisting of following protection thermal overload, locked rotor, short circuit, negative sequence and earth fault.

LV switchboard

(i) The ACB feeders shall be provided with electronic releases for IDMT Short circuit, over current and earth fault.

(ii) The ACB bus coupler feeders shall be provided with electronic releases for IDMT

short circuit and over current.

(iii) The MCCB feeders shall be provided with Thermo magnetic releases for IDMT Short circuit, over current and earth fault.

LV Motors

(i) For motor ratings less than or equal to 132kW shall be provided with overload protection by thermal (bimetal) relays in all the three phases to trip with single phase preventer (SPP)

(ii) For motor ratings above 132kW shall be provided electronic comprehensive motor protection relay consisting of following protection thermal overload, locked rotor, short circuit, negative sequence and earth fault.

338. *Metering & Protection***.** The following metering shall be provided.

(i) 6.6 kV Incomer:

- Ammeters with ammeter selector switch
- Voltmeter with voltmeter selector switch
- kW meter
- Power factor meter
- Kilowatt-hour meter
- Frequency meter

(ii) 6.6 kV Outgoing Feeders: Ammeters with ammeter selector switch

(iii) 6.6 kV Incomer & Bus coupler: Circuit breaker ON, OFF & TRIP, spring charged, control supply healthy and trip circuit healthy.

(iv) 6.6kV Motor Feeders: Motor ON, OFF & Trip indication (Red, green & Amber), control supply healthy and trip circuit healthy.

(v) LV Incomer: Mains ON (red, yellow & blue)

(vi) LV Motor Feeders**:** Motor ON, OFF & Trip indication (Red, green & Amber)

339. L.T motor up to and equal 5.5kW shall be provided with DOL starters, motor ratings above 5.5kW up to or equal to 200kW shall be provided with Star delta starters and all motor above 200kW shall be provided with Reactance soft starters. If a motor rating goes beyond 200kW then H.T motors shall be used with voltage supply 3.3kV/6.6kV. The method of starting shall be either DOL or soft starter such that voltage dip during starting shall be within 15 percent.

340. The main LV switchboard is proposed with 'Form-4' enclosure as per the Indian Standards. All indoor boards/panels and motors are proposed with a degree of protection of IP 54, while all outdoor equipment will be with a degree of protection of IP55. Necessary metering, protections and indications will be provided on the LV switchboard.

341. All power cables shall be sized based on continuous current capacity, permissible voltage drop and short circuit current rating. The voltage drop will be limited to 2.5 percent at

rated equipment current rating. The other rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, depth of laying, etc. shall also be considered for cable sizing.

342. All LV power cables up to 6 sq mm shall have stranded copper conductors and above that, it shall be stranded aluminum conductor. Power cables shall be XLPE / PVC insulated, extruded inner and outer sheaths and galvanized flat/wire armoring. The main L.V cable from transformer secondary to the incomer of main L.V switchboard which is laid directly in ground shall be XLPE insulated. The outgoing cables from main L.V switchboards and Sub distribution boards which are laid on cable trays and trenches shall be PVC insulated. Control cables will be with stranded copper conductor, PVC insulation, extruded inner and outer sheaths and galvanized flat/wire armoring

343. The illumination levels for various areas shall be considered as follows:

Area	Illumination level (Lux)
Pump House	200
Office Room	300
Switchboard Room	200
Cable Galleries	150
All other indoor areas	150
Outdoor plant area and Road	10 – 20

344. The earthing shall be carried out as per IS: 3043. The material of ear thing conductor will be GI. The values of fault level for designing the electrical system shall be based on transformer capacity, its impedance and system fault level. Fault clearing time for sizing of earth conductor will be taken as one second. While sizing the buried earth conductor, a corrosion allowance of at least 20 percent shall be taken. Plant ear thing system shall be designed such that the overall ear thing grid resistance is maximum one ohm. Main ear thing conductors outside and inside the building shall be planned in such a manner that various equipments are connected to ear thing system by two connections in a reliable manner. Earth leakage Circuit Breaker (ELCBs) shall be provided at the incomer of lighting panels.

345. *Compliance to Standards***.** The electrical safety and clearances will be maintained as per Indian Electricity Rules and CBIP guidelines. The equipment selection and electrical installation will generally conform to the latest edition of Indian Standards (IS) and the International Electro-technical Commission (IEC).

C. Remodeling, Rehabilitation and Expansion of Distribution System

346. As stated earlier, there are no defined distribution zones for supply of water in Panipat at present. The distribution system in Panipat has been generally laid on ad hoc basis. All tube wells are directly connected to distribution pipe lines. Compared to this, in areas served by HUDA, distribution system has been laid on sectoral basis and water is first pumped to a clear water reservoir and then boosted to the distribution system. The total length of existing distribution system has been reported to be around 285 km and comprises of mainly AC pressure pipes and in some cases of CI and PVC pipes. As the pressures in distribution system are generally low, there are very few cases of pipe bursting.

347. It is proposed to remodel the entire system through zones and zonal reservoirs for equitable distribution of water supply at adequate terminal pressure. A detailed hydraulic analysis of the distribution network has been carried out using Water CAD software. Peak factor has been kept as recommended in the Manual. Minimum terminal pressure of 12 m has been proposed in line with recommendations in Manual assuming that houses are one storeyed and that for houses which are more than one storey the individual house hold will boost water in his house. The optimization in the distribution system has been achieved by restricting head loss to less than 5-10 m per km. in the network design many iterations were done to reduce head loss (by increasing pipe dia) in pipes where head loss was more and to increase head loss(by decreasing pipe dia) in pipes where head loss was less. However this was subject to keeping minimum pipe dia of 100 mm as per recommendations in the Manual.

348. *Distribution Network Analysis*. The existing water distribution network was reviewed, rezoned and redesigned, where applicable, to include uncovered project areas and entail strengthening of the existing water distribution system. Water shall be supplied to consumers through 18 Zonal OHSRs. Distribution network analysis is being carried out through Water CAD. The analysis is made with 24x7 water supply concept. The 24*7 concept provides economical distribution system and also prevents entry of pollutants and keep water safe for drinking and as such has been proposed. All consumers will be connected through ferrule connection to control terminal pressure in the system. As mentioned earlier while discussing pipe material selection, HDPE pipe will be used in distribution system main lines and MDPE pipe will be used for service connections. The remodeling and rehabilitation of the distribution system is presented in the following Tables. About 263 km of new pipeline will be laid, and 138 km of existing distribution pipes will be replaced with new pipes. The Diameter of distribution system ranges from 110 – 450 mm. About 79 percent of total length of pipelines will be of small diameter (110-125 mm). Detailed hydraulic network analysis (Zone-wise) using Water CAD is presented in **Appendix D-20** in **Volume I-B: Detailed Designs.**

Table 10-15: Distribution System Remodeling & Expansion:

Zone	New Pipeline	Replacement	Total
	Length (m)	*Length (m)*	*Length (m)*
Zone 1	9,587	5,114	14,700
Zone 2	4,218	5,124	9,342
Zone 3	12,494	4,260	16,754
Zone 4	4,788	2,023	6,811
Zone 5	19,018	5,373	24,392
Zone 6	26,904	759	27,663
Zone 7	10,706	27,784	38,490
Zone 8	8,114	3,994	12,109
Zone 9	11,238	15,436	26,674
Zone 10	18,359	7,103	25,462
Zone 11	9,559	5,876	15,447
Zone 12	10,530	0	10,530
Zone 13	12,569	6,706	19,276
Zone 14	27,577	394	27,972
Zone 15	2,325	11,995	14,320
Zone 16	31,694	11,897	43,591
Zone 17	32,668	16,648	49,316
Zone 18	1,469	3,758	5,227
Total	**253,817**	**134,244**	**388,061**

Table 10-16: Distribution System

Diameter	Pipe	New Pipeline		Replacement		Total	
		Length (m)	*%*	*Length (m)*	*%*	*Length (m)*	*%*
110 mm	HDPE	198,661	78.27	68,792	51.24	267,453	68.91
125 mm	HDPE	17,672	6.90	21,897	16.31	39,569	10.19
140 mm	HDPE	12,748	5.02	11,385	8.48	24,133	6.21
160 mm	HDPE	8,567	3.37	13,565	10.10	22,132	5.70
180 mm	HDPE	5,902	2.32	6,526	4.86	12,427	3.20
200 mm	HDPE	4,791	1.88	4,145	3.08	8,936	2.30
225 mm	HDPE	629	0.24	1,478	1.10	2,107	0.54
250 mm	HDPE	2,229	0.87	3,522	2.62	5,751	1.48
280 mm	HDPE	255	0.10	901	0.67	1,156	0.29
300 mm	HDPE	-	-	124	0.09	124	0.03
315 mm	HDPE	1,590	0.62	749	0.55	2,338	0.60
355 mm	HDPE	383	0.15	877	0.65	1,260	0.32
400 mm	HDPE	389	0.15	268	0.19	657	0.16
450 mm	HDPE	-		25	0.01	25	0.00
Total		**253,813**		**134,250**		**388,063**	

349.. **Specifications:** Detailed material and equipment specifications have been prepared and are presented in **Volume I-C: Specifications**. These specifications will form basis for bid

specifications.

D. UFW reduction

350. Water distribution systems get exposed to pollution loads due to various reasons that pollute the system and the supplies. The health of consumer is at stake and the system needs to be corrected. The water security system thus needs an in depth study and implementation scrupulously.

351. Considerable quantity of water is normally not accounted due to a variety of reasons; some of them are given below:

(i) Leakages in the transmission, distribution network and storage;
(ii) Unauthorized and illegal tapings.
(iii) Wrong and inefficient water meter functioning.
(iv) Un-metered supply.
(v) Insufficient consumer awareness
(vi) Inefficient system
(vii) Drop in pressures due to illegal sucking
(viii) Aging of pipes, corrosion, incrustation etc.

352. Thus the primary function of a water distribution system to reliably deliver adequate good quality and good quantity of water to its customer is not achieved. As such water audit becomes an important and unavoidable issue.

353.. Water distribution systems are changing continuously as a result of growth or decline of demand, changes in water quality, aging of infrastructure, corrosion etc. The performance indicators that are generally adopted for evaluating the system are:

(i) Adequacy: Quantity, Quality, Pressure.
(ii) Dependability: Duration without interruptions, absorption of consumer's shocks
(iii) Efficiency: Better control over Un-accounted For Water (UFW)
(iv) Quality of service: Customer satisfaction regarding aesthetics and above three aspects, better O&M services.

354. In order to achieve the required performance indicators, the present day answer is to divide the reticulation system into District Metered Areas (DMAs).

355. The term District metering is used to describe the method whereby flow meters are installed such that several thousand consumers are supplied via each meter or combination of meters. DMA is a discrete area of a distribution system usually created by the closure of valves or complete disconnection of the pipe network in which the quantities of water entering and leaving the area are metered. The whole system is put under designed pressure. The flow is analyzed to quantify the level of leakage. This enables to determine

more precisely where and when it is most beneficial to undertake leak detection activities. Normally a DMA comprises of 3000 to 5000 consumers.

356. At present there is no water meter installed in Panipat city water supply system. The meters are neither provided on tube wells delivery nor on consumer connections. It is therefore essential that water meters are installed on the delivery of each tube well and also on each of the delivery main at CWPS. This will enable to determine the total quantity of water produced. In addition to these, one bulk water meter needs to be installed at the feeding pipe line of each OHSR to determine the Zonal distribution of water. The total requirement of water meters for production part comes to as below:

(i)	Bulk Meters for pumping mains	1 nos.
(ii)	Bulk meters near OHSR	18 nos.

357. There are reported to be around 27303 connections in the city as on 1.11.2008. All these connections are proposed to be metered. Therefore consumer meters of 15mm size 30000 nos. needs to be provided under this plan. The department may make obligatory on the part of consumers to bring their own water meters at the time of getting new connections or department may charge cost of water meter from the applicant consumer.

358. Provision of these bulk and consumer water meters will help in regular monitoring of water supply and overall gap between water produced and water billed every month on one hand and help in carrying out leak detection and control and there by UFW reduction work on the other hand. This one time investment in metering will ease and expedite the process of DMA evaluation and reduction in UFW. A dedicated team needs to be formed to undertake UFW reduction program involving DMA formation, leak assessment, detection and control etc. The zonal distribution also needs to be designed in a fashion which will help easy formation of DMAs.

359. One of the key components of distribution system contributing to high leakage level is consumer service pipe lines. These are generally of GI pipes which get corroded and starts leaking. These service pipes are not only responsible for high leakage loss but also main source of pollution in distributed water. It would be desirable that all service pipe lines are replaced under the project with MDPE pipe. These pipes have given excellent performance without leakage on long term basis. In future, the service agency also need enforce use of MDPE pipes only for consumer service pipe lines.

360. A continuous exercise of leak assessment, detection and removal is likely to bring down the UFW to below 15 percent level. This will improve the financial condition of the water supply system and thereby reducing burden on the consumers. This also likely to improve consumer satisfaction and reduce chances of water pollution in distribution network.

E. Water Safety Plan

361. The main objective of the water security plan (WSP) is to supply water of a quality that will allow health based targets to be met. WHO guidelines for Drinking Water Quality

(GDWQ) proposed a more effective risk assessment and risk management approach for drinking water quality and its control. The conventional approach of water quality and safety management is focused on testing of drinking water after contamination take place and to control the same. In the WSP approach the study is focused on vulnerable points and remedial measures within the water distribution system which prevents the contamination before it reaches the consumer.

362. In the water distribution systems contamination is mainly caused due to leakages, lack of consumer awareness, cross connections of Sewerage/Storm Water drainage and Water supply network, recalcitrant attitude of the staff and bad O&M practices etc.

363. A Water Safety Plan (WSP) highlights the effective control in water supply systems to produce safe water and reticulate to the consumer maintaining quality at the designed rate of supply. Under WSP, water quality analysis is mainly used for periodic verification of water safety. The design and construction phases of water supply provision should take into account the risks of contamination and provide means of controlling the risks identified and this should take into account the risks of contamination and provide means of controlling the risks identified and this should be based on the concept of a WSP. Control of risks needs good operation and maintenance practices that are simple and rapidly applicable. These practices should help to detect and apply remedial measures at a rapid stage. WSP addresses the following aspects:

(i) The hazards that the water supply is exposed to and the level of risk associated with each.
(ii) How each Hazard will be controlled;
(iii) How the means of control will be monitored;
(iv) How the operator can tell if control has been lost;
(v) What actions are required to restore control and
(vi) How the effectiveness of the whole system can be verified.

364. By developing a WSP, the system managers and operators will gain a thorough understanding of their system and the risks that must be managed. This knowledge can then be used to develop operational plans and identify key priorities for action. The development of a WSP will also identify requirement to support and improve the performance of the water supplies in meeting the water safety targets.

365. WSP will increase the amount of time that the staff spends in the field for inspecting the system and undertaking physico-chemical analysis and reduce the dependence on analyzing samples of water for micro-organisms in a laboratory. Crucially the WSP enables the operators to get to know their system more effectively as they spend more time to identify and control risks rather than just analyzing them.

11. OPERATION AND MAINTENANCE

A. Overview

366. A well designed Operation and Maintenance (O&M) Plan for a water supply system is critical to ensure that the design intent is conveyed in daily operation resulting in maximum benefit to the residents at the minimum possible level of investment. Proper implementation of the O&M plan results in low maintenance costs and ensures longer service life of all system components. A detailed analysis has been performed on the water supply system of Panipat City and modifications recommended as part of this improvement project include the following:

(i) Construction of out lets across Delhi Link Channel and the Delhi Parallel Canal along with the inlet channel

(ii) Construction of Raw water sump and pump house

(iii) Construction of Rapid Gravity Filter Plant 100 MLD in the first phase.

(iv) Construction of a Clear Water Reservoir and a Clear Water Pumping Station near the WTP.

(v) Construction of OHSR, one for each zone. There are 32 zones but in the Phase I only 18 OHSR shall be constructed in the area already developed.

(vi) Laying of trunk main pumping pipe line from the CWPS connecting all OHSRs.

(vii) Providing bulk water meters, one on each pumping main and one near each OHSR.

(viii) To put a SCADA system in place for automatic operation of Raw Water Pump House, WTP, CWPS, All Tube Wells etc.

(ix) Construction of an online boosting pumping station to feed OHSR of Zone no.16 as the elevation of local ground is about 10m higher compared to rest of the town.

(x) Providing of distribution system in the areas not covered so far.

(xi) Providing of distribution system as per new zonal system designed.

(xii) Non Revenue Water assessment and reduction works.

361. The critical issues that will be dealt in development of an O&M Plan will be the maintenance of equipment, pipelines, valves and other appurtenances and the system of providing house service connections.

B. Existing System of O&M

367. The existing O&M plan of Panipat City requires to be upgraded to reflect present day operational conditions and labour/material requirements to handle the existing system and proposed improvements. Presently, as is the situation in most of the Government departments, repairs are performed on need basis without proper analysis directed towards identification and long term rectification of system deficiencies.

368. The Operation and Maintenance issues of the present water supply system in Panipat City are:

(i) Lack of training to enhance skills of O & M staff: No periodic training of O & M staff is arranged by the department to upgrade their skills. The staff mostly learns the O & M practices during job. This leads to improper handling of equipments, which results in untimely damage of equipments.

(ii) Field engineers are responsible for large areas: The jurisdiction areas of field engineers are large. This has resulted in insufficient attendance to the work fronts by the field engineers.

(iii) Shortage of field staff such as fitters, operators, and mechanics: There is shortage of skilled fitters, operators and mechanics in PHED. Because, of this, operational problems are not attended to, in time.

(iv) Lack of motivation of operational and field staff: Operational and field staff is not motivated to perform efficiently in the organization. There is no incentive or reward in performing efficiently to operate and maintain water supply system.

(v) Submersible pump and electrical equipment quality and their repairs: The quality of Submersible pump sets results in frequent breakdowns. There is no system for checking quality of repairs with regard to the post repair performance. This results in recurring breakdowns and lower efficiency resulting in higher electrical consumption.

C. Proposed O&M System

1. Preventive Maintenance

369. Preventive Maintenance of a water supply and distribution system is a set of activities that shall be performed on a regular basis. Preventive maintenance may increase the initial project cost marginally, but will result in economical maintenance of the system over the project life. Specifically in the internal distribution system, Preventive Maintenance will increase the life of water mains and appurtenances, which in turn will assure regular and uninterrupted water supply to consumers. The distribution system is usually the most expensive component of a water supply system and its proper maintenance will reflect on the functioning of a system and its associated service life.

370. Maintenance issues in pipelines will differ from place to place depending on conditions encountered. Selection of suitable pipe material and periodical maintenance is essential to ensure that the public receives protected water supply at the most economical rate with minimum breakdowns, which will ultimately manifest itself as consumer satisfaction. Salient points to be considered while planning are enumerated below:

(i) Inspection of mechanical / electrical equipment such as pumps, valves, capacitors for trouble-free operation and optimum performance

(ii) Equipment shall be chosen of established quality to provide sustained desired performance.

(iii) Newly laid mains shall be tested to ensure leakage level below specified in IS.

(iv) Precautionary measures against corrosion shall be performed

(v) A leak detection survey and control shall be performed through DMAs.

(vi) Ducts shall be provided across streets in large towns to permit easy laying of additional mains, if and where required.

(vii) Provisions of stubs (short length mains) to accommodate a group of ferrule connections where required.

(viii) Use of equipment like submersible dewatering pumps, pipe cutting machines, under pressure cutting machines, pipe detectors, leak detectors, lighting sets, butterfly valves etc.

(ix) Use of proper chlorinators

(x) Preparation of 'ward manuals' with details of mains, valves, hydrants, etc. within a ward or zone

(xi) Maintaining emergency labour teams to work on Sundays and holidays to attend to emergency works

(xii) Liaison with other utilities for proper work co-ordination and reduced interference

(xiii) Adequate staff training

(xiv) Application of SCADA and automation to the extent feasible to improve system reliability and performance.

(xv) System of information dissemination to consumers on possible disruption in supply

2. Breakdown/Emergency Maintenance

371. In case of damage (burst) resulting on a branch main, the following operational sequence shall be adopted:

(i) Labour workforce (skilled & unskilled) shall be mobilized and required materials shall be assimilated and the team shall be directed to the breakdown site.

(ii) Main control stations, senior officers concerned with maintenance and distribution shall be informed of the situation and kept updated on progress.

(iii) The concerned control office shall be intimated to isolate the damaged main and alternative supply arrangements (if possible tankers) for water supply to the localities affected shall be pressed into action.

(iv) Utilities such as Gas, Electricity and Telephones shall be informed on the breakdown and request them to be present at site to ensure contractor co-ordination.

(v) The local traffic police shall be informed to ensure proper traffic regulation.

(vi) Isolation of the water main by closing sluice valves on both the sides. This will have to be done if the pipe is damaged severely (pipeline burst).

3. Maintenance & Appurtenances

372. The objective of installing appurtenances on water pipelines is to permit control of water supply, protect the pipelines and assist with periodical cleaning. Normally installed appurtenances are described below.

4. Sluice Valves

373. Sluice valves are required to control and regulate water supply and shall be provided at key locations. Defects normally reported on the sluice valves are:

(i) Gland leaks: Gland leaks can be rectified by replacing the hemp packing at specified intervals or through visual observation

(ii) Spindle damage: Unequal application of effort results in damage to the spindle, which can be avoided by training valve operators to operate the valve in accordance with manufacturer recommendations on tightening pressure. It is necessary to have spare spindles for the full range to ensure replacement in the shortest possible timeframe

(iii) Partial valve closure: Debris accumulated in the valve seat and around spindle heads causes this problem and can be removed by opening the top cover of the sluice valves. Rounding of spindle heads are a direct consequence of wear and tear and this can be reduced by using specially prepared caps. It is a recommended practice to provide a name plate near the curb or edge of a footpath detailing sluice valves with location, size and direction of opening. This will incidentally reduce the complaint regarding sluice valves getting buried during road construction and/or trench backfill. When possible, sluice valves shall be installed along pavements. Sluice valves in roads where there is intense traffic shall be provided with heavy-duty pre-cast concrete cover slabs to avoid intentional or accidental damage. The longer side of the cover shall be kept parallel to the pipeline to indicate alignment.

(iv) Scour Valves: Scour valves are normally provided at the bottom of pipelines (normally horizontal) and operated to flush and dewater the mains.

5. Maintenance of Service Reservoirs

374. Important aspects to be considered in the maintenance of service reservoir are:

(i) Measurement of inflows / outflows: Supply /Discharge flows shall be measured to ensure that they tally. Water level indicators and flow indicators / recorders shall be in working condition.

(ii) Structural leakage: There shall be no structural damages and leak and shall be promptly repaired as soon as noticed.

(iii) External Pollution: Manhole openings, ventilation shafts and overflow pipes shall be adequately protected and checked periodically to prevent any contaminant infiltration.

(iv) General cleanliness in and around the service reservoirs should be maintained and

observed.

(v) A garden around the service reservoir may be provided for aesthetic considerations.

(vi) A program to clean the service reservoir at least once in a year shall be undertaken. Such cleaning process shall be performed during non-supply times or a facility to by-pass the water supply shall be in place.

(vii) Appropriate measures to prevent entry of unauthorized persons shall be provided.

(viii) All guide and hand railings shall be maintained in a safe and firm condition.

6. Maintenance of Water Distribution System

375. Conveyance and water distribution are items that involve substantial expenditure in a large water supply scheme. For effective maintenance, the entire water distribution system shall be divided into Zones served preferably from one elevated service reservoir. Operation and Maintenance of the water distribution system should be entrusted to a Junior Engineer who shall be the authorised official and controlling authority to receive and deal with complaints. Redressel of consumer complaints promptly is key to success of operational agency. Appropriate registers shall be maintained to record complaints and track follow up action to ensure that the complaint is addressed timely. If the complaint is such that it cannot be dealt with at his level, the Junior Engineer shall promptly refer the matter to a higher authority and also intimate the action taken to the complainant. Frequent vigilance checks in areas receiving maximum complaints shall be made an essential part of the supervisory staff's daily schedule of duties.

7. Distribution System Losses & Leak Detection

376. Wastage of water is the principal problem and concern in a water distribution system. Wastage of water accounts for nearly 40 percent of the total flow and is often due to the following reasons:

(i) Leaks from storage reservoirs due to cracks, leaky joints and valves

(ii) Leakage from water mains due to leaky joints, corroded pipes, fractures in ferrule connections, valves and hydrants

(iii) Leak through abandoned or unused service pipes and damaged pipes

(iv) High pressure in the water distribution system intensifying existing leakage

(v) Leaks in service piping and fittings within the consumer premises due to faulty joints, corrosion, faulty washers or glands in stop valves and faucets

(vi) Unregulated and excessive consumption of water by consumers for garden watering, flushing, cleaning utensils and washing

(vii) Failure to close faucets inside or outside premises willfully or inadvertently or complete removal of taps

(viii) Misuse of protected water for miscellaneous purposes

377. Major areas in a water distribution system that contribute to a high wastage of water are house service piping and connections to public taps, hydrants and leaky plumbing fixtures. Leak in a water distribution system can be significantly reduced or even eliminated through systematic detection and damage control procedures. A program of Leak Detection shall be established for the entire water distribution system such that each section of the system turns up for leak detection at least once in three years. Leaks and damages detected shall be promptly repaired.

378. One other major cause of system loss is unauthorised connections. Procedures for granting connections require streamlining and regulation. The officer in-charge of this operation shall be equipped with the required authority to inspect households for water supply and ascertain the authenticity of an application for a new connection. The procedure for release of new connections shall be simplified and expeditious to encourage people taking connections legally.

8. Pipe Flushing

379. The pipe flushing process involves allowing water at high flow rates through piping to assist removal of deposits and contaminants in the pipelines. In a systematic flushing program, water from the cleaned main is allowed to enter the affected main for cleaning within in an isolated zone of the water distribution system. For effective flushing, a minimum velocity of 1.00 m/s (preferably 1.20 to 2.40 m/s) in the mains flowing full shall be maintained. Water shall be allowed to exit through a hydrant, scour valve or a temporary opening for a period of 5 to 15 minutes.

380.. It is recommended to perform this operation during periods when storage or supply at the source is satisfactory. In some situations, even with high scouring velocity of 1.20 to 2.40 m/sec certain deposits, slime and heavier particles are not eliminated.

D. Public Private Partnership in Water Supply O&M

381. It will be desirable to involve private agencies in O&M to reduce O&M expenditure, improve efficiency and ensure timely preventive maintenance. To achieve this, giving some activities of O&M like new production system from canal, comprising of Inlet channel, Raw Water Pump House, WTP, CWPS, Pumping mains and OHSRs including bulk meters on service /management contract for 5 years is proposed. This will also ensure that designed capacities of water are timely available for distribution. The existing technical employees may continue to look after the maintenance of distribution system. This will also improve the maintenance of distribution system as well as make it possible to work upon water safety plan and better customer service.

382. Another area which may be considered for giving on management contract is water meter reading, billing and revenue collection. This is an area which is mainly responsible for customer dissatisfaction. By giving this work on management contract customer satisfaction level is likely to increase substantially.

12. COST ESTIMATES & CONTRACT PACKAGES

A. Cost Estimates

383. *Basis of Costing*. The proposed cost of this water supply improvements project in Panipat City has been performed based on the following sources:

(i) Design of the Proposed Improvements.
(ii) PWD Standard Schedule of Rates (SOR) of Haryana.
(iii) RUIDP Standard Schedule of Rates (SOR)
(iv) Consultant's data bank and experience on similar projects.
(v) For items not present in the aforementioned SOR, market rates have been taken.

384. Block rates have been determined for construction of WTP, Pumping Stations etc. for projecting the cost of each activity as these works are proposed to be put to bidding on turnkey basis as Lump sum. Reference has been made to prevailing rates for current projects like Rohtak Water supply Project involving construction of Water Treatment Plant with Raw and Clear Water pumping stations.

385. An abstract of estimated costs, in millioin Rs, for the proposed works is presented in **Table 12-1**. Detailed cost estimates are presented in **Volume I-D: Detailed Estimate.**

Table 12-1: Abstract Cost Estimate of Improvement of Water Supply System in Panipat

S. No	Item	Cost in Rs. Millions
1	Providing out lets in WJC Canal and Delhi Parallel Canal of 100 cusecs each and construction of inlet channel up to RWPS site (As per estimate from Irrigation Department)	47.88
2	Construction of Raw Water Pumping Station comprising of Sump, Pump House building and 6nos. VT Pumping sets with required electrical switch gear (Total KW 225)@Rs25000 per KW	5.625
3	Construction of Water Treatment Plant complete of 100 MLD including SCADA system @ Rs.25 lakh/MLD	250.00
4	Construction of Clear Water Pumping Station comprising of Sump, Pump House building and 3 nos. Pumping sets with required electrical switch gear(Total 1140 KW)@Rs25000 per KW	28.50
5	Construction of Clear Water Reservoir near WTP of 10 ML capacity @Rs.2000 per KL	20.00
6	Providing 33 KV Electrical feeder line from 132 KV GSS to WTP site along with construction of 33/11 KV & 33/0.4KV substation 1500KVA & 315KVA (As per estimate of Electricity department)	21.60
7	Cost of land 4 Hectares land required for construction of WTP, RWPH, CWPS, supporting infrastructure etc.@ Rs.100 lakh/hectares	40.00
8	Cost of pumping main pipe line DI complete with valves, chambers, rail line and NHW crossings etc. complete	256.72
9	Construction of 17 nos. OHSR with a staging of 20m and a total storage capacity of 26.75 ML complete in all respect @Rs.8000 per KL and one GLSR of 1 ML @3000	217.00
10	Improvement of distribution system in zones where water supply network already exist or un-served areas by laying of new, additional or higher sized pipelines with required appurtenances, chambers, thrust blocks etc.	251.61
11	Providing Bulk water meters (1 no EMFB type) and 33000 Domestic water meters complete including installation and commissioning	155.00
12	Replacement of consumer service pipe lines with MDPE pipes for 33000 connections @Rs.1500 per connection	54.45
13	NRW Identification and Reduction Works lump sum	214.76
14	Centralized Training Center of PHED lump sum	50.00
15	Sub Total	1613.15
16	Physical contingencies @3%of sub total	48.39
17	Design Supervision and third party inspection @ 3%	48.39
18	Provision for Information Education and Communication @ 1%	16.13
19	Provision for Environmental Mitigation @ 1%	16.13
20	Provision for Institutional Development @ 1%	16.13
21	Provision for Incremental Administration @ 2%	32.26
	Grand Total	**1,790.60**

B. Contract Packages

386. It has been observed that implementing agencies tend to split the work in small packages which results in too many contracts to be procured and monitoring of contract administration, work progress and quality control becomes cause of concern in addition to problem of coordination amongst different contractors.

387. It is therefore proposed to have only following two packages for executing the whole project:

(i) Turnkey contract for Design, Procurement, Construction and O&M of RWPS, WTP, CWR, CWPS, Pumping main pipe line and 18 OHSR including bulk meters, electrical works and SCADA etc.

(ii) Contract for providing, laying and jointing of distribution system and related works, replacement of service pipe lines, providing and installation of consumer meters, road repair etc.

388. The remaining works like construction of outlets, inlet canal, road over bridge on canal etc. will be carried out by state Irrigation department and 33kv electric line will be carried out by Electricity Company. The work of crossing of National Highway and Rail line can be undertaken in the contract if agreed by respective agencies or otherwise these works will be carried out by respective agencies like NHAI, Railways etc.

C. Implementation Arrangements

389. *Implementation Plan.* The whole project is proposed to be executed in a period of 36 months including 9 months for bidding and contract award.

390. *Institutional Set- up.* Public Health Engineering Department, GOH will be executing agency. The controlling officer is Executive Engineer, PHED Dn.I, Panipat and supervising officer is Superintending Engineer, PHED, Karnal. It would be appropriate to have two full time Assistant Engineers dedicated for execution of this project and they should be assisted by supervision consultants.

Appendices

Appendix 1

Appendix 1-A: Details of Tube Wells inside Municipal Boundary

S. No	Name of Location	Location Code	Pump details			
			Pump Discharge	Head	BHP of Motor	Operating Time
			LPM	*m*	*HP*	*hr/day*
1	Old Housing Board I	TW001	800	70	25	22
2	Old Housing Board II	TW002	600	70	20	22
3	Slaughter House	TW003	800	60	20	22
4	Quila W/Works-I	TW004	750	70	25	22
5	Quila W/Works-II	TW005	750	70	25	22
6	Quila W/Works-III	TW006	750	90	30	22
7	Quila 1000ft new	TW007	1200	60	30	22
8	Sukhdev Nagar-I	TW008	600	70	20	10
9	Sukhdev Nagar-II	TW009	600	60	15	10
10	Rajiv Colony	TW010	600	60	15	10
11	Mangewala Ward 11	TW011	600	60	15	20
12	Mohinderwala Ward 11	TW012	450	70	15	20
13	Chandni Bagh	TW013	600	60	15	10
14	Saini Colony	TW014	600	60	15	18
15	SalarganjGate (Devimurthy Colony)	TW015	750	70	25	22
16	Near Lal Maszid Ward 8	TW016	600	60	15	8
17	Green Park	TW017	600	70	20	10
18	Nehru Nagar	TW018	600	70	20	10
19	Ram nagar-I(Melaram Park)	TW019	600	70	20	10
20	Ram nagar-II(Ranjan Park)	TW020	600	60	15	10
21	Jai Dalal Colny(Fatehpuri Chawk)	TW021	600	70	20	10
22	Ashok Nagar (Tehsil camp)	TW022	800	60	20	12
23	Ramesh Nagar (Tehsil camp)	TW023	800	60	20	12
24	Ramesh Nagar-II (Tehsil camp)	TW024	750	60	20	10
25	Sudhir Nagar	TW025	800	70	25	16
26	Preet Vihar colony	TW026	600	70	20	10
27	Patel nagar	TW027	750	48	15	8
28	Bhagat nagar	TW028	600	70	20	10
29	Vet.Hospital-I	TW029	600	60	15	10
30	Vet-Hospital-II	TW030	750	70	25	10
31	Durgamandir Krishanpura	TW031	600	90	25	12
32	Sarai Mohalla	TW032	800	60	20	22
33	Geetha Colony	TW033	600	60	15	10
34	Kataria Colony	TW034	600	90	25	22
35	Netaji colony	TW035	450	70	15	22
36	Bishan Sarup Colony I	TW036	600	70	20	10
37	Bishan Sarup Colony II	TW037	600	70	20	10
38	Sabji Mandi-I	TW038	600	60	15	22
39	Sabji Mandi-II	TW039	600	60	15	22
40	Mahavir Colony-I Mandir	TW040	600	60	15	8
41	Mahavir Colony-II Mal Godown Road	TW041	600	70	20	10
42	Mahavir Colony-III Paliwal Factory	TW042	800	60	20	10
43	Khatican Basti-I	TW043	600	60	15	10
44	Khatican Basti-II	TW044	600	60	15	10

S. No	Name of Location	Location Code	Pump details			
			Pump Discharge	Head	BHP of Motor	Operating Time
			LPM	*m*	*HP*	*hr/day*
45	Khatican Basti-III	TW045	300	60	7.5	6
46	Bank Colony	TW046	600	60	15	10
47	I B School	TW047	800	70	25	16
48	Khadi Ashram	TW048	600	70	20	14
49	Deha Basti	TW049	600	60	15	8
50	Balmiki Basti Jattal Road	TW050	600	70	20	10
51	Shiv Nagar-1 (Advt.Wala)	TW051	600	60	15	8
52	Shiv Nagar-2 (Peer Wala)	TW052	600	70	20	8
53	Shiv Nagar-3 (Gali no.2)	TW053	600	60	15	8
54	Krishanpura 1 (Tankiwala)	TW054	600	60	15	8
55	Krishanpura 2 (Sanjaypark)	TW055	600	70	20	22
56	Krishanpura 3 (Govt.school)	TW056	600	60	15	20
57	Krishanpura 4 (Fatakwala)	TW057	600	60	15	16
58	Booster Ward no.10	TW058	800	60	20	18
59	Sant Nagar	TW059	600	60	15	8
60	Pachranga Bazar	TW060	600	70	20	16
61	Chawla colony	TW061	600	70	20	22
62	Amar Bhavan Chowk	TW062	750	48	15	16
63	Raj Colony Ward 10	TW063	600	60	15	16
64	Khadi Ashram 1000'new	TW064	1200	60	30	16
65	Idgah Colony	TW065	600	60	17.5	14
66	Sadanand Park	TW066	400	90	20	14
67	Lal Tanki	TW067	600	60	15	14
68	Hero Ground	TW068	400	60	12.5	12
69	Stadium	TW069	400	70	17.5	12
70	Gurutegbahadur Colony	TW070	600	70	20	12
71	Gole Market Old	TW071	400	60		14
72	Gole Market New	TW072	800	60	20	14
73	Bosa Ram Chowk	TW073	400	70	17.5	12
74	National Park	TW074	600	70	20	12
75	Rotary Club	TW075	600	70	20	12
76	Kamalia Bhawan Old	TW076	400	70	15	12
77	Kamalia Bhavan New	TW077	600	60	17.5	12
78	New Model Town	TW078	600	70	20	14
79	Virat Nagar Old	TW079	600	70	20	12
80	Virat Nagar New	TW080	600	60	17.5	12
81	Agrasian Colony II	TW081	400	70	17.5	12
82	Shanti Nagar	TW082	600	70	20	14
83	8-Marla Behind Mandir	TW083	400	90	20	14
84	8-Marla Park II	TW084	600	90	25	12
85	8-Marla -III New	TW085	600	90	25	14
86	Dhanak Basti	TW086	400	90	20	14
87	Sat Kartar Colony	TW087	400	70	15	14
88	Deswal Colony	TW088	400	70	17.5	14
89	Azad Nagar Old	TW089	400	90	20	14
90	Azad Nagar New	TW090	600	90	25	14

S. No	Name of Location	Location Code	Pump details			
			Pump Discharge	Head	BHP of Motor	Operating Time
			LPM	*m*	*HP*	*hr/day*
91	Raj Nagar New	TW091	600	90	25	12
92	Raj Nagar Shiv Chowk	TW092	600	70	20	12
93	Sanjay Colony Old	TW093	400	70	17.5	12
94	Sanjay Colony New	TW094	600	90	25	14
95	Weavers colony	TW095	600	70	20	12
96	Adarsh Nagar New	TW096	600	60	17.5	12
97	Hali Park	TW097	400	60	12.5	12
98	Narain Singh Park	TW098	400	70	17.5	14
99	Catering Institute	TW099	400	60	12.5	12
100	Court Complex	TW100	600	70	20	14
101	Bhatia Colony-I	TW101	400	110	25	12
102	Bhatia Colony-II New	TW102	600	70	20	12
103	Hari Bagh Colony Old	TW103	400	60	12.5	12
104	Hari Bagh Colony New	TW104	400	60	12.5	12
105	New Diwan Nagar	TW105	600	70	20	12
106	Katcha Camp School	TW106	400	70	17.5	12
107	Katcha Camp Opp. Shivamandi	TW107	600	60	17.5	14
108	Batra Colony New	TW108	600	90	25	14
109	Labour colony	TW109	600	90	25	14
110	Gandhi Colony	TW110	400	70	15	8
111	Purewal colony	TW111	600	60	17.5	12
112	Gautam nagar	TW112	600	60	15	12
113	Basant Nagar	TW113	600	60	15	12
114	RK Puram	TW114	600	60	15	12
115	Friends Colony	TW115	400	70	15	12

hr/day – Hours per day; HP – Horse Power; LPM – liters per minute; m - meter

Source: PWD - WSSD

Appendix 1-B: Details of Tube Wells inside Municipal Boundary

S. No	Name of Location	Location Code	Pump details			
			Pump Discharge	Head	BHP of Motor	Operating Time
			LPM	*m*	*HP*	*hr/day*
1	Binjhol (28) T/W No.01	201	800	60	15	6
2	Binjhol (28) T/W No.02	202	800	60	15	6
3	Binjhol (28) T/W No.03	203	800	60	15	6
4	Mehrana (29)T/W No.01	204	800	60	15	6
5	Kheri Nangal (31)T/W No.01	205	800	60	15	6
6	Kheri Nangal (31)T/W No.02	206	800	60	15	6
7	Kheri Nangal (31)T/W No.03 Vikas Nagar (VN)	207	800	60	20	8
8	Kheri Nangal (31)T/W No.04 VN	208	800	60	15	6
9	Kheri Nangal (31)T/W No.05 VN	209	800	60	15	6
10	Kheri Nangal (31)T/W No.06 VN	210	800	60	15	6
11	BichpariT/W No.01	211	600	60	15	6
12	BichpariT/W No.02	212	600	60	15	6
13	BichpariT/W No.03	213	600	60	15	6
14	BichpariT/W No.04	214	600	60	15	6
15	BichpariT/W No.05	215	600	60	15	6
16	BichpariT/W No.06	216	600	60	15	6
17	BichpariT/W No.07	217	600	60	15	6
18	BichpariT/W No.08	218	600	60	15	6
19	BichpariT/W No.09	219	600	60	15	6
20	BichpariT/W No.10	220	600	60	15	6
21	NoorwalaT/W No.01	221	600	60	15	6
22	NoorwalaT/W No.02	222	600	60	15	6
23	NoorwalaT/W No.03	223	600	60	15	6
24	NoorwalaT/W No.04	224	600	60	15	6
25	NoorwalaT/W No.05	225	600	60	15	6
26	NoorwalaT/W No.06	226	600	60	15	6
27	NoorwalaT/W No.07	227	600	60	15	6
28	NoorwalaT/W No.08	228	600	60	15	6
29	NoorwalaT/W No.09	229	600	60	15	6
30	NoorwalaT/W No.10	230	600	60	15	6
31	NoorwalaT/W No.11	231	600	60	15	6
32	NoorwalaT/W No.12	232	600	60	15	6
33	NoorwalaT/W No.13	233	600	60	15	6
34	NoorwalaT/W No.14	234	600	60	15	6
35	NoorwalaT/W No.15	235	600	60	15	6
36	Azzizulapur (5)T/W No.01	236	400	60	15	6
37	Nizampur (3)T/W No.01	237	600	60	15	6
38	Simla Molana (2)T/W No.01	238	600	60	15	6
39	Faridpur (17)T/W No.01	239	600	60	15	6

Source: PWD - WSSD

Appendix 1-C: Details of Tube Wells HUDA Area, Panipat

S. No	Name of Tube Well	Location Code	Pump details			
			Pump Discharge	Head	BHP of Motor	Operating Time
			LPM	*m*	*HP*	*Hours/day*
1	Sector.6T/W No.01	301	600	45	20	10
2	Sector.6T/W No.02	302	600	45	20	10
3	Sector.7T/W No.01	303	600	45	20	10
4	Sector.11T/W No.01	304	380	45	20	10
5	Sector.11T/W No.02	305	380	45	15	10
6	Sector.11T/W No.03	306	380	45	20	10
7	Sector.11T/W No.04	307	380	45	20	10
8	Sector.11T/W No.05	308	530	45	20	10
9	Sector.11T/W No.06	309	530	45	20	10
10	Sector.11T/W No.07	310	760	45	20	10
11	Sector.11T/W No.11	311	250	45	10	10
12	Sector.12T/W No.08	312	760	70	15	20
13	Sector.12T/W No.10	313	760	70	15	10
14	Sector.12T/W No.12	314	700	60	15	10
15	Sector.12T/W No.13	315	700	60	15	20
16	Sector.12T/W No.14	316	760	70	20	10
17	Sector.12T/W No.15	317	700	60	15	20
18	Sector.12T/W No.16	318	700	60	20	10
19	Sector.12T/W No.17	319	760	70	20	10
20	Sector.12T/W No.18	320	760	70	20	10
21	Sector.13-17T/W No.01	321	600	45	15	10
22	Sector.13-17T/W No.02	322	150	45	20	10
23	Sector.13-17T/W No.03	323	600	45	20	10
24	Sector.13-17T/W No.05	324	600	45	20	10
25	Sector.13-17T/W No.06	325	600	45	20	10
26	Sector.13-17T/W No.07	326	600	45	20	10
27	Sector.18T/W No.12	327	600	45	20	10
28	Sector.18T/W No.13	328	600	45	20	10
29	Sector.24T/W No.01	329	760	45	15	10
30	Sector.24T/W No.02	330	760	45	15	10
31	Sector.25-I T/W No.01	331	380	45	20	10
32	Sector.25-I T/W No.02	332	760	45	20	10
33	Sector.25-II T/W No.02	333	760	60	15	10
34	Sector.25-II T/W No.03	334	760	60	15	10
35	Sector.25-II T/W No.04	335	760	60	15	10
36	Sector.29-I T/W No.01	336	760	60	15	10
37	Sector.29-I T/W No.02	337	760	70	20	10
38	Sector.29-II T/W No.01	338	600	60	20	8
39	Sector.29-II T/W No.05	339	600	60	20	8
40	Sector.40 T/W No.01	340	600	45	20	2
41	Govt.Land T/W No.01	341	230	45	10	3

Source: PWD - WSSD

Appendix 1-D: Details of Tube Wells constructed in Panipat Town

S. No	Location of Tubewell	Size of Bore (Inches)	Size of Bore Well Pipe	Static Water Level (m)	Year of Drilling	Depth (m)	Length of Filter Pipe				Discharge in GPH	Q in LPM	Draw down
							8-5/8 Stainless steel filter	8-5/8 MS filter	8-5/8 LCG screen	8-5/8 GAL screen			
1	Bishan Sarup colony	27 x 24	12"x 8"	24.4	2001	102.1	40'-3"	30'-0"			20000	946/1262	10'-16'
2	Vetenary Hospital	27 x24 x 22	10" x 8"	42.7	2007	84.9			52'-10"		7000	441.6	15'
3	No.2 Amar Bhawani Chowk	27 x24	10" x 8"	33.5	2008	91.1		36'-1"					
4	I B Collge,Panipat	27 x24 x 22	10" x 8"	39.6	2005	98.1			39'-6"		9000	567.8	15'
5	Bank Colony,Panipat	27 x22	12"x 8"	24.4	1997	82.8		64'-10"			10000	630.9	16'
6	Mahabir Nagar/Colony	27 x 24 x22	10" x 8"	57.9	2007	94.3			52'-8"		9000	567.8	15'
7	Saini colony,Ward no.11		12"x 8"	32.6	2002	78.4		33'-4"					
8	New Geeta Colony	27" x24"	10" x 8"	25.9	2000	123.3		70'-2"			22000	410/1388	16'-20'
9	Geeta Colony	27 x22	12"x 8"	22.9	1997	82.8		65'-11"			11000	694.0	16'
10	T B No.2 at Chandni Bagh Colony	27 x24 x22	10" x 8"	35.1	2004	83.3				57'-5"	5000	315.4	16'
11	M.Karnal		14" x 8"	13.7	1986	79.0		76'-6"			22000	757/1388	15'/23'
12	Sabzi Mandi	24		42.7	2007	81.2		36'-3"					
13	New Sabzi Mandi	27 x 22	12"x 8"	18.3	1998	82.5		96'-1"			15000	946.3	16'
14	Chandni Bagh,Panipat	27 x24 x 22	10" x 8"	39.6	2007	92.7			52'-8"		6000	378.5	15'
15	Netaji Colony,Panipat	27 x22	12"x 8"	21.9	1995	77.6		82'-8"			10000	630.9	10'
16	Kataria colony	27 x 24	12"x 8"	30.5	2001	80.5		70'-0"			15000	946.3	13'
17	Shiv Nagar,Panipat	27 x 22	12"x 8"	30.5	1999	76.8		81'-10"			9000	567.8	16'
18	Shiv Nagar,Panipat	27	12"x 8"	36.6	2002	96.7		58'-5"			5000	315.4	12'
19	Shiv Nagar,Panipat	27 x 24	10" x 8"	33.5	2007	76.7		32'-11"					
20	TB No.3 at Shiv Nagar	27 x24 x 22	10" x 8"	38.1	2004	84.4				52'-7"	4000	252.3	16'
21	Quila Water works	27 x24 x 22	10" x 8"	36.6	2004	81.6				49'-4"	12000	757.0	15'
22	Chawla colony,ward no.11	27 x 24	10" x 8"	38.1	2007	78.9		32'-11"			12000	757.0	16'
23	Bosa Ram Chawk MT	27 x24 x 22	10" x 8"	30.5	2006	95.5			65'-10"		9000	567.8	15'

24	Kamala Bhavan	27 x24 x 22	10" x 8"	32	2004	85.3				57'-3"	15000	946.3	16'
25	Hero Ground Model	27 x 22	12"x 8"	21.3	1997	71.5		61'-6"			11000	694.0	16'
26	Hari Nagar	27 x24 x 22	10" x 8"	24.4	2006	97.1			52'-8"		10000	630.9	15'
27	Bhatia colony	24	10" x 8"	35.1	2007	83.4		39'-1"			13000	820.1	14'
28	Katchcha camp	27 x 22	12"x 8"	21.3	2002	96.6				79'-0"	10000	630.9	15'
29	8 Marla colony	27	10" x 8"	30.5	2002	99.6		46'-6"			10000	630.9	12'
30	No.4 Kacha camp	27 x 24	10" x 8"	35.1	2007	113.1		46'-1"			15000	946.3	
31	Adarsh Nagar	27 x 22	12"x 8"	19.8	1997	77.7		64'-8"			9500	599.3	16'
32	Rotary club model town	27 x 22	12"x 8"	22.9	1998	75.5		74'-8"			1000	63.1	16'
33	Deshwal colony	27 x 24	12"x 8"	22.9	2002	116.7		31'-8"			12000	757.0	13'
34	New Raj Nagar	27 x24 x 22	10" x 8"	29	2007	94.7				54'	12000	757.0	15'
35	District court	27 x24 x 22	10" x 8"		2003	96.1				53'	20000	1261.7	30'
36	Rajnagar(Shiv chawk)	27 x 24	10" x 8"	39.6	2007	123.3		39'-6"			10000	630.9	13'
*37	Gole Market Model Town	27 x 22	12"x 8"	15.2	1996	86.2		87'-8"					
38	Tubewell at Azadnagar		12"x 8"	14.6	1989	76.3		76'-4"			30000	1892.6	13'
	***L.C.G- Low Carbon Grade;M.S- Mild Steel; GAL-Galvanised**												

Appendix 2

"Organisation Structure of Public Health Engineering Department" **Appendix - 2**

Engineer-In-Chief					
Chief Engineer(Urban)		**Chief Engineer (Projects)**	**Chief Engineer(Rural)**	**Chief Engineer** (pogram)	
SE Vigilance	**SE Urban**	**SE YAP**	**SE Planning**	**SE IGDWS**	**SE MM Cell**
EE Vigilance	EE Urban I/ EE Urban II	EE YAP	EE Budget/EE Monitoring	EE Planning /EE Works/EE IGDWS	EE Coordination

S E (Ambala)	**S E (Bhiwani)**	**S E (Faridabad)**	**S E (Gurgaon)**	**S E (Palwal)**	**S E (Hisar)**	**S E (Jind)**	**S E (Karnal)**	**S E (Rewari)**	**S E (Rohtak)**	**S E (Sirsa)**	**S E (Sonipat)**
			E E (D &W)		**E E (D & W)**				**E E (D & W)**	**E E (D & W)**	**E E (D & W)**
E E 1 (SDE-5)	**E E 1** (SDE-4)	**E E 1** (SDE-3)	**E E** (SDE-5)	**E E(P)2** (SDE-4)	**E E 1** (SDE-4)	**E E** (SDE-4)	**E E 1** (SDE-4)	**E E** (SDE-4)	**E E 1** (SDE-4)	**E E 1** (SDE-4)	**E E 2** (SDE-4)
E E 2 Naraingarh (SDE-3)	**E E 2** (SDE-3)	**E E 2 Palwal** (SDE-4)	**E E Sohna** (SDE-3)	**E E(TM)** (SDE-3)	**E E 2** (SDE-4)	**E E Kaithal** (SDE-6)	**E E 2** (SDE-3)	**E E Narnaul** (SDE-3)	**E E 2** (SDE-4)	**E E 2** (SDE-5)	**E E Gohana** (SDE-3)
E E PKL(CHD) (SDE-4)	**E E C Dadri** (SDE-3)		**E E Nuh** (SDE-3)	**E E(P)2 Nuh** (SDE-3)	**E E Hansi** (SDE-3)	**E E Narwana** (SDE-3)	**E E 1 Panipat** (SDE-3)	**E E Mohindergarh** (SDE-3)	**E E 3** (SDE-3)	**E E Fatehabad** (SDE-4)	**E E (D & P)** (SDE-3)
E E 1 Y Nagar (SDE-3)	**E E Tosham** (SDE-3)						**E E 2 Panipat** (SDE-2)		**E E 1 Jhajjar** (SDE-3)		**E E (GWI)** (SDE-2)
E E Mech. (SDE-2)							**E E Kurukshetra** (SDE-5)		**E E 2 Jhajjar** (SDE-3)		
E E 2 Y Nagar (SDE-3)									**E E Bahadurgarh** (SDE-3)		

Appendix 3

Appendix 3- A: Population of Water Supply Zones as per the Master Plan of Panipat

Zone	Wards	Population 2011		Population 2026		Population 2041	
		Wardwise	Zone	Wardwise	Zone	Wardwise	Zone
1	W-31	14,895	17,000	22,532	25,532	34,085	38,360
	W-29p	2,105		3,000		4,275	
2	W-3p	4,211	17,640	6,000	25,135	8,549	35,814
	W-29p	5,917		8,431		12,013	
	W-30	7,512		10,704		15,252	
3	W-2	8,899	16,679	11,588	22,673	15,089	30,884
	W-3p	7,780		11,085		15,795	
4	W-1	17,247	17,247	20,414	20,414	24,163	24,163
5	W-26	9,150	17,428	10,598	19,598	12,275	22,106
	W-25p	4,317		5,000		5,791	
	W-27p	3,961		4,000		4,040	
6	W-24	13,178	19,629	15,375	24,044	17,938	28,005
	W-25p	4,651		5,387		6,240	
	S-32	900		1,555		1,790	
	S-33	900		1,727		2,037	
7	S-1A	11,000	15,500	18,439	28,439	29,916	50,130
	S-34Ap	4,500		10,000		20,214	
8	S-32A	7,500	12,000	11,859	21,030	13,860	25,135
	S-33A	2,000		3,370		3,854	
	S-34Ap	2,500		5,801		7,421	
9	S-35	2,000	12,000	3,208	22,089	3,494	32,316
	S-35A	10,000		18,881		28,822	
10	S-36	5,000	10,800	10,376	23,590	17,856	42,857
	S-37	5,000		11,579		21,845	
	S-37A	800		1,635		3,156	
11	S-38	4,500	9,500	13,616	28,218	31,649	65,438
	S-39	5,000		14,602		33,789	
12	Sp.Zone	10,000	10,000	20,422	20,422	29,266	29,266
13	S-6	1,173	11,777	1,471	20,620	1,845	36,422
	S-7	5,912		10,703		19,375	
	S-8	4,692		8,446		15,202	
14	W-5	10,749	10,749	22,627	22,627	47,632	47,632
15	W-28	8,261	13,876	11,777	19,777	16,790	28,189
	W-4p	5,615		8,000		11,399	
16	W-10	8,176	36,361	8,516	37,332	8,870	38,338
	W-11	11,084		11,544		12,023	
	W-14	7,512		7,587		7,663	
	W-17	9,589		9,685		9,782	
17	W-12	9,091	23,724	9,468	25,141	9,861	26,696
	W-13	6,812		6,880		6,949	
	W-15	7,821		8,793		9,886	
18	W-18	8,558	19,507	9,622	23,081	10,818	27,764
	W-16p	5,589		5,821		6,063	
	W-4p	5,360		7,638		10,883	
19	W-16p	4,800	20,058	5,000	25,937	5,208	34,847
	W-19p	6,625		10,937		18,056	
	W-20p	8,633		10,000		11,583	
20	W-27p	6,880	22,039	6,949	26,417	7,018	32,550
	W-22p	4,820		6,000		7,469	
	W-23	7,310		8,468		9,809	

Zone	Wards	Population 2011		Population 2026		Population 2041	
		Wardwise	Zone	Wardwise	Zone	Wardwise	Zone
	W-19p	3,029		5,000		8,254	
21	W-21	6,378	17,190	15,835	28,624	39,316	54,461
	W-22p	3,082		3,836		4,775	
	W-20p	7,730		8,953		10,370	
22	S-40	6,794	9,255	15,594	22,080	35,790	52,882
	S-19A	2,461		6,486		17,092	
23	S-19	10,000	13,945	20,035	24,935	33,657	39,743
	S-20	3,945		4,900		6,086	
24	S-17	3,401	9,401	6,169	22,460	11,190	42,152
	S-18	6,000		16,291		30,962	
25	S-13	7,000	15,000	13,290	29,696	21,932	51,463
	S-14	8,000		16,406		29,531	
26	S-15	7,000	16,081	17,365	32,785	29,472	50,838
	S-16	4,500		9,352		13,576	
	S-21	2,173		2,819		3,406	
	S-22	2,408		3,249		4,384	
27	S-9p	2,500	18,529	6,000	22,029	10,800	26,829
	W-6	7,708		7,708		7,708	
	W-7	8,321		8,321		8,321	
28	W-8	5,992	15,628	5,992	19,834	5,992	25,682
	W-9	7,636		9,578		12,014	
	S-9p	2,000		4,264		7,676	
29	S-12	7,500	13,000	15,333	27,724	21,296	41,513
	S-23	2,000		3,528		4,263	
	S-24	3,500		8,863		15,954	
30	S-25	8,000	16,000	16,408	33,805	24,612	50,708
	S-28	8,000		17,397		26,096	
31	S-29(1)	5,000	13,000	11,988	30,383	17,982	45,575
	S-29(2)	8,000		18,395		27,593	
32	Sector 30	7,000	10,000	19,929	28,568	29,894	46,168
	Sector 31	3,000		8,639		16,274	
	Total		500,543		805,039		1,224,926

Source: Analysis; KLD – kilo liters per day

Appendix 3-B: Zonal Water Demand as per Water Supply Master Plan of Panipat

Zones	Demand in KLD		
	2011	**2026**	**2041**
1	2,720	4,085	6,138
2	2,822	4,022	5,730
3	2,669	3,628	4,941
4	2,760	3,266	3,866
5	2,788	3,136	3,537
6	3,141	3,847	4,481
7	2,480	4,550	8,021
8	1,920	3,365	4,022
9	1,920	3,534	5,171
10	1,728	3,774	6,857
11	1,520	4,515	10,470
12	1,600	3,268	4,683
13	1,884	3,299	5,828
14	1,720	3,620	7,621
15	2,220	3,164	4,510
16	5,818	5,973	6,134
17	3,796	4,023	4,271
18	3,121	3,693	4,442
19	3,209	4,150	5,576
20	3,526	4,227	5,208
21	2,750	4,580	8,714
22	1,481	3,533	8,461
23	2,231	3,990	6,359
24	1,504	3,594	6,744
25	2,400	4,751	8,234
26	2,573	5,246	8,134
27	2,965	3,525	4,293
28	2,500	3,173	4,109
29	2,080	4,436	6,642
30	2,560	5,409	8,113
31	2,080	4,861	7,292
32	1,600	4,571	7,387
Total	**80,087**	**128,806**	**195,988**

KLD: kilo liters per day

Source: Analysis

Appendix 4

Appendix 4: Recommended Guidelines for Driking Water Quality(As per CPHEEO Manual)

S.No.	Characteristics	Acceptable	Cause for Rejection
1	Turbidity (NTU)	1	10
2	Colour (Units on Platinum Cobalt scale)	5	25
3	Taste and Odour	Unobjectionable	Objectionable
4	pH value	7.0 to 8.5	<6.5 or > 9.2
5	Total dissolved solids (mg/l)	500	2000
6	Total harrdness (as CaCO3) mg/l	200	600
7	Chlorides (as Cl) (mg/l)	200	1000
8	Sulphates(as SO4) (mg/l)	200	400
9	Fluorides (as F) (mg/l)	1	1.5
10	Nitrates (as NO3) (mg/l)	45	45
11	Calcium (as Ca) (mg/l)	75	200
12	Magnesium (as Mg) (mg/l)	<30	150
13	Iron (as Fe) (mg/l)	0.1	1
14	Manganese (as Mn) (mg/l)	0.05	0.5
15	Copper (as Cu) (mg/l)	0.05	1.5
16	Aluminium (as Al) (mg/l)	0.03	0.2
17	Alkalinity (mg/l)	200	600
18	Residual Chlorine (mg/l)	0.2	>1.0
19	Zinc (as Zn) (mg/l)	5	15
20	Phenolic compounds (as Phenol) (mg/l)	0.001	0.002
21	Anionic detergents (mg/l) (as MBAS)	0.2	1
22	Mineral Oil (mg/l)	0.01	0.03
	Heavy Metals		
23	Arsenic (as As) (mg/l)	0.01	0.05
24	Cadmium (as Cd) (mg/l)	0.01	0.01
25	Chromium (as hexavalent Cr) (mg/l)	0.05	0.05
26	Cyanides (as CN) (mg/l)	0.05	0.05
27	Lead (as Pb) (mg/l)	0.05	0.05
28	Selenium (as Se) (mg/l)	0.01	0.01
29	Mercury (total as Hg) (mg/l)	0.001	0.001
30	Polynuclear aromatic hydrocarbons (PAH) (microgram/litre)	0.2	0.2
31	Pesticides (total,mg/l)	Absent	Refer to WHO guidelines for drinking water qaulity Vol.I.-1993
	Radioactivity		
32	Gross Alpha activity (Bq/l)	0.1	0.1
33	Gross Beta activity (Bq/l)	1	1

Appendix 5

Appendix 5: Groundwater Resources and Development in Haryana State (2003-04)

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
AMBALA							
Ambala	16,976.92	10,188.18	1,800.00	11,988.18	714.78	6,073.97	0.71
Barara	14,613.02	12,835.09	1,035.00	13,870.09	407.48	1,370.46	0.95
Naraingarh	10,010.73	7,007.11	615.00	7,622.11	219.86	2,783.77	0.76
Shazadpur	8,446.04	3,945.04	390.00	4,335.04	140.43	4,360.56	0.51
TOTAL	50,046.72	33,975.42	3,840.00	37,815.42	1,482.55	14,588.75	0.76
PANCHKULA	-						
Barwala	6,471.66	3,784.17	375.00	4,159.17	151.12	2,536.37	0.64
Pinjore	4,258.70	564.88	720.00	1,284.88	105.05	3,588.77	0.30
Raipur Rani	4,143.76	3,381.99	270.00	3,651.99	120.70	641.07	0.88
TOTAL	14,874.12	7,731.04	1,365.00	9,096.04	376.87	6,766.21	0.61
FATEHABAD							
Bhattu Kalan	5,188.85	623.38	-	623.38	124.83	4,440.64	0.12
Bhuna	6,362.04	3,299.72	12.67	3,312.39	119.20	2,943.12	0.52
Fatehabad	6,632.00	11,222.71	81.45	11,304.16	510.88	(5,101.59)	1.70
Ratia	10,607.03	17,988.50	108.60	18,097.10	1,994.85	(9,376.32)	1.71
Tohana	10,016.02	19,763.59	39.82	19,803.41	165.91	(9,913.47)	1.98
TOTAL	38,805.94	52,897.90	242.54	53,140.44	2,915.67	(17,007.60)	1.37
BHIWANI							
Badra	4,225.21	11,100.22	184.62	11,284.84	296.14	(7,171.15)	2.67
Bhawani Khera	6,190.15	3,482.68	36.20	3,518.88	221.57	2,485.90	0.57
Bhiwani	11,119.57	7,295.95	63.35	7,359.30	415.37	3,408.26	0.66
Dadri-I	5,143.97	7,935.78	36.20	7,971.98	297.61	(3,089.42)	1.55
Dadri-II	5,564.05	9,277.61	86.88	9,364.49	146.03	(3,859.59)	1.68
Kairu	4,698.60	7,295.95	63.35	7,359.30	98.64	(2,695.99)	1.57
Loharu	6,906.86	8,164.30	184.62	8,348.92	85.15	(1,342.59)	1.21
Siwani	6,075.27	2,398.47	63.35	2,461.82	164.06	3,512.75	0.41
Tosham	7,899.63	2,356.42	36.20	2,392.62	190.47	5,352.74	0.30
TOTAL	57,823.31	59,307.37	754.77	60,062.14	1,915.04	(3,399.10)	1.04

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
HISSAR							
Adampur	3,291.14	2,028.80	14.48	2,043.28	41.00	1,221.35	0.62
Agroha	5,957.10	2,182.75	12.67	2,195.42	37.88	3,736.47	0.37
Barwala	5,623.74	1,499.04	30.77	1,529.81	81.71	4,042.99	0.27
Hansi-I	11,560.01	9,717.21	48.87	9,766.08	49.88	1,792.92	0.84
Hansi-II	5,731.03	2,425.52	27.15	2,452.67	27.98	3,277.53	0.43
Hissar-I	5,697.32	4,288.72	41.63	4,330.35	65.11	1,343.49	0.76
Hissar-II	6,097.70	3,679.97	50.68	3,730.65	90.94	2,326.80	0.61
Narnaund	8,186.77	9,546.02	5.43	9,551.45	64.97	(1,424.21)	1.17
Uklana	3,724.02	2,088.28	30.77	2,119.05	46.85	1,588.89	0.57
Total	55,868.82	37,456.30	262.45	37,718.75	506.32	17,906.21	0.68
GURGAON							
Farukhnagar	3,989.63	5,809.33	99.55	5,908.88	820.76	(2,640.45)	1.48
Ferozepur Zhirka	4,500.71	3,440.48	124.89	3,565.37	356.90	703.33	0.79
Gurgaon	5,985.16	8,442.17	10,167.50	18,609.67	1,051.41	(3,508.41)	3.11
Nagina	3,147.27	2,480.73	139.37	2,620.10	219.18	447.36	0.83
Nuh	6,061.66	2,740.32	164.71	2,905.03	375.44	2,945.90	0.48
Pataudi	4,917.64	10,723.63	175.57	10,899.20	325.40	(6,131.40)	2.22
Punhana	4,937.70	2,661.71	121.27	2,782.98	516.25	1,759.73	0.56
Sohna	5,323.32	8,080.20	144.80	8,225.00	434.27	(3,191.15)	1.55
Tauru	4,254.18	6,778.60	177.38	6,955.98	339.28	(2,863.69)	1.64
Total	43,117.28	51,157.18	11,315.04	62,472.22	4,438.90	(12,478.80)	1.45
FARIDABAD							
Ballabhgarh	8,640.27	2,974.61	148.42	3,123.03	-	5,665.66	0.36
Faridabad	8,323.64	5,821.94	449.58	6,271.52	961.53	1,540.16	0.75
Hassanpur	6,415.59	2,077.57	36.20	2,113.77	-	4,338.02	0.33
Hatin	8,396.38	4,511.75	104.98	4,616.73	-	3,884.63	0.55
Hodel	10,037.75	5,668.94	61.54	5,730.48	-	4,368.82	0.57
Palwal	13,260.18	5,756.55	200.91	5,957.46	-	7,503.64	0.45
Total	55,073.81	26,811.36	1,001.63	27,812.99	961.53	27,300.92	0.51
JHAJJAR							
Bhadurgarh	10,329.14	9,413.00	45.25	9,458.25	12.59	903.55	0.92
Beri	5,918.96	4,161.68	14.48	4,176.16	1.00	1,756.28	0.71
Jhajjar	8,811.29	9,350.73	43.44	9,394.17	8.51	(547.95)	1.07

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
Matanhail	5,526.57	2,874.54	27.15	2,901.69	3.51	2,648.51	0.53
Salhawas	5,059.80	5,073.43	25.34	5,098.77	2.36	(15.99)	1.01
Total	35,645.75	30,873.38	155.66	31,029.04	27.98	4,744.40	0.87

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
JIND							
Alewa	4,148.13	4,060.16	60.00	4,120.16	258.96	(170.99)	0.99
Jind	13,440.99	6,254.24	247.97	6,502.21	484.69	6,702.06	0.48
Julana	7,216.49	2,422.58	23.53	2,446.11	421.93	4,371.98	0.34
Narwana	15,425.76	14,843.00	404.48	15,247.48	716.85	(134.09)	0.99
Pilukhera	7,984.34	6,106.39	45.00	6,151.39	248.55	1,629.40	0.77
Safidon	10,733.23	10,177.65	1,068.62	11,246.27	319.52	236.06	1.05
Uchana	11,004.66	2,955.97	100.86	3,056.83	560.38	7,488.31	0.28
Total	69,953.61	46,819.98	1,950.46	48,770.44	3,010.90	20,122.73	0.70
KAITHAL							
Gulha	13,590.31	25,569.63	767.06	26,336.69	908.50	(12,887.80)	1.94
Kaithal	13,618.21	22,673.92	1,074.82	23,748.74	730.15	(9,785.87)	1.74
Kalyat	5,819.47	8,140.53	5.43	8,145.96	-	(2,321.06)	1.40
Pundri	15,488.72	26,618.96	604.91	27,223.87	686.98	(11,817.20)	1.76
Rajaund	7,795.99	15,151.29	45.00	15,196.29	103.18	(7,458.48)	1.95
Total	56,312.70	98,154.35	2,497.22	100,651.60	2,428.82	(44,270.50)	1.79
KARNAL							
Assandh	13,758.90	21,640.00	52.00	21,692.00	498.00	(8,379.10)	1.58
Gharaunda	11,678.60	15,337.46	200.91	15,538.37	388.81	(4,047.66)	1.33
Indri	16,016.09	21,081.65	133.94	21,215.59	347.91	(5,413.47)	1.32
Karnal	17,046.73	21,507.60	503.18	22,010.78	401.33	(4,862.19)	1.29
Nilokheri	13,978.62	19,438.19	206.34	19,644.53	389.18	(5,848.75)	1.41
Nissang	15,371.26	20,229.75	148.42	20,378.17	410.53	(5,269.02)	1.33
Total	87,850.21	119,234.60	1,244.79	120,479.40	2,435.76	(33,820.20)	1.37
KURUKSHETRA							
Babain	3,411.47	5,709.16	303.62	6,012.78	294.06	(2,591.74)	1.76
Ladwa	3,981.20	7,999.77	285.77	8,285.54	284.35	(4,302.91)	2.08
Pehowa	12,959.38	22,683.06	632.58	23,315.64	888.26	(10,612.00)	1.80
Shahbad	8,692.15	9,586.56	706.79	10,293.35	661.77	(1,556.17)	1.18
Thaneswar	11,394.51	18,217.02	849.28	19,066.30	820.41	(7,642.92)	1.67
Total	40,438.71	64,195.56	2,778.04	66,973.60	2,948.84	(26,705.70)	1.66
MAHENDRAGARH							
Ateli	3,226.74	3,103.35	70.35	3,173.70	269.82	(146.43)	0.98
Kanina	4,423.27	7,105.35	44.80	7,150.15	427.96	(3,110.04)	1.62

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
Mahendragarh	4,518.40	4,128.56	81.92	4,210.48	605.60	(215.76)	0.93
Nangal Chaudary	3,158.28	3,171.68	107.64	3,279.32	791.06	(804.47)	1.04
Narnaul	2,887.41	1,631.62	83.16	1,714.78	588.79	667.00	0.59
Total	18,214.10	19,140.55	387.87	19,528.42	2,683.24	(3,609.69)	1.07

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
PANIPAT							
Bapoli	6,148.88	11,425.63	47.06	11,472.69	217.29	(5,494.04)	1.87
Israna	7,057.92	11,314.00	18.00	11,332.00	280.00	(4,536.08)	1.61
Madlauda	8,051.29	10,318.87	28.96	10,347.83	337.90	(2,605.47)	1.29
Panipat	6,508.41	8,579.27	327.61	8,906.88	202.00	(2,272.86)	1.37
Samalkha	5,175.85	9,301.37	74.21	9,375.58	194.71	(4,320.22)	1.81
Total	32,942.36	50,939.14	495.84	51,434.98	1,231.89	(19,228.70)	1.56
REWARI							
Bawal	7,564.40	7,863.96	69.58	7,933.54	308.48	(608.04)	1.05
Jatusana	5,144.75	5,763.30	26.10	5,789.40	484.62	(1,103.17)	1.13
Khol	2,753.80	4,607.54	70.98	4,678.52	336.70	(2,190.44)	1.70
Nahar	4,741.46	4,149.89	17.16	4,167.05	164.45	427.13	0.88
Rewari	5,860.39	8,705.68	117.30	8,822.98	386.97	(3,232.25)	1.51
Total	26,064.81	31,090.37	301.12	31,391.49	1,681.22	(6,706.77)	1.20
ROHTAK							
Rohtak	9,888.01	6,553.60	-	6,553.60	-	3,334.41	0.66
Kalanaur	4,045.69	2,644.56	-	2,644.56	-	1,401.13	0.65
Lakhan Majra	2,496.49	1,179.41	-	1,179.41	10.34	1,306.74	0.47
Meham	5,184.77	2,689.28	-	2,689.28	31.96	2,463.54	0.52
Sampla	3,697.93	3,722.90	-	3,722.90	26.91	(51.88)	1.01
Total	25,312.90	16,789.75	-	16,789.75	69.21	8,453.94	0.66
SIRSA							
Baraguda	11,870.08	11,165.87	25.34	11,191.21	41.00	663.21	0.94
Dabwali	9,497.63	5,824.33	36.20	5,860.53	434.55	3,238.75	0.62
Ellenabad	7,180.13	14,800.30	112.22	14,912.52	420.25	(8,040.42)	2.08
Ns Chopta	8,649.74	5,920.62	50.68	5,971.30	364.02	2,365.10	0.69
Odhan	5,623.18	3,876.89	30.77	3,907.66	214.30	1,531.99	0.69
Rania	5,954.13	12,173.32	83.26	12,256.58	293.37	(6,512.56)	2.06
Sirsa	9,974.09	12,884.45	175.57	13,060.02	505.63	(3,415.98)	1.31
Total	58,748.97	66,645.76	514.04	67,159.80	2,273.13	(10,169.90)	1.14
SONEPAT							
Ganaur	11,305.26	16,089.11	1,047.40	17,136.51	279.25	(5,063.11)	1.52
Gohana	4,920.70	5,009.10	54.30	5,063.40	4.04	(92.44)	1.03
Kathura	3,093.39	1,369.17	-	1,369.17	-	1,724.23	0.44

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
Kharkhoda	4,892.24	3,106.84	94.12	3,200.96	14.51	1,770.88	0.65
Mundlana	5,696.15	3,958.49	-	3,958.49	4.60	1,733.06	0.69
Rai	5,356.42	6,708.42	690.50	7,398.92	3.27	(1,355.28)	1.38
Sonepat	9,693.42	11,938.20	1,044.80	12,983.00	5.56	(2,250.34)	1.34
Total	44,957.56	48,179.32	2,931.12	51,110.44	311.23	(3,532.99)	1.14

District/Assessment Unit	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Allocation for domestic, and industrial requirement supply upto next 25 years	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development
YAMUNANAGAR							
Bilaspur	8,717.66	6,266.73	570.00	6,836.73	238.34	2,212.59	0.78
Chachrauli	14,643.53	10,167.89	645.00	10,812.89	393.76	4,081.88	0.74
Jagadhri	9,282.34	13,933.78	930.00	14,863.78	223.95	(4,875.39)	1.60
Mustafabad	6,000.88	6,422.12	225.00	6,647.12	169.85	(591.09)	1.11
Radour	8,344.79	8,815.10	450.00	9,265.10	286.79	(757.10)	1.11
Sadhuara	4,136.01	2,727.10	495.00	3,222.10	117.19	1,291.72	0.78
Total	51,125.22	48,332.71	3,315.00	51,647.71	1,429.89	1,362.62	1.01
STATE TOTAL	863,176.90	909,732.10	35,352.59	945,084.70	33,128.97	(79,684.10)	1.10

Status of Groundwater Development in Panipat District

District/Assessment Unit	Stage of Ground Water Development	Is there a significant decline of pre-monsoon water table levels	Is there a significant decline of post-monsoon water table levels	Categorization for future ground water development
	(%)	(Yes/No)	(Yes/ No)	(safe/ semi-critical/ critical/ over-exploited)
Bapoli	187%	YES	YES	OVER-EXPLOITED
Israna	161%	YES	YES	OVER-EXPLOITED
Madlauda	129%	YES	YES	OVER-EXPLOITED
Panipat	137%	YES	YES	OVER-EXPLOITED
Samalkha	181%	YES	YES	OVER EXPLOITED
Total	**156%**			

Appendix 6

Appendix 6: Tube Well Water Quality in Panipat,

Sl.No.	Name of Tube Well	Date of collection	Total Dissolved Solids	pH value	Total hardness(as CaCo3),mg/l	Calcium(as Ca),mg/I	Iron (as Fe),mg/I	Chloride (as CI),mg/I	Sulphate (as SO4) mg/I	Fluoride (as F),mg/I	Nitrate (as No3),mg/I	Remakrs
					400	80	Nil	80	95	0.75	Trace	Potable
2	Ram Nagar	15/2/08	610	7.52	240	56	Nil	70	59	0.71	Trace	Potable
3	Ramesh Nagar	15/2/08	570	7.6	220	40	Nil	90	45	1.02	Trace	Potable
4	Sukhdev Nagar	21/1/08	900	7.4	560	96	Nil	120	98	0.716	Trace	Potable
5	H.B.C	15/2/08	620	7.65	270	68	Nil	75	78	0.85	Trace	Potable
6	Devi Murli colony	15/2/08	650	7.55	300	60	Nil	75	65	0.81	Trace	Potable
7	Bishansarup colony	4/10/2007	590	7.42	250	60	Nil	30	65	0.71	Trace	Potable
8	Palika Bazar	21/1/08	900	7.55	700	120	Nil	250	130	0.715	Trace	Not potable
9	Tubewell	19/2/08	490	7.65	260	64	Nil	65	75	0.52	Trace	Potable
10	T.B School	19/2/08	710	7.75	340	56	Nil	75	59	0.71	Trace	Potable
11	Amar Bhavani chowk	21/1/08	2000	7.65	1150	200	Nil	300	215	0.98	Trace	Not potable
12	Saini colony	15/2/08	560	7.65	200	40	Nil	110	49	1.01	Trace	Potable
13	Gilla	15/2/08	670	7.58	350	60	Nil	100	58	0.95	Trace	Potable
14	Netaji colony	21/1/08	2200	7.52	1100	320	Nil	250	330	0.996	Trace	Not potable
15	Kataria colony	21/1/08	2000	7.52	1400	280	Nil	275	290	1.06	Trace	Not potable
16	Booster W-10	19/2/08	820	7.73	410	80	Nil	90	85	0.63	Trace	Potable
17	Old Sabzi Mandi	21/1/08	1700	7.65	950	160	Nil	300	175	0.978	Trace	Not potable
18	Sanjay Park	19/2/08	300	7.45	210	44	Nil	25	49	0.51	Trace	Potable
19	Krishanpura	21/3/06	410	7.55	230	52	Nil	20	132	0.725	Trace	Potable
20	Tankiwala krishanpura	19/2/08	500	7.65	300	60	Nil	55	71	0.57	Trace	Potable
21	Govt School	10/10/2007	770	7.65	550	80	Nil	75	95	0.75	Trace	Potable
22	Katoni Fatak	19/2/08	400	7.6	250	40	Nil	45	49	0.59	Trace	Potable
23	New T/W at Rajiv Colon	21/3/06	310	7.6	280	60	Nil	25	141	0.69	Trace	Potable
24	Rajiv Colony	15/2/08	550	7.61	290	40	Nil	100	55	0.99	Trace	Potable
25	Slaughter House	15/2/08	590	7.72	250	60	Nil	90	71	1.05	Trace	Potable
26	Bhagat Nagar T Camp	4/10/2007	550	7.5	240	56	Nil	90	65	0.89	Trace	Potable

Sl.No.	Name of Tube Well	Date of collection	Total Dissolved Solids	pH value	Total hardness(as CaCo3),mg/l	Calcium(as Ca),mg/I	Iron (as Fe),mg/I	Chloride (as CI),mg/I	Sulphate (as SO4) mg/I	Fluoride (as F),mg/I	Nitrate (as No3),mg/I	Remakrs
27	Khali K Basti	4/10/2007	630	7.52	350	80	Nil	75	81	0.81	Trace	Potable
28	Bhagat Nagar	7/3/2008	650	7.52	370	68	Nil	90	78	0.83	Trace	Potable
29	Bhagat Nagar	19/2/08	590	7.7	300	40	Nil	60	45	0.53	Trace	Potable
30	Bhagat Nagar	31/10/07	760	7.55	350	80	Nil	90	99	1.08	Trace	Potable
31	Ramesh Nagar T Camp	4/10/2007	650	7.4	400	80	Nil	150	71	0.99	Trace	Potable
32	New Ramesh Nagar	19/2/08	700	7.52	350	60	Nil	65	75	0.54	Trace	Potable
34	T-8 Marla	16/3/06	530	7.7	250	52	Nil	25	122	0.71	Trace	Potable
35	T-Rajnagar	16/3/06	430	7.68	300	60	Nil	30	141	0.62	Trace	Potable
36	T-Batra colony	16/3/06	420	7.72	260	40	Nil	35	94	0.81	Trace	Potable

Source: Water Quality Testing Laboratory, PWD Public Health Department,Karnal

Appendix 7

Appendix 7-A

Comparison of Initial investment & annual energy cost of water from Canal or River Yamuna

i) Initial Cost

A Water From Yamuna					
Item	Quantity	Rate	Unit	Amount	Units
Ranney Well each of 10 MLD, including 25% stand bye with M & E	13	20,000,000	No	260,000,000	Rs
Pipe line, 1000 mm DI Pipe, including specials, valves, excavation,laying etc	19,000	27,531	m	523,089,000	Rs
Total				783,089,000	Rs
				78.31	Crore Rs
B Water From Canal					
WTP capacity 100 MLD	100	2,500,000	MLD	250,000,000	
RWPS 5 Pumps each of 45 KW	225	25,000	KW	5,625,000	
Total				255,625,000	Rs
ii) Annual Energy Costs				25.56	Crore Rs
Energy Cost of pumping water from River to Intake WTP	River Bed			226	meter
	Likely Water Level in Ranney Well			225	meter
	CWR FSL level			236	meter
	Static level difference			11	meter
	Friction loss in 19 KM@0.8 m/Kmplus 10% losses in specials			28	meter
	Annual energy cost, Ref Appendix 7-B			11,560,210	Rs
				1.16	Crore Rs
Energy Cost of pumping water from Canal to Intake WTP	Average pump head Ref Appendix D11			7	Meter
	Annual Energy cost, Refer Appendix D-4A			2,919,399	Rs
				0.29	Crore Rs

Note: detailed design of pipeline from Yamuna River to WTP is given in Appendix 7-B

Appendix 7-B: Design of Raw Water Main from Yamuna River to WTP

From: **Yamuna River** To: **WTP**

INPUT DATA PANIPAT

PANIPAT

1) Water requirement : Year Peak Discharge

A.	Initial			2011	62.02	mld
B.	Intermediate			2026	83.85	mld
C.	Ultimate			2041	105.00	mld
2) Pumping main				LENGTH	19000	M
3) Static head for pump				ST.HEAD	11.00	M
4) Design period				YEAR	30	yr.
5) Combined eff. of pump set				EFF. %	75	%
6) Cost of pumping unit				Rs./KW	25000	Rs
7) Interest rate				INTEREST	10.00	%
8) Life of electric motor & pump set				P.Yrs	15	yr.
9) Energy charges per kWh				P/KWH	475	paise
10) Pumping hours for discharge				PUMPING-	23	hrs
	at the end of 15 years			HOURS		

PIPE DATA				
DIAMETER MM.	MATER-IAL	CLASS	HWC	RATE Rs/M
250	DI	K7	140	2005
300	DI	K7	140	2543
350	DI	K7	140	3197
400	DI	K7	140	3833
450	DI	K7	140	4547
500	DI	K7	140	5325
600	DI	K7	140	7015
700	DI	K7	140	9622
800	DI	K7	140	12550
900	DI	K7	140	15314
1000	DI	K7	140	18354
1100	DI	K7	140	21600

CALCULATIONS:

			1st 15 years		2nd 15 years	
1) Discharge at Start OF PERIOD			62.02	mld	83.85	mld
2) Discharge at the end of 15 yrs			83.85	mld	105.00	mld
3) Average Flow			881	lps	1140	lps
4) Average Discharge			72.94	mld	94.43	mld
5) Avg.pumping hours during the period			20.01	hrs	20.68	hrs
6) KW required at combined			12.02	* H1	15.56	* H2
efficiency of pumping set						
7) Avg annual charges for electrical						
energy Rs.			417035	* KW1	558198	* KW2

Modified Hazen William's Formula

V= 143.534CR r0.6575 S0.5525

h= [L(Q/CR)1.81]/[994.62D4.81]

Friction Head Loss (First 15 years)

Dia. in mm	L	Q	CR	Q/CR	(Q/CR)1.81	994.62	D	D4.81	h(First 15 yrs)
250mm	1000	0.881	1.000	0.881	0.795	994.620	0.250	0.001	628.826
300mm	1000	0.881	1.000	0.881	0.795	994.620	0.300	0.003	261.619
350mm	1000	0.881	1.000	0.881	0.795	994.620	0.350	0.006	124.639
400mm	1000	0.881	1.000	0.881	0.795	994.620	0.400	0.012	65.571
450mm	1000	0.881	1.000	0.881	0.795	994.620	0.450	0.021	37.211
500mm	1000	0.881	1.000	0.881	0.795	994.620	0.500	0.036	22.417
600mm	1000	0.881	1.000	0.881	0.795	994.620	0.600	0.086	9.326
700mm	1000	0.881	1.000	0.881	0.795	994.620	0.700	0.180	4.443
800mm	1000	0.881	1.000	0.881	0.795	994.620	0.800	0.342	2.338
900mm	1000	0.881	1.000	0.881	0.795	994.620	0.900	0.602	1.327
1000mm	1000	0.881	1.000	0.881	0.795	994.620	1.000	1.000	0.799
1100 mm	1000	0.881	1.000	0.881	0.795	994.620	1.100	1.582	0.505

Velocity

Dia. in mm	143.534	CR	r=A/P=D/4	r0.6575	S	S0.5525	V
250	143.534	1.000	0.063	0.162	0.629	0.774	17.945
300	143.534	1.000	0.075	0.182	0.262	0.477	12.461
350	143.534	1.000	0.088	0.202	0.125	0.316	9.155
400	143.534	1.000	0.100	0.220	0.066	0.222	7.010
450	143.534	1.000	0.113	0.238	0.037	0.162	5.538
500	143.534	1.000	0.125	0.255	0.022	0.123	4.486
600	143.534	1.000	0.150	0.287	0.009	0.076	3.115
700	143.534	1.000	0.175	0.318	0.004	0.050	2.289
800	143.534	1.000	0.200	0.347	0.002	0.035	1.752
900	143.534	1.000	0.225	0.375	0.001	0.026	1.385
1000	143.534	1.000	0.250	0.402	0.001	0.019	1.121
1100	143.534	1.000	0.275	0.428	0.001	0.015	0.927

Friction Head Loss (Second 15 years)

Dia. in mm	L	Q	CR	Q/CR	(Q/CR)1.81	994.62	D	D4.81	h(Second 15 yrs)
250mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.250	0.001	1,003.515
300mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.300	0.003	417.505
350mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.350	0.006	198.906
400mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.400	0.012	104.642
450mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.450	0.021	59.383
500mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.500	0.036	35.774
600mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.600	0.086	14.884
700mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.700	0.180	7.091

800mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.800	0.342	3.730
900mm	1,000.000	1.140	1.000	1.140	1.268	994.620	0.900	0.602	2.117
1000mm	1,000.000	1.140	1.000	1.140	1.268	994.620	1.000	1.000	1.275
1100 mm	1,000.000	1.140	1.000	1.140	1.268	994.620	1.100	1.582	0.806

Velocity

Dia. in mm	143.534	CR	r=A/P=D/4	r0.6575	S	S0.5525	V
250	143.534	1.000	0.063	0.162	1.004	1.002	23.232
300	143.534	1.000	0.075	0.182	0.418	0.617	16.133
350	143.534	1.000	0.088	0.202	0.199	0.410	11.853
400	143.534	1.000	0.100	0.220	0.105	0.287	9.075
450	143.534	1.000	0.113	0.238	0.059	0.210	7.170
500	143.534	1.000	0.125	0.255	0.036	0.159	5.808
600	143.534	1.000	0.150	0.287	0.015	0.098	4.033
700	143.534	1.000	0.175	0.318	0.007	0.065	2.963
800	143.534	1.000	0.200	0.347	0.004	0.046	2.269
900	143.534	1.000	0.225	0.375	0.002	0.033	1.793
1000	143.534	1.000	0.250	0.402	0.001	0.025	1.452
1100	143.534	1.000	0.275	0.428	0.001	0.020	1.200

TABLE 1 - VELOCITY AND HEADLOSSES FOR DIFFERENT PIPE SIZES

							Total head(m) for		19000.00	m length	
Sl.	Pipe	Frictional Head		Velocity in			including	11.00	m static head		
No.	Size	loss per		m/s		------	---------	---------	---------	---------	---------
	in	1000 m				1st stage flow			2nd stage flow		
	mm	----------		----------		-------	---------	--------	-------	---------	---------
		1st	2nd	1st	2nd	Frict-		Total	Frict-		Total
		stage	stage	stage	stage	ional	Other*	losses	ional	Other*	losses
		flow	flow	flow	flow	loss	losses	H1	loss	losses	H2
1	250	628.83	1003.52	17.94461127	23.2320677	11947.70	1194.77	13153.47	19066.79	1906.68	20984.47
2	300	261.62	417.51	12.4614788	16.13330681	4970.76	497.08	5478.83	7932.60	793.26	8736.86
3	350	124.64	198.91	9.155336898	11.85299606	2368.15	236.81	2615.96	3779.22	377.92	4168.14
4	400	65.57	104.64	7.009531412	9.074919814	1245.85	124.59	1381.44	1988.20	198.82	2198.02
5	450	37.21	59.38	5.538378882	7.1702859	707.01	70.70	788.71	1128.28	112.83	1252.11
6	500	22.42	35.77	4.486075078	5.807916281	425.92	42.59	479.51	679.71	67.97	758.68
7	600	9.33	14.88	3.115315715	4.033256811	177.20	17.72	205.92	282.79	28.28	322.07

8	700	4.44	7.09	2.288794562	2.963197666	84.42	8.44	103.86	134.72	13.47	159.20
9	800	2.34	3.73	1.752352487	2.26869064	44.41	4.44	59.85	70.88	7.09	88.96
10	900	1.33	2.12	1.384570727	1.792540412	25.20	2.52	38.72	40.22	4.02	55.24
11	1000	0.80	1.28	1.121499335	1.45195391	15.18	1.52	27.70	24.23	2.42	37.65
12	1100	0.51	0.81	0.926856746	1.19995905	9.60	0.96	21.56	15.32	1.53	27.85

---------- >>> * Other losses = 10% of frictional loss

TABLE 2 - KILOWATTS & COST OF PUMP SETS REQUIRED FOR DIFFERENT PIPE SIZES AND PIPE COST

			1st stage flow of				2nd stage flow of			Cost	Cost
	72.94		million liters/day				94.43	million liters/day		of	of
			--------	---------	---------		--------	---------	---------	pipe	19000
Sl.	PIPE	Class	H1	Kw	Pump		H2	Kw	Pump	per	meter
No.	Size	of	Total	req'd	Cost @ Rs		Total	req'd	Cost @ Rs	unit	pipe
	in	PIPE	head		25000.00		head	plus %	25000.00	length	line
	mm		in	plus 50%	per kw		in	50	per kw		THS
			meters	standby	Rs THS		meters	standby	Rs THS	(Rs)	(Rs)
1	250	K7	13153.47	237060	5926511		20984.47	489630	12240744	2005	38095
2	300	K7	5478.83	98743	2468578		8736.86	203857	5096423	2543	48317
3	350	K7	2615.96	47147	1178664		4168.14	97255	2431375	3197	60743
4	400	K7	1381.44	24897	622430		2198.02	51286	1282159	3833	60743
5	450	K7	788.71	14215	355365		1252.11	29215	730385	4547	86393
6	500	K7	479.51	8642	216053		758.68	17702	442556	5325	101175
7	600	K7	205.92	3711	92782		322.07	7515	187870	7015	133285
8	700	K7	103.86	1872	46798		159.20	3715	92864	9622	182818
9	800	K7	59.85	1079	26968		88.96	2076	51895	12550	238450
10	900	K7	38.72	698	17448		55.24	1289	32225	15314	290966
11	1000	K7	27.70	499	12482		37.65	879	21964	18354	348726
12	1100	K7	21.56	389	9714		27.85	650	16247	21600	410400

TABLE 3 - COMPARATIVE STATEMENT OF OVERALL COST OF PUMPING MAIN FOR DIFFERENT PIPE SIZES

	1st stage flow		72.94	mld	2nd stage flow		94.43	mld			
											GRAND
											TOTAL
											of
	Cost	Annual	Capital-	Capital-	Cost	Annual	Capital-	Capital-	Initial	PIPE	Capital-
	of	Energy	ised	ised	of	Energy	ised	ised	Capital	SIZE	ised
Sl.	pump	Charges	Energy	Total	pump	Charges	Energy	Total	Investment	in	cost
No.	sets		Charges	Cost	sets		Charges	Cost	for pumpsets	(mm)	for
									& annual ele		
									ct. Charges		30 yrs
	THS	THS	THS	THS	THS	THS	THS	THS	THS		THS
	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)	(Rs)		(Rs)
1	5,926,511	5,485,452	41,722,350	47,648,861	12,240,744	11,713,479	89,092,723	101,333,467	24,259,868	250	71,946,824
2	2,468,578	2,284,863	17,378,666	19,847,244	5,096,423	4,876,897	37,093,675	42,190,098	10,100,574	300	29,996,135
3	1,178,664	1,090,946	8,297,736	9,476,400	2,431,375	2,326,644	17,696,457	20,127,831	4,818,729	350	14,355,872
4	622,430	576,108	4,381,878	5,004,308	1,282,159	1,226,931	9,332,033	10,614,192	2,541,104	400	7,606,156
5	355,365	328,918	2,501,753	2,857,118	730,385	698,924	5,316,012	6,046,397	1,447,545	450	4,391,056
6	216,053	199,974	1,521,002	1,737,055	442,556	423,494	3,221,092	3,663,648	877,100	500	2,715,331
7	92,782	85,877	653,178	745,959	187,870	179,777	1,367,385	1,555,254	372,338	600	1,251,582
8	46,798	43,315	329,453	376,250	92,864	88,864	675,896	768,759	184,046	700	743,114
9	26,968	24,961	189,857	216,825	51,895	49,660	377,714	429,609	102,851	800	558,126
10	17,448	16,149	122,832	140,280	32,225	30,837	234,547	266,772	63,867	900	495,113
11	12,482	11,553	87,870	100,351	21,964	21,018	159,866	181,830	43,531	1,000	492,609
12	9,714	8,991	68,388	78,102	16,247	15,547	118,252	134,499	32,200	1,100	520,702

*** TABLE 3 shows that the most economical size of MAIN from **WTP to J1** Yamuna to WTP Panipat
1000 mm costing : CAPITALISED Rs 492,609 thousands

Appendix 8

Appendix 8: Raw Water Quality of Canal Water in Hyderpur WTP

S. No	Parameter	Units	RAW WATER	
			2/12/2009	4/22/2009
1	Color	-	Turbid	Turbid
2	Odour	-	Earthy	Earthy
3	Turbidity	NTU	55	35
4	PH Value		8	8
5	E. Conductivity	mmhos/cm	258	242
6	Temperature	oC	16	26
7	Pth alkalinity	mg/l	NIL	NIL
8	Nitrates	mg/l	0.16	0.2
9	Flourides	mg/l	0.18	0.18
10	Biss Iron	mg/l	0.2	0.24
11	Chromium	mg/l	Absent	Absent
12	Sulphates	mg/l	22	25
13	Chlorides	mg/l	7	7
14	Total alkalinity	mg/l	92	88
15	Total Hardness	mg/l	124	120
17	Nitrates	mg/l	0.003	0.003
18	Diss oxygen	mg/l	9.4	8.8
20	clr demand	mg/l	0.8	0.8
22	Cyanides	mg/l	Absent	Absent

Appendix 9

Hon'ble Chief Minister's Announcements

Chief Minister's IT Centre, Haryana.

Announcement Code	Date of Announcement	Place Constituency Block & District	Announcement in Brief	Likely date of Initiation	Likely date of Completion	Latest Status Officer & Department	Remarks
No. 2/2/2008-5ga/cms Department: P.W.D.(Water Supply & Sanitation)							
1 2.831	20/01/2008	PANIPAT PANIPAT PANIPAT - Block Panipat	THE SCHEME WORTH RS. 204 CRORES WILL BE EXECUTED FOR ENFORCEMENT OF WATER SUPPLY SCHEME THROUGH CANAL BASE.			Pending FCPH P.W.D.(Water Supply & Sanitation)	

Appendix 10

O/O THE EXECUTIVE ENGINEER W/S & SANITATION DIVN. NO.1, PANIPAT

To

The Executive Engineer,
Water Services Division,
Panipat.

Memo No. 29143 dt. 31/12/08

Sub: - CM announcement: - Canal based scheme for Panipat Town.

Presently water supply to Panipat Town is given through ground water sources comprising of around 170 Tubewells. The ground water is depleting fast on account of over exploitation. The quality of ground water is also deteriorating fast on account of exploitation putting health at risk.

Hon'ble Chief Minister during his visit to Panipat Town on 20.01.2008 has declared that looking to the above problems local water supply shall be given from WJC canal.

A water supply project is being prepared by the Consultants appointed by Asian Development Bank for providing water supply to Panipat Town from WJC canal.

The consultants have indicated that requirement of water from the canal for this purpose will be 100 cusecs (200 MLD) for the design year 2041 and for the present 80 MLD (40 cusecs) of water will be required.

It is requested that your consent for providing 80 MLD of water for the present to be gradually increased to 200 MLD (100 cusecs) from WJC canal may b conveyed to full fill the commitment of worthy C.M.

Sd/-
EXECUTIVE ENGINEER

Endst. No. dated/

A copy of the above is forwarded to the following for information and necessary action.

1. Superintending Engineer, PWD W/S & Sanitation Circle Karnal.
2. Sub Divisional Engineer, PWD W/S & Sanitation S/Divn. No.4 Panipat.

Sd/-
EXECUTIVE ENGINEER

Appendix 11

3949
T-7708

From,

Senior Town Planner,
Rohtak Circle, Rohtak

To,

The Director,
Town and Country Planning,
O/o CCP (NCR),
HUDA Complex, Sector-6,
Panchkula

Memo No. **Date**

Subject: C.M. Announcement – Land for canal based water works for water supply scheme Panipat Town.

Please refer to Circle Office memo no. STP(R) 1102 dated 28-02-08, on the matter cited as subject above. (Copy enclosed for ready reference)

PWD W/S & Sanitation Division has formulated a proposal of canal based water works for water supply scheme of Panipat Town. The site proposed for water works is falling in the residential zone and in the alignment of western peripheral development plan road and thus not in conformity with the development plan proposal. The Circle Office has reported this position to the directorate vide letter referred above.

Now, Deputy Commissioner Panipat vide memo no.915 dated 02-06-08, (Copy enclosed for ready reference) while informing that the proposed peripheral road is not feasible at site wherein water works is proposed due to construction in the surrounding area therefore, either it may be dropped or shifted from the abadi area. A request has also been made that 55 acres of land as shown on the plan may be earmarked for canal based water works scheme.

Undersigned, along with DTP Panipat inspected the area. It is correct that in the alignment of western peripheral road adjacent to the site proposed for water works and at other places, as shown in red colour in the development plan, construction has come up due to which the construction of western peripheral road at these places may not be feasible.

Regarding, the site of water works, official of water supply division has informed that as the scheme is a canal based water works, therefore, it will have to be located on the canal bank and accordingly keeping in view the requirement of the scheme, the site for water works is proposed.

Keeping in view the position explained above, Circle Office is of the view that since canal based water works scheme is being formulated as per Hon'ble C.M. announcement therefore, if it is considered for approval then an amendment in the development plan will have to be carried out by changing the alignment of the western peripheral road and earmarking the proposed site of water works as public utility zone. Hence, decision on it may be taken.

DA/As above

Senior Town Planner,
Rohtak Circle, Rohtak

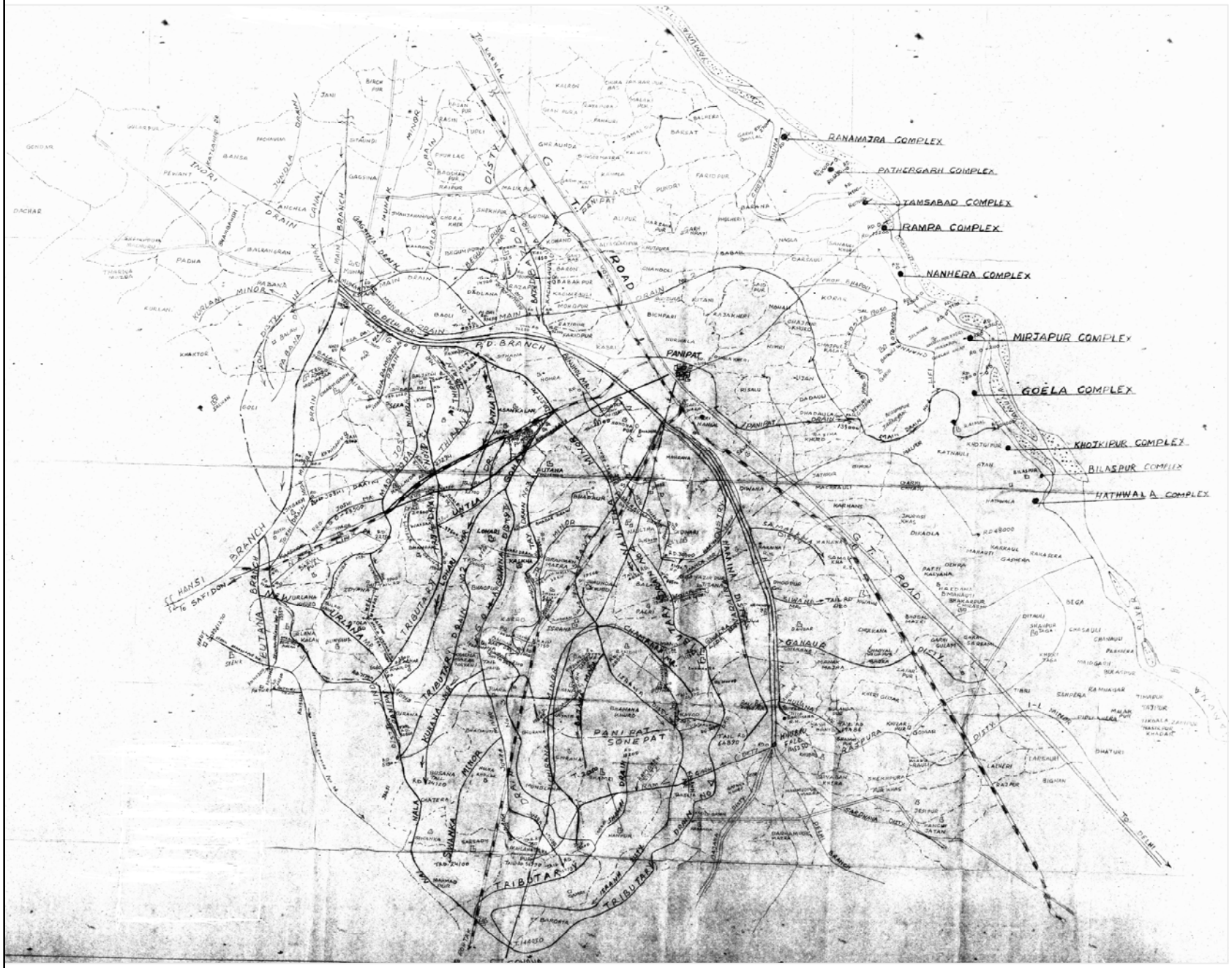
Endst. No. STP(R) 2744 **Date:** 13/06/08

A copy is forwarded to the following for information and necessary action:-

1. Deputy Commissioner, Panipat w.r.t. his office memo no.915 dated 02-06-08
2. District Town Planner, (P) Panipat.
3. Executive Engineer, W/S & Sanitation Division No. 1 Panipat.

Senior Town Planner,
Rohtak Circle, Rohtak

Appendix 12



Capcity Development of the NCRPB: Component B (ADB TA-7055)

Panipat
Canal Network of Haryana

Legend

- River
- Canal
- Drains
- District Boundary
- Villages
- Railway Line

Client
Asian Development Bank
National Capital Region Planning Board

Consultant
Wilbur Smith Associates Pvt Ltd

Drawn: SK	Checked: OPG
Date: Jan. 2009	Approved: NSS
Scale: NTS	

Annexure-7

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