SUPERINTENDING ENGINEER
CONTRACTS & MONITORING

Chennai Metropolitan
Water supply
and
Sewerage Board

No.1, Pumping Station Road, Chennai - 600 002
FAX : 044-2845 4336 E-Mail:secandm@gmail.com

Lr. No. CMWSSB/CNT/WSS/NCB/AMRUT–GoTN/400MLD/CP4/012/2024-25 dt 08.04.2025

To

Sir,

Sub: CMWSSB - C&M Wing – Implementation of continuous Water Supply of Pallipattu WDS & Thiruvanmiyur WDS under Area XIII of Chennai City under Hybrid Annuity Model (HAM) – e-Tender invited – Corrigendum - I has been prepared – forwarded - Reg

Ref : Tender No. CNT/WSS/NCB/AMRUT–GoTN/400MLD/CP4/012/2024-25

-o0o-

With reference to the above work, Corrigendum - I have been prepared and enclosed herewith. You are requested to take these Corrigendum - I into due consideration while submitting your bid. All the other terms and conditions already stipulated remain unaltered.

The bid documents will be available for submission up to 3.00 P.M. on 16.04.2025. The Tender can be uploaded up to 3.00 P.M. on 16.04.2025. The Tender will be opened on 17.04.2025 from 3.30 P.M. onwards.

You are requested to acknowledge the receipt of this letter.

SUPERINTENDING ENGINEER
(CONTRACTS & MONITORING)

Encl : 1. Confirmation Letter – Pg. 2
2. Corrigendum - I – Pg.3
I. DPR with all Annexures
II. GIS Network drawings, hydraulic modelling & other drawing in appropriate (shp or gbd and dwg or dxf) format
III. CMWSSB's financial model

Corrigendum - I

Name of Work: Implementation of continuous Water Supply of Pallipattu WDS & Thiruvanmiyur WDS under Area XIII of Chennai City under Hybrid Annuity Model (HAM)

Tender No: CNT/WSS/NCB/AMRUT–GoTN/400MLD/CP4/012/2024-25

-o0o-

We have taken into due consideration of the Corrigendum - I while submitting our bid.

Signature of the bidder

Name and Address of the bidder

Corrigendum - I

Name of Work: Implementation of continuous Water Supply of Pallipattu WDS & Thiruvanmiyur WDS under Area XIII of Chennai City under Hybrid Annuity Model (HAM)

Tender No: CNT/WSS/NCB/AMRUT–GoTN/400MLD/CP4/012/2024-25

I. DPR with all Annexures
II. GIS Network drawings, hydraulic modelling & other drawing in appropriate (shp or gbd and dwg or dxf) format
III. CMWSSB's financial model

Sd/- 08.04.2025
Engineering Director.i/c

Chennai Metropolitan Water Supply
& Sewerage Board, Chennai

Improvement of Water Supply System in Pallipattu & Thiruvanmiyur WDS Under Area-XIII of Chennai City

Project Management Consultancy Services

Detailed Project Report

(PALLIPATTU & THIRUVANMIYUR WDS)

JANUARY 2025

Submitted by:

Water Corporation of Odisha
Unnati Bhawan, Satya Nagar,
Bhubaneswar-751009 Odisha

Project	Conversion of existing water distribution system in Area X & Area XIII of Chennai City to 24x7 DFT Water Supply.
Client	Chennai Metropolitan Water Supply & Sewerage Board
Services	Project Management Consultancy

Contract Agreement No.	---	**Document**	Detailed Project Report
Contract Date	20th July, 2023	**Submission Date**	Jan 2025

Authors	**Document Category**	
Mr. Guru Charan Das, MD, WATCO Mr. Debabrat Mohanty, Director (PMC), WATCO	**Project Submission**	✓
	Memorandum	×
	Client Reference	×
	Client Information	×

Document Total Volume	**1**	Detailed Project Report

Report Distribution	**Copies**	**Mode of Submission**	
CMWSSB	2	Direct	
			PMC Signing Authority
			(Internal Quality Check Done)

Table of Contents

VOLUME – I – DETAILED PROJECT REPORT

VOLUME – II – COST ESTIMATE

VOLUME – III – DRAWINGS AND MAPS

ANNEXURES / APPENDICES:

VOLUME – I – DPR (PALIPATTU & THIRUVANMIYUR WDS

VOLUME – II – COST ESTIMATE

VOLUME – III – DRAWINGS & MAPS

ABBREVIATIONS

CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
BCA	Bachelor of Computer Applications
BE	Bachelor of Engineering
CAD	Computer Aided Design
CEO	Chief Executive Officer
CPHEEO	Central Public Health & Environmental Engineering Organization
CV	Curriculum Vitae
DGPS	Differential Global Positioning Systems
DMA	District Metered Areas
DPR	Detailed Project Report
DSP	Desalination Plant
EA	Executing Agency
EMI	Electro Mechanical and Instrumentation
ESR	Elevated Service Reservoir
GIS	geographic information system
HP	Horse Power
HSCF	Horizontal Split Centrifugal Pump
IIT	Indian Institute of Technology
JICA	Japan International Cooperation Agency
JMR	Joint Measurement Report
Kms	Kilometres
KW	Kilo Watt
IoT	Internet of Things
Lpcd	Litre per capita per day
M	Meter
MBA	Master of Business Administration
MCA	Master of Computer Application
ML	Million Liter
MLD	Million Liter per day

NRW	Non-Revenue Water
O&M	Operation and Maintenance
OHT	Over Head Tank
PIF	Program Implementation Framework
PIU	Project Implementation Unit
PLC	Programmable logic controller
PMC	Project Management Consultants
PMU	Project Management Unit
PPMS	Project Performance Monitoring System
QA/QC	Quality Assurance and Quality Control
S	Standby
SCADA	Supervisory control and data acquisition
SQ.KM	Square Kilometer
ToR	Terms of Reference
UGR	Under Ground Reservoir
UGT	Under Ground Tank
VT	Vertical Turbine
W	Working
WATCO	Water Corporation of Odisha
WB	World Bank
WDS	Water Distribution Stations
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

1. PROJECT BACKGROUND:

Chennai, formerly known as Madras, is the Capital City of Tamil Nadu State. Located on the Coromandel coast of Bay of Bengal, the city is a major Commercial, Cultural, Economic and Educational Centre in South India. It is also known as the Cultural Capital of South India.

As per the 2011 census, the population of Chennai Core city was 46,46,732, with an area of 176 Sq km. The city has 107 wards/Depots lying within the 7 administrative areas, namely IV, V, VI, VIII, IX, X & XIII. Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB") is responsible for administration, operation and maintenance of the Chennai City's water production, treatment, storage, distribution, billing and revenue collection. The present water supply system is intermittent due to various constraints in source, storage facilities and inadequacy of the existing distribution system. The Chennai Core city's average per capita water supply is about 101 lpcd against per capita supply norm of 150 lpcd as per CPHEEO manual 2023.

To improve the current water supply situation, CMWSSB has engaged Water Corporation of Odisha (WATCO) to provide Project Management Consulting Services for the work improvement of existing water distribution networks under Area-X and Area-XIII of Chennai City for achieving 24X7 water supply. The contract agreement between CMWSSB and WATCO was signed on 20th July 2023 for a period of forty eight (48) months.

Broad scope of services of WATCO for providing 24X7 water supply to administrative block X & XIII of Chennai Metropolitan Water Supply and Sewerage Board Are:

i. Survey and investigations.
ii. Planning and design for converting the existing intermittent water supply to 24 X 7 in all water distribution system of Areas -X and XIII of CMWSSB.
iii. Preparation of Detailed Project Report (DPR).
iv. Preparation of technical specifications and tender documents for the work.
v. Assisting the employer in the bidding process and recommendation of the right bidder for award of the works contract for 24 X 7 sustainable water supply.
vi. To conduct Environment and Social Impact Assessment (ESIA) and prepare the Environment and Social Management Plan (ESMP).
vii. Services covering approval of detailed designs, coordination with the contractor, monitoring work, assist in dispute resolution, specialized techno-commercial advice during execution of work for ensuring completion of the work in a time bound manner.
viii. Assist the employer in commissioning the work.

2. NEED FOR THE PROJECT:

The Water supply in Chennai city, apart from intermittency in supply, water supply in Chennai core city is characterized by irregular and inequitable distribution of drinking water both in terms of quantity and pressure as well as the water quality issues. This is because of the inadequacy in the existing water distribution management infrastructure to run on a demand /supply management regime. Therefore, it is imperative to formulate a proposal to improve the existing distribution system to achieve equitable and sustainable 24 X 7 water supply to all the zones of Chennai core city.

However, administrative areas X and XIII are prioritized based on the CMWSSSB's funding availability.

The **present report comprises of Detailed Project Report for improving water distribution networks containing 7 water supply depots, out of 13 water supply depots, under 2 WDS namely Palipattu and Tiruvanmiyur under admin Area XIII**. The design broadly consists of replacement/strengthening of existing distribution pipes, pumping systems, adequacy check of storage tanks, development of District Metering Areas, instrumentation, control and automation system with smart water management, billing and collection system, O&M protocol, financial modelling for funding under Hybrid annuity model , project implementation schedules, bid management and PMC services for achieving 24X7 water supply pressurized system ensuring proper efficiency, quality, maintainability, and flexibility for water supply services.

3. CONTENTS:

The Detailed Project Report (DPR) for the Delineated Area under XIII (refer to the project area location map in Fig 1). The DPR comprises of the following Chapters:

1- Project Background and scope of services

2- Brief Overview of the existing water supply system

3- Survey and Investigation

4- Design Criteria

5- Population projection and water demand assessment

6- Design of Proposed Water supply system

7- Cost estimates

8- Financial Modelling

9- Project implementation plan

10- Operation and maintenance

11- Social and Environmental Impact Assessment

4. PROJECT AREA:

Area XIII covers a total of 13 wards/Depots numbered from 170 to 182. However, the Project Area of the present detailed project report covers Palipattu WDS and Thiruvanmiyur WDS, with 7 depots (6 depots fully covered and 1 depot partially covered, namely Depot No.s 169 (P), 170, 173, 174, 178, 179 and 180. The map showing proposed operational zone boundaries is presented in Figure-1 below.

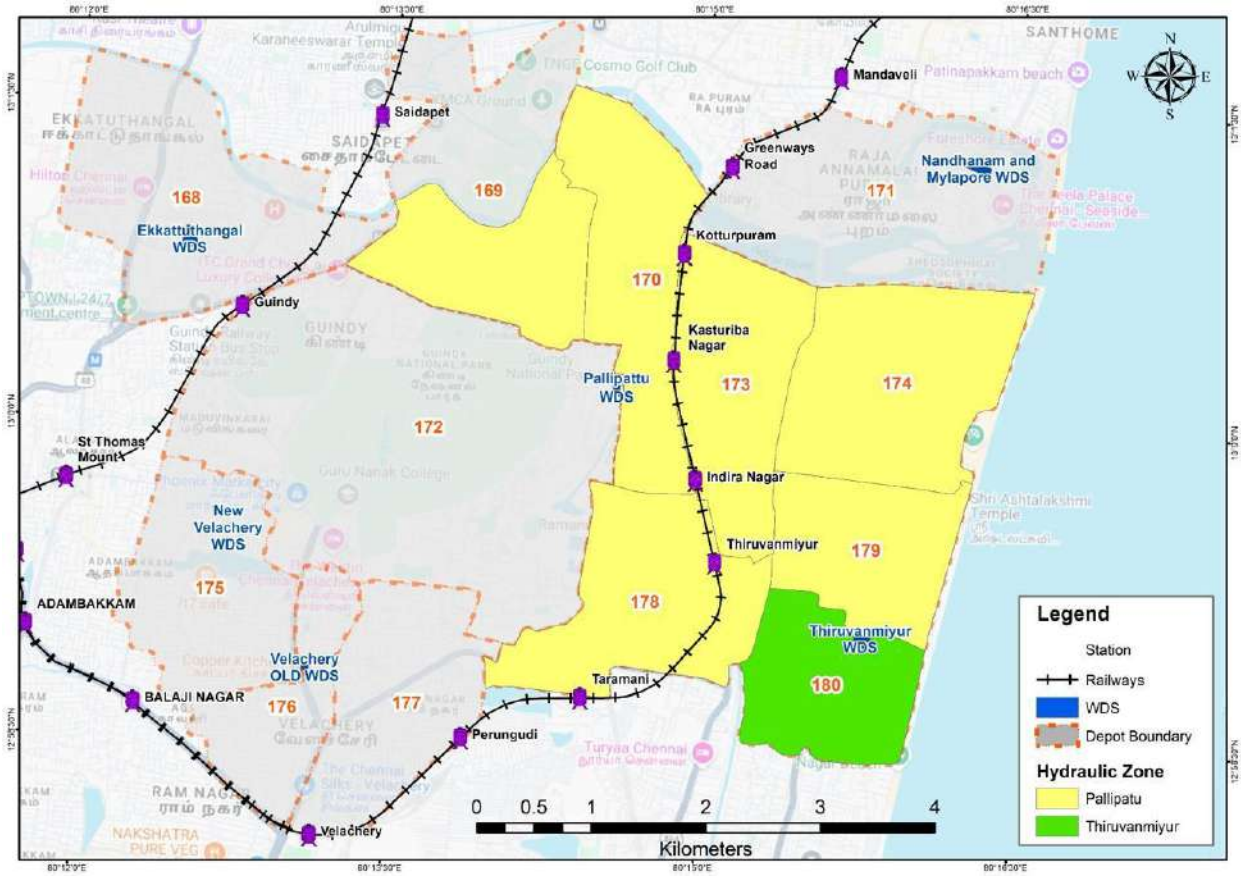


Figure- 1. Map Showing the Proposed Hydraulic Zonal Boundaries of Project Area Under Area XIII

5. PROJECT DESIGN PERIOD:

The project will be commissioned in 2026 (Base year), So, the horizon years are considered as 2041 (as intermediate year) and 2056 (the ultimate year).

6. SURVEY AND INVESTIGATION:

WATCO carried out the following survey and investigation activities. The detailed Findings of the survey & investigation activities have been detailed in Chapter 3

(i) **GIS based Asset Survey:**

Asset survey has been conducted on site using DGPS survey followed with development of asset survey maps on GIS platform duly validated by the Department. As per the asset survey, the total lengths of the existing pipelines are about 630 km with diameter ranging from 100mm to 1100mm. The CI piping material comprises nearly 81.16% of the total pipe-lengths, while DI and PVC piping material comprises

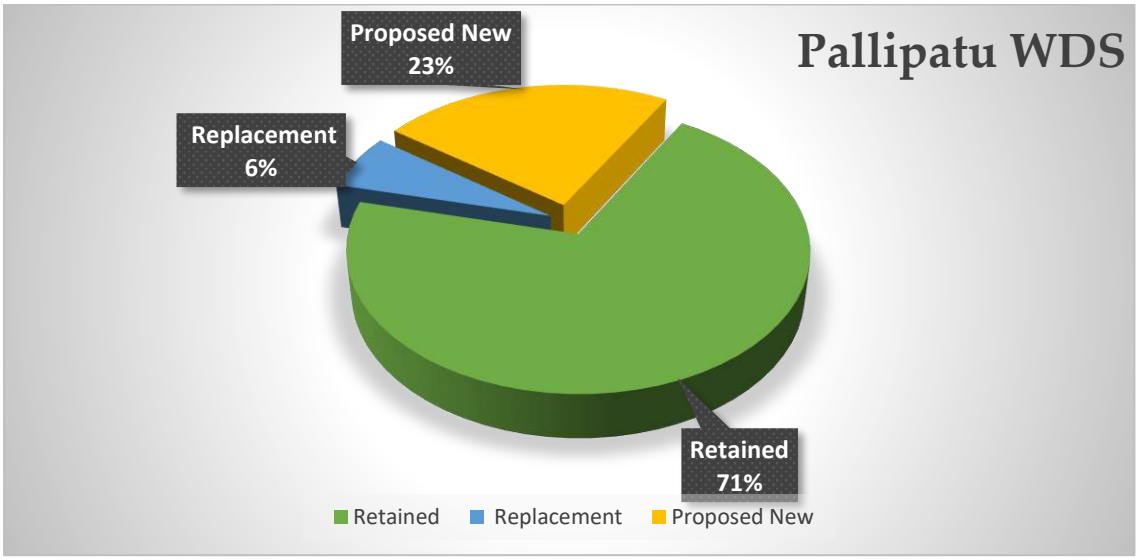
14.88% and 3.93 %, respectively, with 0.03% only MS piping and other materials. The total existing network which would be connected to Pallipatu WDS for distribution of water is 245.69 KM & the network connected from Thiruvanmiyur WDS is 49.79 KM. The total existing distribution considered in this DPR is 295.46 KM.

(ii) **GIS Based Consumer Survey:**

Through door-to-door consumer survey, it is found that, there are about 75618 premises with 136829 households with total population of 644075. Out of the total households, 71242 households receive water supply from CMWSSB, while 3923 households receive water from their own borewells whereas 61585 depend on both CMWSSB supply and own borewell supply.

(iii) **Condition Assessment Survey:**

Condition assessment survey of pipeline was carried out based on analysis of existing data on frequent breakdown history, low pressure areas, no water areas, water quality deficiency areas, by adopting different technology/methods such as flow measurement using ultrasonic flow meter, conducting on the site Brinell's hardness test, destructive testing and robotic camera inspection of the internal surface of pipeline. Pipeline location identification has been done using GPR method. Study outcomes reveal that overall 7% of existing pipes mainly at tail ends are found to be in deteriorating conditions, requiring replacement, whereas from the robotic test, it has been found that some areas are experiencing low pressure, need flushing due to deposition/incrustation to maintain required capacity/flow. A pictorial pie chart is shown below,



7. EXISTING WATER SUPPLY SYSTEM IN AREA XIII:

7.1. Sources of Water Supply:

Presently, all areas under XIII water distribution stations (WDS) are receiving water mainly from three sources, namely Vadakuthu WTP, Chembarambakkam WTP and Nemmeli DSP. The details of Thiruvanmiyour and Pallipattu WDS under Area XIII with their source connectivity and beneficiary Depots are presented below in Table-3.

Table- 3 WDS WITH SOURCE CONNECTIVITY AND BENEFICIARY DEPOTS

Sl.No.	WDS Name	Beneficiary Depots	Sources
1.	Thiruvanmiyur	173P,174P,178P, 179P, 180P	Nemmeli DSP
2	Pallipattu	173P,174P,178P,179P,180P,169P,170P	Chembrambakkam & Vadakuthu WTPs and Nemmeli DSP

Source: As per site information, P- Part of the Depot

Presently, there are no specific hydraulically delineated discrete zones catered by command area based on the storage reservoir's capacity, topographical features or population. There is absence of isolation of Water Distribution Zones (WDZ) further characterized by existence of interconnections between the WDZs, making the system difficult to achieve equitable water distribution with designated pressure

7.2. House Service Connections:

The area XIII has total service connections 93113 nos. of which 2036 nos. (2%) are metered and 91077 nos. (98%) are unmetered.

8. POPULATION PROJECTION-WATER DEMAND OF AREA XIII:

As per the 2011 census, the total population of Chennai core city is 46,46,732, out of which Admin Area -XIII contributes to 5,49,760. Population forecasting has been done by various methods and after deliberation with CMWSSB, the decadal growth method has been adopted with a growth rate of 6.8% per decade. Table 8 and 9 show the projected population and water demand details at the WDS level for the base, intermediate and ultimate years for the admin Area XIII respectively. Domestic water demand has been considered @ 150lpcd, Institutional/Industrial/Commercial demand as per survey data, Fire demand @100√P, floating population @2% of domestic demand i.e. 3lpcd and distribution losses @10% of domestic demand i.e. 15lpcd.

Table- 8: Population Estimation Details Of WDS And Operational Zones

Name of the WDS	Operational Zone (Depots) Number	Population Projection		
		2026 (Base Year)	2041 (Intermediate Year)	2056 (Ultimate Year)
Pallipatu WDS	170, 173, 174, 178, 179, 169(P)	260957	288879	319791
Thiruvanmiyur WDS	180	67215	74407	82368
Total		**328172**	**363286**	**402159**

Table 9: Demand Calculation of WDS And Its Operational Zones

Name of the WDS	Operational Zone (Depots) Number	Demand Calculation (Domestic Demand + Commercial/Institutional Demand + Fire Demand+10% Distribution System losses)		
		2026 (Base Year)	2041 (Intermediate Year)	2056 (Ultimate Year)
Pallipatu WDS	170, 173, 174, 178, 179, 169(P)	39.67	44.12	48.92
Thiruvanmiyur WDS	180	10.34	11.44	12.66
Total		**50.01**	**55.56**	**61.58**

9. PROPOSED WATER SUPPLY INFRASTRUCTURE:

9.1. Proposed Source and it's Sustainability:

It is proposed to use the Nemmeli DSP with a capacity of 100MLD for the water supply to the project area. As presented in Table-9 above, total quantity of water required for

base year (2026) is 50 MLD, for Intermediate year (2041) is 55.56 MLD & for ultimate year (2056) is 61.57 MLD. At present Nemmeli treatment plant is producing 80 MLD which is sufficient to meet the water demand of 50MLD, 55.56MLD and 61.58MLD in the base year (2026), intermediate year (2041) and ultimate year (2056) respectively.

9.2. Transmission Mains:

Transmission mains have been designed for the ultimate design period i.e. for the year 2056. Capacity enhancement by laying additional pipeline is proposed wherever required. However, cost of transmission additional transmission mains system is not covered in the present proposal due to funding constraints.

9.3. Storage Facilities:

The existing storage reservoir capacity of Pallipatu WDS is 17 ML and the requirement of reservoir for the intermediate design year is 11.92 ML and as per CPHHEO guideline, storage reservoir capacity is in excess by 14.35% & as per Mass balancing storage reservoir capacity is in excess by 29.85%

The existing storage reservoir capacity of Thiruvanmiyur WDS is 3 ML and the requirement of reservoir for the intermediate design year is 3.77 ML & as per CPHHEO guideline, reservoir storage capacity is meager by 25.67% & as per Mass balancing, reservoir storage capacity is meager by 3.33%. As the deficit in Mass balancing exercise, it is coming 3.33%, considering space constraints no additional storage is proposed. Details are presented in Table 11 below.

Table-11: Storage Facilities

Storage capacity Details						
Sl. No.	**WDS Name**	**Present Storage**	**Required Storage Capacity @ 33% in MLD**	**Required Storage Capacity as per mass balancing MLD**	**Storage Capacity Deficit / Excess**	
		Capacity in MLD, 2023	**2041 (Intermediate Year)**		**As per CPHEEO (33%)**	**As per Mass Balancing**
	A	D	F	G	H=D-F	I=D-G
1	Pallipatu WDS	17	14.56	11.925	2.44	5.075
2	Thiruvanmiyur (New) WDS	3	3.77	3.1	-0.77	-0.1

9.4. Pumping facilities:

Pumps are designed to provide water from WDS to the operational zones. Pumping system consists of six pumps, four working and two stand-by for Pallipatu WDS and

two working and one stand-by for Thiruvanmyur WDS. Details of Pump sets are presented in Chapter-6.

9.5. Hydraulic Zones / Operational Zones:

There are seven operational zones covered in this DPR, out of which six operational zones are supplied by Pallipatu WDS namely OZ-169(P), OZ-170, OZ-173, OZ-174, OZ-178, OZ-179 & one operational zone is supplied by Thiruvanmiyur WDS namely OZ-180, as presented below in Table-13.

Table-13: Operational Zones

Detail of Proposed No. of Operational Zones			
Sl. No.	**Name of the WDS**	**No. of Operational Zones Proposed**	**Operational Zone Name**
1	**Pallipatu WDS**	6	OZ-169(P), OZ-170, OZ-173, OZ-174, OZ-178 & OZ-179
2	**Thiruvanmiyur (New) WDS**	1	OZ-180

10. DMA Demarcation, Hydraulic Modelling for Distribution System:

Each Operational Zone is divided into number of DMAs, considering easiness of operation, control & monitoring of DMAs with number of house connection between 250-1000. Each DMA can be isolated during breakdown without affecting the water supply of other DMAs / areas. 97 DMAs have been proposed under Pallipatu WDS and 28 DMAs under Thiruvanmiyur (New) WDS as presented in Table-14.

Table-14: Number Of DMAs Under The WDS

Detail of Proposed No. of DMAs		
Sl. No.	**Name of the WDS**	**No. of DMAs, Proposed**
1	**Pallipatu WDS**	97
2	**Thiruvanmiyur (New) WDS**	28
Total		**125**

10.1. Distribution Network:

As per condition assessment survey of pipelines, in Pallipatu about 20 KM of pipelines of different diameters out of 245.69 KM of pipeline has to be replaced, while 74.75KM of new pipelines are proposed. Similarly, as per condition assessment survey of pipelines, in Thiruvanmiyur (New) WDS about 12.75 KM of pipeline of different diameters out of 49.8KM of pipeline has to be replaced while 5.9KM of new pipeline is proposed.

Details of new pipe proposed and existing pipes retained/replaced are presented in Chapter-6.

10.2. Digital Water Management- Instrumentation, Control & Automation:

To achieve reduced Non revenue Water through real-time data capture, analysis, decision making, the deployment of "Digital Water Management System" is proposed. Some of the unique aspects of the Smart Water Management system includes the following:

i. Real-time quality surveillance to ensure drink from tap quality water at every home.
ii. Real-time data analysts and decision making resulting in uninterrupted and consistent water supply service delivery.
iii. Data capture for preventive maintenance of water supply assets.
iv. Reduction of non-revenue water through leakage detection and control.
v. Efficient incidence management and quick resolution of problems.
vi. Efficient consumer complaint redressal for enhancing consumer satisfaction.

10.3. The following control philosophy and system architecture is proposed.

10.3.1. Instruments within Pump house

- Butterfly Valve with feedback,
- Vertical Inline pump with motor,
- Pressure Gauge,
- Electromagnetic Flow Meter,
- Motor operating valve,
- Discharge Manifold.

10.3.2. Instrument outside the Pump house:

- Bulk flow meter
- Pressure Transmitter

Pumping system will run on automation through PLC and SCADA system controlled through VFD. The PLC-SCADA system will be connected to the Depot by OFC cables.

10.3.4. Control Unit at DMA entry consists of following instrumentation

- DI Double Flange resilient seated glandless gate valve
- Electro Magnetic Flow Meter
- Double Chamber DI Control valve, Hydraulic Operated 24 V DC, Solenoid control, IP 68, Integrated with PLC panel,
- Pressure Gauge
- Pressure Transmitter

10.3.5. Control Unit at Lane/Sub Lane entry consisting of following instruments:

- Flow Meter
- Basket Strainer
- Air Valve
- Globe Valve

The RTU based instrumentation control system at Lane/Sub- Lane level shall be connected to the PLC panel at DMA level for integration of data for communicating to SCADA-PLC Control Centre at Depot. All communications shall be through Fiber Optic cables laid for the purpose. There shall be DG power backup system at different points as per necessity.

10.3.6. House Service Connections:

House service connection is the most vulnerable point of leakage. To achieve leak proof house connections, all house connections are proposed with saddle and compression fittings. At the Consumer end, a mechanical flow meter shall be installed with an isolation valve.

Proposed House Service Connection consists of following,

- Compression Fitting
- Pipe Material used: - MDPE & UPVC
- Ball Valve
- Non-Returning Valve

11. Domestic Water Meters and Bulk Water Meters:

IOT based AMR meters have been proposed connecting to the Billing and collection system at Depot level.

12. PROJECT COST ESTIMATE:

The cost estimate was prepared by taking the rates from the reference documents,

- CMWSSB-SOR-2024-25, Schedule of rates 2024-25
- Govt. of Tamil Nadu
- MJP SoR 2023-24
- RUIDP SoR 2023-24
- Circular dated 10-09-2020, GCC- Greater Chennai Corporation- Bus route road Department

For those items rates which are not available in the SoR, market price has been adopted, after taking 3 nos. of quotations from relevant Suppliers/Manufactures.

13. Project Financial Model:

The project is proposed to be developed in Hybrid Annuity Model (HAM). The capital structure evolved is presented in table-20 below,

Table 20- Capital structure

Capital Structure	Overall	After excl. grant	INR Crore
Equity	13.33%	33.33%	36.99
Debt	26.74%	66.67%	73.99
Grant-construction	59.9%		165.75
Total	100%		276.73

Source: Consultant's Analysis

The concession period considered is 17 years, overall, which includes 2 years of construction & 15 years of operation period.

The revenue figures are in a modest range from INR 20.0 Crores in the initial year to INR 30.00 Crores in the last year owing to an increase only in operation & maintenance compensation while Capax lined annuity component remains flat.

Project financial returns for the PPP developer are comfortable with a project IRR over 10.29%, equity IRR above 12.28% & DSCR above 1.82.

The detailed financial model and project cashflow is presented in Chapter- 8.

14. Project Implementation Schedule:

The project will be completed within a period of 24 (twenty-four) months.

15. Project O&M:

The O&M period shall be 15 years to be operated and maintained by the HAM developer.

16. Social and Environmental Impact Assessment (SEIA):

SEIA study has been conducted to assess the social and environmental impact during pre-construction, construction, and operation and maintenance period and mitigation measures recommended. There will be an overall positive impact once the project is completed and commissioned, benefiting people of all categories.

CHAPTER -1- PROJECT BACKGROUND AND SCOPE OF SERVICES

1.1 Project Background

Chennai, formerly known as Madras, is the capital city of Tamil Nadu, the southernmost state of India. It is the state's primary city and is located on the Coromandel Coast of the Bay of Bengal. According to the 2011 Indian census, Chennai is the sixth-most populous city in India and forms the fourth-most populous urban agglomeration.

The Greater Chennai Corporation (previously Madras) is the Oldest Municipal Institution in India established in the year 1866. The Madras Municipal Corporation Act, 1919 (as amended) provides the basic Statutory authority for the administration of Chennai corporation. Incorporated in 1866, the Greater Chennai Corporation is the oldest municipal corporation of India and the second oldest in the world after London.

According to 2011 census, the city (Chennai Core City) had a population of 4,646,732, within an area of 176 square kilometers. Post expansion of the city to 426 km^2, the population including the new city limits as per the 2011 census was 6,748,026 with Chennai Municipal Corporation being renamed as Greater Chennai Corporation.

The Cooum (Koovam) River flows through its Centre and the Adyar River through its southern portion. The Buckingham Canal runs parallel to the coast, joining the Kortalaiyar (Kosasthalaiyar) River in the northern edges of the city and the Muttukadu backwaters south of the city. Both rivers are heavily polluted with effluents and trash from domestic and commercial sources. The Adyar, which is much less polluted than the Cooum, is de-silted and cleaned periodically by the state government. A protected estuary of the Adyar forms the natural habitat of several species of birds and animals. The Buckingham Canal, 4 km (2.5 mi) inland, travels parallel to the coast, linking the two rivers. The Otteri Nullah, an east–west stream runs through north Chennai and meets the Buckingham Canal at Basin Bridge. Several lakes of varying size are located on the western fringes of the city. Red Hills, Sholavaram and Chembarambakkam Lake supply Chennai with potable water. Groundwater sources are mostly brackish. Chennai is well connected by road, rail, air, and sea. It has an international airport and seaport. Within the city a network of bus services and auto-rickshaws are common modes of transport.

Historically, Chennai faces problems of water supply shortages as no big river flows through it with a resulting over-reliance on annual monsoon rains to replenish water in reservoirs. The city's ground water levels have been depleted to very low levels in many areas. Many residents buy their drinking water. The entire Chennai core city is divided into 18 Water distribution Zones (WDZs) based on storage facilities in the area. However, the present system could not ensure equitable water supply with adequate pressure at

all points due to improper zoning/operational problems/inadequate distribution management system.

In 2016, the Government of Tamil Nadu established a Master Plan for Water Supply and Sewerage Sectors (MPWSSS) for Chennai Metropolitan Area (CMA). The aim of MPWSSS was to develop a proper overall long- term plan to fulfil the expected water supply demands and sewerage services over a 30-year horizon starting from 2020 up to 2050. According to the output of the master plan and based on water demand statistics (2015), the Government of Tamil Nadu noted a 36% deficiency between the supply and demand (686 MLD against 933 MLD) upon which, it was decided to establish an additional new Water Desalination Plant (DSP) of capacity 400MLD for overcoming the identified deficiency and to secure reliable water sources for consumers of CMA.

Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB" or "the Client") is responsible for the administration and operation, and maintenance of Chennai City's water production, treatment, storage, distribution, billing and revenue collection. The present water supply system is intermittent due to various constraints in source, storage facilities and inadequacy of the existing distribution system. The Chennai Core city's average per capita water supply is around 101 LPCD. To improve the current water supply situation, the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) has obtained loans from funding agencies such as JICA and World Bank through the Tamilnadu Government to supplement current supplies and water infrastructure. A DPR has been prepared for JICA Assisted "Project for Construction of 400 MLD Capacity Seawater Reverse Osmosis Desalination Plant at Perur and Allied Works by a consortium of Consultants, SMEC International / TCE / NJSE India / SMEC India". The Project report was prepared for the development of source & conveyance of water for capacity of 400mld and providing 24x7 water for Area X and XIII (prioritized areas) for improving water supply services.

Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB) has engaged Water Corporation of Odisha (WATCO) for providing Project Management Consulting Services for the work of "Improvement of existing Water Distribution Network in Water in Area-X and Area-XIII of Chennai City for achieving 24x7 water supply". The Contract Agreement between CMWSSB and WATCO was signed on 20th July 2023 for a period of 48 months. WATCO has implemented 24X7 water supply projects in different cities and urban local bodies of Odisha.

1.2 Need for the project:

The entire Chennai core city is divided into 18 Water distribution Zones (WDZs) based on storage facilities in the area. However, the present system does not provide equitable water supply with adequate pressure at all points primarily due to improper zoning,

absence of discrete DMAs, interconnection between operational zones and inadequate capacity of distribution pipes/reduction of flow area due incrustation.

Therefore, it is imperative to formulate a proposal that aims to improve the existing distribution system, ensuring an equitable and sustainable 24 X 7 water supply to all zones within the core city of Chennai. The administrative areas of X and XIII are priority zones based on the client's funding allocation and execution purpose. The present study comprises preparing detailed project report for improving water distribution networks in admin Area XIII, covering Palipattu and Thiruvanmiyur WDS.

1.3 Design Horizon

The project will be commissioned in 2026 (Base year), So, the horizon years are considered 2041 (as an intermediate year) and 2056 (the ultimate year).

1.4 Project Area Delineation

Area XIII presently covers a total of 13 wards/Depots numbered from 170 to 182, however, for the Project area covering Palipattu WDS and Thiruvanmiyur WDS, only 7 depots including 1 partial depot are covered, namely Depot No.s 169 (P), 170, 173, 174, 178, 179 and 180. The map showing project area is provided at Figure 1.1 below. The salient features of the project area are provided in the Table 1.1 below:

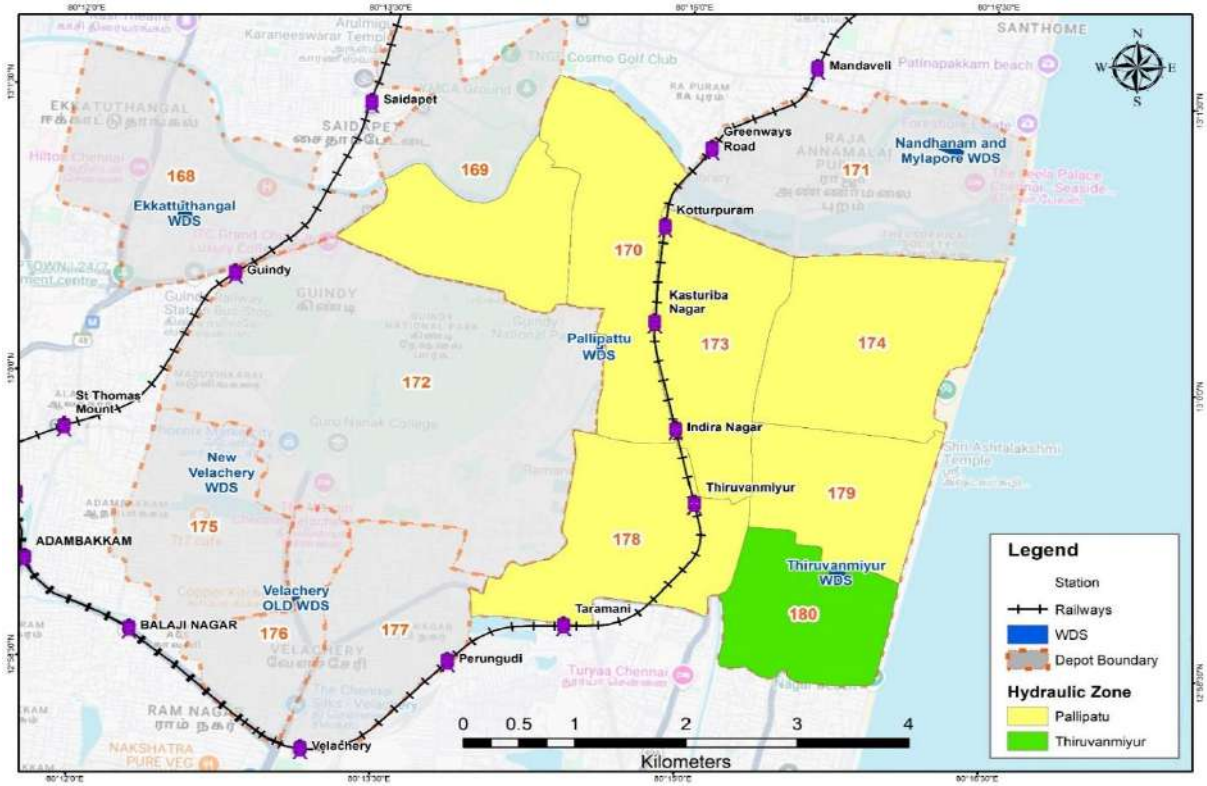


Fig 1.1: Project Area Map

Table 1.1: Salient Features of Admin Area XIII – Palipattu WDS & Thiruvanmiyur WDS

Sl. No.	Details	Area XIII	Project Area
1.	Area (sq.km)	40.22	18.05
2.	Total Number of Depots	13	7 (6 full and 1 partial)
3.	Population as per 2011 Census – For Area XIII	5,49,760	-
4.	Base Year Population Adopted 2026 – For Project Area	6,08,270	3,28,1172
5.	Intermediate Year Population Adopted – 2041 – For Project Area	6,62,450	3,63,826
6.	Ultimate Year Population Adopted – 2056 – For Project Area	7,19,410	4,02,159
7.	Total number of Assesses (Based on previous DPR)	1,27,469	-
8.	Total numbers of Households (Per Survey)	1,36,869	63,933
9.	Total number of House service connection (Per Survey)	95,149	-
10.	Total No. of Premises (Per Survey)	75,618	38,668
11.	No of metered connections (Per previous DPR)	2,036	2,036
12.	Length of Roads (in Kms)	535 km approx.	270 km approx.

1.5 Broad Scope of Services

a. Primary and Secondary data collection and study of existing reports
b. Survey and Investigations: Asset Survey, Consumer survey and condition assessment survey.
c. Planning and design for converting the existing intermittent water supply to 24 X 7 in project area under Areas X and XIII of CMWSSB.
d. Preparation of Detailed Project Report (DPR).
e. Preparation of technical specifications and tender documents for the works.
f. Assisting the employer in bidding process and recommendation of the right bidder for award of the works contract for 24 X 7 sustainable water supply.
g. Services covering approval of detailed designs, coordination with the contractor, works monitoring, assist in dispute resolution, specialized techno-commercial advice during execution of work for ensuring completion of the work in a time bound manner.
h. Assist the employer in monitoring the implementation of the works and commissioning of the works.

1.6 Basic Design Objectives:

To achieve the specific needs of the project, the following broad design objectives have been evolved.

1. Ensure continuous water supply on a 24/7 basis.
2. Achieve client's operational needs to satisfy minimum residual pressure of 17m during peak supply hours.
3. Establish district metering areas within each zone to be hydraulically monitored and locally controlled through Automation.
4. Introduce proper Instrumentation, control and automation system to achieve smart water management.
5. Provide a control strategy for reduction of NRW (Non-Revenue Water) based on leak detection devices locally managed.
6. Implement water quality monitoring points locally managed.
7. Maximize the benefits of the existing assets by applying optimization techniques based on hydraulic modelling and outcome of condition assessment survey.
8. Design the house services connection and ensure a proper metering, billing and collection strategy for economic gains and self-sustainability.
9. Implement proper operational strategies that are necessary for providing efficient water supply services and maximizing the assets' lifespan.

The PMC design team has adopted a design philosophy that ensures the application of modern technology, problem-solving techniques, and engineering sustainability concepts. The design approach will include optimization and reliability-based engineering solutions that are flexible and readily available. The proposed solutions and alternatives also considered possible risks as a function of supply, demand, and operational processes, supported by evidence-based hydraulic analysis simulations using Water Gems hydraulic modelling software developed by BENTLEY.

CHAPTER -2-EXISTING WATER SUPPLY SYSTEM

2.1 INTRODUCTION

This chapter provides a brief outline of the existing water supply system of Chennai Core City with details of Water Supply Sources, Water Treatment Plants (WTPs), Transmission Mains, Pumping Stations, Zone-wise Water Distribution Stations (WDS), Service Reservoirs and Distribution Systems serving the zones and specific existing water supply infrastructure of the project area under Admin Area XIII. The admin boundary map showing various depots under area XIII is shown in figure 2.1 below.

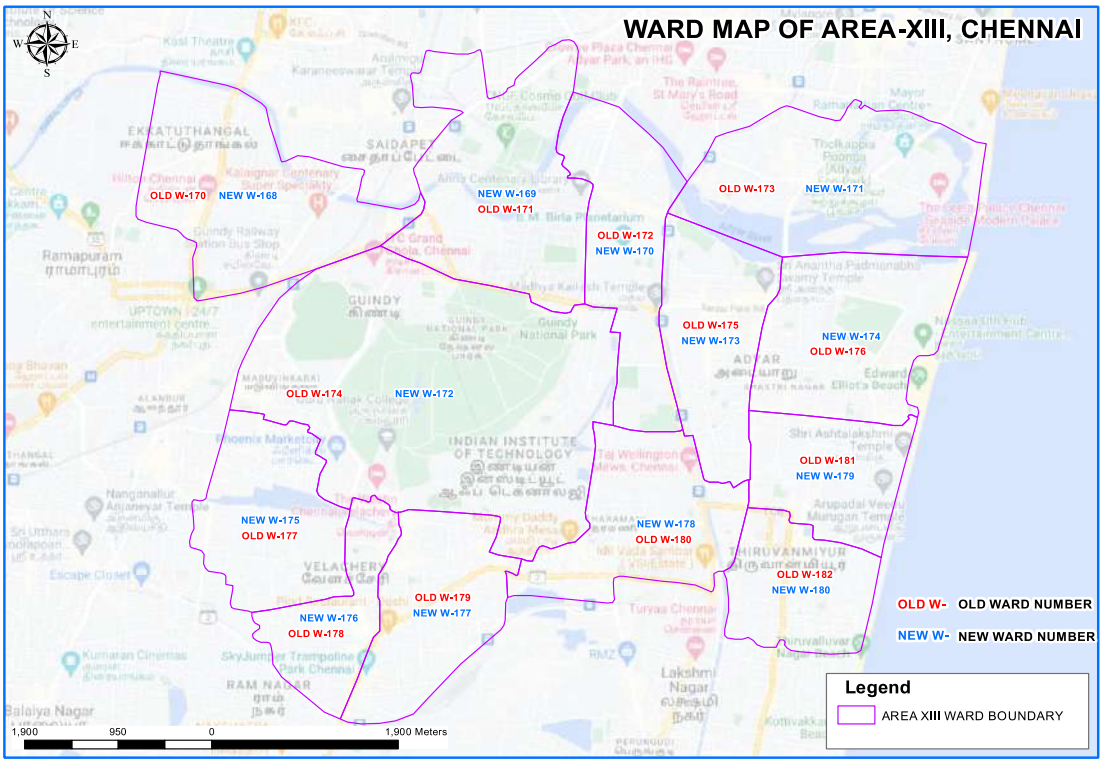


Fig: 2.1 AREA XIII – Admin Boundary Map

2.2 WATER SUPPLY SOURCE

Presently Chennai core city receives water from four different water supply sources, i.e. surface water, groundwater, seawater desalination plants, and wastewater recycling plants, as presented in table 2.1 below,

Table 2.1: Different Water Sources

Sl. No	Production facilities	Capacity (MLD)	Source of water
1	Kilpauk WTP, Surapet WTP, Puzhal WTP, Chembarambakkam WTP	1114	Poondi, Red hills, Cholavaram & Chembarambakkam lakes and Telugu Ganga Project
2	Vadakuthu WTP	180	Cauvery River (Veeranam Reservoir)
3	Minjur DSP	100	Seawater
4	Nemelli DSP	100	
5	Nemelli DSP	150	Commissioned in the year 2024
6	Groundwater	128	Northern well fields and Extended area well fields
	Tertiary Reverse Osmosis Plants at Koyambedu and Kodungaiyur	90	Sewage water Commissioned in the year 2019
Total of Core City		1862	

However, Area XIII water distribution stations (WDS) receive treated water mainly from three sources, namely Vadakuthu WTP, Chembarambakkam WTP and Nemmeli DSP. The details of each WDS under Area XIII with their source connectivity and beneficiary Depots are tabled below in table 2.2.

Table 2.2: WDS Area with Source

Sl. No.	WDS Name	Beneficiary Depots	Sources
1.	Nandanam	173, 122, 123P ,126P	Chembrambakkam & Vadakuthu WTPs and Nemmeli DSP
2.	Thiruvanmiyur	175P, 176P, 180P, 181P, 182P	Nemmeli DSP
3	Pallipattu	175P, 176P, 180P, 181P, 182P, 171P, 172P, 175P, 176P	Chembrambakkam & Vadakuthu WTPs and Nemmeli DSP
4	Velachery Old	177, 178, 179,174P	
5	Velachery New	174P	
6	Ekkatuthangal	170	Chembrambakkam & Vadakuthu WTPs

Source: As per site information, P- Part of the Depot

The potential of various sources of water for the Chennai city is presented in Table-2.3 below.

Table 2.3: Water Sources - Potential

S.No.	Particulars	Potential Expected during planning (mld)	Yield after Construction (mld)	Present yield (mld)
1	Surface Water Sources			
	Poondi, Red hills, Cholavaram, Chammbarambakkam lakes	200	125	75
	Telguganga Project	930	400	200
	Veeranam Lake Source	180	100	100
2	Ground Water Source/Sub Surface Water Source			
	Northern Well field/Southern Coastal aquifer	100	25	25
	Sub Surface water sources in rest of CMA	32	32	32
3	Sea Water Desalination			
	Minjur DSP	100	100	100
	Nemmeli DSP	100	100	100
	Nemmeli DSP	150	150	150
4	Water Recycle System-TTRO			
	Kodungaiyur TRO	45	45	45
	Koyambedu TRO	45	45	45
	Total	1782	1122	872

2.3 RAW WATER TRANSMISSION SYSTEM OF CHENNAI CORE CITY.

The schematic drawing of the raw water transmission mains system Chennai core city area is shown in figure 2.2 below, the total length of the raw water rising main is around 367 KM.

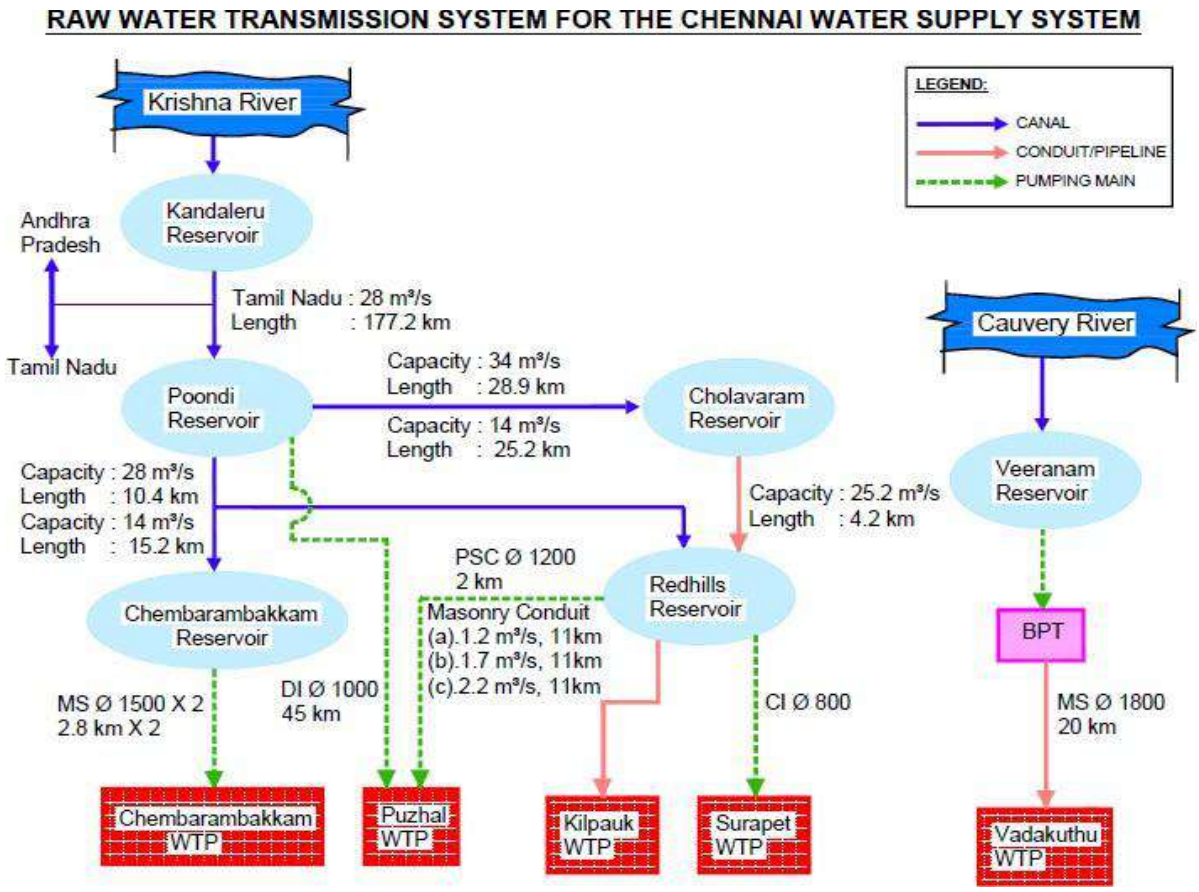


Fig: 2.2 Raw water transmission network - Chennai water supply system

2.4 DETAILS OF EXISTING WTPs AT CHENNAI CORE CITY

The total installed capacity of water treatment system for the city is 1862 MLD, consisting of 69 % treated water capacity coming from 5 WTPs, 19% from three number desalination plants, 7% from ground water & 5% from tertiary RO plant. Details are presented in Table 2.4 below.

Table 2.4: Details of Existing Water Treatment Facilities at Chennai

S. No.	Production facilities	Capacity (mld)	Source
1	Kilpauk WTP Surapet WTP Puzhal WTP Chembarambakkam WTP	1114	Poondi, Red hills, Cholavaram, Chammbarambakkam lakes, Telgu ganga Project
2	Vadakuthu WTP	180	Cauvery River (Veeranam Reservoir)
3	Minjur DSP	100	Sea Water
4	Nemelli DSP	100	Sea Water

5	Nemelli DSP	150	Sea Water
6	Ground Water	128	
7	Territory RO Plant at Koyambedu and Kodungaiyur	90	Sewage Water Commissioned in 2019
TOTAL		1862 MLD	

2.5. CLEARWATER TRANSMISSION MAIN:

Treated water from WTPs and Desalination plants is transported to 18 water distribution stations located in core city of Chennai. Length of transmission main is 490 kms and dia is ranging from 225 to 2000 mm and of material CI, PSC, DI and MS. In addition to the above pipeline, clear water rising main of 40KM length of dia 1200-1400mm and of DI 300mm of length 9km exist from 100 MLD Nemelli Desalination Plant to the core city. Further the existing 1400mm dia MS pipeline from 150 MLD Nemelli Desal Plant to Shollinganallur Intermediate Pumping Station for a length of 21.95 km, 1200mm dia MS pipeline from Akkarai Intermediate Pumping Station to link with existing 1200mm dia

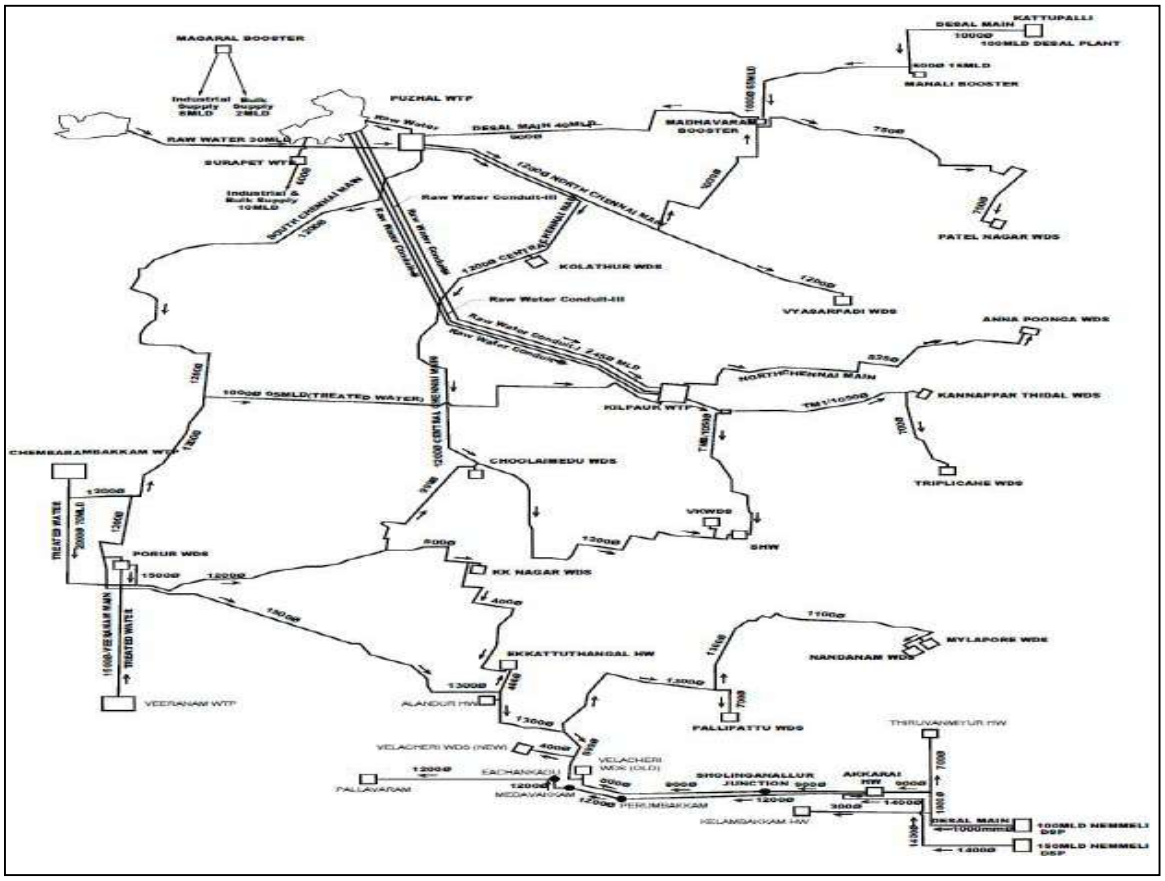


Fig: 2.3 Clearwater transmission main layout diagram of Chennai Core city

pipeline at Pallavaram GST Road for a length of 16.67 km. Schematic layout of existing clear water transmission network is presented in figure 2.3 below.

2.5 Water Distribution Stations:

There are 18 Water Distribution Stations (WDS) in Chennai's core city. Initially designed as isolated hydraulic zones, over time, numerous interconnections have been established between these zones. This has affected the efficiency of demand-supply management from an operational and maintenance perspective. The WDS under operation having their own water storage capacities are detailed below in table 2.5.

Table 2.5: Existing WDS - Chennai Core City

WDS Zone	Name of WDS	Under-ground Tank (ml)	Elevated Service Reservoir	Planned Supply Volume (mld)	Supplied by
1	Kilpauk	81.32	15.80	94	Pump &ESR
2	Anna poonga	22.50	2.50	20	Pump &ESR
3	Kannaparthidai	16.00		18	Pump
4	Triplicane	10.00	2.40	10	Pump &ESR
5	KK Nagar	14.00	2.40	28	Pump &ESR
6	Valachery	6.00		25	Pump
6A	Velachery (New)	2.00		5	Pump
7	Ekkatuthangal	4.50		5	Pump
8	Choolaimedu	43.00		35	Pump
9	Kolathur	20.00		30	Pump
10	Vysarpadi	22.00		30	Pump
11	Patel nagar	14.00		20	Pump
12	Pallipattu	17.00	0.75	29	Pump &ESR
12A	Thiruvanmiyur	3.00	0.75	5	Pump &ESR
13	Nandanam	11.00		15	Pump
14	Mylapore	11.50		25	Pump
15	Southern HW	24.00	4.50	55	Pump &ESR
16	Vallubvarkottam	15.00	3.00	15	Pump &ESR
	Other area (industries Expanded areas, bulk supply, tank, lorries etc.)			366	Various
		336.92	32.10	830	
		368.92			

(Ref Master Plan JICA Report)

The existing water distribution station under area XIII are presented in Table 2.6 below.

Table 2.6: Existing WDS serving Area XIII Presently.

Sl. No.	Existing Storage Facilities				Exiting Pumps Details			Type	Beneficiary Depots
	Location	UGR (ml)	OHT		Discharge MLD	Head (m)	No (W+S)		
			Capacity	Staging					
1	Nandanam	11.0			45	30	2+1	VT	172.122,123P And 176P
2	Thirvanmiyur	3.0			9	32	4+2	HSC	175P,176P,180P, 181P,182P
3	Palliapttu	17.0	0.7	10	36.29	32.5	4+2	VT	171P,172P,175P, 176P.180P,181P, 182P
4	Ekkatuthangal	4.5			11.62 7.8	32 32	1 1+1	HSC	170
5	Velacherry old	7.3			32.8	32.2	2+1	VT	177, 178, 179, and 174P
6	Velacherry new	2.0			6	34	4+2	HSC	174P

2.5.1 Thiruvanmiyur WDS:

Thiruvanmiyur WDS

Thiruvanmiyur WDS Pump House

This WDS located at East Seaward Road under depot no 180, which is fed treated water from Nemmeli DSP. This WDS distribute water to part of depot 173, part of depot 174, part of depot 178, part of depot 179 and part of depot 180 of Area XIII. The existing UGR of 3 ML and ESR of 0.70 ML capacity planned to supply 5 MLD through pumping as well as through gravity from ESR. The existing pumping system includes 6 nos 55KW of HSC pumps (2W+ 4S) discharges water at head 32m with pumping rate 9.07 MLD.

2.5.2 Palliapatu WDS:

This WDS located at Sriram Nagar Main Road, near IIT Chennai, under depot no 170, which is fed treated water from from Chembarambakkam & Vadakuthu WTPs and Nemmeli DSP. This WDS distribute water to part of depot169, part of depot 170, part of depot 173, part of depot 174, part of depot 178, part of depot 179, part of depot 180 of Area XIII. The existing UGR of 17.0 ML and ESR of 0.70 ML capacity planned to supply 29 MLD through pumping as well as through gravity from ESR. The existing pumping system includes 6 nos 180 KW of vertical turbine (VT) pumps (2W+ 4S) discharges water at head 32.5 m with pumping rate 36.29 MLD.

Palliapatu WDS

2.7. Water Distribution Network

Based on the data from CMWSSB, the core city's water distribution network spans approximately 2,381 km. Most of this network has been redeveloped according to the Detailed Project Report (DPR) titled "Detailed Engineering Design of Water Distribution System for Chennai City," prepared by M/s Kirloskar Consultant in September 2018. According to the JICA report in the year 2017, the total length of the distribution network, based on field data, is around 2,303 km. This network comprises of various materials: CI (91.62%), uPVC (6.17%), DI (1.80%), GI (0.38%), and AC (0.03%), with diameters ranging from 40mm to 750mm. As presented in Table 2.7 below.

Table 2.7: Diameter, length and material of pipe

S.NO	PIPE DIAMETER (mm)	PIPE MATERIAL with (Length in m)						TOTAL LENGTH (m)
		PSC	AC	CI	PVC	MS	DI	
1	100			1900530.70	121.00	0.00	177058.22	2077709.92
2	110				23490.42			23490.42
3	125			4140.82				4140.82
4	140				215.00			215.00
5	150			300164.92	23442.00		41681.45	365288.37
6	160				4798.00			4798.00
7	175			4266.57				4266.57
8	200		1770.00	152975.86	1270.00		18420.58	174436.44
9	225			22409.07				22409.07

S.NO	PIPE DIAMETER (mm)	PIPE MATERIAL with (Length in m)						TOTAL LENGTH (m)
		PSC	AC	CI	PVC	MS	DI	
10	250			58387.10			5908.70	64295.80
11	300			90414.44			11683.63	102098.07
12	350			24149.79			9763.72	33913.51
13	400			27203.72			3490.94	30694.66
14	450			39323.12			11.66	39334.79
15	500			6933.42			3558.93	10492.35
16	525			12214.17				12214.17
17	575			1272.00				1272.00
18	600			21772.76			6229.73	28002.48
19	675			8668.62				8668.62
20	700			19514.59			3093.71	22608.30
21	750			6591.58			244.00	6835.58
22	800			4694.00			2279.40	6973.40
23	825			9332.38				9332.38
24	900			13730.06		29.90		13759.96
25	1000			301.84			1602.00	1903.84
26	1050			3494.00				3494.00
27	1100							0.00
28	1200	724.00				4985.58		5709.58
29	1300							0.00
30	1600			830.56				830.56
TOTAL LENGTH		**724.00**	**1770.00**	**2733316.09**	**53336.42**	**5015.48**	**285026.66**	**3079188.66***

Source – Earlier prepared DPR

Since no consolidated database for pipeline inventory was available, the PMC (WATCO) engineers have visited the Area/Depot offices and collected the available data and drawings pertaining to the project area i.e. Area XIII covering Palipattu WDS and Thiruvanmiyur WDS.

2.8. Existing Scenario – Area XIII

Area XIII, (Adyar) is part of the project area covering 13 wards, i.e. from Depot no. 170 to Depot no. 182 with an area of 40.22 Sq km and a road network of 520 Km. The total population of this area as per the 2011 census is 5,49,760. Presently, this area is being served by six existing WDS located within the Area XIII admin area. In addition to the above WDS, some overhead tanks are located within area XIII, but most of them are not operational due to their condition, lesser capacity, and smaller staging height.

2.8.1. Water Distribution System and Pumping Facilities

At present, Area XIII is supplied with water through 6 no.s of WDSs with a combined storage capacity of 45.5ML. The below table 2.8 shows the WDS wise storage and pumping facilities of Area XIII.

Table 2.8: WDS wise storage and pumping facilities of Area XIII

S No	Existing Storage Facilties (ML)				Existing Pumps Configuration		Type of Pumps		Beneficiary Depots
	WDS Location	UGR (ML)	OHT (ML)	Staging ht (m)	Discharge (MLD)	Head (m)	No (W+S)	Type	
1	Nandanam	11.0	-	-	45	30	2+1	VT	173,122,123P and 176P
2	Thirvanmiyur	3.0	-	-	9	32	4+2	HSC	175P,176P,180P,181P,182P
3	Palliapattu	17.0	0.7	10	36.29	32.5	4+2	VT	171P,172P,175P,176P,180P, 181P, 182P
4	Ekkatuthangal	4.5	-	-	11.62, 7.8	32, 32	1, 1+1	HSC	170
5	Velacherry Old	7.3	-	-	32.8	32.2	2+1	VT	177,178,179 and 174P
6	Velacherry New	2.0	-	-	6	34	4+2	HSC	174P

Source: Site information

It is understood that none of the command areas under the above WDSs is isolated; multiple interconnections were made in the distribution network between the command areas. Further, the operational areas and depots of CMWSSB are aligned geographically to the depots but not spatially to the water distribution stations. Due to this misalignment, interface issues across the areas are always in place, resulting in the inefficiency of O & M Works.

2.8.2. Existing Distribution System – Area XIII

As per the latest site information, drawings and data collected and digitalized by PMC (WATCO), the total length of the existing pipeline in the area is about 520 Km, with the diameter ranging from 100 to 1100 mm for a total road network length of around 535 km. The CI piping material comprises 74.47% of the total pipe-lengths with DI 21.76%, and MS and PVC piping material comprise 0.01 % and 3.76%, respectively. 69.1% (around 359.9 km) of the total piping lengths have 100/110mm diameter, 12.08% of the total piping length have 150/160mm diameter, while the rest of 18.82% has diameters ranging from 200 mm to 1100mm. From the above information, nearly 30.9% of the road network is not covered by 100mm diameter pipeline where HSC connections need to be made. CMWSSB continues to provide HSC connections for all pipe diameters ranging from 100mm to 250mm, which is not desirable for better management of the system. Present Water Supply in area XIII is intermittent with a daily average supply of 3 to 4 hours. Dia and material-wise existing distribution network breakup of Area XIII is presented in Table 2.9 below.

Table 2.9: Existing Distribution system Details of Area XIII

Sl. No.	Dia (mm)	Diameter				Total (m)
		CI	PVC	MS	DI	
1.	100	268655.12			75187.82	343842.94
2.	110		16083.36			16083.36
3.	140		214.91			214.91
4.	150	43795.10			16886.14	60681.24
5.	160		1978.69		4.36	1983.05
6.	200	21004.42	1267.08		4401.45	26672.94
7.	250	7592.20			654.58	8246.77
8.	300	15360.45			10023.40	25383.84
9.	350	8567.99			5293.37	13861.36
10.	400	6379.58			825.25	7204.83
11.	450	4791.06				4791.06
12.	500	734.24				734.24
13.	525	22.40				22.40
14.	600	5537.14				5537.14
15.	700	3131.98				3131.98
16.	750	38.89				38.89
17.	800	1376.11				1376.11
18.	900	606.50				606.50
19.	1100			60.00		60.00
Total		**387,593.16**	**195,44.04**	**60.00**	**113,276.36**	**520,473.57**

2.8.3. House Service Connections:

As per the latest CMWSSB records, the total number of House Service Connections existing in area XIII is 93113, of which 2036 (i.e. 2.18 %) are metered and the rest all unmetered. Out of 2036 metered connections, 1854 are AMR and the remaining are non-AMR. Depot wise House Service Connections (HSC) with meters are presented in Table 2.10 below.

Table 2.10: House Service Connections – Area XIII

Depot	Metered Consumers			Un-metered Consumers			
	Old meter Total	AMR meter Total	Meter consumer Total	Domestic	Partial commercial	Non water intensive	Others
170	18	179	197	3239	914	178	51
171	14	262	276	4148	217	278	14
172	10	87	97	4819	228	49	7
173	76	106	182	5132	325	76	10
174	3	113	116	4820	438	93	27
175	20	200	220	8465	477	440	41
176	11	98	109	5737	243	115	29
177	1	130	131	12259	448	63	11
178	8	119	127	6685	204	55	8
179	17	203	220	10164	291	157	35
180	4	121	125	6107	344	56	26
181	0	106	106	5979	202	79	18
182	0	130	130	6962	229	67	18
Total	**182**	**1854**	**2036**	**84516**	**4560**	**1706**	**295**

2.8.4. Bulk Water Connections – Area XIII.

As per information received from CMWSSB, the Bulk Water Connections Consumer information is Presented below, in Table-2.11.

Referring table there are 85 number of bulk consumers with 11.77 MLD consumption.

Table 2.11: Bulk water Consumers in Area XIII

Sl. no	Depot no	Consumer Name	Unit Details	Consumption in MLD
1.	170	Khivraj tech Park (Olympia tech park)	-	0.010
2.		Director EDII	-	0.008
3.		Bristol IT Park	-	0.012
4.		Kings institute	-	0.006
5.		Kings' hospital	-	0.180
6.		VGN Fairmount	-	1.052
7.		Olympia cyberspace	-	0.012
8.	171	MD CMRL	PC	0.040
9.		Register - Anna University	NWI	0.040
10.		Staff - Anna University	-	0.450
11.		Hostel - Anna University	-	0.067
12.		Todd hunter Nagar A,B & C BLOCKS	PWD quarters	1.404
13.	172	Ramco Cements	-	0.01
14.		Krishna tower, 50, Sardar Patel	-	0.037
15.		CLRI main block	-	0.049

Sl. no	Depot no	Consumer Name	Unit Details	Consumption in MLD
16.		CLRI (II type)	-	0.184
17.		The Director (Admin), Cancer Institute	-	0.040
18.		The Director Regional labour, 999, Sardar Patel Road	-	0.010
19.		Appasamy	-	0.180
20.	173	Chaitanya ficus grove	Apartment	0.017
21.		TVH belicia Towers	Commercial	0.020
22.		Ceebros	Apartment	0.167
23.		Leela Palace	Hotel	0.200
24.		RM towers	Apartment	0.100
25.		Somerset	Hotel	0.017
26.		Lord's Avenue	Gated Community Apartment	0.020
27.		Ragamaliga apartment	108 units	0.080
28.		Jains sagaarika	-06 units	0.079
29.		Hiranya Apartmnets	160 units	0.119
30.		Grey shott apartments	110 units	0.082
31.		PWD sump near Tamilnadu maritime board	Institute	0.067
32.		TNSCB - 600 tenants Maleswaran thottam	Slum board - 600 units	0.446
33.		Judge quarters - 1	Quarters	0.083
34.		Judge quarters - 2	Quarters	0.333
35.	174	Westin Hotel, Velachery main road	-	0.017
36.		park (Hayatt)	200 rooms	0.020
37.		IIT	-	1.213
38.		Rajbhavan	120 Quarters inside	0.100
39.		Phoneix mall	No CMWSSB Connection	1.000
40.		Mahalaxmi flats, Secretariat colony	300 units	0.203
41.	175	TVH, LB road (167 FLATS)	150 units	0.124
42.		MIG & HIG Flats, Indira nagar	150 units	0.111
43.		TNHB Flats, 2 nd avenue	200 units	0.149
44.		Tower of Adyar, L.B. Road (167 flats)	150 units	0.124
45.	176	3 roses, Vannathurai (Ellaiamman Koil street)	*70* units	0.052
46.		Casagrand apartment, Vannathurai (Ellaiamman Koil street)	66 units	0.049
47.		Ragamaliga, Jeevarathinam main road (3 blocks)	109 units	0.081
48.		Jeevarathinam, 1 st Street (5 blocks) Shanthi colony	252 units	0.187
49.		Basant Nagar 2 nd cross new CPWD (7 block)	272 units	0.202
50.		Basant Nagar 2 nd cross old CPWD (6 block)	152 units	0.113
51.		RBI quarters	200 units	0.149
52.	177	NIL	-	

Sl. no	Depot no	Consumer Name	Unit Details	Consumption in MLD
53.	178	Sai Sarovar apartments, 100 ft, Bypass Road, Velachery	-	0.012
54.		Vasanth apartments, 100 ft bye pass road, Velachery	-	0.048
55.	179	Ramaniyam marvel apartments, 1 st main road, Shashatripuram, Velachery	142 units	0.105
56.		Anmol abhinandanam, 1 st main road, Shastripuram, Velachery	62 units	0.046
57.		AKS garden, Ramagiri nagar, Velachery	102 units	0.076
58.		Kgeyes apartments, Udayam Nagar, Velachery	112 units	0.083
59.		Baba Garden apartments, Sastri Street, baby Nagar, Velachery	84 units	0.062
60.		CEEDEYS (Regale palm garden), Velachery	412 units	0.306
61.	180	Holiday inn	-	0.002
62.		IBMS	-	0.087
63.		IWS	-	0.002
64.		Ascendas	-	0.019
65.		Spastic society	-	0.005
66.		CSIR	-	0.0003
67.		TTTI/NITTTR	-	0.034
68.		Tidel park	-	0.038
69.		Elnet	-	0.038
70.		Tamilarasu Press	-	0.004
71.		MGR film city	-	0.014
72.		Institute of mathematical science	-	0.031
73.		Catering college	-	0.037
74.		Thiruvanmiyur MRTS	-	0.009
75.		NIFT	-	0.001
76.		World bank	-	0.00003
77.		SETS	-	0.037
78.		Taj Hotel	-	0.231
79.		Ramanujam IT Park	-	0.144
80.		CPT (ward 172)	-	0.008
81.	181	The Atrium	188 units	0.140
82.	182	Appasamy Springs	144 units	0.107
83.		TNSCB-128	128 units	0.109
84.		TNSCB-360	360 units	0.307
85.		Appasamy water Ford	160 units	0.119
			TOTAL	11.77

CHAPTER -3-SURVEY &INVESTIGATION

3. INTRODUCTION

This chapter consists of the followings,

- Topographical Survey
- Asset Survey & Mapping
- House Level Survey
- Conditional Assessment Survey of Pipeline

3.1. TOPOGRAPHICAL SURVEY

3.1.1 Introduction

Prior to topo survey, secondary data, as available, such as Depot and Area Boundary maps, Water Distribution network drawings etc were collected. The collected documents were analyzed and further discussed with officials of CMWSSB. Thereafter, topographic survey was carried out through DGPS (Differential Global Positioning System). The Survey was with reference to known base point (provided by CMWSSB), Base stations were then fixed at identified suitable locations. Topographical features like road width, side shoulders, and important infrastructures along the roads were captured. Pictures showing the Ground control point (GCP) provided by CMWSSB and base stations identified for triangulation given in image 3.1 & 3.2 respectively. The surveyed area is flat terrain with elevation ranges varying between 1m to 8 m with respect to MSL.

Image-3.1: GCP #16 and #23 PROVIDED BY CMWSSB

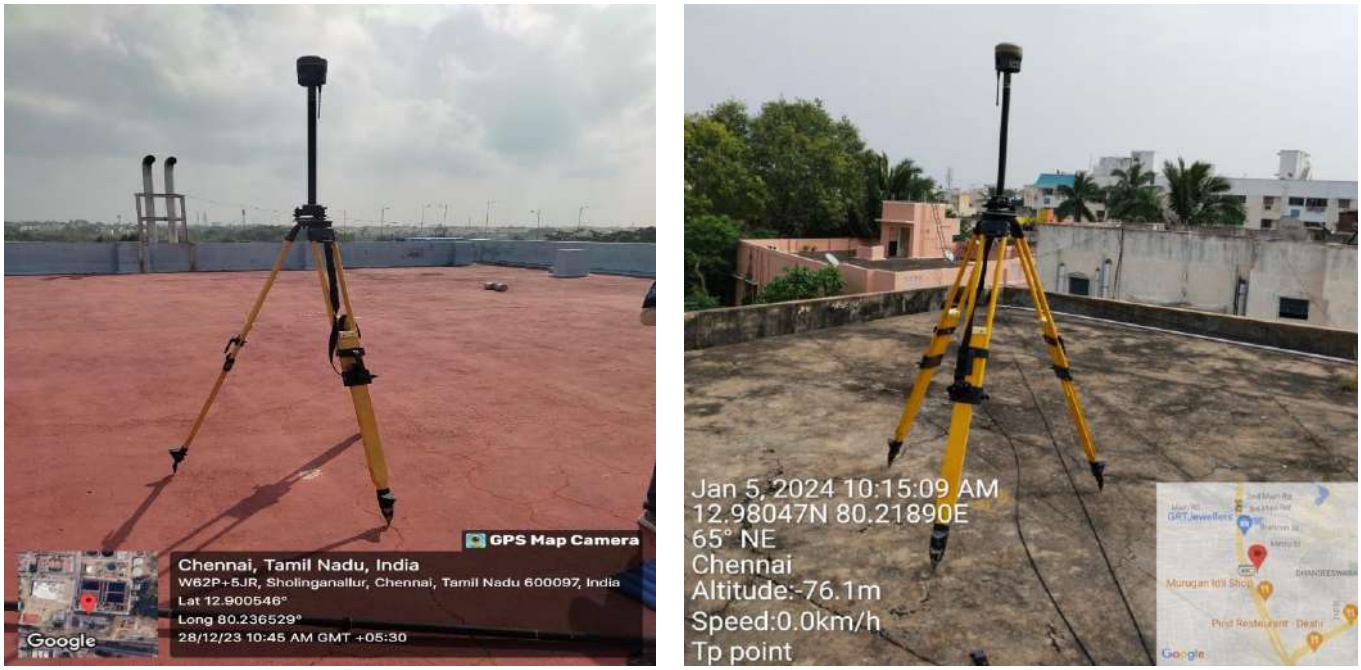


Image 3.2: Base Station for Triangulation

3.1.2 Methodology & Process

The following sequence of activities were carried out using DGPS instruments to capture levels of road, topographical features like road width, side shoulders, other important structures and levels of water supply assets such as tapping & receiving point of house connections, pump house & water distribution stations.

3.2. ASSET SURVEY

3.2.1. Introduction

The GIS based Asset Mapping work of the existing Water Supply system involved detailed inventorying and documenting of all components, from Pumping Stations to pipelines and distribution networks. This process started with field surveys, where data on the location, condition, and specifications of assets is collected using DGPS (Differential Geo Positioning System). Then, Geographic Information System (GIS) technology was used to create a geo-reference digital map, showing the spatial distribution and attributes of each asset. This helps in better management, maintenance, and planning of the water supply system.

3.2.2. Process of Data Collection, Validation & Updation

Data Collection:

- Study & analysis of Existing asset database.
- Identification and marking of Points of Interest, namely, landmark areas, sub-areas, location etc.
- Generation and printing of section wise/ward wise Asset maps in soft/hard copies.
- Survey of existing & new water supply assets for ground truthing by GPS/DGPS.
- Asset data module updation.

3.2.3. Asset map and database

- creating database of assets for Inventory management & smart solution,
- Asset map development
- Attribute data linking
- GIS based Mapping of existing, new & replaced assets.
- Asset Map and Drawing preparation

3.2.4. Summary of Pipeline Assets and Depot-wise Asset maps

3.2.4.1. Pipeline Assets of Area XIII

Asset survey has been conducted on site using DGPS survey followed with development of asset survey maps on GIS platform duly validated by the Department. As per the asset survey of area XIII, the total lengths of the existing pipelines are about 630 km with diameter ranging from 100mm to 1100mm. The CI piping material comprises of nearly 81.16% of the total pipe-lengths, while DI and PVC piping material comprises 14.88% and 3.93 %, respectively, with 0.03% only MS piping and other materials. Material-wise Pipeline breakup is presented in Table-3.1 below.

Table 3.1: Depot wise pipeline length - material wise of Area XIII

DEPOT	LENGTH IN METERS				
	CI	DI	PVC	MS	OTHERS
168	128.27	47563.48			
169	46341.25	939.916			
170	39882.20	369.42	292.48		
171	34157.80	475.06			
172	37260.07	8208.52	263.51		
173	53280.10		357.87		
174	54188.208	479.60	535.97		
175	71185.43				
176	28473.86	7493.59	393.02		
177	54113.05				
178	45771.12	185.25			
179	27658.74	8220.71	9812.67		
180	18994.74	19850.30	13158.33	15.02	109.08
TOTAL	**511434.84**	**93785.85**	**24813.85**	**15.2**	**109.8**

3.2.4.2. Pipeline Assets of Project Area

Based on the asset survey, the total lengths of existing network which would be connected to Pallipatu WDS for distribution of water is 245.69 KM & the network connected from Thiruvanmiyur WDS is 49.79 KM. The total length of existing distribution pipeline considered in this DPR is 295.46 KM. The abstract of diameter wise pipe length in individual operational zones is presented in below Table-3.2.

Table 3.2: Diameter wise pipe length in the project area

S. No.	Diameter (mm)	Pallipatu WDS						Thiruvanmiyur WDS
		OZ - 169 (P)	OZ - 170	OZ - 173	OZ - 174	OZ - 178	OZ - 179	OZ-180
1	100	12997	20264	27570	30645	29186	21026	21966
2	110		0	760	536		7353	10382
3	125				0		0	1031
4	150	6053	8405	12016	11835	6823	6568	5866
5	200	1124	0	2312	1734	2467	3181	4866
6	250	24	11	1370	109	0	563	954
7	300	863	1105	540	693	1343	253	3999
8	350	1105	833	0	1464	0	1320	644
9	400	2096	0	0	0	0	747	0
10	450	0	0	102	5085	2661	468	0
11	500	0	0	1767	723	0	0	0
12	600	0	0	2945	1842	1932	0	26
13	700	0	0	0	56	0	0	44
14	900	0	0	0	0	811	0	0
Grand Total		24262	30618	49382	54722	45223	41479	49778

3.2.5. Details of Rising Main

As per the asset survey, the total length of rising main is 74.2 KM out of which 1.8KM is CI and 72.4 KM is DI. Details of rising mains are presented in **Table 3.3** below.

Table 3.3: Details of Raising Mains under Area XIII

DIA	LENGTH IN METERS		
	CI	DI	Grand Total
1000	68.17	26034.93	26103.10
1200	92.83	3925.65	4018.49
350	76.59	430.15	506.74
400	179.61	919.76	1099.38
450	51.97	2063.64	2115.61
500	37.56	8136.92	8174.48

DIA	LENGTH IN METERS		
	CI	DI	Grand Total
550	31.24		31.24
600	126.58		126.58
700	107.88	10149.34	10257.22
750	242.44	5440.65	5683.08
800	522.23	11941.70	12463.93
900	310.65	3321.09	3631.74
Grand Total	**1847.77**	**72363.82**	**74211.59**

Asset maps of water distribution station (WDS) and water distribution network (WDN) depot wise were prepared and further verified from the depot engineer. The verified maps were used for design of the water supply network. The maps were digitally reproduced in GIS platform using ArcGIS and ArcMap. and the asset database were developed. Operational zone wise asset maps & drawings of Pallipatu WDS & Thiruvanmiyur WDS are appended Under Appendix 2. A validated approved model map, Pallipatu WDS & Thiruvanmiyur WDS drawings are presented below in figure 3.1, 3.2 & 3.3 respectively, for better appreciation.

Figure 3.1: Asset Map of Depot 169

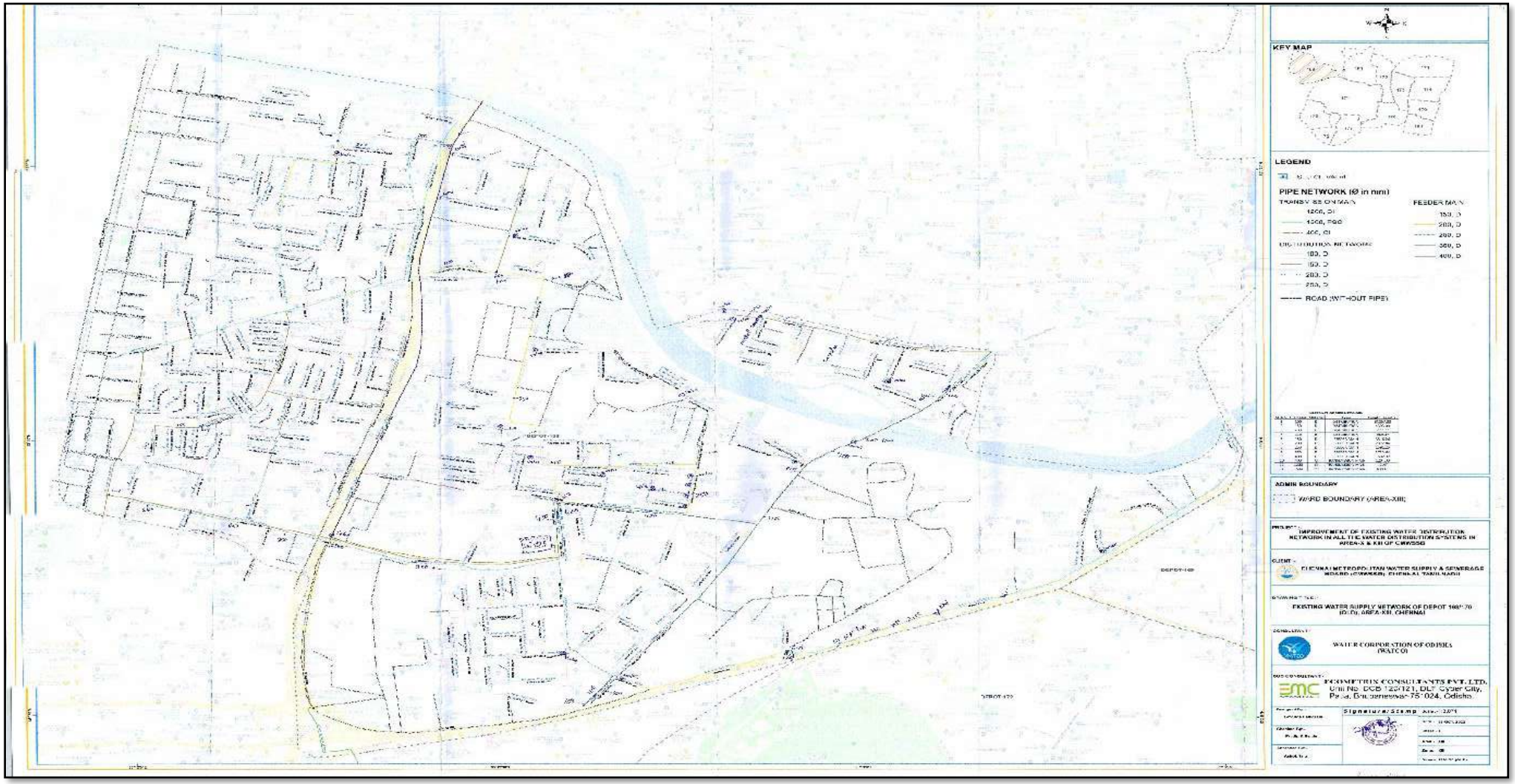


Figure 3.2: Asset Drawing of Pallipatu WDS

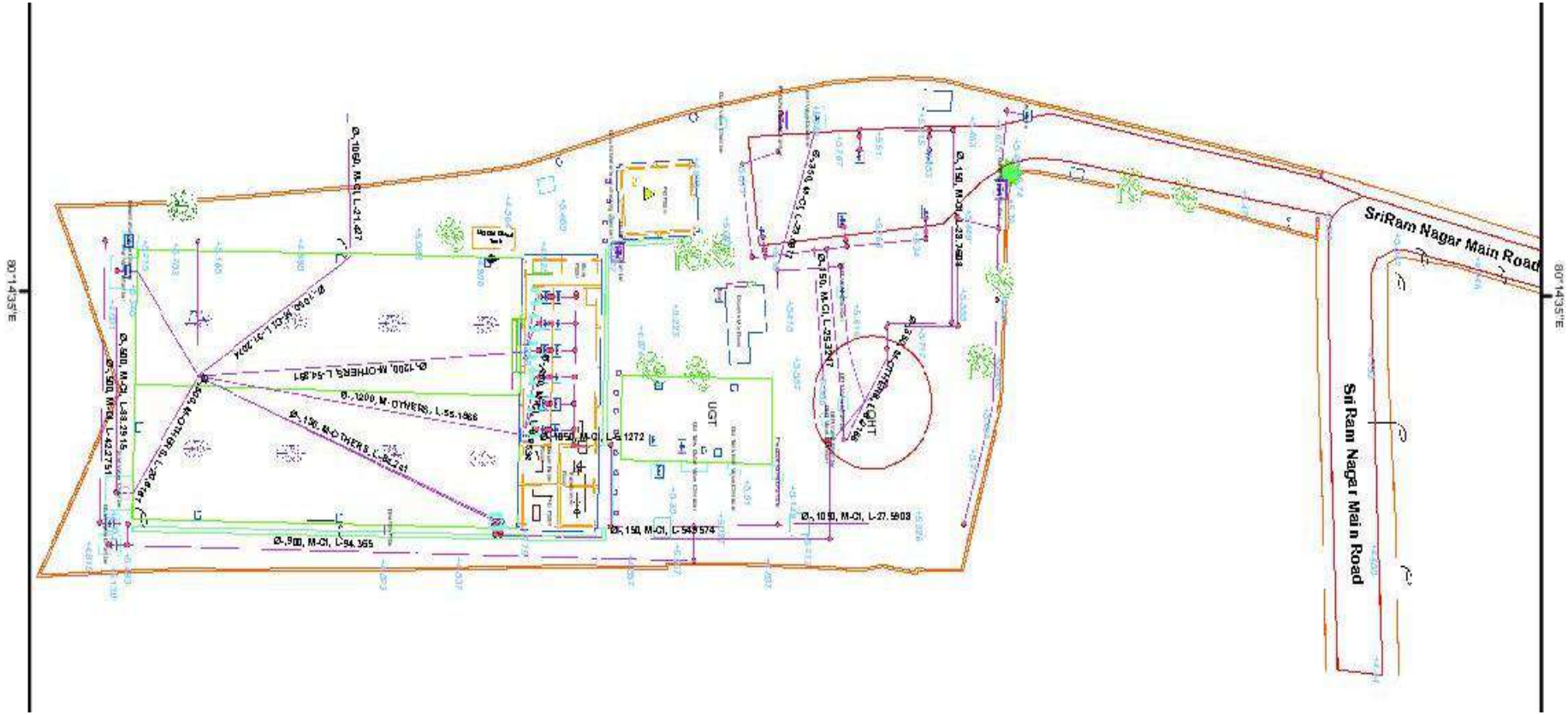
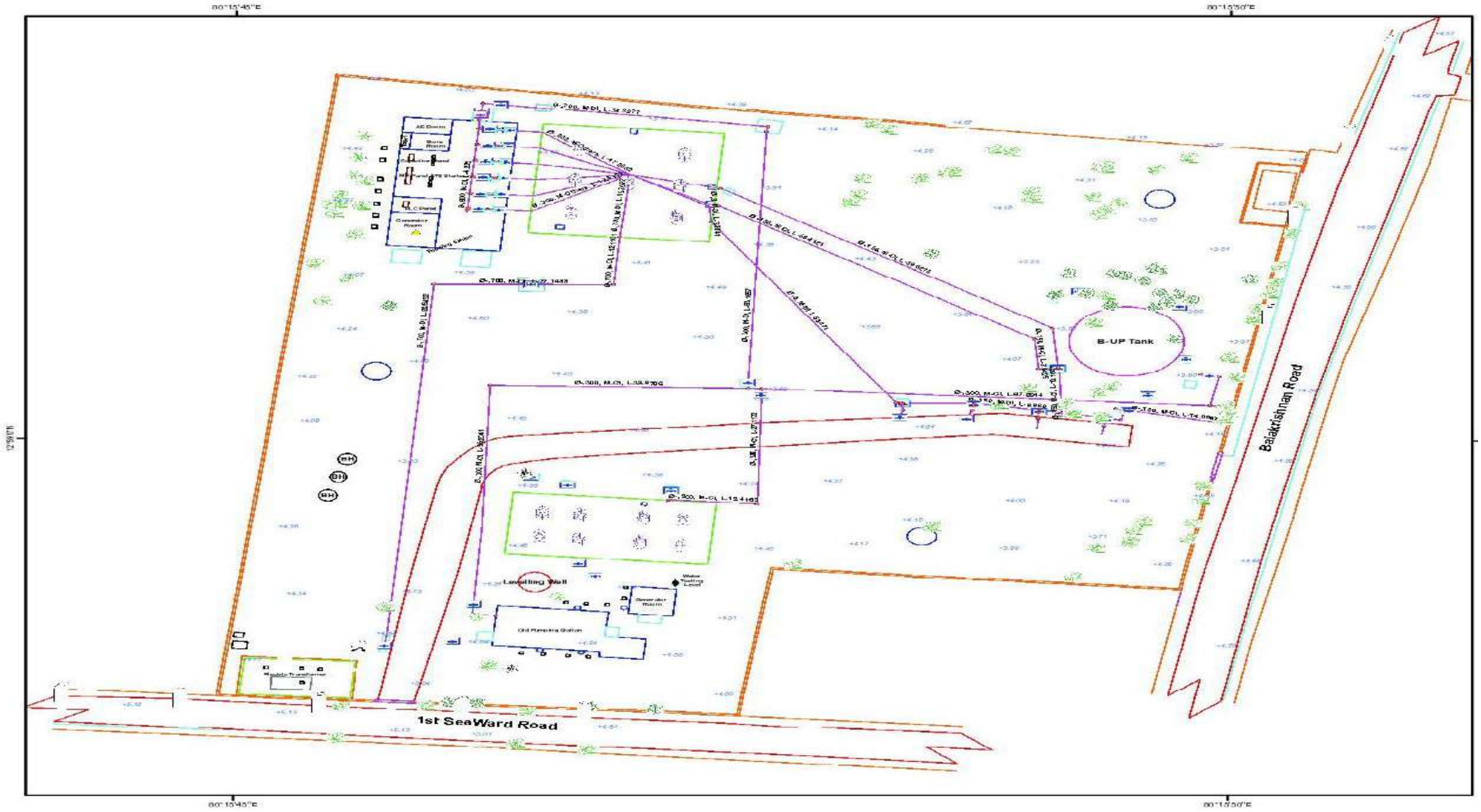


Figure 3.3: Asset Drawing of Thiruvanmiur WDS



3.3. HOUSE LEVEL CONSUMER SURVEY AND DATA COLLECTION:

3.3.1. General

A house level survey for a 24x7 water supply project is critical for understanding the current water usage patterns, identifying gaps, and planning for uninterrupted supply. This involves collecting data from individual households about their current water access, consumption habits, and any issues they face.

The survey typically covers:

- Water Sources: Identifying where households currently get their water (borewells, municipal supply, etc.)
- Water Consumption: Measuring daily or monthly water usage.
- Access and Quality: Assessing the frequency and quality of water supply.
- Infrastructure: Noting the condition and type of water delivery infrastructure (pipes, tanks, etc.)
- Willingness to Pay: Gauging households' readiness to pay for a consistent 24x7 water supply.

3.3.2. Necessity of Household Survey

Household survey is the key for calculation of demand for designing of water supply system. The information collected through household survey shall be used for following process:

1. Demand calculation and allocation in District Meter Area (DMA)
2. To understand demand for institutions, hotels etc
3. To understand the quantity of water received by consumers.
4. To understand about existing sources and its sustainability.
5. This helps to identify revenue gaps.

Therefore, household survey is necessitated for precise demand allocation for hydraulic design of the distribution network.

Through this house level survey, geo-coordinates of premises, connection points, households and population, type of house, floors, quantity of water received by residents etc. were collected.

House level survey in areas X and XIII were carried out using **mobile application**, which integrates all DGPS (Differential Global Positioning System) data with a base map layer. This ensured accuracy in capturing the Geo- coordinates of each surveyed household.

The questionnaire for the survey was prepared in consultation with officials of CMWSSB. A mobile application was developed to capture the requisite information through the survey. Subsequently, the application and the process were piloted in one of the depots of area XIII. Based on the results of piloting, the application was further fine-tuned and processes were strengthened. All fields and columns have been incorporated into the application as per the specifications provided by CMWSSB.

3.3.3. Structure of the Survey Questionnaire

The questionnaire is structured into **seven distinct sections**:

1. **Geographical Information** – This section captures the location-based details of the premises.
2. **Topological Information** – This covers the structural layout and characteristics of the house.
3. **Social Information** – Includes demographic and household composition data.
4. **Building Information** – Details regarding the construction and design of the building.
5. **Water Use Information** – This section focuses on water consumption patterns and sources.
6. **House-Level Connection Information** – Information about the household's water supply connections.
7. **Survey Requisites** – Any additional data or documents required for completing the survey.

To carry out the humongous survey activity, dedicated survey teams were formed lead by an experienced lead surveyor. All team members were field trained before they could start the work at site. An appropriate plan, based on individual coverage, was devised and the field team was capacitated to carry out the task within the schedule.

Based on the plan, each surveyor visited the assigned area / street / houses and collected the required data in accordance with the structure outlined above. The developed survey application allows for seamless data collection, ensuring both spatial and non-spatial data are captured accurately and efficiently. The questionnaire utilised is presented in Table 3.4 below.

Table 3.4: Survey Questionnaire

"GIS BASED HOUSE LEVEL SURVEY FOR IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF GCMC"			
A	**GEOGRAPHICAL INFORMATION**		
A.1	WDS		
A.2	NAME OF THE AREA (13/10)		
A.3	NAME OF THE DEPOT		
A.4	DEPOT NUMBER		
A.5	ROAD/LANE/STREET NAME		
A.6	ROAD/ LANE/STREET NO		
B	**TOPOLOGICAL INFORMATION OF THE HOUSE**		
B.1	LONGTITUDE		
B.2	LATITUDE		
B.3	HOUSE NO	**OLD**	**NEW**
C	**SOCIAL INFORMATION**		

C.1	NAME OF THE OWNER		
C.2	NAME OF THE RESPONDENT		
C.3	RELATIONSHIP OF RESPONDENT WITH THE OWNER		
C.4	MOBILE NUMBER OF CONSUMER/OWNER		
C.5	NO OF HOUSEHOLD		
C.6	NO OF OCCUPANTS		
D.	**BUIDLING INFORMATION**		
D.1	HOUSE/BUILDING TYPE	Pucca	
		Semi Pucca	
		Kucha	
D.2	HOUSE/BUILDING USE	Residential	
		Commercial	
		Residential & Commercial	
D.3	IF COMMERCIAL & SEMI-COMMERCIAL (mention the Type of Shop/Commercial Establishment)		
D.4	FLOORS OF THE HOUSE *(G/G+1/G+2/G+3)*		
D.5	IF APPARTMENTS NO OF FLATS		
D.6	IF SLUM THEN MENTION INDIVIDUAL HOUSE OR GROUP HOUSING		
E.	**WATER USE INFORMATION**		
E.1	SOURCE OF WATER USE	Water Supply	
		Bore Well	
		Purchasing Water	
		Hand Pump	
		Metro Water Tanker	
E.2	TIMING OF WATER SUPPLY		
E.3	FREQUENCY OF WATER SUPPLY	Daily	
		Alternative Days	
		Once on a 03 days	
		Others	
E.4	SUFFICIENCY OF WATER SUPPLY	Reasonably Sufficient	
		Seasonal Deficiency	
		Not Sufficient	
E.5	NO OF WATER SUPPLY CONNECTIONS & CONSUMER NO (CMC NO)	**NUMBER**	**CMC NO**
		1st Number	
		2nd Number	
		3rd Number	
		If more write the no	
E.6	WATER METER NO IF AVAILABE SERIEL NO OF WATER METER		
E.7	TYPE OF WATER METER		

E.8	YEAR OF CONNECTION TAKEN		
E.9	WATER COLLECTION TYPE	Sump	
		Overhead Tank	
		BOTH	
F.	**HOUSE LEVEL CONNECTION INFORMATION**		
F.1	NUMBER OF RECEIVING POINT & ITS LONG & LAT	**NUMBER**	**LONG & LAT**
		1st Number	
		2nd Number	
		3rd Number	
F.2	DIA OF HOUSE CONNECTION PIPE (15mm, 20mm, 25mm, 32mm etc)	(15mm, 20mm, 25mm, 32mm etc)	
F.2	DISTRIBUTION PIPE DIA		
F.3	APROX. DEPTH OF RECEIVING POINT		
G.	**SURVEY REQUISITES**		
G.1	DATE & TIME OF THE SURVEY	DATE	TIME
G.2	NAME OF THE SURVEYOR		
G.4	VERIFICATION OFFICER		
G.5	PHOTO OF THE HOUSE		

3.3.4. Summary of House Level Survey of Area XIII

The abstract of House level survey is presented below in Table 3.4.1. The detailed Survey output, depot wise, was submitted to CMWSSB separately.

Referring Table 3.4.1, under area XIII, total number of premises, household & population are 82388, 136829 & 669501 respectively.

Table 3.4.1: Summary of House Level Survey of Area XIII

S. No.	DEPOT NO	No. Of Premises	No. Of Household	POPULATION
1	168	5855	10928	56017
2	169	3521	11002	42731
3	170	4014	7254	38789
4	171	3947	8932	43936
5	172	6110	9351	43939
6	173	10386	12910	68829
7	174	4848	10848	48923
8	175	7852	9058	45067
9	176	8105	11457	55796
10	177	8893	14985	81563
11	178	5446	6534	33960
12	179	6224	9007	42835
13	180	7187	14563	67116
		82388	**136829**	**669501**

3.4. CONDITION ASSESSMENT SURVEY

3.4.1. Background

Water distribution systems contain different types of buried pipes (i.e., cast iron, ductile iron, asbestos cement, polyethylene, and polyvinyl chloride). As water distribution systems become older, their structural condition, hydraulic capacity and performance deteriorates. Several factors impact the structural deterioration of water mains and their failures, including pipe material, pipe size, pipe age, soil type, climate, and cyclic pressures. However, the physical processes that cause pipe breakage are very complicated. Most water pipes are buried, so there is little data available about how they deteriorate and fail. Deterioration of water mains is neither identical nor uniform. This is because water mains are operated under pressure, and usually unreachable. Therefore, it is essential to inspect and assess water system conditions to efficiently maintain and improve its elements to prevent catastrophic failures and emergency repairs.

In present context out of total length of 630KM of pipeline diameter ranges between 100mm to 1100mm distribution system under area XIII, the length of cast iron (CI) pipes constitutes about 81.16% were DI pipeline comprise of 14.88%, where PVC pipeline consist of 3.93 % & others are 0.03%. Out of the total length 95% are metallic pipes (DI & CI) of which significant length is older than 20 to 30 years.

The metallic pipes under operation are venerable to external corrosion, erosion internal encrustation after use for longer period, results in reduction in diameter & affecting carrying capacity of pipelines.

Accordingly, it is important to conduct conditional assessment survey of the metallic pipes, moreover the PVC pipes are already designated for replacement by DI pipes due to structural strength & better pressure sustaining capacity of DI material.

In the present context based on available technology and ease of doing, conditional assessment of the buried distribution pipes in each depot of area XIII has been caried out by a combination of hydraulic, non-hydraulic, on the spot hardness test and destructive testing facilitated. Ground penetration radar survey for identification of precise location of pipeline. A brief description of various techniques adopted in survey are as follows:

- **GPR Survey** - It is a non-intrusive method of surveying the sub-surface to precisely locate underground utilities below the ground
- **Flow measurement (Hydraulic)using clamp-on type portable Ultrasonic flow meter** that attach to the exterior of the pipe (and fit a variety of pipe sizes) and enable measurement of flow of liquids without damage to the ultrasonic sensor.
- **Destructive Testing (often abbreviated as DT)** is a test conducted on a sample of pipe to find strength of material., During the process, the tested item undergoes stress that eventually deforms or destroys the material.
- **Hardness Test**- A hardness test is typically performed by pressing a specifically dimensioned and loaded object (indenter) into the surface of the pipe material that is being tested.

- **Robotic camera inspection**(Non-hydraulic method) conducted using Pipe inspection robots, also known as robotic pipe inspection cameras or sewer crawlers, are specialized tools used to inspect the inner physical state of pipes and sewer systems.

3.4.2. Steps followed for the survey

While carrying out the conditional assessment, the following steps were taken:

1 Collection of Historical Data

2 Prepare/collect -Zone wise pipe network Map

3 Mobilization of Men and machinery

4 Identify All Critical Pipe Location on Field

5 Identification of underground junctions through GPR survey.

6 Markup/identify the test Location in Map

7 Permission from various departments in consultation with CMWSSB for carrying out all tests at site .

8 Safety barricading / Traffic Management

9 Digging up to required level

10 Carry out the Tests

- Flow measurement through Ultrasonic clamp on flow meters
- Brinell's Hardness Test
- Destructive Testing of sample pipes collected from existing distribution system
- Robotic camera Inspection

11 Spool pieces of pipe are to be placed where destructive and robotic tests were carried out.

12 The test pits are to be restored with proper backfilling and concrete at the top.

13 In case of damage to other utilities restoration was done.

14 Sample collection from site and delivery at designate Lab for testing

15 Field Test result

3.4.3. Identification of Pipeline Stretches for Conditional Assessment Survey

Based on the study of historical pipe performance data from Depot Log books, complaint register and local enquiry , problematic areas have been identified which are classified under four categories such as:

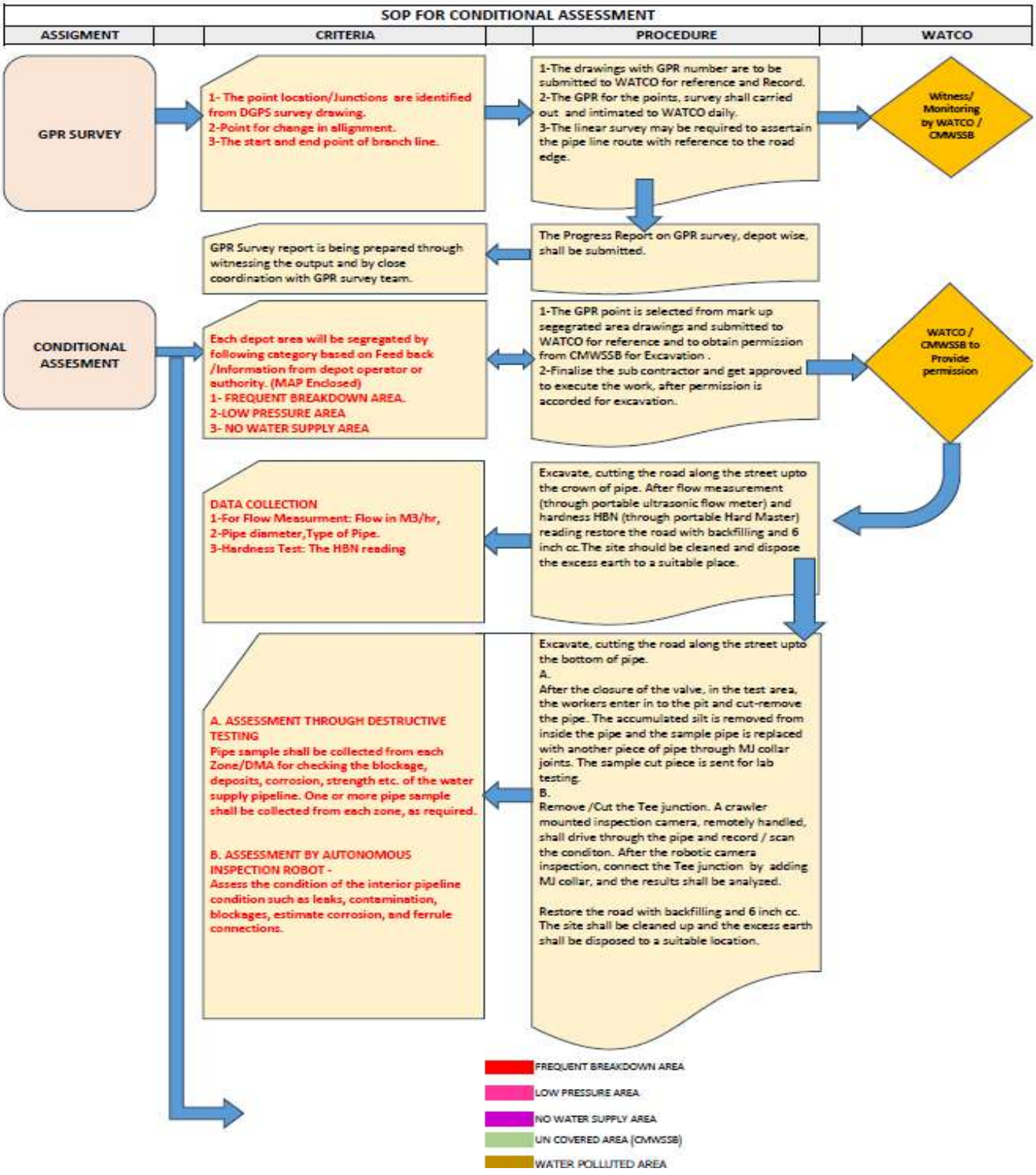
- Frequent Breakdown areas
- Low pressure areas
- No water supply areas
- Poor water quality areas

These areas have been mapped on depot wise distribution pipe asset maps identifying the representative pipe lengths/junctions/intersections for carrying out GPR survey for precisely location of the pipeline underneath as shown in maps are appended in Appendix 3 for carrying out condition assessment survey with required techniques. These location maps have been vetted by CMWSSB.

3.4.4. Approach and Methodology Process Flow Sheet

A detailed approach, identifying each process and considering time required for the activities, was developed and adopted to carry out the condition assessment Study as provided in the Figure 3.3 below.

Figure 3.4: Approach and Methodology Flow Sheet



3.4.5. Technology adopted for Condition Assessment

3.4.5.1. Ground Penetrating Radar (GPR)

Ground-penetrating radar (GPR) is a non-intrusive geophysical method that uses radar pulses to image the underground utilities. GPR Surveys are used to find the exact location of natural or man-made objects underground, natural elements or detect changes in the position of those objects. For carrying out the work, SUE method and EPL (data storing) was used. As presented in Image 3.3 below,

Image 3.3: GPR equipment

3.4.5.2. Ultrasonic flow meter

In water supply systems, the common methods used for flow measurement consists of differential pressure types, displacement types, inferential types, magnetic types, ultrasonic types, and open channel types. Ultrasonic clamp-on flow meters measure fluid flow in water mains. By using sound waves to determine the transit time of a gas or liquid, ultrasonic flow meters can accurately monitor any changes in flow, both upstream and downstream. Clamp on flow meter usage is presented in the Image 3.4 below.

Image 3.4 - Ultra sonic flow measurement

3.4.5.3. Hardness Test at Field

Hardness testing is a test method that involves applying a constant load via a rounded or pointed object, under controlled conditions, to create an indentation in a metal surface. This is then measured to determine the hardness of the material. Hardness tests on pipes are performed primarily to examine two aspects: testing of weld seams and determination of the basic hardness of the pipe depending on the application. Hardness tests are performed to ISO 6506-1 (Brinell) using portable Brinell hardness tester. All Brinell tests use a carbide ball indenter. As presented in image 3.5 below, The test procedure is as follows:

- The indenter is pressed into the sample by an accurately controlled test force.
- The force is maintained for a specific dwell time, normally 10 - 15 seconds.
- After the dwell time is complete, the indenter is removed leaving a round indent in the sample.

Image 3.5 - Hardness Testing instrument

- The size of the indent is determined optically by measuring two diagonals of the round indent using either a portable microscope or one that is integrated with the load application device.
- The Brinell hardness number is a function of the test force divided by the curved surface area of the indent. The indentation is considered to be spherical with a radius equal to half the diameter of the ball. The average of the two diagonals is used in the following formula to calculate the Brinell hardness.

3.4.5.4. Destructive Test

Destructive testing is undertaken in order to understand a specimen's performance or material behaviour, these procedures are carried out to test specimen's failure. Destructive testing procedures can either follow specific standards or can be tailored to reproduce set service conditions. Brinell hardness testing machine as presented in image 3.6, 3.7 & 3.8, is used to determine the strength of the pipe sample.

Image 3.6: Site Excavation for Destructive Testing

Image 3.7: Brinell Hardness Tester

Image 3.8: Cut piece of pipe for lab testing

Image3.9: Inspection through the robotic camera

3.4.5.5 Inspection of underground pipeline through robotic camera

In this method a section of pipe is selected and removed, an autonomous inspection robot fitted with camera and hydroponics inserted into the section opening to assess the interior of the pipeline such as leaks, blockages, encrustations, ferrule connections etc. This helps to pinpoint the exact location of failure and give a detailed analysis to allow the data analysis managers to determine the pipe strength/condition. Inspection through the robotic camera is presented in the below Images in **Image-3.9.**

The activity of condition assessment, through GPR, Flow & Pressure measurement, Hardness test, Destructive testing & robotic visual inspection, was carried out with the standard practice and the Condition Assessment Report was submitted to CMWSSB. The Condition Assessment Report is annexed at Appendix 3. A map of model is presented in figure-3.10 below, for better appreciation.

Fig 3.10: Condition assessment - Survey Locations

3.4.6. Condition assessment Survey Processes and outcomes

3.4.6.1. GPR Survey

Based on the preliminary data collected and analysis thereof some locations were identified and the GPR survey was carried out. Subsequently the work progressively covered the area under each Depot of Area XIII. In the following paragraphs, the field methodology is described and related GPR findings. *One number of trial pit is made at different locations in each Depot* to verify the results of the GPR survey. Site pictures are presented in Image-3.11 below,

Image-3.11 GPR Survey

The depth, diameter, exact location of Tee-points, change of alignment were recorded by the method using GPR and EPL (Data storing) Technology. The location reference was identified from GIS Map of DEPOTs. The GPR survey carried from tail end to start point at night time when noise level are minimal. The number of locations of the Area XIII (depot wise) GPR Survey done in each depot is listed in Table-3.8.

Table-3.8: Showing Depot-wise GPR survey locations

Depot No (New)	168	169	170	171	172	173	174	175	176	177	178	179	180
No of GPR Locations Survey Completed	207	247	213	197	226	248	239	270	185	258	206	113	199

When the GPR unit crosses the utility, the display screen of the GPR shows an image of hyperbolic shape (inverted V) such as presented in Figure-3.12 below,

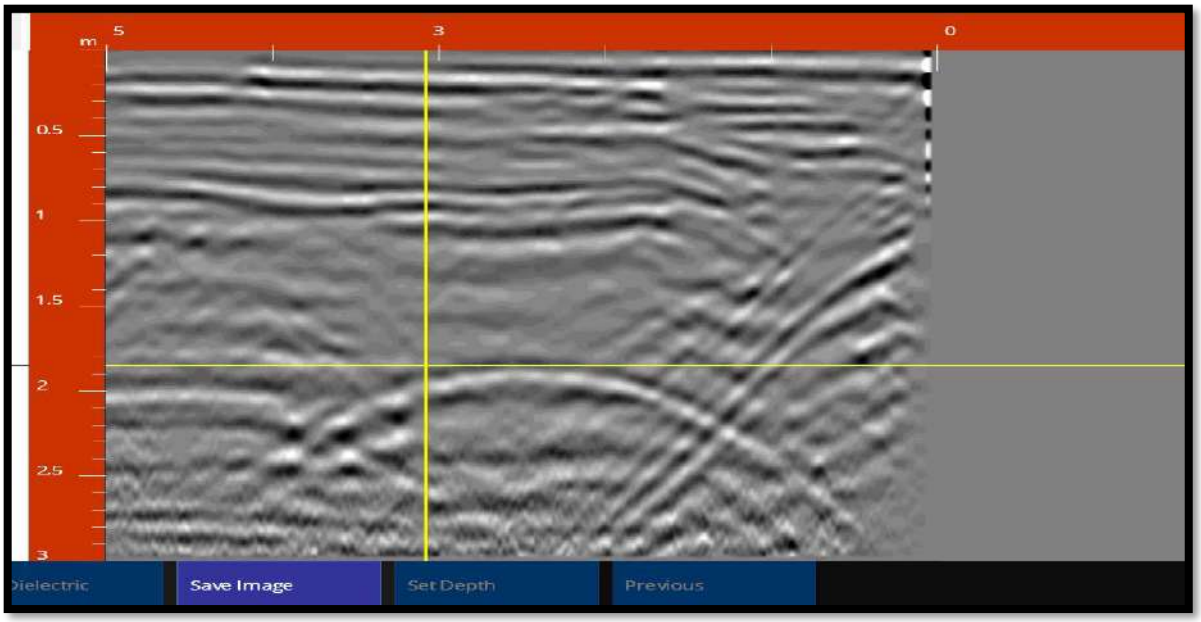


Figure 3.12: Machine Screen shot

The apex or top of the hyperbola is the position of the utility. The distance to the top of the hyperbola is an estimate of depth. By moving the GPR back and forth and marking the ground where the top of the hyperbola is observed, the alignment of the subsurface utility can be traced out as the X's in Figure indicate. The inverted V visible on each transect, clearly identifies the alignment of the pipe. *The detail list of locations with co-ordinates are included in* Appendix *-3.*

This annexed data will provide the knowledge for locating the underground pipeline and junction for future reference.

The key map for each depot with indicating the GPR point included in Appendix *-3*

The GPR survey was carried out for each location and the drawing prepared with taking latitude -longitude with depth of pipe. The individual GPR location drawing has been prepared for future reference and identification of point. The sample drawing is presented in Figure-3.13 and 3.14 below.

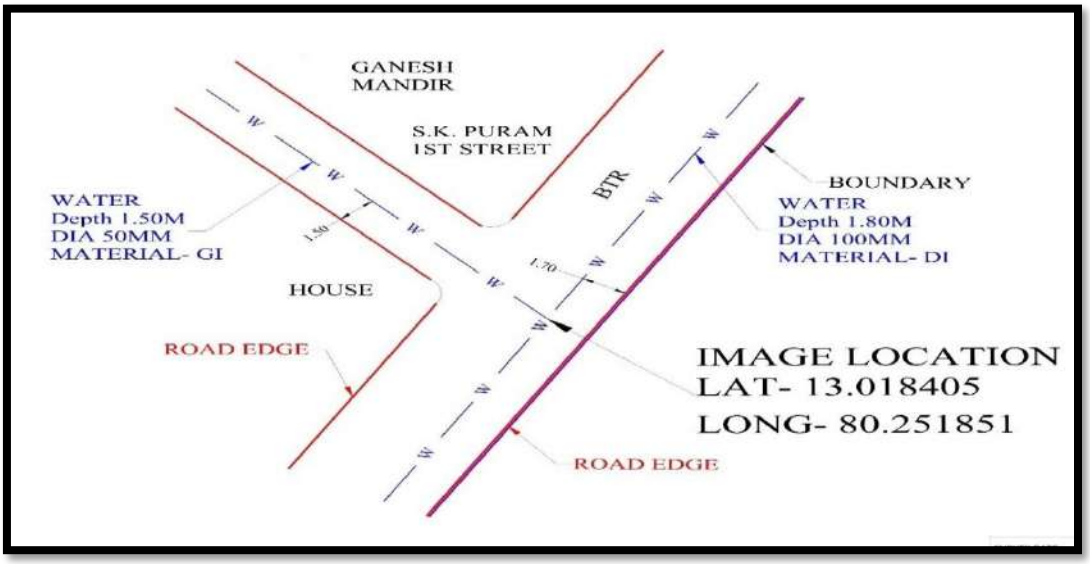


Figure3.13: Sample drawing

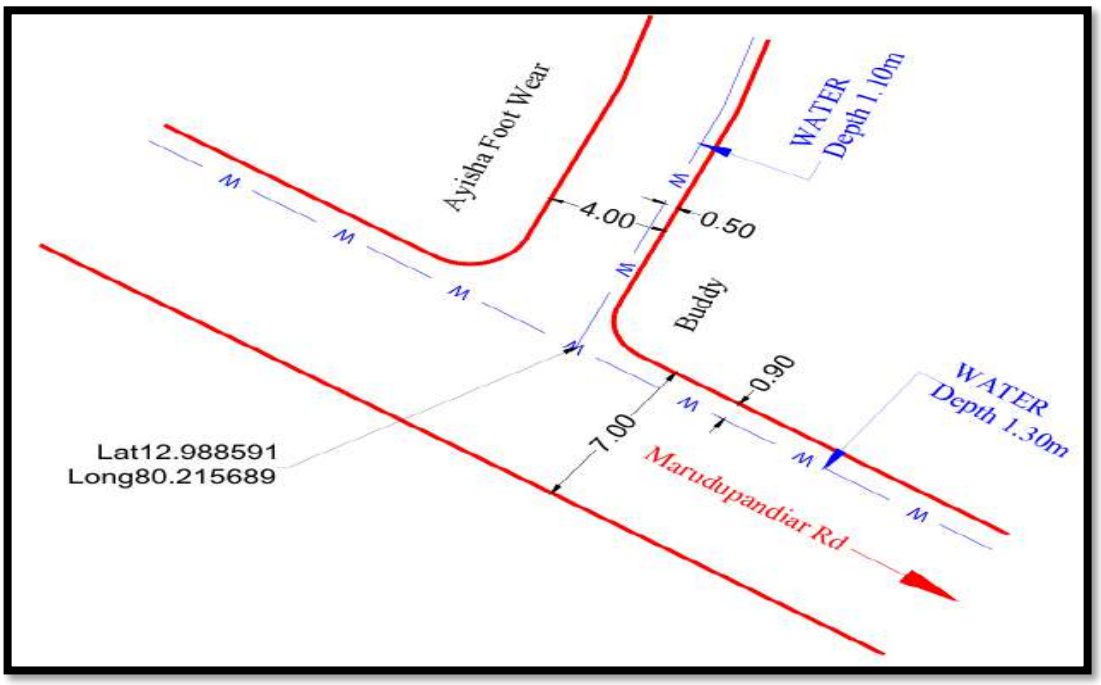


Figure 3.14 – GPR result output (samples)

The details for each locations wise map with co-ordinates are included in Appendix -3.

3.4.6.2. Flow Measurement

Prior to start of flow measurement, locations are identified from the historical data under each depot. Locations from GPR survey were analyzed and used for identification of suitable locations for flow measurement. After getting the permission for working in the nighttime, the excavation was carried out at the identified location to trace the pipe. Then flow measurement was carried out during the water supply time through clamp on ultrasonic flow meters. This is used in the field due to easy transportation and installation

requirements. However, performance of these meters may vary in different diameter pipes and under non ideal conditions wherein sufficient minimum straight length as prescribed by the manufacturer may not be available at site. Flow measurement photographs are presented in Image-3.15 below.

Image 3.15: Flow measurement using Ultrasonic clamp on flow meter

The field Observations of flow measurements are tabulated below in Table-3.9 below.

Table-3.9: Field Observations of Flow Measurement

S.NO	DATE	AREA	DEPOT	LOCATION	REMARKS FROM SITE	POBEBLE RESIONS
1	27-02-2024	XIII	168	VGP Road, Saidapet	Low Pressure	Deep ferrule found
2	27-02-2024	XIII	168	VGP Road, Saidapet	Very low Flow	Numerous deposits of silts and sand observed.
3	01-03-2024	XIII	169	North avenue, Srinagar Colony, Saidapet	Very low Flow	Blockage due to Encrustation and stones

S.NO	DATE	AREA	DEPOT	LOCATION	REMARKS FROM SITE	POBEBLE RESIONS
4	01-03-2024	XIII	169	North avenue, Srinagar Colony, Saidapet	Very low Flow	Blockage due to Encrustation, stones and Ferrule pierced the pipeline
5	01-03-2024	XIII	169	Venkta Puram, Sardar Patel Road, Guindy	Very low Flow	Blockage Observed in the pipeline by Large Stones and also Cracks formed in the pipeline
6	01-03-2024	XIII	169	Venkta Puram, Sardar Patel Road, Guindy	Very low Flow	Blockage due to silts and tree roots pierced the pipeline.
7	01-02-2024	XIII	171	Srinivasa Beach Road, Srinivasapuram, Pattinapakkam	low Flow	The Pipeline is blocked, due to Encrustation
8	01-02-2024	XIII	171	Srinivasa Beach Road, Srinivasapuram, Pattinapakkam	low Flow	Heavy sludge and Encrustation were observed
9	26-02-2024	XIII	172	Gangai Amman Kovil stret, Velachery	Very low Flow	Pipeline is fully encrusted and also sludge accumulated
10	26-02-2024	XIII	172	Gangai Amman Kovil street, Velachery	Very low Flow	Pipeline is fully encrusted and also sludge accumulated
11	21-02-2024	XIII	173	Periyar nagar, LB Road, Thiruvanmiyur	Very low Flow	Waterline is completely blocked by Concrete
12	21-02-2024	XIII	173	Periyar nagar, LB Road, Thiruvanmiyur	Very low Flow	Waterline is completely blocked by Concrete
13	06-03-2024	XIII	173	Ist Main Road, Indra Nagar,Adyar	low Flow	Blockage due to heavy stones observed in the pipeline
14	06-03-2024	XIII	173	Ist Main Road, Indra Nagar,Adyar	low Flow	Pipeline is fully blocked-up by heavy encrustation and roots formation
15	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	low Flow	Pipe line is fully encrusted and stones has been present
16	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	low Flow	Dust particles present due to lot of encrusted line
17	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	low Flow	Blockage due to full of encrustation and stones

S.NO	DATE	AREA	DEPOT	LOCATION	REMARKS FROM SITE	POBEBLE RESIONS
18	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	low Flow	Blockage due to full of encrustation and stones
19	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	low Flow	Blockage due to full of encrustation and stones
20	14-03-2024	XIII	175	2nd Main Road, TNHB Colony, Velachery	Very low Flow	Sludges blocked the water pipeline
21	14-03-2024	XIII	175	2nd Main Road, TNHB Colony, Velachery	Very low Flow	Sludges blocked the water pipeline
22	08-02-2024	XIII	176	Ram Nagar, Vijaya Nagar 6st Cross Street, Velacherry	Very low Flow	Heavy Encrustation observed in pipeline. Rendering the water flow is not possible
23	08-02-2024	XIII	176	Ram Nagar, Vijaya Nagar 6st Cross Street, Velacherry	low Flow	Infiltration found in pipeline
24	16-03-2024	XIII	177	VGP Seethapathi street, Velachery	low Flow	Pipeline damaged due to corrosion, and sediments like stones, silts along with foreign objects has created by Partial blockage.
25	16-03-2024	XIII	177	VGP Seethapathi street, Velachery	low Flow	Leakage observed in the pipe line due to incorrect installation of ferrule with deep insertion.
26	16-03-2024	XIII	177	Murphydoss Street,Velachery	low Flow	Blockage due to Pipeline is fully encrusted by wrong installation of ferrule by deep insertion and Big metal pieces found in the pipeline.

S.NO	DATE	AREA	DEPOT	LOCATION	REMARKS FROM SITE	POBEBLE RESIONS
27	16-03-2024	XIII	177	Murphydoss Street,Velachery	low Flow	Pipeline corrosion above the encrusted area poses a potential threat and ferrule was totally protruded inside.
28	16-04-2024	XIII	177	Tharamani Link Road, Velachery	low Flow	Pipeline with Ferrule Protrusion Observed and Coupler, stones, suspected pipejoint and ferrule fully pierced the pipeline.
29	16-04-2024	XIII	177	Tharamani Link Road, Velachery	low Flow	Pipeline with Ferrule Protrusion Observed
30	29-02-2024	XIII	180	PTC Colony 2nd Street, Thiruvanmiyur	Very low Flow	The Pipeline is blocked, due to Encrustation
31	29-02-2024	XIII	180	PTC Colony 2nd Street, Thiruvanmiyur	Very low Flow	The Pipeline is blocked, due to Encrustation

3.4.6.3. Destructive Test

For the purpose of destructive testing locations were identified from available data. After a pipe sample location was finalized, which valve was to be closed to isolate the section was determined. Consumers were notified earlier for interruption of water supply in that area. After valve closure, dewatering/ mud pumps were used to drain the pipe break points. Roads were barricaded, traffic was re-routed, sides of the trenches were protected firmly before workers entered the pit. The sample pipe along with the accumulated silt was removed. After the pipe was replaced, the joints were made leak proof.

Image 3.16: Destructive Testing

The consolidated laboratory test of destructive tests, results are Tabulated in Table-3.10 below. ISO 6506 specifies the method for the Brinell hardness test for metallic materials and is applied. Brinnel's hardness should be >=140.

Table-3.10 – Hardness Test Results

Sl no	Pipe Size in mm	Type	Ref ID (Depot / GPR Point)	LAT.	LONG.	VALUE - 1	VALUE - 2	VALUE - 3	Result Evaluation
1	100mm	DI	168/49	13.020623	80.201703	144	141	144	Good
2	100mm	DI	168/70	13.017542	80.200436	153	162	162	Good
3	100mm	DI	168/7	13.025408	80.206328	147	156	156	Good
4	100mm	DI	168/1	13.019377	80.242344	150	156	156	Good
5	100mm	DI	168/25	13.019377	80.242344	153	147	147	Good
6	100mm	DI	169/52	13.019377	80.242344	157	156	153	Good
7	100mm	DI	169/83	13.019377	80.242344	150	153	147	Good
8	100mm	DI	169/72	13.019377	80.242344	150	156	156	Good
9	100mm	DI	169/57	13.019377	80.242344	150	156	156	Good

Sl no	Pipe Size in mm	Type	Ref ID (Depot / GPR Point)	LAT.	LONG.	VALUE - 1	VALUE - 2	VALUE - 3	Result Evaluation
10	100mm	DI	169/95	13.019377	80.242344	153	156	156	Good
11	100mm	DI	170/83	13.019377	80.242344	150	153	150	Good
12	100mm	DI	170/245	13.019377	80.242344	144	150	150	Good
13	100mm	DI	170/268	13.019377	80.242344	159	156	156	Good
14	100mm	DI	170/14	13.019377	80.242344	150	153	150	Good
15	100mm	DI	170/90	13.019377	80.242344	150	159	159	Good
16	100mm	DI	171/3.24	13.020859	80.277773	153	162	165	Good
17	100mm	DI	171/17	13.018724	80.261242	162	169	169	Good
18	100mm	DI	171/28	13.023878	80.257546	162	169	169	Good
19	100mm	DI	171/7	13.018545	80.251931	150	153	150	Good
20	100mm	DI	171/15	13.025042	80.265205	123	121	119	Critical
21	100mm	DI	172/98	13.001559	80.209742	150	159	156	Good
22	100mm	DI	172/111	12.999980	80.211638	153	147	147	Good
23	100mm	DI	172/13	12.989604	80.2187	150	153	150	Good
24	100mm	DI	172/3	12.988591	80.215689	121	119	121	Critical
25	100mm	DI	172/26	12.989556	80.221323	123	125	121	Critical
26	100mm	DI	173/14	13.009716	80.250328	150	156	159	Good
27	100mm	DI	173/87	13.003897	80.248523	159	156	156	Good

Sl no	Pipe Size in mm	Type	Ref ID (Depot / GPR Point)	LAT.	LONG.	VALUE - 1	VALUE - 2	VALUE - 3	Result Evaluation
28	100mm	DI	173/78	13.006582	80.251716	127	121	123	Critical
29	100mm	CI	173/114	13.002674	80.253474	141	150	144	Good
30	100mm	CI	173/220	12.990885	80.253041	153	150	153	Good
31	100mm	DI	174/3	13.010135	80.260414	125	121	123	Critical
32	100mm	DI	174/40	13.003096	80.261612	159	159	162	Good
33	100mm	DI	174/144	12.999640	80.261772	156	147	144	Good
34	100mm	DI	174/120	12.997903	80.259478	153	156	156	Good
35	100mm	DI	174/46	13.002461	80.260014	162	165	162	Good
36	100mm	DI	175/321	12.992933	80.212873	156	150	147	Good
37	150mm	DI	175/50	12.9929326	80.2128727	165	165	169	Good
38	100mm	DI	175/73	12.989926	80.214173	150	159	156	Good
39	100mm	DI	175/313	12.980036	80.217303	144	147	147	Good
40	100mm	DI	175/87	12.982618	80.215972	144	150	150	Good
41	100mm	DI	176/119	12.982605	80.218700	169	159	159	Good
42	100mm	DI	176/120	12.980580	80.219504	150	159	156	Good
43	100mm	DI	176/90	12.975343	80.217120	147	150	153	Good
44	100mm	DI	176/7	12.972462	80.213671	153	156	156	Good
45	100mm	DI	176/134	12.985011	80.220487	144	144	150	Good

Sl no	Pipe Size in mm	Type	Ref ID (Depot / GPR Point)	LAT.	LONG.	VALUE - 1	VALUE - 2	VALUE - 3	Result Evaluation
46	100mm	DI	177/105	12.979241	80.230314	156	150	150	Good
47	100mm	DI	177/91	12.977285	80.228894	153	162	162	Good
48	100mm	DI	177/164	12.979852	80.226510	147	141	141	Good
49	100mm	DI	177/113	12.979580	80.232153	144	144	141	Good
50	100mm	DI	177/95	12.979211	80.227833	144	150	147	Good
51	100mm	DI	178/3.26	12.980036	80.239535	150	153	`156	Good
52	100mm	DI	178/3.18	12.982160	80.243081	139	144	144	Good
53	100mm	DI	178/21	12.982896	80.253739	150	156	159	Good
54	100mm	DI	178/9	12.982216	80.239592	162	156	153	Good
55	100mm	DI	178/11	12.984854	80.240215	119	121	121	Critical
56	100mm	DI	178/5	12.981214	80.239599	119	121	123	Critical
57	100mm	DI	179/13	12.991878	80.268177	150	147	147	Good
58	100mm	DI	179/61	12.994179	80.255999	153	153	144	Good
59	100mm	DI	179/62	12.989756	80.257996	144	153	150	Good
60	100mm	DI	179/20	12.984560	80.264345	116	119	121	Critical
61	100mm	DI	179/5	12.987737	80.255846	117	116	119	Critical
62	100mm	DI	180/8	12.983228	80.25749	119	121	123	Critical
63	100mm	DI	180/14	12.977200	80.263975	147	153	144	Good

Sl no	Pipe Size in mm	Type	Ref ID (Depot / GPR Point)	LAT.	LONG.	VALUE - 1	VALUE - 2	VALUE - 3	Result Evaluation
64	100mm	DI	180/4.21	12.974739	80.259745	147	147	153	Good
65	100mm	DI	180/4.51	12.978657	80.264820	153	159	159	Good

The detailed reports are included in Appendix -3.

From the above lab results it is found that, out of 65 samples 10 nos of samples are under critical state.

3.4.6.4. Robotic Visual Inspection

Equipment and tools were transported to the site location to perform the inspection with the help of representatives of CMWSSB. Access point in the pipeline was opened and the pipelines were dewatered. Considering the sizes of the pipeline and the space available for insertion of the tools, cameras were chosen to perform the inline video inspection. Safety precautions were taken after thorough preliminary study of the subject to perform the inspection safely.

From the Flow measurement data, the locations to carryout robotic visual inspection were identified and a schedule was prepared to carry out the tasks. Once the site was prepared for inspection, it was handed over to survey team for installing the inspection equipment and carry out the task.

Inspection Equipment's deployed are:

- Video Cameras with DVR
- Endobot/Endoscopy and Other Mechanical Tools
- Personal Protective Equipment (PPE)

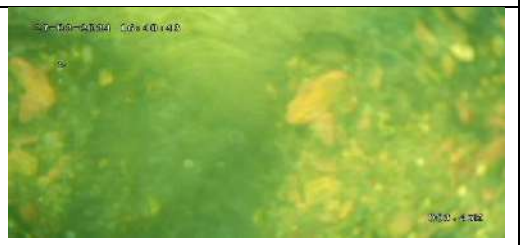
The Endobot was inserted into the pipeline through an opening, remotely controlled with the help of a tether. The equipment was driven inside the pipeline through controlled manual-feed or remote in the case of Endobot. The live video feed from the camera is obtained at the base station. The feedback was used to identify and locate the critical spots in the pipeline. The locations of the defects were recorded, and this data is provided immediately for precise localization of the defects/features identified. Risk analysis was done to each section of pipeline inspected. It was done with the help of the below-mentioned matrix in Table 3.8. Initially with all the defects and the condition of the pipeline the probability of failure was calculated. Probability of failure (POF) refers to the likelihood that a particular component or system will fail to perform its intended function. Later, the consequence of the failure is calculated. Consequence of failure (COF) refers to the potential impact or outcome of a failure of a particular component or system.

Out of the total robotic inspections conducted, 39 are presented here that need specific attention. It's estimated that 60% of the total inspections conducted needed attention to ensure safe and quality drinking water. Image-17 presented below shows the site photograph, while doing robotic camera inspection of pipe.

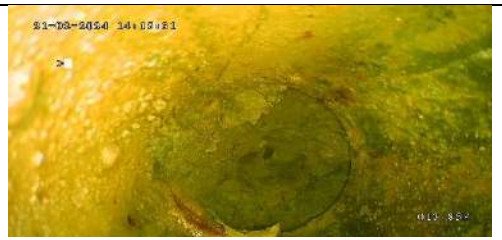
Image 3.17- Robotic Camera Inspection of pipeline

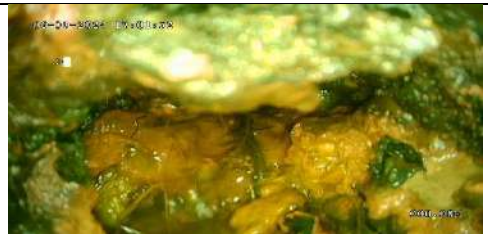
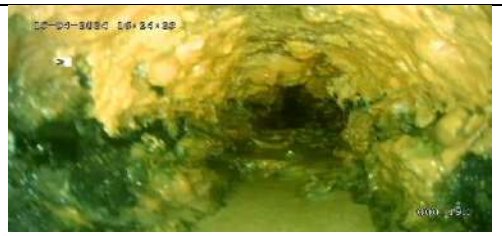
The inspection results, including the imagery and video reference are given in Appendix -3. The consolidated report is tabulated in Table-3.11 below.

Table-3.11: Consolidated Inspection Report

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
1	27-02-2024	XIII	168	VGP Road, Saidapet	Deep ferrule found	
2	27-02-2024	XIII	168	VGP Road, Saidapet	Numerous deposits of silts and sand observed.	
3	01-03-2024	XIII	169	North avenue, Srinagar Colony, Saidapet	Blockage due to Encrustation and stones	
4	01-03-2024	XIII	169	North avenue, Srinagar Colony, Saidapet	Blockage due to Encrustation, stones and Ferrule pierced the pipeline	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
5	01-03-2024	XIII	169	Venkta Puram, Sardar Patel Road, Guindy	Blockage Observed in the pipeline by Large Stones and also Cracks formed in the pipeline	
6	01-03-2024	XIII	169	Venkta Puram, Sardar Patel Road, Guindy	Blockage due to silts and tree roots pierced the pipeline.	
7	01-02-2024	XIII	171	Srinivasa Beach Road, Srinivasapuram, Pattinapakkam	The Pipeline is blocked, due to Encrustation	
8	01-02-2024	XIII	171	Srinivasa Beach Road, Srinivasapuram, Pattinapakkam	Heavy sludge and Encrustation were observed	

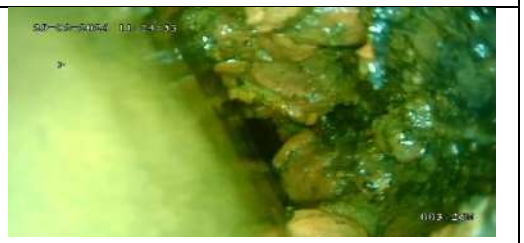
CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
9	26-02-2024	XIII	172	Gangai Amman Kovil stret, Velachery	Pipeline is fully encrusted and also sludge accumulated	
10	26-02-2024	XIII	172	Gangai Amman Kovil street, Velachery	Pipeline is fully encrusted and also sludge accumulated	
11	21-02-2024	XIII	173	Periyar nagar, LB Road,	Waterline is completely blocked by Concrete	
12	21-02-2024	XIII	173	Periyar nagar, LB Road,	Waterline is completely blocked by Concrete	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
13	06-03-2024	XIII	173	Ist Main Road, Indra Nagar,Adyar	Blockage due to heavy stones observed in the pipeline	
14	06-03-2024	XIII	173	Ist Main Road, Indra Nagar,Adyar	Pipeline is fully blocked-up by heavy encrustation and roots formation	
15	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	Pipe line is fully encrusted and stones has been present	
16	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	Dust particles present due to lot of encrusted line	

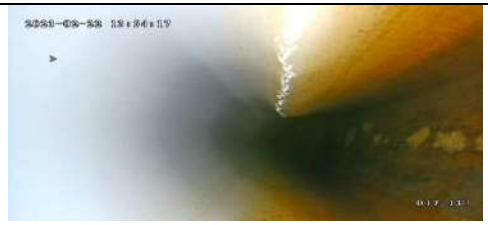
CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
17	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	Blockage due to full of encrustation and stones	
18	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	Blockage due to full of encrustation and stones	
19	15-04-2024	XIII	173	6th Main Road, Kasthuri Bai Nagar, Adyar	Dust particles present due to lot of encrusted line.	
20	14-03-2024	XIII	175	2nd Main Road, TNHB Colony, Velachery	Sludges blocked the water pipeline	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
21	14-03-2024	XIII	175	2nd Main Road, TNHB Colony, Velachery	Sludges blocked the water pipeline	
22	08-02-2024	XIII	176	Ram Nagar, Vijaya Nagar 6st Cross Street, Velacherry	Heavy Encrustation observed in pipeline. Rendering the water flow is not possible	
23	08-02-2024	XIII	176	Ram Nagar, Vijaya Nagar 6st Cross Street, Velacherry	Infiltration found in pipe line	
24	16-03-2024	XIII	177	VGP Seethapathi street, Velachery	Pipeline damaged due to corrosion, and sediments like stones, silts along with foreign objects has created by Partial blockage.	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
25	16-03-2024	XIII	177	VGP Seethapathi street, Velachery	Leakage observed in the pipe line due to incorrect installation of ferrule with deep insertion.	
26	16-03-2024	XIII	177	Murphydoss Street,Velachery	Blockage due to Pipeline is fully encrusted by wrong installation of ferrule by deep insertion and Big metal pieces found in the pipeline.	
27	16-03-2024	XIII	177	Murphydoss Street,Velachery	Pipeline corrosion above the encrusted area poses a potential threat and ferrule was totally protruded inside.	
28	16-04-2024	XIII	177	Tharamani Link Road, Velachery	Pipeline with Ferrule Protrusion Observed and Coupler, stones, suspected pipejoint and ferrule fully pierced the pipeline.	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
29	16-04-2024	XIII	177	Tharamani Link Road, Velachery	Pipeline with Ferrule Protrusion Observed	
30	29-02-2024	XIII	180	PTC Colony 2nd Street, Thiruvanmiyur	The Pipeline is blocked, due to Encrustation	
31	29-02-2024	XIII	180	PTC Colony 2nd Street, Thiruvanmiyur	The Pipeline is blocked, due to Encrustation	
32	17-12-2023	XIII	179	Rukkumani Rd,Kalakshetra Colony, Besant Nagar	Encrustation was observed	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
33	17-12-2023	XIII	179	Rukkumani Rd,Kalakshetra Colony, Besant Nagar	Encrustation was observed	
34	21-12-203	XIII	179	Thirumurugan St,Kalakshetra Cl,Besant Nagar	Roots from nearby vegetation had penetrated the pipe wall	
35	21-12-203	XIII	179	Thirumurugan St,Kalakshetra Cl,Besant Nagar	Stones were observed inside the pipeline.	

CONSOLIDATED CCTV INSPECTION REPORT						
S.NO	**DATE**	**AREA**	**DEPOT**	**LOCATION**	**RESULTS**	**VISUAL**
36	23-12-2023	XIII	179	Thirumurugan St,Kalakshetra Cl,Besant Nagar	A Ferrule was installed	
37	23-12-2023	XIII	179	Coastal Road, Kalakshetra Cl	A Ferrule was installed deeper than the recommended length.	
38	07-01-2024	XIII	179	Arundale Beach Rd,3rd St, Kalakshetra Colony, Besant Nagar	Presence of sludge was observed inside the pipeline.	
39	07-01-2024	XIII	179	Arundale Beach Rd,3rd St, Kalakshetra Colony, Besant Nagar	Deformation was identified in the pipeline.	

3.4.6.5. Hardness Test

There is more pit excavated in addition to pit for Flow measurement. Hardness of the pipe line was checked through portable hardness tester. Hardness is a measurement of how resistant solid matter is to various kinds of permanent shape change when a force is applied. Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness. When the test is carried out, an impact body with a tungsten carbide test tip is impelled by spring force against a test surface from which it rebounds. Impact and rebound velocities are measured by following method: a permanent magnet integrated into the impact body passes through a coil and induces an electric voltage during its forward and return travel. These voltages were proportional to the velocities and were processed and displayed as the hardness value i.e Brinell Hardness number (HBN) on the indicating device.

Image 3.9 - Hardness test

As per IS-8329-2000 (HBN<=230) but the results are observed mostly greater than 250 HBN. The higher HBN number pipes are at risk conditions. The samples of the pipe are not possible to take from various location for laboratory testing because during cutting the sample piece of pipe it may damage to extended length which cannot be rectified at site with our limited resource. The data recorded 5nos tail end locations in each Depot are listed in Table-3.12 below.

Table-3.12: Hardness Test Result

Depot No	*Hardness value in HBN of (CI Pipe)*					*Brinell HBN*	*Risk*	*Below Trend (240)*
	1	*2*	*3*	*4*	*5*			
DEPOT168	268	252	256	261	271	262	Medium	240
DEPOT169	274	261	287	271	276	274	High	240
DEPOT170	262	302	284	257	285	278	High	240
DEPOT171	243	259	248	267	261	256	Low	240
DEPOT172	256	249	251	263	272	258	Low	240
DEPOT173	282	242	253	251	263	258	Low	240
DEPOT174	298	257	269	247	282	271	High	240
DEPOT175	267	258	279	266	278	270	High	240
DEPOT176	283	271	256	244	269	265	Medium	240
DEPOT177	276	263	269	251	256	263	Medium	240
DEPOT178	249	252	258	248	247	251	Low	240
DEPOT179	258	266	259	251	249	257	Low	240
DEPOT180	245	259	263	249	241	251	Low	240

From the above table of field inspection, it is observed that out of 13 field results, pipes in 4 locations hardness value are under high-risk condition.

3.5. SUMMARY OF EVALUATION

The summary of evaluation of the condition assessment results are presented in Table 3.13 below. Overall replacement is estimated at 7% of the total pipe lengths under project area.

Table 3.13: The data from field, evaluation results are tabulated below:

Evaluation and Analysis											
PROJECT: **Conditional Assessment of Water supply Distribution Network for Area-XIII of Chennai**											
From Field Data						***Evaluation Result***		***Recommendation***			
Sl No	***Depot no***	***Hardness Test value from Field (HBN 230 to 260)***	***Hardness Test value from Lab***	***Flow Test conducted at site***	***CCTV Inspection Test at site***	***Evaluation For Hardness***	***Evaluation For flow***	***Pipe Replacement***	***cleaning of Pipe line***	***% of Length***	***Remark***
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
1	168	Medium	Low	Medium	Medium	*NON-CRITICAL*	*NON-CRITICAL*	*CONTINUE*	*FLUSHING*	-	-
2	169	High	Low	High	High	*CRITICAL*	*CRITICAL*	*REPLACEMENT*	-	*16%*	*Priority to CI Lines*
3	170	High	Low	Medium	Medium	*CRITICAL*	*NON-CRITICAL*	*REPLACEMENT*	*FLUSHING*	*20%*	*80% for flushing. Priority to CI Lines*
4	171	Low	Medium	Low	High	*NON-CRITICAL*	*CRITICAL*	*CONTINUE*	-	-	-
5	172	Low	High	High	High	*CRITICAL*	*CRITICAL*	*REPLACEMENT*	-	*25%*	-
6	173	Low	Medium	Low	Medium	*NON-CRITICAL*	*NON-CRITICAL*	*CONTINUE*	*FLUSHING*	-	-
7	174	High	Medium	Low	Low	*CRITICAL*	*NON-CRITICAL*	*REPLACEMENT*	*FLUSHING*	*16%*	*84% to be flushed*
8	175	High	Low	High	High	*CRITICAL*	*CRITICAL*	*REPLACEMENT*	-	*10%*	-
9	176	Medium	Low	Low	High	*NON-CRITICAL*	*CRITICAL*	*CONTINUE*	-	-	-

Evaluation and Analysis

PROJECT: **Conditional Assessment of Water supply Distribution Network for Area-XIII of Chennai**

From Field Data						***Evaluation Result***		***Recommendation***			
Sl No	***Depot no***	***Hardness Test value from Field (HBN 230 to 260)***	***Hardness Test value from Lab***	***Flow Test conducted at site***	***CCTV Inspection Test at site***	***Evaluation For Hardness***	***Evaluation For flow***	***Pipe Replacement***	***cleaning of Pipe line***	***% of Length***	***Remark***
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***
10	177	Medium	Low	Low	Low	*NON-CRITICAL*	*NON-CRITICAL*	*CONTINUE*	*FLUSHING*	-	-
11	178	Low	High	Low	Low	*CRITICAL*	*NON-CRITICAL*	*REPLACEMENT*	*FLUSHING*	*16%*	*84% to be flushed*
12	179	Low	High	Medium	Medium	*CRITICAL*	*NON-CRITICAL*	*REPLACEMENT*	*FLUSHING*	*26%*	*74% to be flushed*
13	180	Low	Medium	High	High	*NON-CRITICAL*	*CRITICAL*	*CONTINUE*	-	-	-

	HBN	**Risk**	**HB**	**Risk**		
	240 to 260	**Low**	**More than 140**	**Low**	***Overall Replacement***	***7%***
	260 to 270	**Medium**	**130 to140**	**Medium**		
	More than270	**High**	**Less than 130**	**High**		

Evaluation and Analysis

PROJECT: **Conditional Assessment of Water supply Distribution Network for Area-XIII of Chennai**

From Field Data						***Evaluation Result***		***Recommendation***			
Sl No	***Depot no***	***Hardness Test value from Field (HBN 230 to 260)***	***Hardness Test value from Lab***	***Flow Test conducted at site***	***CCTV Inspection Test at site***	***Evaluation For Hardness***	***Evaluation For flow***	***Pipe Replacement***	***cleaning of Pipe line***	***% of Length***	***Remark***
1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***

3.6. RECOMMENDATIONS:

a. Inspection test points are at 5 locations under each depot. The total length pipeline where conditional assessment survey has been conducted is about 5KM.
b. Location of junctions and alignment of pipe along the street are identified by GPR survey which shall be used for future maintenance work.
c. The evaluation table results indicate about 7% of pipe for replacement at tail-end that are in a deteriorated condition.
d. The Robotic test indicated that the flow in some of the area under low pressure which need flushing to maintain the desired flow.
e. Excluding the above the pipes which are underrated may be replaced

CHAPTER -4-DESIGN CRITERIA

4.1. INTRODUCTION

Design of Water supply system components in the DPR has been carried out based on guidelines of Manual on Water Supply & Treatment-Dec 2023, published by the Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development Government of India and as per provisions of relevant Indian standards & Manuals (IS/BIS codes/SP etc.) and International Standards & Manuals (ISO/AWWA etc.).

This Chapter describes various design criteria used in the design of the water supply system.

4.2. DESIGN PERIOD

Water supply projects are designed to meet the future requirement of a stipulated design period. For CMWSSB project, a design horizon of 30 years is considered as per CPHEEO Manual (Para. 2.8.2.1). Considering the base year of 2026, intermediate design year is 2041 with ultimate design year of 2056. The design period for various components considered is presented in Table 4.1 below.

Table 4.1: Component-wise Design Period

Sr No	Components	Design period	Design Year
1.	All Civil structures (Pumping stations, Storage reservoirs)	30 years	2056
2.	Pumping Mains & Gravity Mains	30 years	2056
3.	Mechanical and Electrical, I&C Equipment	15 years	2041
4.	Distribution System	30 years	2056

4.3. WATER DEMAND ESTIMATION

4.3.1. Background

The Chennai Metropolitan city has an Underground Sewerage system, Per capita supply has been considered as 150lpcd as per CPHEEO Manual. Provisions are also made for floating Population demand @ 2% of domestic demand and firefighting demands. Commercial & Institutional demands are considered as per field survey.

The details of per capita water demands considered for Chennai Core City (CCC) are presented in Table 4.2

Table 4.2: Water Demand Norms Considered for CMWSSB Project

Sl. No.	Description	Units	Demand Norms	Remarks
1.	Per Capita Water Supply (Domestic water Demand)	LPCD	150	As per CPHEEO Guidelines, Para 2.4 Pg 39
2.	Commercial & Institutional water demand	MLD	As per Field survey	CPHEEO Guide lines and observation in field survey
3.	Floating Population	LPCD	2% of Domestic water demand	As per CPHEEO Guidelines, Cl. 2.8.2.5-II Pg no 40 for Class -I Cities
4.	Fire Fighting Demand	KL/Day	$100\sqrt{P}$ P = Population in Thousands	As per CPHEEO Guidelines, Cl. 2.8.2.5-IV

4.3.2. Unaccounted for Water (UFW) Losses in the System

As per the CPHEEO manual (Para. 2.8.2.5-V-Fig 2.4), 15% of UFW losses should be limited in the system. Accordingly, a total system loss of 15% for CMWSSB project (1% in Raw water transmission, 3% in Treatment Plant and 1% in Clearwater transmission & storage reservoir losses and 10% as distribution losses) is considered in the design.

4.3.3. Peak Factor

The per capita water supply indicates only the average water consumption. As far as the design of distribution network is concerned, it is the hourly variation in domestic consumption that matters. The fluctuation is accounted for by considering the peak factor:

Peak rate of consumption= average water consumption x Peak factor.

As per the CPHEEO Manual 2023 guidelines (Chapter-2, S.No. 7, Pg. No. 76), Water distribution networks of urban schemes: Peak factor should be considered as 2.5 irrespective of population.

As per CPHEEO Manual, the water distribution system for 24x7 water supply is designed with a peak factor of 2.5. The proposed network is modelled for continuous water supply and the consumer consumption pattern considered is shown in Figure-4.1 and Table 4.3 below.

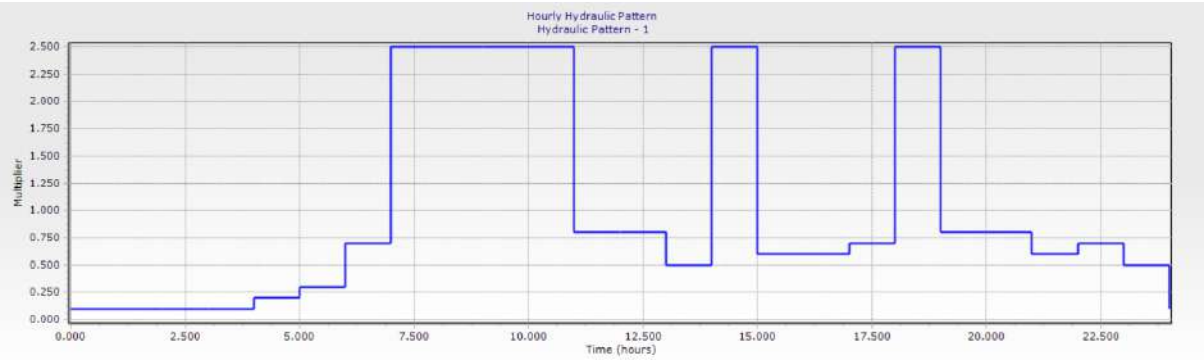


Figure: 4.1: (Hourly Hydraulic Pattern)

Table-4.3: Hourly Peak Factor Based on Consumption Pattern

Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Draw off	0.10	0.10	0.10	0.20	0.30	0.70	2.50	2.50	2.50	2.50	0.80	0.80	0.50	2.50	0.60	0.60	0.70	2.50	0.80	0.80	0.60	0.70	0.50	0.10

4.3.4. Minimum Residual Head at Ferrule

As per the CPHEEO Manual 2023 guidelines (Chapter-2, S.No. 10, Pg. No. 77), the residual nodal pressures at ferrule at highest node shall be 17-21 m for Class I and II cities and 12-15 m for other cities. Considering all aspects, residual nodal pressure at highest node is considered as 17mtr.

4.3.5. Storage reservoirs capacities

As per the CPHEEO Manual 2023 guidelines (Chapter-2, S.No. 12, Pg. No. 79), Balancing capacity of the service reservoir shall be calculated by: (i) mass balance, or (ii) 33% of the total demand of ultimate stage (30 years from the base year) of the OZ of that ESR. In any case, the minimum capacity shall not be less than 33% of the demand as above. However, for rural areas the service tank may be designed for 50% of the ultimate demand. These recommendations have been considered in the design.

4.4. CLEAR WATER TRANSMISSION MAINS

Clear water Transmission Main is the piped network connecting from clear water sump in treatment plant premises to Storage reservoirs in various locations.

Generally peak factor of 1.1 to 1.2 of average demand in consideration of pumping hours is considered for design of transmission main. Economic size of pumping main is carried out according CPHEEO guidelines.

The minimum and maximum design velocity for transmission mains is 0.6 m/s and 2.5 m/s respectively. The minimum velocity is selected to prevent the settlement of grit and suspended matter, and the maximum velocity is selected to minimize erosion of the pipe. Water hammer calculations are done based on the economic size of pumping main.

4.5. CLEAR WATER PUMPING MACHINERIES

The pumping capacity is proposed to supply water from sump to Ground level service reservoirs (GLSR)/ Overhead Service Reservoirs (OHSR's) located in various locations in the project area. 22 hrs, a day pumping operation is considered for lifting water from Sump to GLSR's/ OHSRs. The number of working and standby pumps for single pump operation and multiple pump operation is given below.

- 1 working + 1 standby pumping arrangements (100% standby)– for single pumping operation
- 2 working + 1 standby pumping arrangements (50% standby)– for multiple pumping operation
- 3 working + 2 standby pumping arrangements (66% standby)– for multiple pumping operation

4.6. SURGE ANALYSIS & RECOMMENDATION OF CONTROL DEVICE

The surge control systems have been designed to ensure that:

- The maximum upsurge with the surge control devices has been restricted to 1.1 times the normal operating pressure.
- The vacuum pressure developed in the pipeline at any place has been restricted to 5 m (minus 5 meters);

The surge protection system in such a case will be in the form of hydro-pneumatics/air vessels/Zero Velocity, air valves or combination of these systems.

4.7. DISTRIBUTION SYSTEM

The distribution system may be by gravity or through pumping with supply from the proposed storage reservoirs (OHSRs/GSRs). Water supply pipelines have been proposed all road corridor up to the plot boundary as per the specific requirements of the consumer.

The piping layout shall follow the planning of the existing roads/streets. To avoid cross-cutting of the major roads, especially for house connections and the regular maintenance activities, parallel pipes have been suggested for roads greater than 24 m separated by medians.

4.8. HOUSE SERVICE CONNECTIONS

Service pipes should be laid from the distribution network up to the consumer plot. The service pipe details are summarized as below:

Table 4.4 House Service Connection materials

Sr. No	Pipe Material	Diameter	Remarks
1	Mild Density Polyethylene Pipes (MDPE)	15,25 & 40	

4.9. PIPE MATERIALS

Pipe Material for Transmission/Distribution water mains are considered as Ductile Iron (D.I.) pipes and Mild Steel (MS) Pipe. Mild Steel and Ductile Iron pipes will have internal Cement Mortar Lining (CM) lining in accordance with IS 11906 or ISO 4179 and outside fusion bonded epoxy coating for prevention for corrosion.

All consumers service connections shall be MDPE pipes. Wherever MDPE pipeline crosses drains while giving service connections, HDPE pipe encasements are recommended. Details of pipe material, class and standards are given in Table 4.5 below.

Table 4.5: Pipe Material for Transmission/Distribution water mains

Sr. No	Type	Pipe Material	Class	Standard
1	Diameter up to 1000 mm	Ductile Iron (DI)	K7 /K9	IS 8329
2	Diameter above 1000 mm	Mild Steel (MS)		IS 3589
3	Service Connections	Medium Density Polyethylene Pipes (MDPE)	PE 100, PN 10	IS 4984
4	Crossing for Service Connection	High Density Polyethylene Pipes (HDPE)	PE 100, PN 10	IS 4984

4.10. MINIMUM PIPE DIAMETER

The cost of the transmission and distribution system constitutes a major portion of the project cost. It is desirable to adopt the following guidelines (CPHEEO Manual Para 6.6, pg-288):

(i) In the design of distribution systems, the minimum design velocity should be selected in such a fashion to avoid the deposition at the bottom of the pipe which may result in deterioration of pipe quality.

(ii) A minimum velocity of 0.4 to 0.6 m/s is recommended to avoid depositions and consequent loss of carrying capacity. However, where inevitable due to minimum pipe diameter criteria or other hydraulic constraints, lower velocities up to 0.3 m/s may be adopted with adequate provision for scouring.

(iii) The maximum flow velocity should not be more than *2.5* m/s for raw water to avoid the abrasion and subsequent scouring in the pipelines due to suspended particles. However, in case of filtered water, as the quantity of solids (which contribute to the abrasion) is negligible, the maximum flow velocity to be adopted shall be 3 m/s.

(iv) For hilly area and branch pipe connecting transmission main to service reservoir: The maximum velocity for MS/DI pipes with internal mortar lining shall be limited

to 4.0 m/s for following two cases: a) For hilly regions b) For part of branch pipe connecting transmission main to service reservoir required for dissipation of excess residual head.

(v) In all hydraulic calculations, the actual internal diameter of the pipe shall be considered after accounting for the thickness of the lining, if any, instead of the nominal diameter or outside diameters (OD).

(vi) The Head Loss gradient should not exceed 10m/km

(vii) It is desirable that head loss due to fittings, specials, and other appurtenances are obtained. However, accounting for an individual head loss of each valve and fitting used in transmission mains and water distribution networks (WDN) is not practically possible. Usually, these minor losses are considered as 10% of the frictional losses. In some of the software that are used for the simulation and design of WDNs, there is no provision for a direct increase in friction loss by a certain percentage. Therefore, either the length, flow, or C-value can be modified appropriately. To account for 10% of minor losses, the length of pipes can be increased by 10% or nodal demand can be increased by 5.28%, or the C-value can be reduced by approximately 5%.

4.11. EXCAVATION DEPTH

Excavation may be done by hand or by machine. The trench shall be so dug that the pipe may be laid to the required gradient and at the required depth. When the pipeline is under a roadway, a minimum cover of 1.0 m is recommended for adoption, but it may be modified to suit local conditions by taking necessary precautions. However, the structural strength of the pipe, based on dead load and live load over the pipe, should also be analyzed. The trench shall be so braced and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains and shall not be allowed to be spread in the vicinity of the worksite.

4.12. PIPE TRENCH WIDTH & BEDDING

Trenching includes all excavation which is carried out by hand or by machine. The width of the trench shall be kept to a minimum, consistent with the working space required. At the bottom between the faces, it shall be such as to provide not less than 200 mm clearance on either side of the pipe. The bottom of the trench shall be properly trimmed to permit even bedding of the pipeline. For pipes larger than 1,200 mm diameter in earth and muroom, the curvature of the bottom of the trench should match the curvature of the pipe as far as possible. Where rock or boulders are encountered, the trench shall be trimmed to a depth of at least 100 mm below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with lean cement concrete or with a non-compressible material like sand of adequate depth to give the curved seating. For details on laying of welded steel pipe, IS 5822-1994, Reaffirmed 2019 may be referred to.

4.13. FRICTION LOSSES CALCULATIONS

The water supply system is designed based on Hazen William friction loss formula as given below. The maximum head loss is maintained below 10 m per km.

$$Q = 1.292 \times 10^{-5} \times C \times D^{2.63} \times \left(\frac{H_f}{L}\right)^{0.54}$$

Q = Flow rate (m3/hr),

C = Hazen Williams constant depending upon pipe material,

D = Inner diameter of pipe (mm),

Hf = Head loss (m),

L = Length of pipe (m)

Hazen's Williams Coefficient (HWC) or C value to be used for the pipeline hydraulics shall be based on the design life. The following Table 4.6 presents the recommended C values for design as per CPHEEO Manual (6.5.1.2, Page-281)

Table -4.6- Hazen's Williams Coefficient "C" for design Purposes

Sr. No	Pipe Material	New Pipes	Old Pipes
1	Ductile Iron Pipe (DI) with centrifugally lined with Cement mortar lining	130	100
2	Mild Steel (MS) upto 1200mm with centrifugally lined with Cement mortar lining	140	-
3	Mild Steel (MS) >1200mm with centrifugally lined with Cement mortar lining	145	-
4	High Density Polyethylene Pipes (HDPE)	145	100

4.14. FIRE HYDRANTS & STORAGE REQUIREMENT

Fire hydrants needs to be provided on water network, as per IS 908 (Specification for Fire Hydrant, Stand Post Type). The hydrant shall consist of one or two sluice valves with road surface boxes, a duck foot bend, flange riser and a stand post column fitted with 63-mm male coupling(s).

The hydrants are spaced at a maximum of 100 m center to center as per IS 13039. Fire hydrants shall be provided in spacing around 800 feet (244 meters) as per NFPA Fire Code 2015 Edition.

However, for providing fire-fighting storage, higher provision as recommended by CPHEEO and IS 9668 should be adopted. Additional fire storage is to be adopted within the GLSR/OHSR. The minimum pressure of 14m needs to be maintained within the water network on which the fire hydrants are to be installed. The fire tender has a mounted booster pump capable of boosting the pressure to the required level.

4.15. CONTROL VALVES FOR TRANSMISSION MAIN AND DISTRIBUTION SYSTEM

For operation and maintenance of transmission and distribution system, minimum numbers of valves are necessary. The transmission and distribution mains shall be provided with the following appurtenances and specials as per the following criteria.

4.15.1. Sluice Valves

Resilient seated sluice valve of standard make as per IS 14846 have been proposed at different locations as per requirements to isolate a portion for maintenance.

The distribution system is designed considering DMA formation, and isolation valves will be recommended wherever isolation is required for hydraulic discreteness of the DMA. In addition, valves are recommended to create sub-zones for step tests to identify the leak-prone area.

4.15.2. Non-Return Valve

Non-Return Valves of standard make as per IS 5312 have been proposed at different locations as per requirements to prevent any backflow.

4.15.3. Pressure Reducing Valve

Pressure reducing valves with pressure sustaining override has been provided to reduce the pressure difference between the locations of the same zones. It will also prevent a reduction of pressure beyond a minimum defined value.

PRV might be proposed in specific scenarios where the difference in the residual heads (normally more than 22mm) is critical in terms of operation.

4.15.4. Air Release Valves

Air valves are required at peak points to release entrapped air, admission of air when draining the system and slow release of air during normal operation. Double acting air release valves with EPDM of standard make have been proposed at suitable locations in the rising mains and distribution network to protect the line from both upsurge and down surges. The valves have been provided at a minimum spacing of 400 m. For double acting valves, the valve diameter is generally kept about 1/8th of size of diameter of pipe.

4.15.5. Scour Valves

Scour valves of standard make have been proposed to be installed in the rising mains and distribution system at lower points in the line to drain silt and water from the line whenever required. The discharge generally will be disposed of into a nearby natural stream/valley. All the valves have been enclosed in valve chambers with cover.

4.16. FLOW MEASURING DEVICES:

Flow measuring devices of electromagnetic type are recommended to be provided at all the water distribution stations as these are considered reliable and accurate. The flow totalizer/ computer receives and processes the signal from the transducers. It provides facilities for entering process data connected to the flow measurement and computes and displays the flow. Data such as pipe diameter, pipe material, wall thickness, liquid details, etc., is entered in the flow computer and is stored in its memory. The flow totalizer/ computer displays the flow rate, integrates the flow over a period and stores the flow

trend in its memory. It is possible to achieve about 99.5% accuracy in the flow measurement.

4.17. THRUST AND ANCHOR BLOCKS

Ductile iron pipes with flexible joints will be restrained using concrete thrust blocks in accordance with IS 5330. However, where there are space constraints for construction of standard thrust blocks, a site-specific design is to be adopted, or the joint is to be restrained mechanically using anchored restrained joints.

Concrete thrust blocks have been provided at the bend of the pipes to avoid movement of pipeline as per the requirements.

4.18. WATER DISTRIBUTION HYDRAULIC ZONES & DMAS

The proposed design approach of the water distribution systems incorporated the formation of District Metering Areas (DMAs) for better control and audit of water supply against consumption. Applying zoning via the DMA concept would facilitate monitoring and controlling of the distribution systems in terms of quantities (i.e. water demands), quality (i.e. water quality and residual pressure) and finally resulting in economic return on investment (accurate billing and collection system, reduction in unaccounted for water due to leakage, resulting in financial returns).

Valves have been planned on the boundary of each DMA where pipes are interlinked to adjacent DMA. These valves will generally be kept in closed positions and shall be operated only during emergency conditions. This will help in isolating a part of the area during repairing of leaks or carrying out maintenance, without interrupting the supply to the rest of the DMA. On average 1,000 to 3,000 connections shall be made as one DMA.

4.18.1. Water distribution Modelling Software

Water GEMS software has been used for modelling water distribution networks. The software is comprehensive and easy to use in water distribution modelling applications having Graphic user & GIS interfaces. Water GEMS can be used integrated with ArcGIS or AutoCAD.

4.19. Design Standards:

All designs shall be based on the latest Indian Standard Specifications or Codes of Practice. In addition, the design standards adopted shall follow the best engineering practice in the field based on any other international standard or manuals.

The various referred Indian and International codes & manuals generally used in the design, manufacture and testing of Pipes, Valves, water meters etc. are as mentioned below in Table 4.7 and International Standards relevant to the Water supply system are given in Table 4.8 below.

Table 4.7: Relevant Indian Standards & specifications

Sl. No	Code No.	Code Title
1.	Manual for Water Supply & Treatment	CPHEEO Manual for Water Supply & Treatment - 2023- MoUD, GoI
2.	Manual on operation and Maintenance on water supply	CPHEEO Manual on Operation and Maintenance of water supply systems, 2005 MoUD, GoI
3.	SP 7 (Part-9 Section-1)	National Building Code of India
4.	SP 35	Handbook on water supply & drainage
5.	IS 2065	Code of practice for water supply in buildings
6.	IS 1172	Code of Basic requirements for water supply, drainage and Sanitation
7.	IS 8329	Centrifugally cast(spun) ductile iron pressure pipes for water, gas and sewage – specification
8.	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage – specification
9.	IS 3589	Electrically welded steel pipes for water, gas and sewerage (150 to 2000 mm nominal size)
10.	IS 7322	Code for MS Specials
11.	IS 5504	Specification for spiral welded pipes
12.	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
13.	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
14.	IS 12288	Code of practice for use and laying of Ductile Iron pipes
15.	IS 5822	Code of practice for laying of welded steel pipes for water supply
16.	IS 11606	Methods for sampling of Cast Iron pipes and fittings
17.	IS 4711	Method for sampling of steel pipes, tubes and fitting
18.	IS 11906	Recommendations for cement mortar lining for cast iron, Mild steel and Ductile Iron pipes and fittings for transportation of water
19.	IS 1916	Code for outside coatings for MS pipes

Sl. No	Code No.	Code Title
20.	IS 10221	Code of practice for coating and wrapping of underground steel pipelines
21.	IS 8062	Code of practice for cathodic protection for steel structures
22.	IS 1916	Specification for steel cylinder pipes with concrete lining and coating
23.	IS 7322	Specification for specials for steel cylinder reinforced concrete pipes
24.	IS 4984/1995	High density polyethylene pipes for potable water supplies
25.	IS 7634 Part-2	Code of practice for plastic pipework for potable water supplies –Laying and jointing of polyethylene pipes
26.	IS 8360	Fabricated high Density polyethylene (HDPE) fittings for potable water supplies
27.	IS 8008	Injection-molded HDPE fittings for potable water supplies
28.	IS 5477	Methods for fixing the capacities of reservoirs
29.	IS. - 11682	Criteria for design of R.C.C. staging for overhead tanks.
30.	IS 1387	General requirements for supply of metallurgical materials
31.	IS 1500	Methods for Brinell hardness test for metallic materials
32.	IS 1608	Mechanical testing of metals - tensile testing
33.	BS: 3416	Bitumen based coatings for cold application, suitable for use in contact with Potable water.
34.	IS 14846	Sluice valves for water works purposes (50 to 1200 mm size)
35.	IS 2906	Sluice valves for water works purposes (350 to 1200 mm size)
36.	IS: 13095 / BS 5155	Butterfly Valves
37.	IS 2685	Code of practice for selection, installation and maintenance of sluice valves
38.	IS 5312	Swing check type reflux(non-return) valves for water works purposes

Sl. No	Code No.	Code Title
39.	IS 9739	Pressure reducing valves for domestic water supply systems
40.	IS 779:1994	Water meters (Domestic Type)
41.	BIS IS 2104	Water meter boxes (domestic type)
42.	IS2373	Water meter (bulk type)
43.	BIS IS 2401	Code of Practice for fire selection, installation and maintenance of domestic water meters
44.	IS 3950	Surface boxes for sluice valves
45.	IS:909	Code for C.I. Fire Hydrants
46.	IS 1726	Cast iron manhole covers and frames - specifications
47.	IS 2692:1978	Ferrules for water services
48.	IS 10446:1983	Glossary of terms relating to water supply and sanitation
49.	IS 10500:2012	Drinking water quality
50.	IS2951-1965	Recommendation for estimation of flow of liquids in closed conduits.
51.	A guideline notes on continuous water supply (24X 7 supply)	Guidelines for preparation of DPRs for water supply system by MoUD, 2021
52.	Advisory note on improving Urban Water Supply & Sanitation Services	Guidelines for preparation of DPRs for water supply system by MoUD, 2013
53.	General Guidelines for water Audit & water Conservation	Central Water Commission, December 2005
54.	IWWA Publication	Leak Detection and Waste Prevention in Water Distribution Systems.
55.	IWA Publication	Losses in water distribution network
56.	IWA Publication	DMA Management Manual by the Water Losses Task Force

Table 4.8: Relevant International Standards & specifications

Sl. No	Code No.	Code Title
1.	ISO 2531	Ductile iron pipes, fittings, accessories and their joints for water applications
2.	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure Pipelines- Cement mortar lining
3.	ISO 4633	Rubber seals -- Joint rings for water supply, drainage and sewerage pipelines - Specification for materials
4.	ISO 8179 (Part-1)	Ductile iron pipes -- External zinc-based coating – Part 1: Metallic zinc with finishing layer
5.	ISO 8179 (Part-2)	Ductile iron pipes -- External zinc coating – Part 2: Zinc rich paint with finishing layer
6.	ISO 8180	Ductile iron pipelines - - Polyethylene sleeving for site application
7.	ISO 10802	Ductile iron pipelines - Hydrostatic testing after installation
8.	ISO 10803	Design method for ductile iron pipes
9.	ISO 16132	Ductile iron pipes and fittings - - Seal coats for cement mortar linings
10.	AWWA C600	Installation of ductile iron water mains and their appurtenances
11.	AWWA M 41	Ductile - Iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying &installation etc.)
12.	BSEN 545	Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods
13.	AWWA Manual M11	Steel Pipe- A guide for design and Installation (Fourth Edition)
14.	AWWA Manual M55	PE Pipe- Design and Installation (First Edition)
15.	AWWA Manual M36	Water Audits and Loss control Programs (Third Edition)
16.	WHO Publication	Leakage Management and control
17.	AWWA Manual M55	PE Pipe- Design and Installation (First Edition)

The various referred Indian codes & manuals generally used in the Reinforced concrete structural design shall generally conform to the following publications by the Bureau of Indian Standards (BIS) as given in Table 4.9 below.

Table 4.9: Other Relevant Indian Standards & specifications

Sr. No.	Code or Standard	Description
1.	IS. 3370 part I to IV	Code of practice for concrete structure for the storage of liquids
2.	IS 455	Portland slag cement
3.	IS 8112	43 grade ordinary Portland cement
4.	IS 456	Code of Practice for plain and reinforced concrete
5.	IS 1893 part I to V	Criteria for earthquake –resistant design of structures
6.	IS 13920	Detailing of reinforced concrete structures subjected to seismic forces
7.	IS 1992/ IS 6403	Code for exploration to find the safe bearing capacity
8.	IS 2309-1969	Code for Lighting arrestors
9.	IS 875 part I to V	Code of practice for design loads for building and structures
10.	IS 7357	Code of practice for structural design of tanks
11.	IS 1786	High strength deformed steel bars and wires for concrete reinforcement
12.	IS 4326	: Code of practice for earthquake resistant design and construction of buildings
13.	IS 800	Code of Practice for general construction in steel
14.	IS 806	Code of Practice for use of steel tubes in general building construction
15.	IS 3414	Code of practice for Design and Installation of Joints in Buildings.
16.	IS 2974	Code of Practice for design and construction of machine foundations (Part 1 to 5
17.	IS 1904	Code of Practice for Design and Construction of Foundation in Soils: General Requirements

Sr. No.	Code or Standard	Description
18.	SP 38	Handbook of Typified Design of Structures with Steel Roof trusses.
19.	SP 16	Design Aids for Reinforced Concrete to IS 456.
20.	SP 34	Handbook on Concrete Reinforcement and Detailing.
21.	IRC 6	Standard Specification and code of practice for roads and bridges: Loads and Stresses

CHAPTER -5-POPULATION PROJECTION AND DEMAND ASSESSMENT

5.1. Introduction

Population projection and demand assessment has been carried out following the CPHEEO manual published in 2023 and in consultation with CMWSSB officials for adopting appropriate growth rate and water demand figure related to Institutional, Commercial & Industrial consumption. This system encompasses selecting design period, population projection of Chennai city & operational zones under the project area, determination of per capita supply & demand calculation of the project area.

5.2. Design Period

Ultimate design period for the project is 30 years, so the base year has been considered as 2026 with intermediate design year as 2041 & Ultimate design year as 2056 as presented in Table 5.1 below.

Table-5.1: Design Horizons for the project

1	2026	Base Year
2	2041	Intermediate Year
3	2056	Ultimate Year

5.3. Population Projection of Chennai City

5.3.1. Censes data of Chennai city

Decadal census data available for different decades is presented in the Table-5.2.

Table 5.2 Decadal Census data for Chennai City

Sr. No.	Census Year	Population (Lakhs)
1	1951	14.27
2	1961	17.49
3	1971	26.42
4	1981	32.84
5	1991	38.43
6	2001	43.44
7	2011	46.47

5.3.2. Population Forecasting Methods and Projected Population

Population forecasting for the Chennai city for the base year 2026, intermediate year 2041 and ultimate year 2056 has been carried out by various methods such as arithmetical, geometric, incremental, decadal growth and semi-graphical methods and the forecasted population figures are presented in Table 5.3 below.

Table 5.3: Projected Population by various methods for Chennai city

Projected Population in lakhs as per various method for City						
S. No	**Year**	**Arithmetic Progression Method**	**Geometric Progression Method**	**Incremental Progression Method**	**Decadal Growth Method**	**Semi Graphical Method**
1	2026	55	60	55	51	51
2	2041	64	78	64	57	59
3	2056	73	101	73	63	68

According to the report of "Selection of experts and supporting staff for the Project Implementation Unit, Chennai Metropolitan Development Authority under the Tamil Nadu Housing and Habitat Development Project", the CMA region comprises of Chennai city and the rest of CMA. Chennai city alone shared 74% of the total population of CMA in 1971. In 2021, It is estimated to share 46% of the CMA. The Chennai city registered a growth rate of 1.23% in 1991 -2021 to 0.68% during the period 2001-2011, ranked the second least decadal change among the districts. The Chennai City Corporation with an area of 176 sq. km. witnessed a population of nearly 4.65 million in 2011. In October 2011, the City area was revised to 426 Sq.km, with a population of about 6.6 million (2011). The workforce participation rate was 43.3%, indicating that nearly 3.68 million people are employed in CMA. Chennai is a major transportation hub for road, rail, air, and sea transport connecting major cities inland and abroad.

After comparing the population figures arrived by different methods and thread bare deliberations with CMWSSB, decadal growth method has been adopted with a growth rate of 6.80% per decade for design of the water supply system.

5.4. Projected Population for Operational Zones

Population has been estimated for individual operational zone by decadal growth method. An abstract of projected population is presented in below Table 5.4.

Table 5.4: Projected population Details of WDS and its Operational Zones

Name of the WDS	Operational Zone (Depots) Number	Population Projection @ 6.80% of Decadal Growth Rate		
		2026 (Base Year)	2041 (Intermediate Year)	2056 (Ultimate Year)
Pallipatu WDS	170	69276	76689	84895
	173	51185	56662	62725
	174	47615	52710	58350
	178	34220	37881	41935
	179	42036	46534	51513
Part is 50% of total	169 Part	16625	18403	20373
Thiruvanmiyur WDS	180	67215	74407	82368
Sub Total		**328172**	**363826**	**402159**

5.5. Per capita Supply for Demand Calculation

Water supply demand calculation has been done considering per capita supply for domestic, industrial/commercial, floating population, fire water demand, permissible losses in accordance with CPHEEO manual as presented in Table 5.5 below.

Table 5.5: Per capita Water supply considered for different uses

S. No.	Particular	Rate
1	Domestic Demand **@ 150 LPCD**	150 LPCD
2	Institutional Demand **As per Actual**	As per Actual
3	Industrial/Commercial Demand **As per Actual**	As per Actual
4	Fire Demand As Per Amrut 2.0 Guideline **@100√P**	Calculated
5	Floating Population Demand **@ 2%** of Domestic Demand	3 LPCD
6	Distribution Losses **@10%**	15 LPCD
*	Total Clear Water Demand as per calculation sheet	**As per Calculation, in table 5.6**

5.6. Demand calculation for WDS and it's Operational Zones

Demand for the design horizon years has been calculated for individual operational zone based on per capita supply and projected population. An abstract of demand calculated is given in the below table 5.6. Referring the table, the design water demand for the project area in the base year 2026, intermediate year 2041 and ultimate year 2056 is 50MLD, 55.56 MLD and 61.58 MLD respectively. Detailed calculation is appended in Appendix 4.

Table 5.6: Demand Calculated Details of WDS and its Operational Zones

Name of the WDS	**Operational Zone (Depots) Number**	Demand Calculation (Domestic Demand + Commercial / Institutional Demand + Fire Demand + 10% Distribution System losses) In MLD		
		2026 (Base Year)	**2041 (Intermediate Year)**	**2056 (Ultimate Year)**
Pallipatu WDS	170	11.10	12.28	13.60
	173	7.43	8.39	9.28
	174	7.32	8.10	8.97
	178	5.04	5.57	6.17
	179	6.18	6.84	7.56
Part is 50% of total	169 Part	2.60	2.94	3.34
Thiruvanmiyur WDS	180	10.34	11.44	12.66
Total		**50**	**55.56**	**61.58**

CHAPTER -6-PROPOSED WATER SUPPLY SYSTEM

6.1. Introduction

This chapter covers adequacy check for the water supply source, design of transmission mains, storage system, pumping systems, operational Zone, DMA & Lane/ sub-lane formation, distribution network design using Water Gems hydraulic modelling software, house service connections, domestic metering aspects and instrumentation, control and automation of the proposed water supply system.

6.2. Sustainability of Proposed Source

It is proposed to use the Nemmeli DSP with a capacity of 100MLD for the water supply to the project area considered under Area XIII. As per demand assessment carried out at Chapter 5, the total quantity of water required for base year (2026) is 50 MLD, for Intermediate year (2041) is 55.56 MLD & for ultimate year (2056) is 61.57 MLD. At present Nemmeli treatment plant is producing 90 MLD which is sufficient to meet the water demand of 50MLD, 55.56MLD and 61.58MLD in the base year (2026), intermediate year (2041) and ultimate year (2056) respectively.

6.3. Design of Transmission Mains

Economic sizing-based design of the existing Transmission mains have been carried out for all the eleven stretches for the ultimate design period i.e. for year 2056. It is found that additional parallel pipes are required to be laid in six stretches, whereas in five stretches, the existing mains are adequate. The Transmission Mains are designed for the system to meet required supply and flow for all WDS, except Ekkathangal WDS, under Area XIII. However, cost of transmission additional transmission mains system is not covered in the present proposal due to funding constraints. An abstract of economical pipe diameter designed is shown below in Table 6.1. Schematic diagram of the proposed transmission network is shown at Figure 6.1 below.

Table 6.1: Abstract Of Economical Design Of Pipe Diameter For The Rising Mains

Clear Water Rising Main Design Sheet											
Sr. No.	Start Node	Stop Node	Length	Existing Material	Flow (MLD) 2026	Flow (MLD) 2041	Flow (MLD) 2056	Economical Dia	Existing Diameter (mm)	Additional Required Diameter	Remark
1	Nemmeli DSP	Akkarai Pumping station	22273	DI- K9	94.296	104.580	115.820	1400	1000	1000	Additional Pipe Line Required
2	Akkarai Pumping station	Thiruvanmiyur (New) WDS	9642	DI- K9	10.336	11.437	12.656	450	700	Sufficient	-
3	Akkarai Pumping station	J1	2,720	DI- K9	83.960	93.143	103.164	1300	900	1100	Additional Pipe Line Required
4	J1	J2	11,942	DI- K9	83.960	93.143	103.164	1300	800	1200	Additional Pipe Line Required
5	J2	Velachery (old) WDS	100	DI- K9	30.463	33.707	37.302	800		800	Additional Pipe Line Required
6	J2	J3	100	DI- K9	53.498	59.436	65.862	1100		1100	Additional Pipe Line Required
7	J3	J4	100	DI- K9	44.003	48.811	54.060	1000		1000	Additional Pipe Line Required
8	J4	J5	818	DI- K9	64.130	71.081	78.705	1200	750	1000	Additional Pipe Line Required
9	J5	Velachery (New) WDS	920	DI- K9	6.954	7.695	8.516	400	400	Sufficient	-
10	J5	J6	1215	DI- K9	57.176	63.386	70.189	1100	750	800	Additional Pipe Line Required

Clear Water Rising Main Design Sheet											
Sr. No.	Start Node	Stop Node	Length	Existing Material	Flow (MLD) 2026	Flow (MLD) 2041	Flow (MLD) 2056	Economical Dia	Existing Diameter (mm)	Additional Required Diameter	Remark
11	J3	Pallipatu WDS	5,797	DI- K9	19.830	22.062	24.459	700	500	500	Additional Pipe Line Required
12	J6	J7	3698	DI- K9	26.713	29.679	32.888	750	1000	Sufficient	-
13	J7	Pallipatu WDS	800	DI- K9	19.830	22.062	24.459	700	1000	Sufficient	-
14	J7	MRC Nagar Nandnam	6,204	DI- K9	6.883	7.617	8.429	400	500	Sufficient	-
Total			**66329 mtrs**								

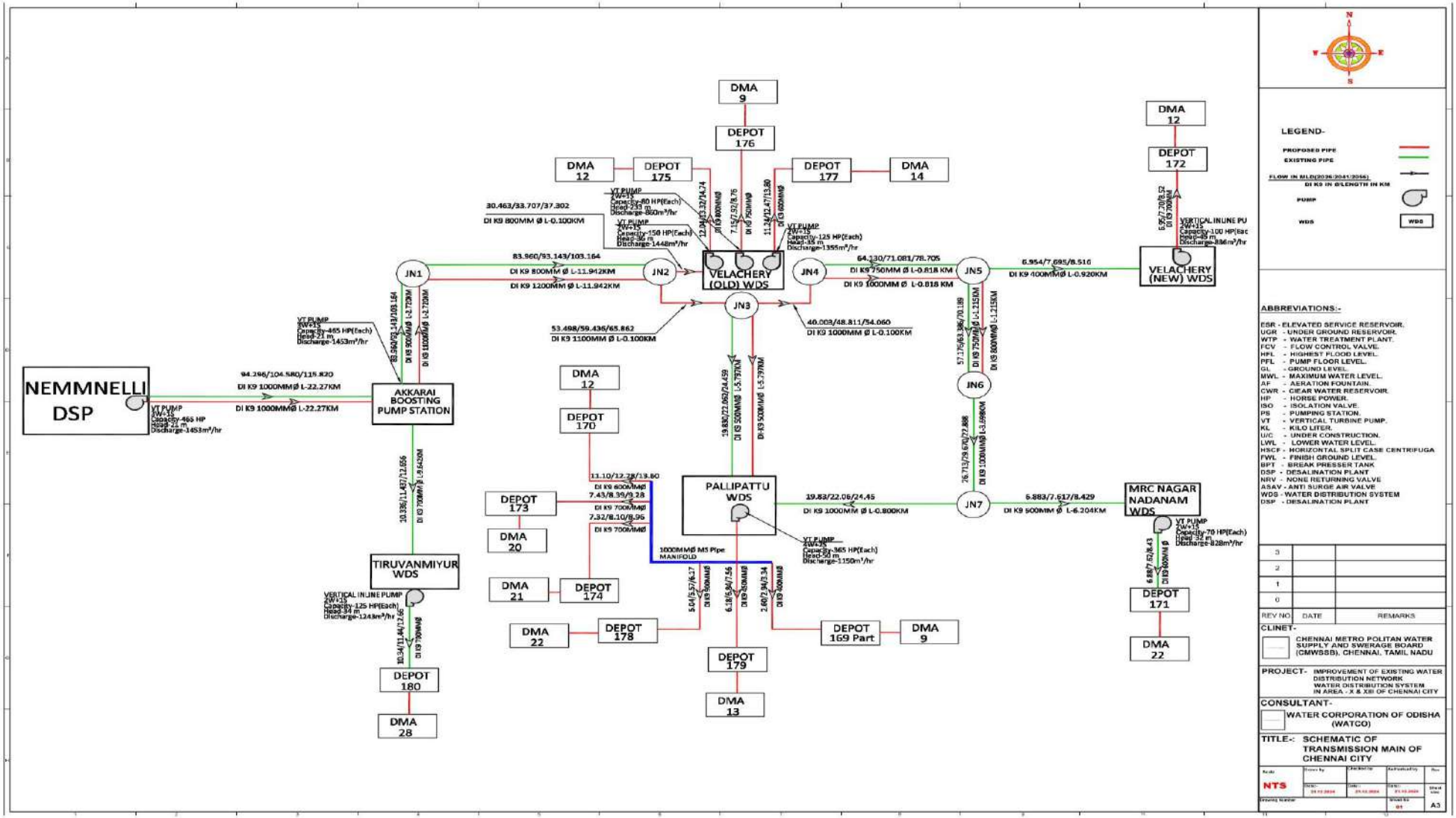


Figure-6.1: Schematic Diagram of proposed transmission Network

6.4. Design of Storage system

The project area covers two WDS for supply of water to seven operational zones, six under Pallipatu WDS i.e. OZ-169(P), OZ-170, OZ-173, OZ-174, OZ-178, OZ-179 & one operational zone under Thiruvanmiyur WDS i.e. OZ-180. The existing and required storage capacity of WDS are given in below table 6.2. The required capacity is estimated as per CPHEEO manual Guidelines.

Table 6.2: Adequacy Check for Storage System

Storage capacity Details						
Sl. No.	WDS Name	Present Storage	Required Storage Capacity @ 33% in MLD	Required Storage Capacity as per mass balancing MLD	Storage Capacity Deficit / Excess	
		Capacity in MLD, 2023	2041 (Intermediate Year)	2041 (Intermediate Year)	As per CPHEEO (33%)	As per Mass Balancing
	A	D	F	G	H=D-F	I=D-G
1	Pallipatu WDS	17	14.56	11.925	2.44	5.075
2	Thiruvanmiyur (New) WDS	3	3.77	3.1	-0.77	-0.1

Table 6.2.1: Storage Capacity Analysis

Storage capacity Details				
Sl. No.	**WDS Name**	**Present Storage**	**Storage Capacity Deficit / Excess**	
		Capacity in ML, 2023	**As per 33%**	**As per Mass Balancing**
1	**Pallipatu WDS**	**17**	**14.35%**	**29.85%**
2	**Thiruvanmiyur (New) WDS**	**3**	**-25.67%**	**-3.33%**

The existing storage reservoir capacity of Pallipatu WDS is 17 ML and the requirement of reservoir for the intermediate design year is 11.92 ML and as per CPHHEO guideline, storage reservoir capacity is in excess by 14.35% & as per Mass balancing storage reservoir capacity is in excess by 29.85%

The existing storage reservoir capacity of Thiruvanmiyur WDS is 3 ML and the requirement of reservoir for the intermediate design year is 3.77 ML & as per CPHHEO guideline, reservoir storage capacity is meagre by 25.67% & as per Mass balancing, reservoir storage capacity is meagre by 3.33%. As the deficit in Mass balancing exercise, it is coming 3.33%, considering space constraints no additional is proposed. Details are presented in Table 6.2 above.

6.5. Pumping System Design Details

Pumps are designed to provide water from WDS to the operational zones. Pumping system/arrangement consists of six pumps (4+2) i.e four working and two standby pumps for Pallipatu WDS. The distribution branch lines will be provided for each operational zone. Similarly, Pumps designed for Thiruvanmyur WDS will consist of three pumps (2+1) i.e.; two working and one stand by.

Details of pumping system for water supply to each Depot is given in Table 6.3 below.

Table 6.3: Details of Pump sets

Pump Details															
S. No.	**WDS Name**	**Name Of**	**Peak Demand**	**Critical Length WDN**	**Elevation At WDS**	**Highest elevation of WDN**	**Diameter @ Outlet**	**Existing Pump Details**				**Required Pump Details**			
		Depot	2041 (Intermediate Year)	M	M	M	mm	Discharge (m3/hr)	Head (M)	Type Of Pump	No. (W+S)	Discharge (m3/hr)	Head	Total HP	No. (W+S)
	A	B	C												
1	Pallipatu WDS	170	30.71	3500.00	5.85	8.30	0.60	1578	32.5	VT	4 +2	4,596.0	50	1460	4+2
		173	20.97	4550.00	5.85	8.45	0.50								
		174	20.26	5430.00	5.85	8.90	0.70								
		178	13.94	3650.00	5.85	10.03	0.90								
		179	17.09	5200.00	5.85	8.70	0.45								
		169 Part	7.35	2350.00	5.85	8.20	0.35								
4	Thiruvanmiyur (New) WDS	180	28.59	4650.00	5.83	6.41	0.70	391	32	HSC	4 +2	1243	34	250	2+1

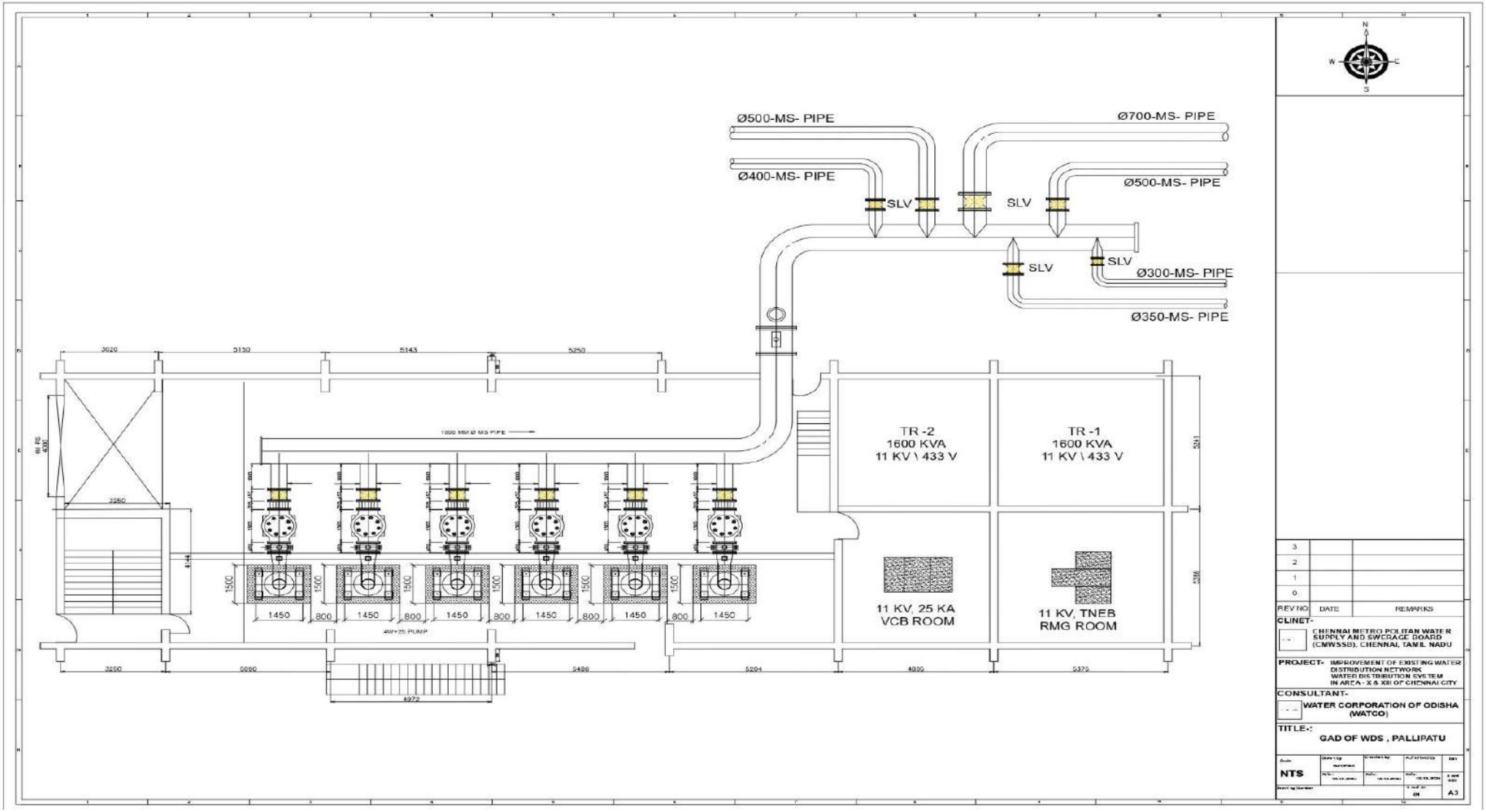


Figure 2 General Arrangement of Pumps in Pallipatu WDS

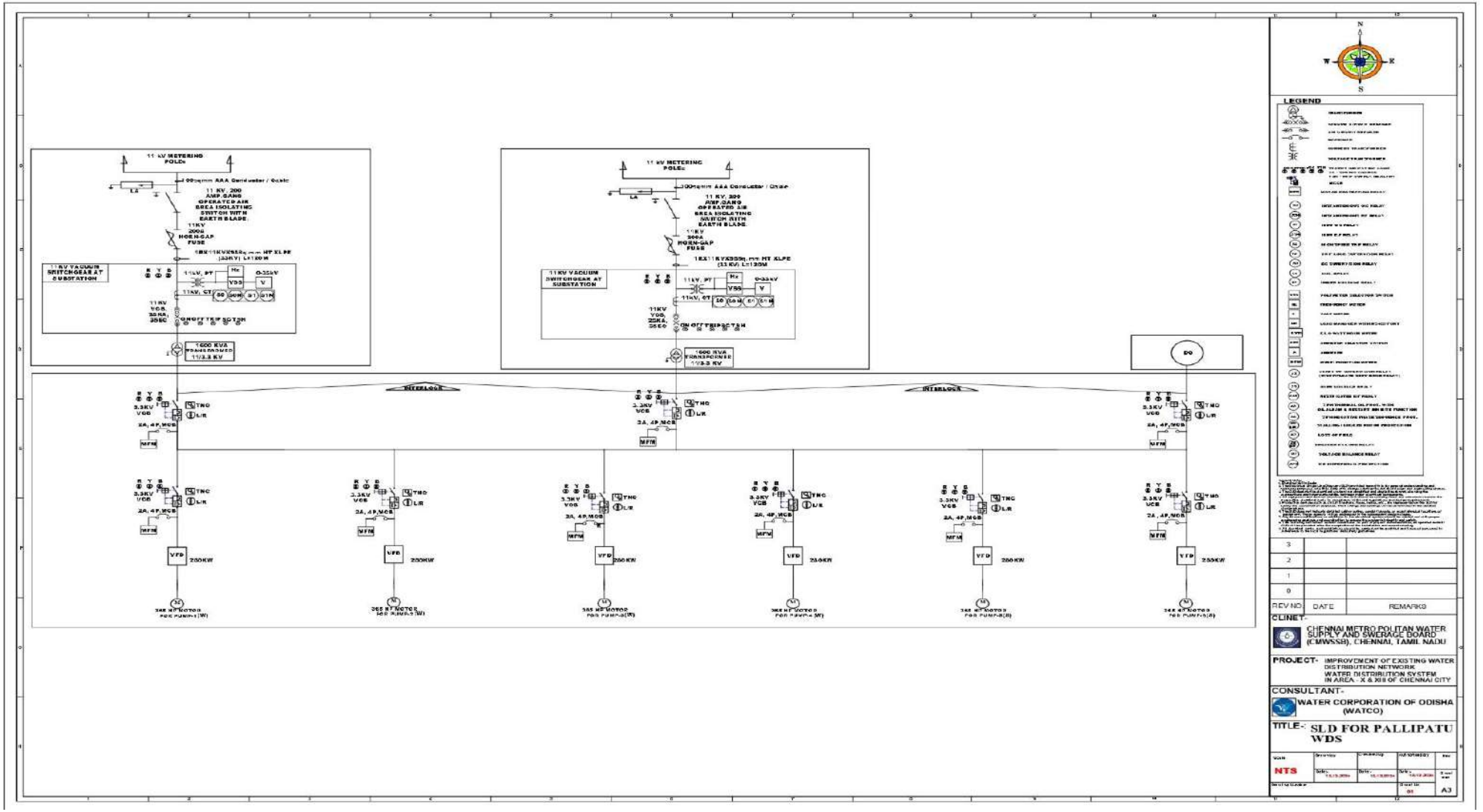


Figure 3 Single Line Diagram for Power Supply of Pumps at Pallipatu WDS

6.6. Defining Operational Zones

There are in total of seven operational zones covered in this DPR, out of this, six operational zones are supplied by Pallipatu WDS namely OZ-169(P), OZ-170, OZ-173, OZ-174, OZ-178, OZ-179 & one operational zone is supplied by Thiruvanmiyur WDS namely OZ-180. Zone boundaries are finalized accordingly and given in Table 6.4.

The above zone boundaries have been frozen based on the following considerations to achieve minimum pressure of 17 m at peak hours of the day. The following considerations have been made to finalize the operational zone boundary.

- Divide the area into zones based on elevation to ensure adequate pressure in high areas without causing excessive pressure in low areas.
- Storage capacity of existing WDS.
- Feasibility of crossing canals and rivers.
- Ensure the zoning allows for flexibility to accommodate increased demand or system changes
- Residential, commercial, and industrial areas may have different water usage patterns and might benefit from separate zones.
- Separate the residential and industrial areas into different zones due to their differing water usage patterns.
- Use natural boundaries like rivers and highways, or major roads to define zone edges.

Table 6.4: Proposed Operational Zones

Detail of Proposed Operational Zones			
Sl. No.	**Name of the WDS**	**No. OF Operational Zones, Proposed**	**Operational Zone Name**
1	**Pallipatu WDS**	6	OZ-169(P), OZ-170, OZ-173, OZ-174, OZ-178 & OZ-179
2	**Thiruvanmiyur (New) WDS**	1	OZ-180

6.7. DMA Demarcation and Hydraulic Modelling for Distribution System:

A District Metered Area (DMA) is a subzone within the operational zone of a water distribution network that can be hydraulically isolated and for which water consumption is measured using water meters. Bulk flowmeters are installed at the entry points of the DMAs, and all user connections are properly metered for recording the consumption. The main purpose of DMA is to identify and priorities leak identification and repair programme by computing NRW values. Another important purpose of DMA is to rationally distribute the water according to the needs with equal pressure. A typical hydraulically discrete single DMA is shown in Figure 6.2.

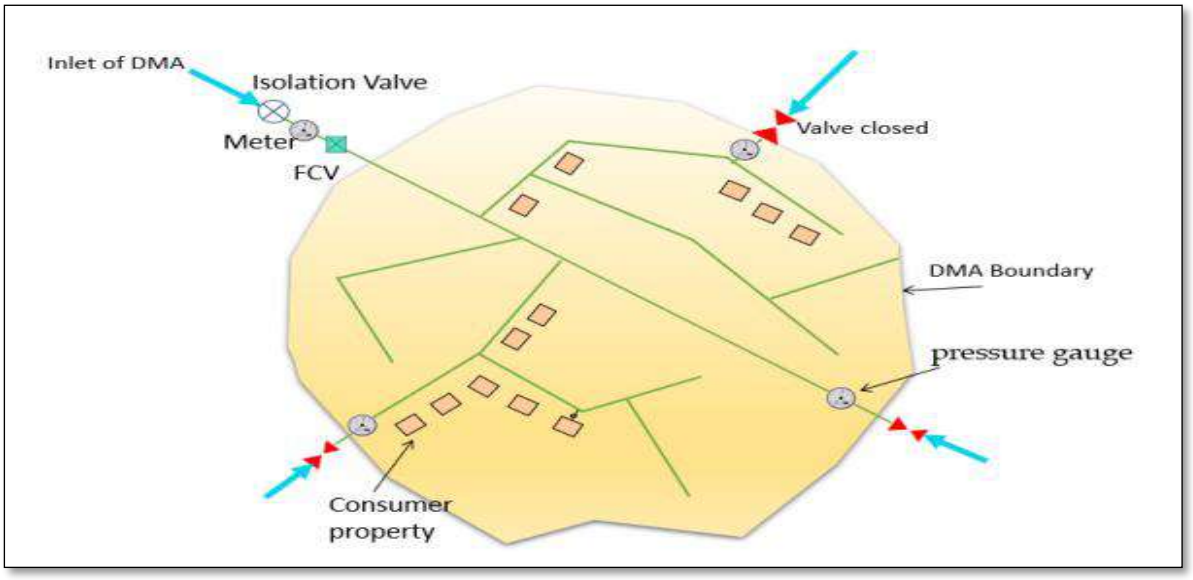


Figure 6.2: Typical hydraulically discrete single DMA

Each Operational Zone is divided into number of DMAs, considering easiness of operation, control & monitoring of DMAs with number of house connection between 250-1000. Each DMA can be isolated during breakdown without affecting the water supply of other areas. 97 DMAs have been proposed under Pallipatu WDS and 28 DMAs under Thiruvanmiyur (New) WDS as presented in Table-6.5 below. And numbers of households per DMA is presented in table 6.5A below.

Table 6.5: Proposed DMAs under WDS

Detail of Proposed No. of DMAs		
Sl. No.	**Name of the WDS**	**No. OF DMAs, Proposed**
1	**Pallipatu WDS**	97
2	Thiruvanmiyur (New) **WDS**	28
	Total	**125**

Table 6.5A: Proposed DMAs wise household

DMA wise House Hold							
OZ/Depot	**169 (P)**	**170**	**173**	**174**	**178**	**179**	**180**
	HH	**HH**	**HH**	**HH**	**HH**	**HH**	**HH**
DMA 1	246	249	168	149	230	910	655
DMA 2	399	337	559	930	600	846	639
DMA 3	1871	437	238	236	395	452	462
DMA 4	491	910	1295	653	148	965	660
DMA 5	102	639	771	102	542	838	466
DMA 6	114	756	386	141	103	808	764
DMA 7	1422	714	468	190	109	1276	400

DMA wise House Hold							
OZ/Depot	**169 (P)**	**170**	**173**	**174**	**178**	**179**	**180**
	HH	**HH**	**HH**	**HH**	**HH**	**HH**	**HH**
DMA 8	458	1436	259	151	390	369	409
DMA 9	398	783	489	266	386	1174	462
DMA 10		350	361	559	348	651	337
DMA 11		300	449	695	159	259	634
DMA 12		343	1104	552	361	273	572
DMA 13			280	317	557	186	230
DMA 14			690	591	198		382
DMA 15			425	682	179		436
DMA 16			342	791	277		662
DMA 17			1215	853	289		664
DMA 18			1156	835	112		743
DMA 19			1520	856	454		831
DMA 20			735	826	355		490
DMA 21				473	189		703
DMA 22					153		581
DMA 23							591
DMA 24							624
DMA 25							593
DMA 26							247
DMA 27							326
DMA 28							639
Total	**5501**	**7254**	**12910**	**10848**	**6534**	**9007**	**14563**

A model of DMA formatted is modeled below in figure 6.2A

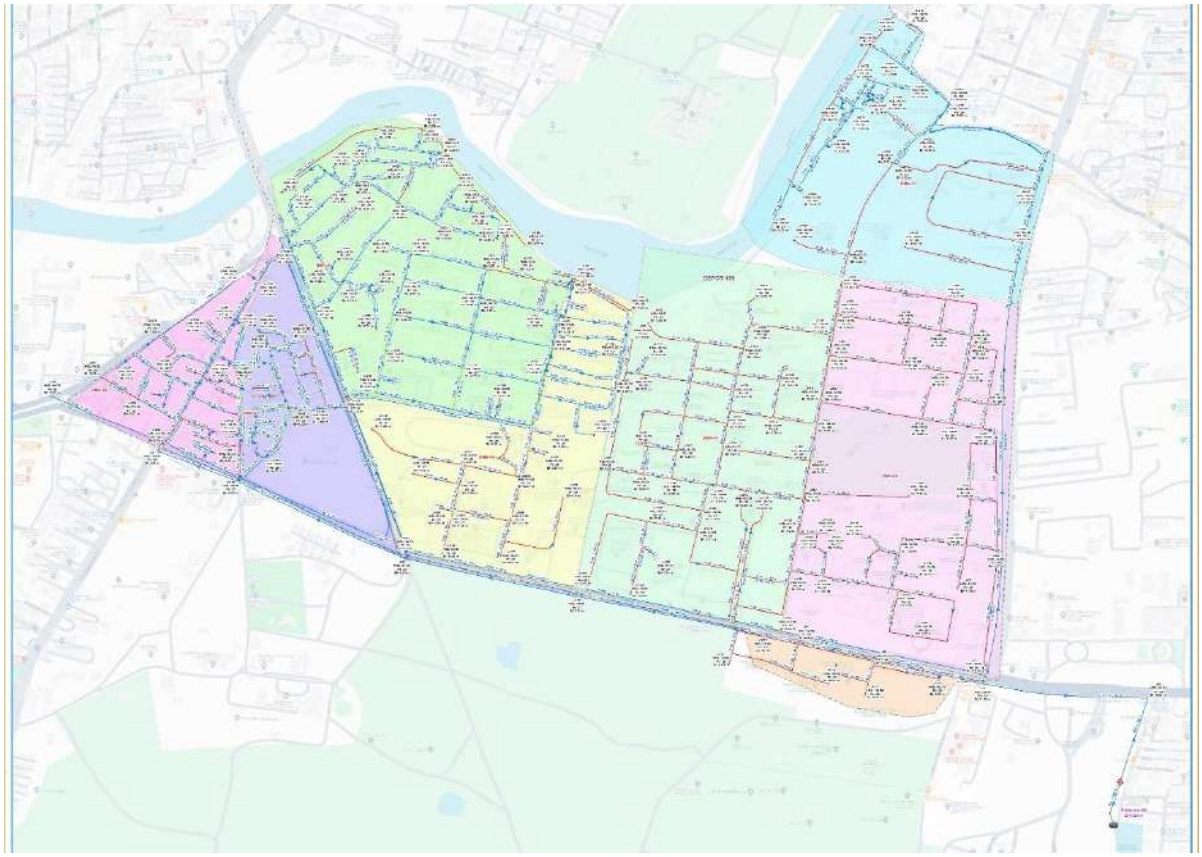


Figure 6.2A: DMA Model

6.8. Design of Distribution System

Hydraulic modelling has been done after optimization of distribution system considering velocity of flow, head loss and verification of residual heads at ferrule points of min 17mt. The network is analysed taking into consideration the design standards, design manuals and field practice. The existing distribution network is modelled considering that utilization of existing system by optimization and adding new pipes & other required components to provide adequate water supply to the Operational area. In the proposed network, provision have been made for pumps with VFD, flow control valves, pressure regulating valves to maintain pressure in the distribution system, regulating flow of water for equitable distribution of water, and for isolation purpose during repair and maintenance. Depending of water supply demand of each Operational zone, water reservoir capacities has been worked out and cross verified with available storage capacity.

Following assumptions are made while carrying out hydraulic model:

- The existing storage capacity of Pallipatu WDS & Thiruvanmiyur WDS of 17 ML & 3 ML respectively, with continuous pumping to the distribution system is used as supply Unit.
- Maximum utilization of existing network is considered.
- Minimum pressure considered is of 17m at ferule point of consumer connection.
- Roughness co-efficient C value for new pipe is 130 and 100 for existing pipe (Old).

- Minimum 100 mm dia DI K7 is considered.
- Minimum velocity at peak flow is 0.6 m/s except dead end pipes
- Maximum head loss of 5 m per km

6.8.1. Peak Factor considered in the design

As per CPHEOO Manual, for water distribution system for 24x7 water supply, the design peak factor shall be 2.5. The proposed network is modelled for continuous water supply and the consumer consumption pattern considered is presented in figure-6.3 and Table 6.6 below.

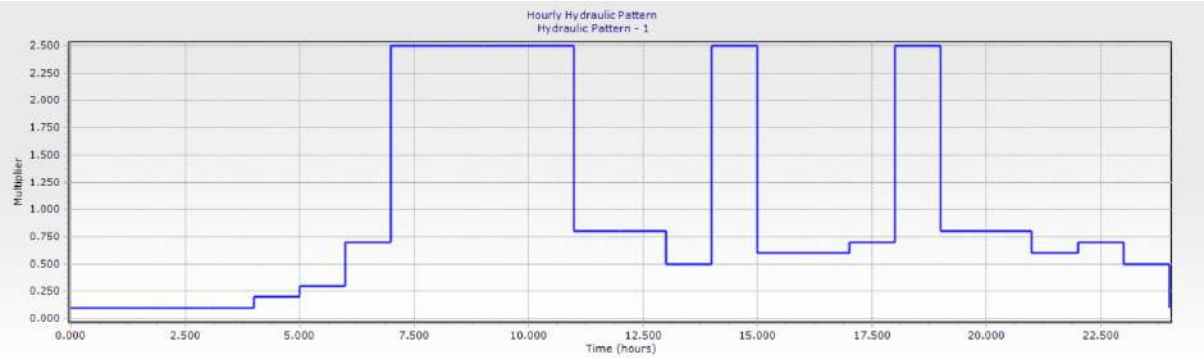


Figure 6.3: Hourly Hydraulic Pattern

Table 6.6: Hourly Hydraulic Pattern

Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Draw off	0.10	0.10	0.10	0.20	0.30	0.70	2.50	2.50	2.50	2.50	0.80	0.80	0.50	2.50	0.60	0.60	0.70	2.50	0.80	0.80	0.60	0.70	0.50	0.10

6.8.2. Simulated Hydraulic Model

From present intermittent water supply, the network will be upgraded to 24 x 7, continuous drink from tap quality water supply. On an average,150 LPCD of water shall be supplied to the consumers. In the proposed upgraded distribution network, the operational zones will have full coverage containing all consumers. Designed population of operational zone is distributed on pipeline length as per house level survey data and the design population data is adopted to design the distribution network. Open Flows Water GEMs, a Bentley ™ proprietary software for hydraulic modelling was used for the Project.

The simulated hydraulic model results in the form of graph with relation of pressure and demand for 24 hours is presented below. The graph of simulated model at Figure 6.7 shows variation of demand and pressure on hourly basis.

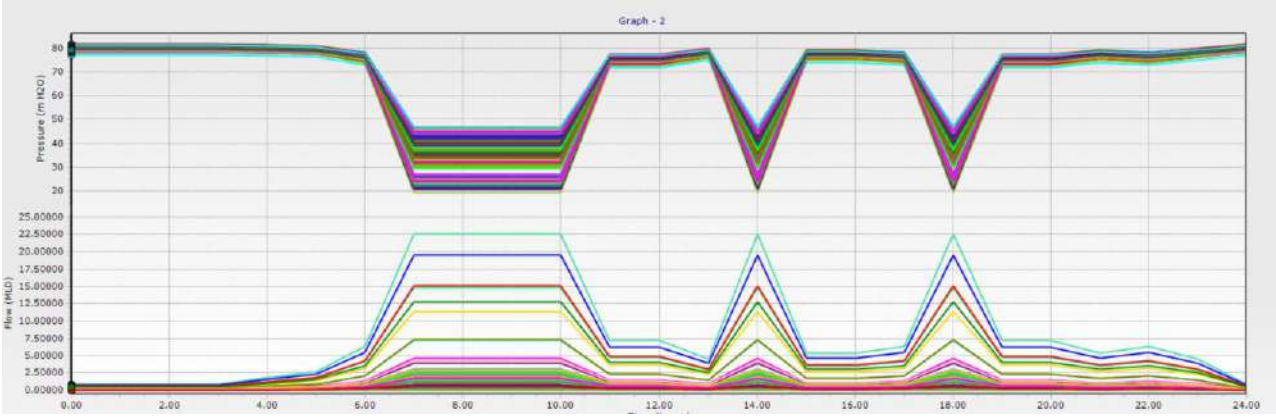


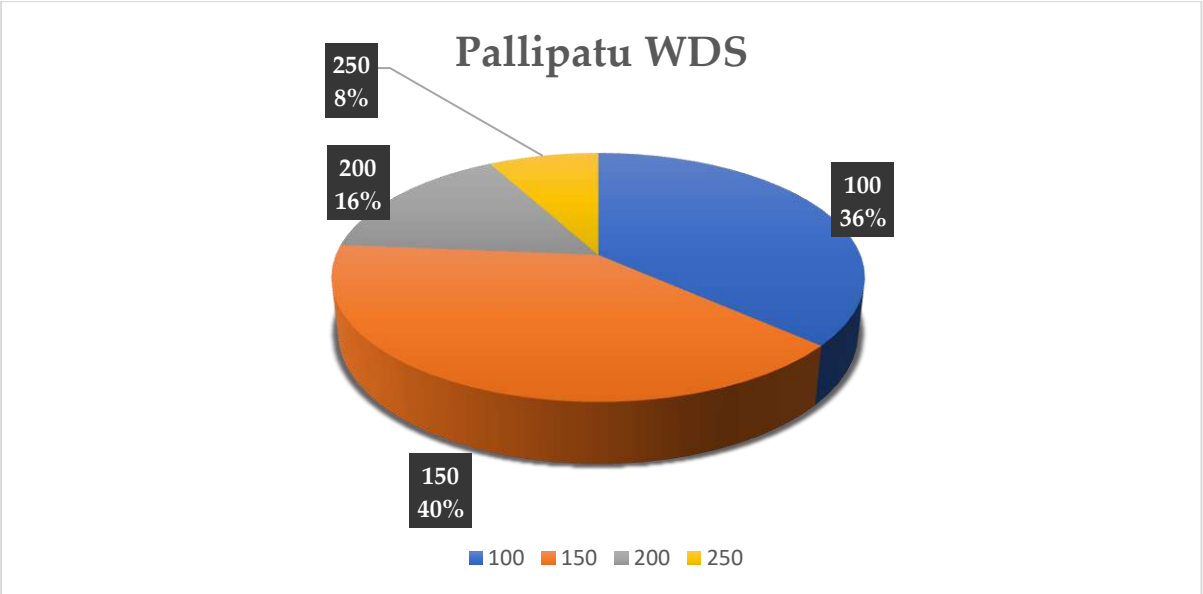
Figure 6.4: Graph showing Simulated Hydraulic Model

6.8.3. Summary of Pipeline Diameter and Length as per design

Based on the hydraulic modelling, operational zone wise network details showing existing pipeline to be retained, replaced & newly proposed pipeline is presented in Table-6.7 & 6.8 for Pallipatu & Thiruvanmiyur WDS operational zones respectively.

Referring table 6.7, for Pallipatu WDS Operational Zones, it is revealed that out of 246 KM existing pipeline network, 20 KM (8% of total length of pipeline) needs to be replaced due to poor condition & inadequate size of diameter. Out of total replacement pipeline length for lower diameter pipeline 100 mm & 150mm stands at 37% & 40% respectively whare as percentage of replacement pipeline for 200mm & 250mm is 16% and 7% respectively. Hence replace of lower diameter pipeline consist about 77% of the total replacement of pipeline. Pictorial Pie Chart is presented below for better appreciation.

Replaced 24X7 Water Supply from Pallipatu WDS distribution Network diameter wise percentage Pie Chart



Replaced 24X7 Water Supply from Pallipatu WDS distribution Network diameter wise percentage Pie Chart

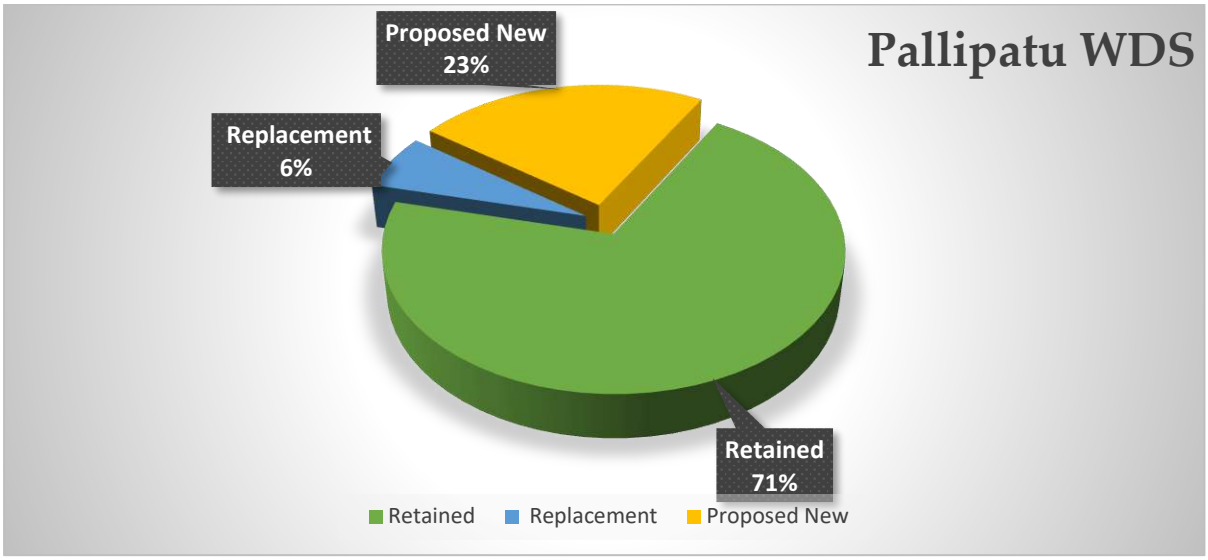


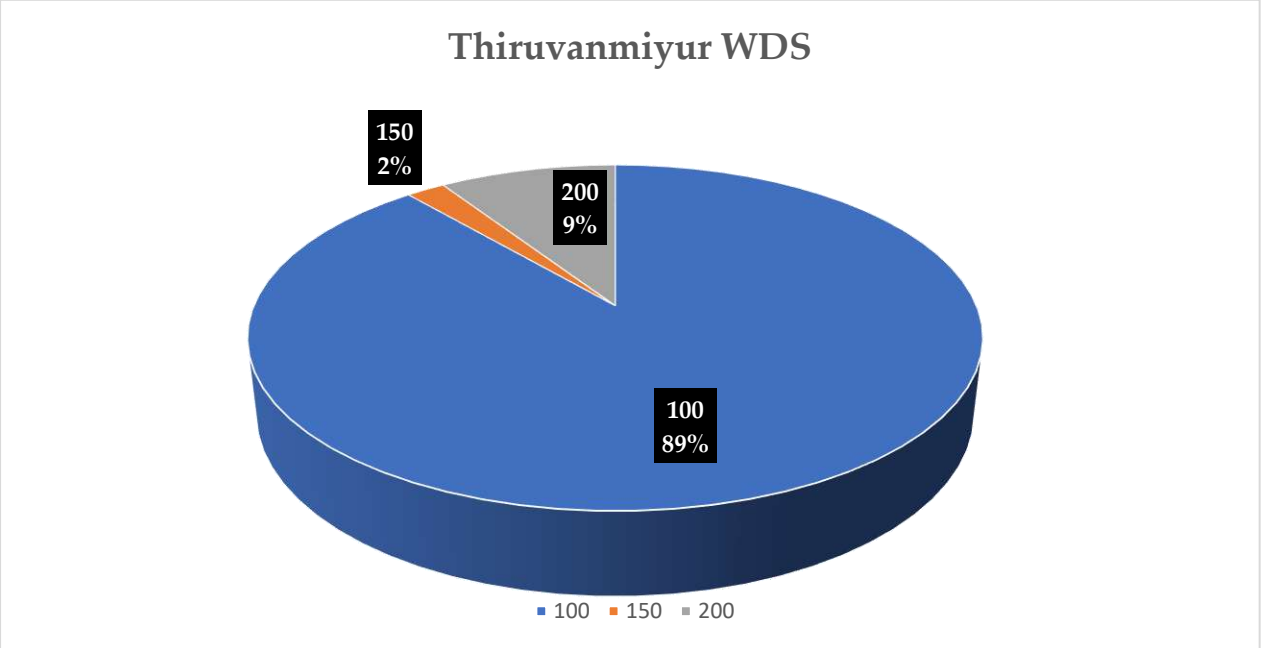
Table 6.7: Designed Distribution Pipeline details

Designed Distribution Pipe Details, Supply from Pallipatu WDS					
Diameter(mm)	**Retained**	**Proposed Replacement**	**Proposed New**	**Total (In Proposal)**	**Grand Total**
100	134784	7413	50964	58377	193161
110	0	0	0	0	0
125	0	0	0	0	0
150	47392	8074	11043	19117	66509
200	8272	3185	2724	5909	14181
250	2599	1611	2279	3890	6489
300	5486	0	579	579	6065
350	4114	0	50	50	4164
400	2878	0	608	608	3486
450	9824	0	3560	3560	13384
500	2854	0	1230	1230	4084
600	5759	0	1718	1718	7477
700	617	0	0	0	617
750	0	0	0	0	0
800	723	0	0	0	723

Designed Distribution Pipe Details, Supply from Pallipatu WDS					
Diameter(mm)	**Retained**	**Proposed Replacement**	**Proposed New**	**Total (In Proposal)**	**Grand Total**
900	811	0	0	0	811
1000	103	0	0	0	103
Grand Total	226216	20283	74755	95038	321254

Referring table 6.8 for Thiruvanmiyur WDS Operational Zones, it is revealed that, out of 49.8 KM existing pipeline network, 12.7 KM (23% of total length of pipeline) needs to be replaced due to poor condition & inadequate size of diameter. Out of total replacement pipeline length for lower diameter pipeline 100 mm & 150mm stands at 89% & 2% respectively whare as percentage of replacement pipeline for 200mm is 9%. Hence replace of lower diameter pipeline consist about 91% of the total replacement of pipeline. Pictorial pie chart is presented below for better appreciation.

Replaced 24X7 Water Supply from Thiruvanmiyur WDS distribution Network diameter wise percentage Pie Chart



Pie Chart based on Retained, Replace and Proposed

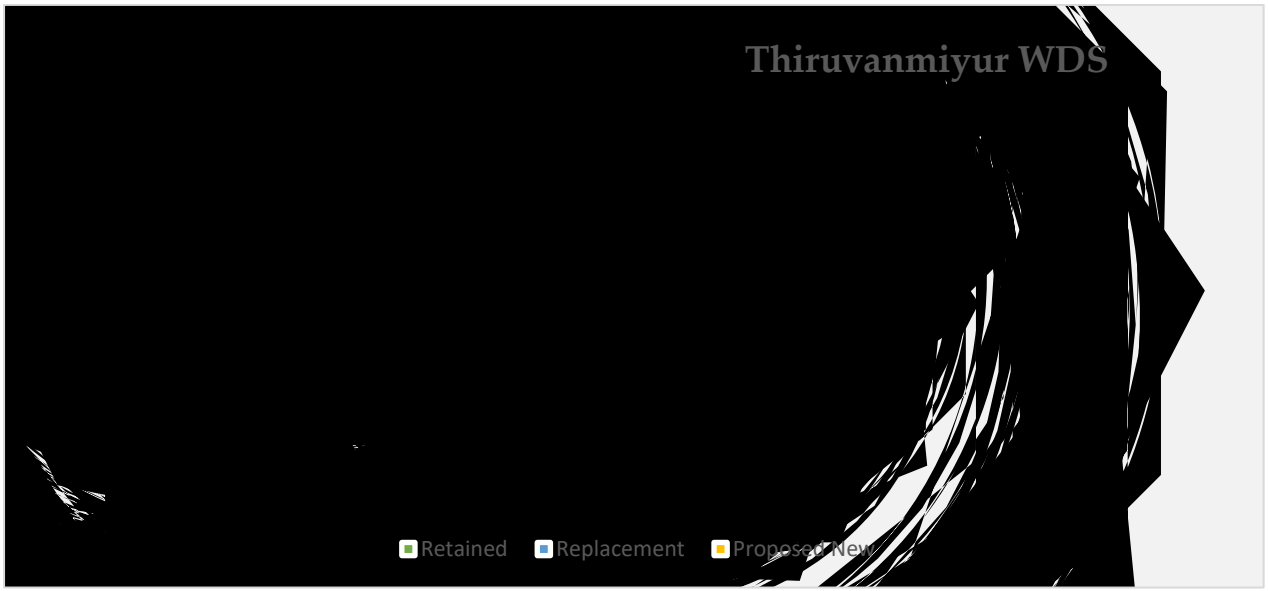


Table 6.8: Designed Distribution Pipe Details, Supply from Thiruvanmiyur WDS

Diameter(mm)	Retained	Proposed Replacement	Proposed New	Total (In Proposal)	Grand Total
100	21351	11312	1000	12312	33663
110	0	0	0	0	0
125	0	0	0	0	0
150	6011	260	2611	2871	8882
200	3734	1183	464	1647	5381
250	1740	0	209	209	1949
300	3507	0	140	140	3647
350	261	0	987	987	1248
400	0	0	0	0	0
450	361	0	266	266	627
500	0	0	0	0	0
600	26	0	230	230	256
700	54	0	0	0	54
750	0	0	0	0	0
800	0	0	0	0	0
900	0	0	0	0	0
1000					0

Diameter(mm)	Retained	Proposed Replacement	Proposed New	Total (In Proposal)	Grand Total
Grand Total	37045	12755	5907	18662	55707

Operation Zone wise detailed pipe abstracts & Hydraulic Model Simulation Results (Pipe and Junction Tables) are attached in Appendix 5.

6.9. House Service Connection:

House service connection is most vulnerable point of leakage. In order to achieve leak proof house connections, all house connections are proposed with saddle and compression fittings. At the Consumer end, AMR flow meter shall be installed, concealed and enclosed in box, with an isolation valve.

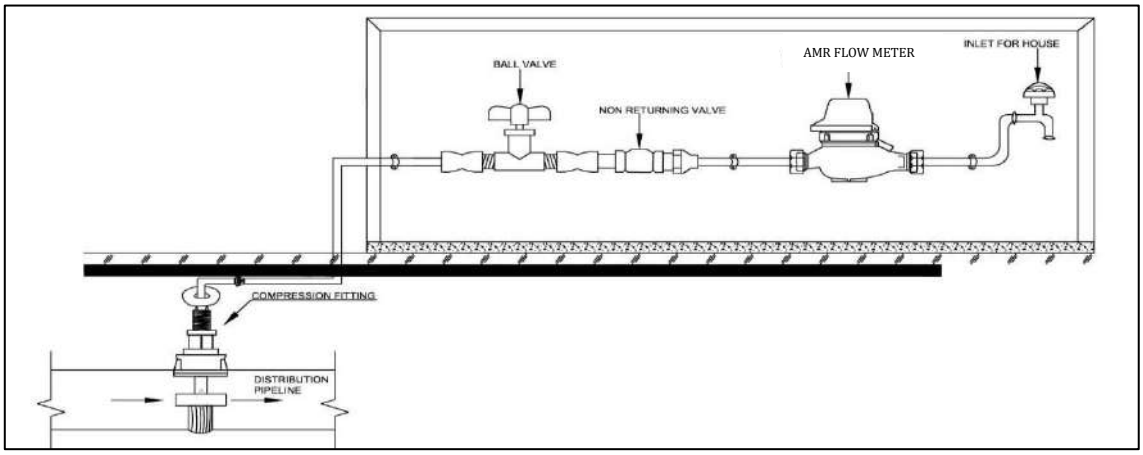


Figure 6.5: Sample House Service Connection Details

Proposed House Service Connection consists of following,

- Compression Fitting
- Pipe Material used: - MDPE & UPVC
- Ball Valve
- Non-Returning Valve

6.10.Automation Design Philosophy and Overview

Pumping is made from DWS to the distribution network system of each depot. The pumps will be operated through VFD controller for Controlling and regulating the pressure in the water supply network.

Each Depot is provided with a flow meter in outlet, with a motor operated flow control valve and pressure transmitter. Control panel of the PLC / SCADA system is installed in pumping station to control the pumps with respect to field demand inputs received from DMA & Lane/Sub-Lane. The SCADA generates the data, which sends the data to command centre through cloud service. This data is accessed by the digital twin software on cloud.

The identified Key locations at the entry of each DMA and the strategic spots such as highest and lowest ground elevations and farthest node in the operational zones. PLC

panel will provide localized communication through OFC between the Pumping station and sub-DMA panel. The control and monitoring elements should further be enabled to communicate the status of their individual locations to an IoT based centralized monitoring and control centre. The power will fetch from the electricity service provider with DG as power back-up.

The hydraulic design for each Lane location is fixed to control through PLC/RTU panel with localized communication through OFC between the DMA and RTU panel of Lane. The control and monitoring elements should further be enabled to communicate the status of their individual locations through wireless network to command centre. The power will fetch from the service provider with DG as power back-up.

Each defined Sub-Lane is controlled through RTU (Remote Terminal unit) based control panels with accessories and power supply from Lane panel with battery backup shall be installed along the Street. The RTU panel are transmit the data through wireless network to Data centre.

The AMI enabled or AMR Water meters will be installed near the property boundary of domestic consumers. The add on component with sim card & battery has to be installed within the life span (5 years) of water meter. The AMR meters are of three types, AMR, Walk-by AMR and GPRS AMR. Meter Data Acquisition System is to read meters through Android based application. The communication between Meter Data Acquisition System and field data collection device or any gateway should be through cellular network.

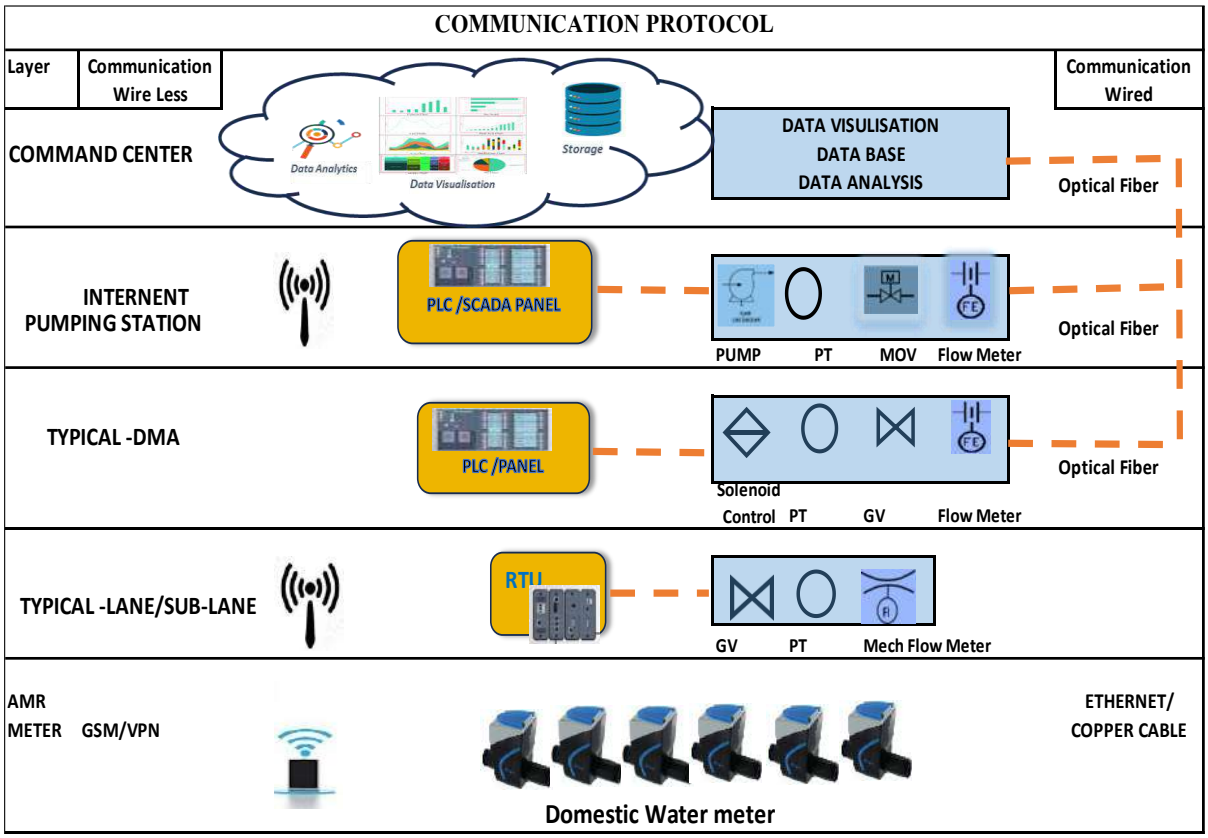


Figure 6.6: Typical System Architect

Component wise details are described in Following Paragraph:

a) Command Centre

Comprehensive data on flow & pressure of water in feeder and distribution network will allow us to control and regulate the water Supply system. This will provide a fair idea about the water demand area wise inside the city. It also helps to monitor real-time values of concentration of residual chlorine in any pipe at any point of time. 100% Consumer metering and telescopic tariff based on volumetric measurement curbs wastage of water as excess and unnecessary consumption becomes costly for consumer. Thus, demand management which reduces NRW. The redressal of complaints is monitored online for compliance of complaint.

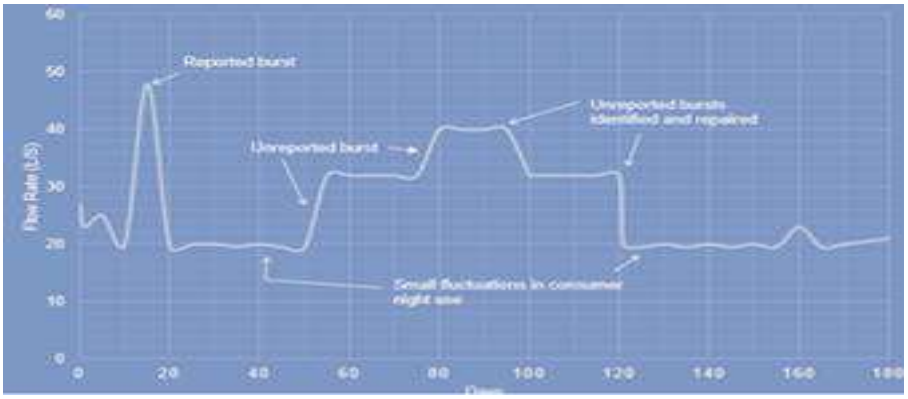


Figure 6.6: Typical System Architect

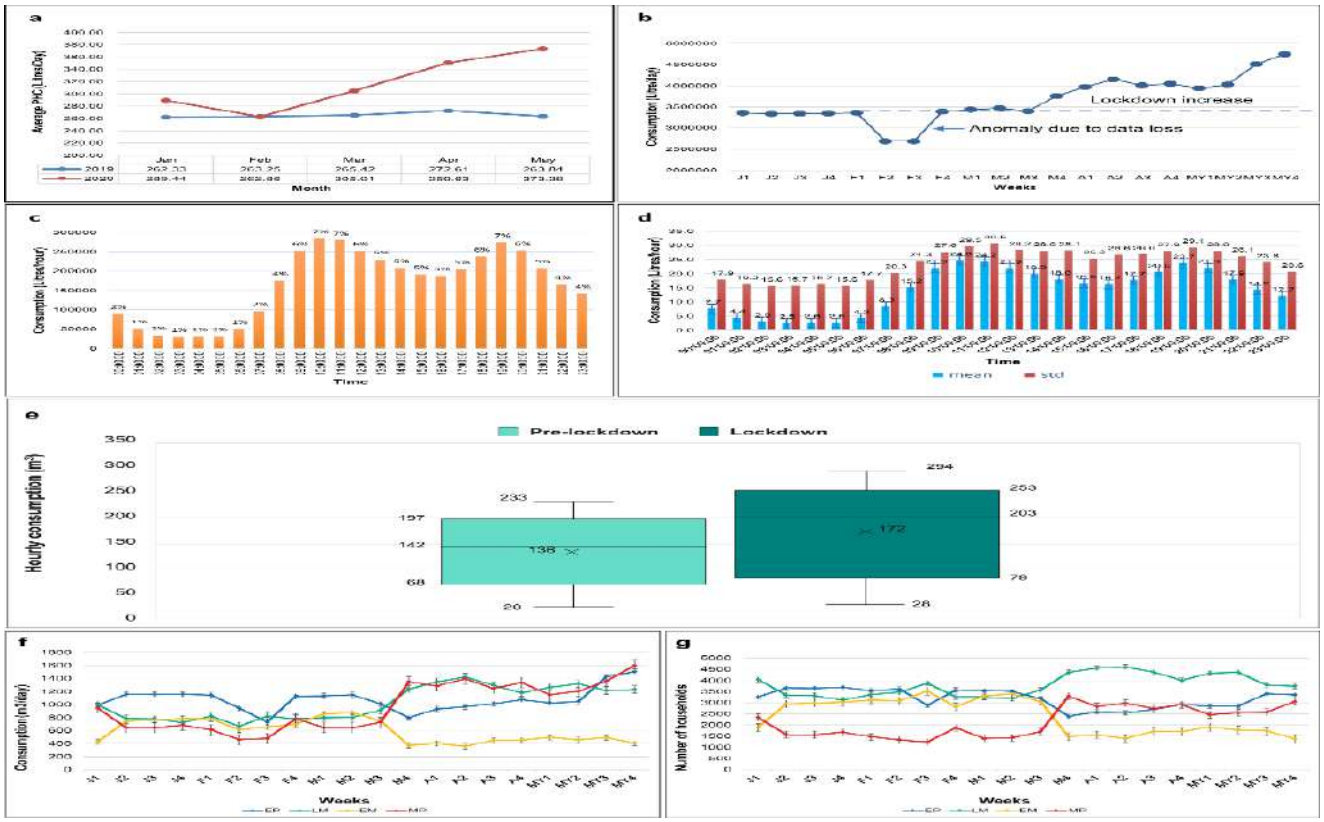


Figure 6.7: Typical data analysis of a DMA

a) Pumping Station

The Schematic sketch of water pumping systems with VFD controller pressure Transmitter, electromagnetic flowmeter, quality analysers. Control panel of the PLC/SCADA system and the electrically controls of actuators shall be installed at a suitable ground location. Supervisory control and data acquisition or SCADA is a type of process control system architecture that uses computers, networked data communications, and graphical human-machine interfaces (HMIs) to enable a high-level process supervisory management and control. Plant floor devices such as pumps, valves, and transmitters transfer real-time data to processors such as remote terminal units (RTUs) or programmable logic controllers (PLCs). That data is then disseminated to various devices within the network such as HMI terminals, servers, and computers. Images of these processes are presented to operators for various types of interaction.

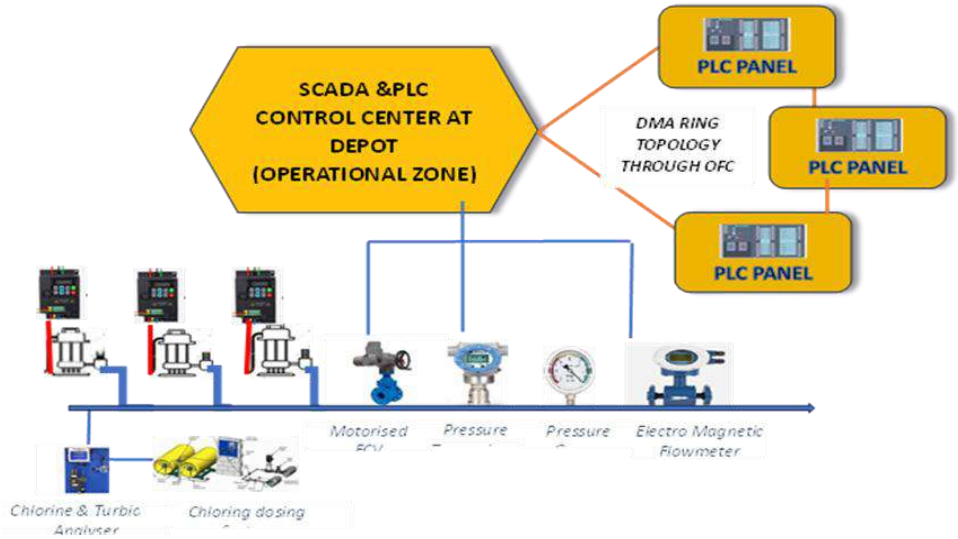


Figure 6.8: Typical Instrument of Pumping Station

b) DMA

A sketch is shown for PLC panel of DMA with communication through OFC between the sub-DMA panel. The control and monitoring elements should further be enabled to communicate the status of their individual locations to an IoT based centralized monitoring and control centre. The power will fetch from the service provider and DG as power back-up.

Figure 6.9: Typical Arrangement of Equipment of At DMA

Equipment for Each DMA

Figure 6.10: Equipment of At DMA

c) Lane/Sub-Lane

The typical drawing for Sub-DMA with communication through OFC between the RTU panel of Lane. The control and monitoring elements should further be enabled to communicate the status of their individual locations to an IoT based centralized monitoring and control center. The power will fetch from the service provider with DG as power back-up.

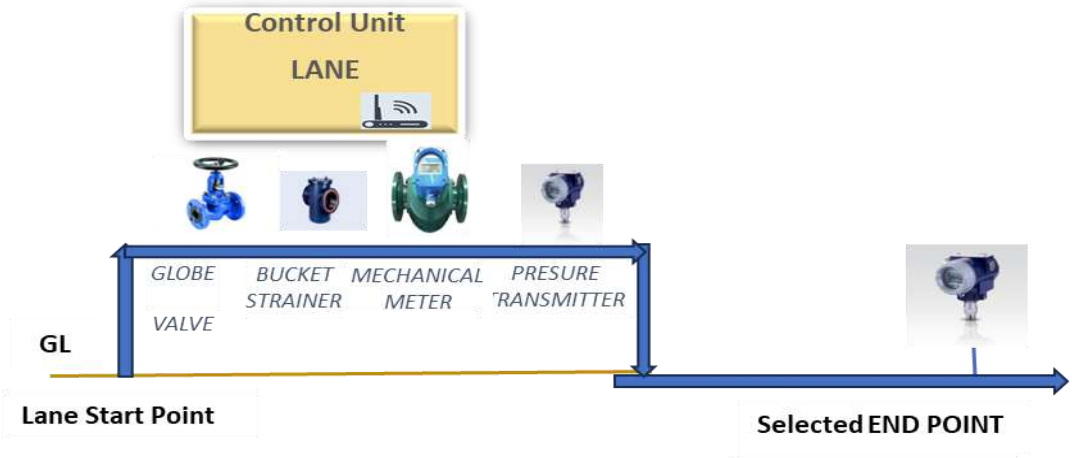


Figure 6.11: Typical Arrangement of Equipment of At Lane-Sub Lane

Equipment for Each Lane

Mechanical Meter with Pulse Output (4-20mA)

Bucket Strainer (micron 40-60)

Globe Valve

Pressure Transmitter (0-4kg)

Figure 6.12: Equipment of At Lane-Sub Lane

6.10.1. Smart Water Management Operational Philosophy

Smart water management systems capitalise on the application of technology to improve water allocation, support efficient water usage and drive the overall sustainable management of water resources. These systems collect, simulate and process data to optimise decision-making processes. A smart pipe is designed as a module unit with capacity for the installation of sensors allowing for the real-time monitoring and automatic detection of flow, pressure, leaks and water quality as well as without changing the operating conditions of the hydraulic circuit. An actuator is hardware through which the analysed data from the sensors are used to perform the resultant action of the water system.

The main advantages are the continuous monitoring of the network without local operator intervention and with the low energy consumption of the wireless sensor.

Main benefits

- Improve water allocation
- Support efficient water usage
- Increase water security

Potential benefits

- Reducing operation costs
- Improving energy usage efficiency
- Promoting sustainable behaviour
- Enhanced data collection

Mandatory functions

Enhance the efficiency of water systems

Such as use of devices to detect water pressure, flow, etc to allow for early leakage detection, pipe damage, and other infrastructure maintenance issues. Consequently, faster execution of repairs, maintenance and general operational efficiency will minimise risks and offer investment protection.

Support easy access and fast processing of information

Such as smart metering provide access to real-time data related to water and associated energy consumption allowing opportunities to have a greater

understanding of consumption (driving behavioural change), ability to integrate consumption data into smart networks for efficiently improvements as well as support the responsibilities and capacity of water service providers.

Enhance customer experience

With greater billing accuracy, portal apps for utility customers and improved infrastructure and supply, customers are expected to experience an improvement in water delivery service.

Potential functions

Improve water quality

The use of sensors and IoT technology facilitate real-time monitoring and control of water quality. Therefore, the entry of pollutants in water systems can be easily and quickly detected and addressed before reaching customers.

Enhance environmental protection

The water savings expected with more precisive metering, monitoring and management will reduce the financial, environmental and social cost associated with water abstraction processes.

Generate new forms of governance

The large volumes of data expected with smart water networks may generate many opportunities for app developers and private citizens that change the trajectory in which water is managed.

6.10.2. Smart Water Metering through AMR & AMI

Smart Water (Electromagnetic/Ultrasonic) Metering System is proposed to reduce the challenges currently faced in the water sector. Information and communication Technologies (ICT) play a major role in Smart Water Metering System, which includes data acquisition and integration using Electromagnetic/Ultrasonic water meters, data distribution using wireless communication, data processing and storage using web-based tools.

RF based communication enables the automated meter reading functions that have been typically accomplished through manually intensive operations, including water meter readings, identifying tamper in the field, etc. AMI & AMR are both based on RF communication.

AMI is the collective term to describe the whole infrastructure from Electromagnetic/Ultrasonic Water Meter to communication network to control centre equipment and all the applications that enable the gatherings and analysis.

AMR is the data collection system where the meters are read automatically when the meter reader either walks-by or drives-by the meter installation area.

The large volumes of data expected with smart water networks may generate many opportunities for app developers and private citizens that change the trajectory in which water is managed.

6.10.2.1. Proposed Smart Water Metering System

In the proposed solution, AMI network will be designed in such a manner that multiple Gateways will cover each meter & fetch the meter data, thereby building redundancy. Each gateway will forward the received packet from the end node to the cloud-based network server via some backhaul (either Cellular, Ethernet). The intelligence and complexity are pushed to the network server, which manages the network and will filter redundant received packets, perform security checks, schedule acknowledgments through the optimal gateway, etc.

6.10.2.2. System Architecture:

Smart water metering systems incorporate AMI/AMR and other advanced systems to manage urban water supplies more effectively. These systems integrate physical infrastructure with digital technologies to create a responsive and efficient network.

The system consists of the below components:

1) Smart (Electromagnetic/Ultrasonic) water meters
2) Walk-by/Drive-by System
3) AMI Gateways
4) Meter Data Acquisition System
5) Android Apps
6) API to integrate

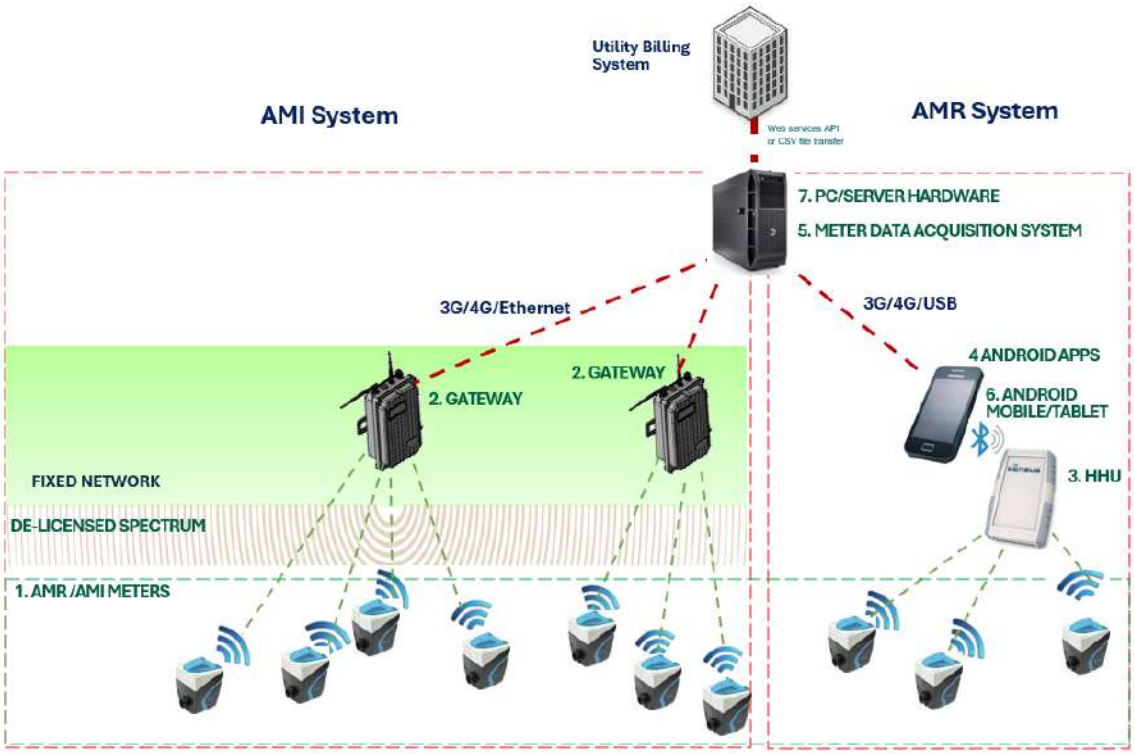


Figure 6.13: Overview of System Architecture

6.10.2.3. Smart water meters:

Electromagnetic and Ultrasonic water meters have inbuilt radio for AMI/AMR communication capability over unlicensed frequency. Installed at consumer endpoints and other strategic locations, these smart water meters serve as the backbone of the smart water metering system. They are used to track water usage, help identify leaks, and provide data log to study the consumption patterns. The meter data is encrypted & securely transmitted to the AMR & AMI system.

The meter shall be suitable for communicating over the AMR & AMI system so that the AMR can be used as a back-up for AMI, in case the meters are not read over AMI due to some unforeseen reason. There should be no need to revisit or configure the meter to switch from AMR to AMI or vice-versa.

Advantages of Electromagnetic and Ultrasonic meters:

- These meters are with no-moving-parts, no strainer required, hence require no maintenance.
- No-moving-parts found in the Electromagnetic and Ultrasonic meters also allows for these meters to be installed in virtually any orientation. This allows increased flexibility as to where the meters can be deployed, and results in less space required for meter installation.
- These Electromagnetic and Ultrasonic meters incorporate solid-state electronics and long-life batteries to support the required power consumption. Manufacturers provide assurance for the operational battery life of 15 years under standard operating conditions & the meters are with warranty for 12 years.
- The meters provide wide operating flow range Ratio (Q3/Q1) 500:1. Hence suitable for measurements of consumption at very low flow to high flow. This helps in NRW reduction.
- The accuracy of the meters is sustained for the life of the meter.
- No air measurement.
- Low pressure Loss
- U0D0 – no upstream & downstream length required
- Composite body has no scrap value hence avoids theft

Highlights of the Features of Electromagnetic/Ultrasonic water meter:

- Approvals and Certifications:
    - MID certified meters & meter manufacturing plant
    - ISO9001, ISO14001, ISO45001, ISO50001 certified meter Manufacturer
    - IP68 certified Electromagnetic/Ultrasonic water meter
    - Endurance certified meter from FCRI
    - Flowrate & Dimensions:
    - Dynamic Ratio (Q3/Q1): Minimum of 500:1

6.10.2.4. Walk-by/Drive-by AMR:

In case of data collection through the gateways is missed for some house connections, a backup data collection system is proposed with Walk-by/Drive-by AMR, which is an Automatic Meter Reading (AMR) system that uses handheld reading units to collect data from meters. The meter readers carry handheld unit with a transceiver & an android device to collect readings as they walk or drive by the meters. The meter readings can then be remotely transferred to the Control Centre over cellular (3G/4G) network.

Advantages:

- Faster & easier meter reading
- Accurate meter reading
- Faster resolution of Billing disputes

6.10.2.5. AMI System:

AMI system consists of Electromagnetic/Ultrasonic Water Meter read using Gateway communication system. This data is then sent to control centre and all the applications that enable the gatherings and analysis in near real-time automatically without any manual intervention. The objective of AMI is remote meter reading for error free data, load profiling and analysis of data.

6.10.2.6. AMI Gateways:

Gateways are typically mounted on utility poles, rooftops, or on top of water tanks. Depending on the vendor and local operating conditions, they may be configured to use alternating current (AC) electrical power or direct current (DC) solar panel cells.

Transferring information from Gateways to the AMI/AMR control facilities (referred to as backhaul) requires a wide area network (WAN). AMI vendors do not typically provide the WAN. Instead, they work with the utility to identify and use locally provided telecommunications facilities. Backhaul may be accomplished over any of several wireless communications systems, including cellular (3G/4G). Backhaul can also be provided over Ethernet.

With current water utility AMI systems, the amount of data being passed in a given time period is not high, so not much bandwidth is required.

Backhaul over commercial networks such as cellular service will generally require monthly service charges.

<u>Highlights of the Technical Features of Gateways:</u>

- Equipment Type Approved by WPC
- UV Resistant Housing
- Operating Temperature -20 °C to +70 °C

Advantages of AMI system:

- Faster & easier meter reading
- Accurate meter reading
- Faster resolution of Billing disputes
- Granular data available
- Early Alarms to identify possible tamper

6.10.2.7. Meter Data Acquisition System:

Software application in the AMI/AMR Control Centre used to acquire data from meters via communication network both the walk-by/drive-by AMR and the AMI system.

Meter Data Acquisition system must have a capability to collect and process meter reading manually (for Non AMR meters) & RF (radio frequency) in drive by/walk by mode or through any fixed network communication. Meter Data Acquisition System must have capability to read meters through Android based application. The communication between Meter Data Acquisition System and field data collection device or any gateway should be through cellular network.

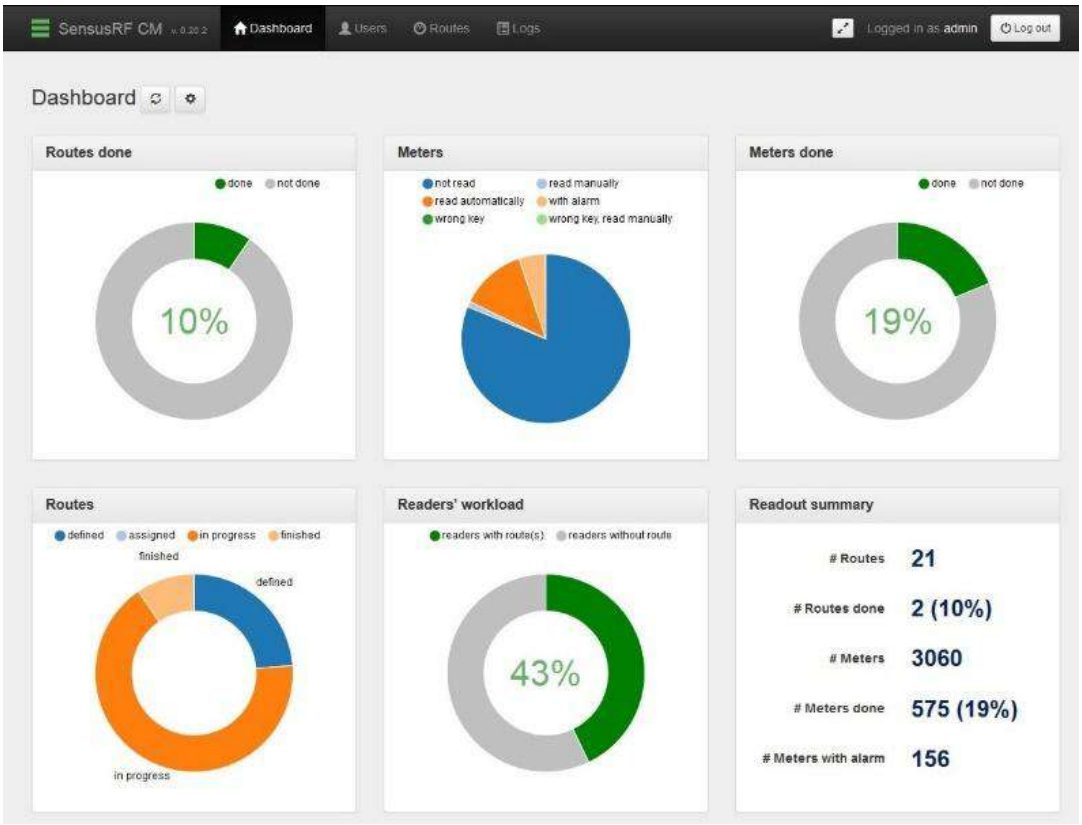


Figure: Dashboard

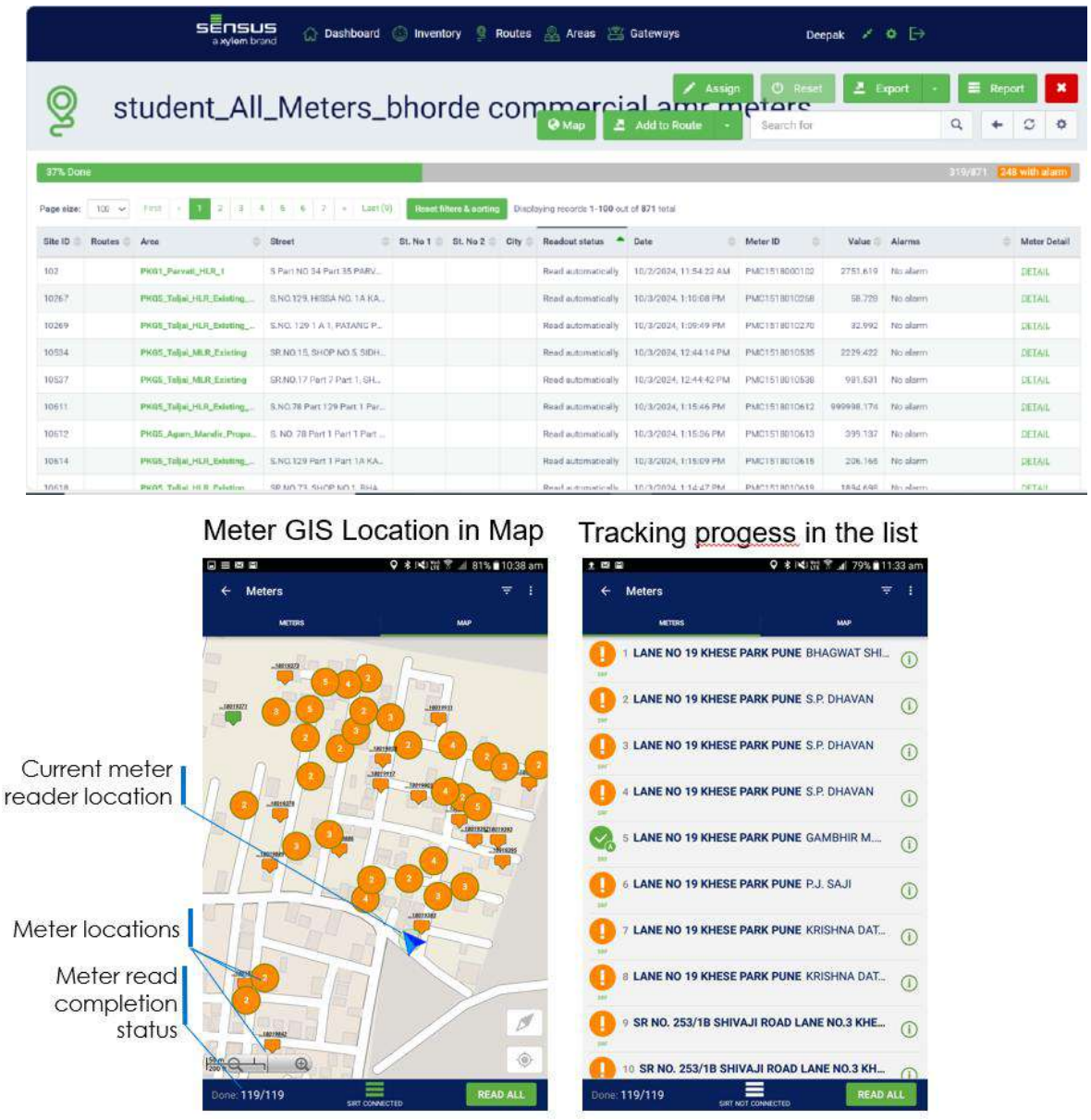


Figure: Dashboard Analysis through GIS

The proposed Electromagnetic / Ultrasonic AMR / AMI Water Meter Solution will provide CMWSSB the reliable, robust system. This will help CMWSSB to monitor and manage the individual consumer consumption and will help to provide equitable water to their consumers. The proposed meter comes with 15 years warranty with low maintenance. This system will enable CMWSSB to reduce losses, increase operational efficiency and improve revenue.

6.11. Instrumentation, Control and Automation

This clause covers Instrumentation, control and automation starting from Pump House level, DMA level, lane/sub-lane level along with communication system PLC and SCADA.

6.11.1. Instrumentation and Control System at Pump House

Following Instruments are proposed within Pump house. Presented in figure 6.14 below,

- Butterfly Valve with feedback,
- Vertical Inline pump with motor,
- Pressure Gauge,
- Electromagnetic Flow Meter,
- Motor operating valve,
- Discharge Manifold.

6.11.2. Instruments are proposed outside pump house:

- Bulk flow meter
- Pressure Transmitter.

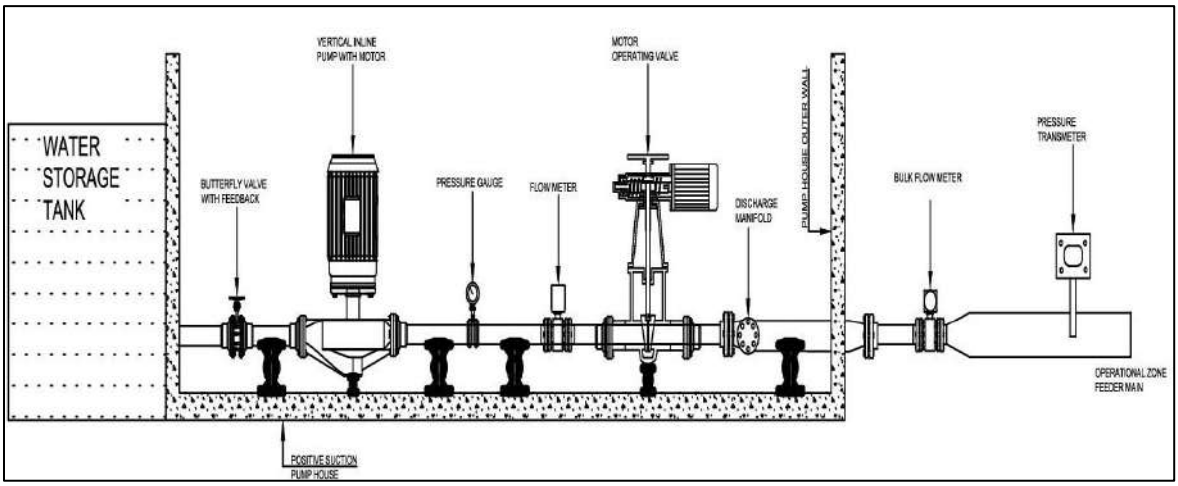


Figure-6.14: WDS Pumping arrangement with Instruments

6.11.3. Operational Zone to DMA entry arrangement

Feeder line shall be laid and at entry point of each DMA. ADMA control unit is to be installed which will transmit data to server by OFC cable which will be laid along the length of pile line from DMA Control unit to server. DMA level control unit is presented at Figure 6.15 below.

DMA control unit comprise of Isolation valve, electromagnetic flowmeter, solenoid valve, pressure gauge and pressure transmitter.

Control Unit at DMA entry consists of following instrument mentioned below,

- DI Double Flange resilient seated glandless gate valve
- Electro Magnetic Flow Meter
- Double Chamber DI Control valve, Hydraulic Operated 24 V DC, Solenoid control, IP 68, Integrated with PLC panel,
- Pressure Gauge
- Pressure Transmitter

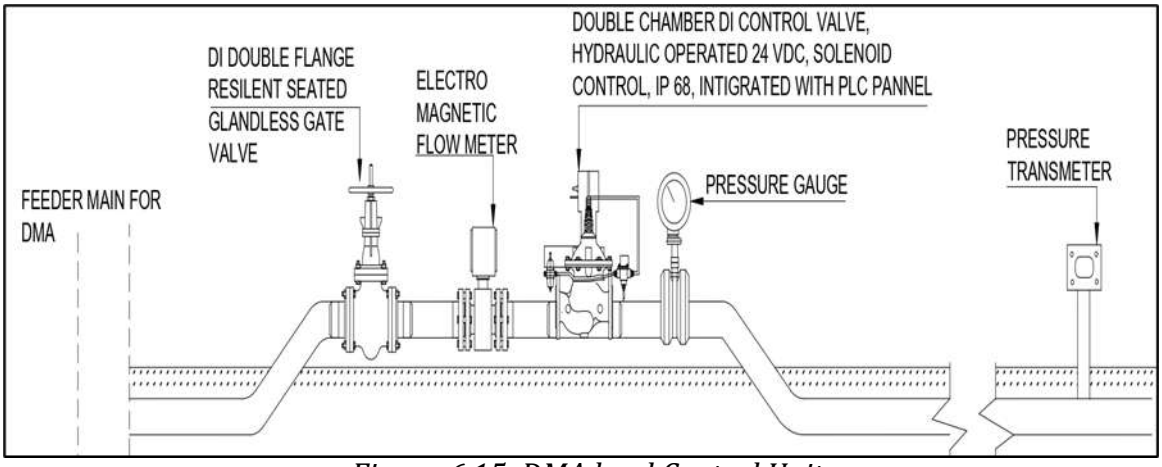


Figure-6.15: DMA level Control Unit

6.11.4. DMA to Lane/sub-Lane:

From DMA to Lane and Sub-Lane, to distribute adequate water with required pressure, and for better control on water audit, Lane-Sub-lane control unit shall be installed at start of lane. This control unit will comprise of isolation valve, basket strainer, Flow meter, Air valve, Globe valve & pressure transmitter. The data will be communicated to server by GSM signal. As presented in figure 6.16 below.

Control Unit at Lane/Sub Lane entry, it is consisting of following instrument mentioned below,

- Flow Meter
- Basket Strainer
- Air Valve
- Globe Valve

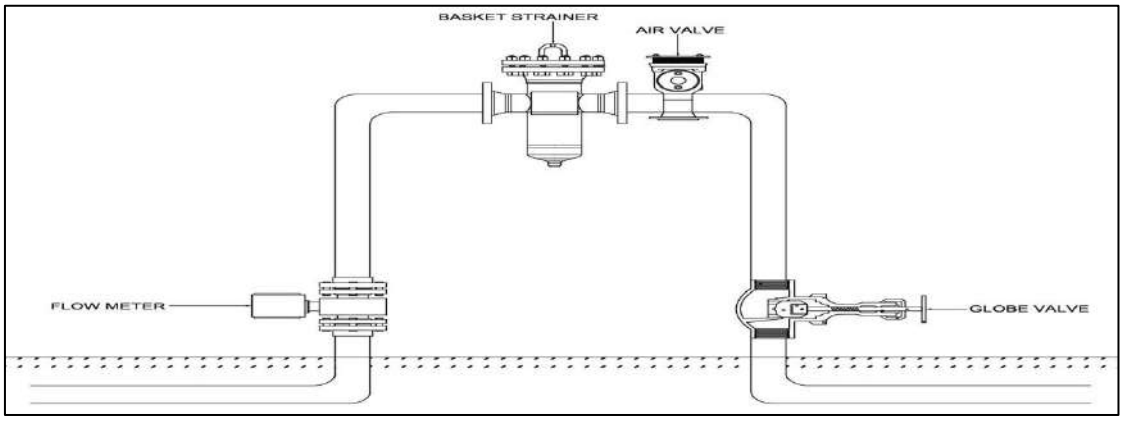


Figure-6.16. Lane/Sub Lane Control Unit.

6.12. Assumptions Made for Hydraulic Modelling

The isolation valve, meter, and the flow control valve (FCV), at the entry point of the DMA, should be connected to the SCADA/IoT.

6.12.1. Key points in Distribution System

Every water supply distribution system has some key notes where it is important to measure various parameters such as pressure, flow, water quality to ascertain that the water supply system is working within normal and permissible limits.

Key locations are identified, generally at the entry of each DMA and the strategic spots such as highest and lowest ground elevations and farthest node in the operational zones. The above-mentioned parameters feedback from predefined locations are key for proper functioning of the overall system. Over a period, these key points may lose / gain importance for parameter measurement in the overall water supply system.

6.12.2. DMA Operation Controls:

- Setting supply pressure at DMA inlet point.
- Controlling isolating valves to control supply in case of failure or shortage or to manage supply for sub-DMAs in case of intermittent supply.

  This information is used to score DMAs based on their situation, set targets, and prioritise activities.

6.12.3. Monitoring DMA inflows and pressures:

- Monitoring DMA inflows and pressures are used for calculation of the following.
- System input volume (SIV).
- Minimum night flow (MNF).
- Supply pressure at inlet point and at critical and average pressure point of the DMA.
- Online bottom-up water balance including leakage, water demand estimation.
- Detection of bursts events.

  Water loss performance Indicators: including leakage per service connections / per length of pipes, and the infrastructure leakage index (ILI).

6.12.4. Monitoring of NRW in 24×7 Water Supply System

The purpose of DMA formation is to monitor the water supply into DMA and measure the consumption of water at household level to monitor and control NRW in a gradual manner. This will also facilitate to conduct regular water audit and take measures to bring down the NRW to the desired level. In order to monitor the NRW at DMA level, the prerequisite is to provide flowmeter at the entry of DMA and 100% House service connections with water meters and proper communication technologies. The frequency of monitoring of NRW and accuracy depends on the type of water meters and communication technologies adopted in the 24×7 water supply distribution system at DMA level.

6.13. SMART WATER MANAGEMENT

Smart water management is the use of data and technology to optimize water usage, reduce waste, and improve overall efficiency. IoT systems can play a critical role in smart

water management by providing real-time monitoring and control of water systems. Here are some examples of how a cloud-based IoT system can be used for smart water management:

- Real-time Monitoring: A cloud-based IoT system can monitor water systems in real-time, including water quality, flow rates, pressure, and other key metrics. This can provide valuable insights into system performance and enable early detection of issues before they become significant problems.
- Remote Control: A cloud-based IoT system can provide remote control of water systems, enabling operators to adjust system settings, turn pumps on or off, and monitor performance from anywhere with a secured internet connection.

6.13.1. Monitoring

The control systems and all the above subsystems would comprise PLC / RTU based control panels with accessories and relevant switchgear as per the system requirement that can be programmed to operate the control systems in a pre-programmed fashion. In addition, as required and as per site conditions, the PLC /RTU panels will have the capability to provide localized communication on technologies such as OFC, ethernet, LoRaWAN, etc. The control and monitoring elements should further be enabled to communicate the status of their individual locations to an IoT based centralized monitoring and control center bracket CMS that enables the water. The control and monitoring elements should further be enabled to communicate the status of their individual locations to an IoT based centralized monitoring and control Centre (CMS) that enables the water supply system to be monitored from one single location for the entire city / town.

CHAPTER -7-COST ESTIMATE

The cost estimate was prepared by taking the rates from the reference documents,

- CMWSSB Schedule of rates 2024-25
- Govt. of Tamil Nadu
- MJP (Maharastra Jeevan Pradhikaran) SoR 2023-24
- RUIDP (Rajasthan Urban Infrastructure Development Project) SoR 2023
- SoR Odisha 2024
- Circular dated 10-09-2020, GCC- Greater Chennai Corporation- Bus route road Department

The items are not available in the SoR, market price has been adopted by taking of quotation from relevant Suppliers/Manufactures.

The Trenchless work item rate is taken from MJP SoR as the details are available in the respective SoR and vendors are not responded in detailed of the item to be executed.

The instrument like pressure gauge, Motor Operated Valve & pressure transmitter rates are taken from RUIDP SoR as quoted prices are enormously vary among the vendors.

The items MS pipe and VT pump prices are taken from SoR Odisha as the price per HP for pumps and MS pipe with fittings per meter length are not provided by the vendors.

The cost estimate is optimized with incorporating the observations provided by CMWSSB officials. The cost estimate is attached in **ANNEXURE 2.**

As per CMWSSB officials, the road restoration work will be done by GCC team by depositing the fund to GCC department as per the Circular dated 10-09-2020, GCC- Greater Chennai Corporation- Bus route road Department. The road restoration cost has been worked out which is 104.61 Cr. The cost is derived considering the bus route, non-bus route, types road etc.,

The derived cost estimate is based on the following:

1. Capital investment costs for supply, installation, construction, testing & commissioning as CAPEX (Capital Expenditures).
2. Operational and maintenance costs are required to maintain and keep the systems working efficiently, OPEX (Operational Expenditures).
3. Financial models for funding by Public-Private Partnership (PPP).

7.1. CAPITAL COST:

The items of bill of quantities considered in the estimates are as follows,

- Distribution Pipe network -Pipes / fittings materials supply / installation / testing / commissioning /spare parts
- Integration with existing water supply Network

- Provision for Cleaning & Flushing of existing pipes
- Road restoration
- Trenchless Arrangement
- Electro-mechanical Instruments
- Transformer & DG set
- Site Clearence & Development
- House service connections
- Gas Chlorine Dosing System
- Automatic Metering Infrastructure
- Measuring & Control Instruments
- Server & Data base
- Communication Infrastructure
- Control & Monitoring panels
- Software
- Operation & Maintenance for 15 years, for the operational area under WDS.

In addition to the item rates, the costs are also considered for the following sub rates as per CMWSSB practice

- Contingencies & unforeseen items
- Provision for investigation charges
- Independent Engineer Charges
- Labour welfare cess
- Third party inspection charges
- TNEB service connection charges
- Provision for shifting of underground utilities
- Price Index Impact
- Interest during Construction
- GST

7.2. Operational & Maintenance

The operational and maintenance cost has been derived by applying as per the industries practices & CPHEEO manual- 2023. The concession period considered is 17 years, overall, which includes 2 years of construction & 15 years of operation period.

CHAPTER -8-FINANCIAL MODEL

8.1. PROJECT BACKGROUND:

Chennai Metro Water Supply and Sewerage Board (CMWSSB) has proposed implementing a 24-x7 water supply system in the areas covered by the water distribution systems (WDS) at Pallipattu and Thiruvanmiyur in Chennai. The project involves investment in improvements to the existing distribution system, installation of electronic meters for recording water consumption by different categories of consumers and subsequent operations and maintenance (O&M) of the WDS to provide reliable water supply. The project will be implemented using a Concession framework on Public Private Partnership basis through a Hybrid Annuity Model (HA-M). Under HAM, the selected PPP developer (the Concessionaire) will be responsible for implementation and operations for an agreed period, i.e. the Concession Period which includes the construction period and the operations period.

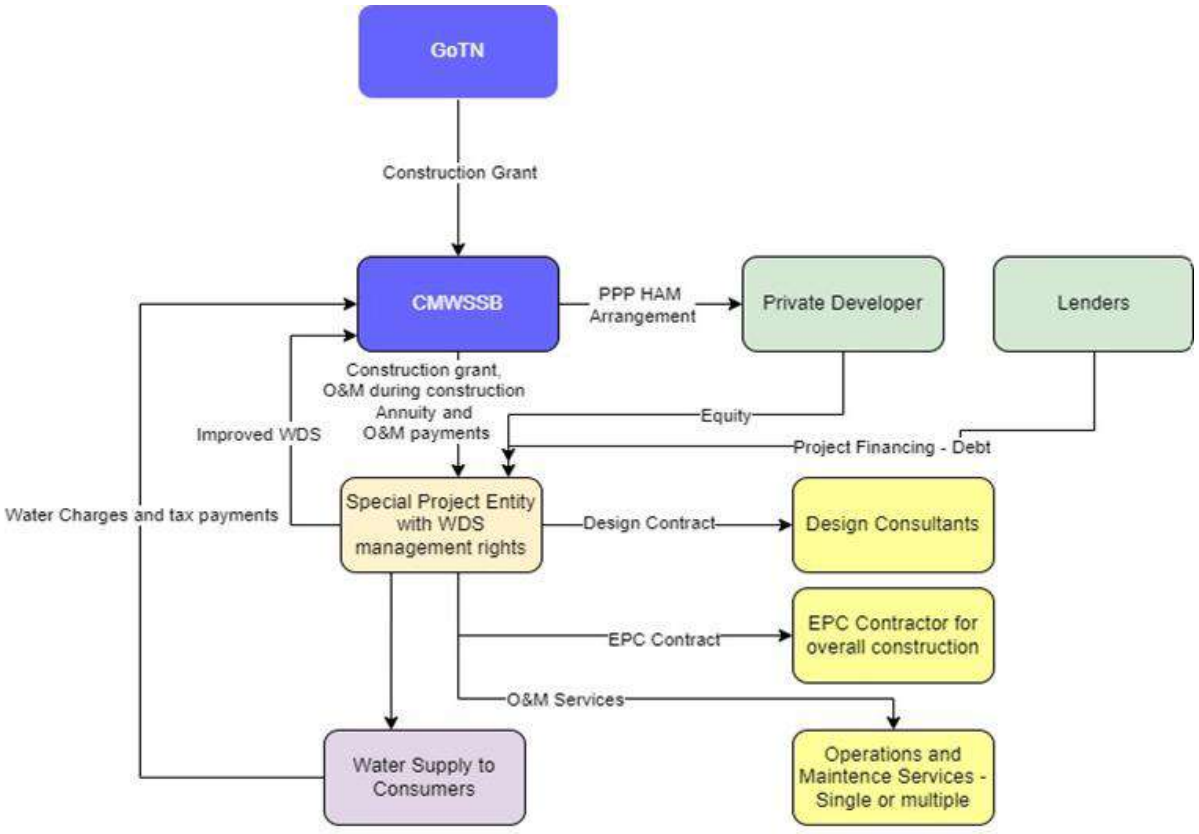


Fig 8.1Project Structure

8.2. PROJECT SCOPE AND COST:

The WDS for Pallipattu and Thiruvanmiyur locations to be improved under the project is expected to initially cover 63,933 consumers including residential and non-

residential consumers distributed as follows.

Table 8.1 No. of consumers

Water Distribution System	No of Consumers	Percentage
Pallipattu - Residential	42,999	67%
Pallipattu - Institutional / Other	6,371	10%
Thiruvanmiyur - Residential	13,308	21%
Thiruvanmiyur - Institutional / Other	1,255	2%
Total	63,933	100%

Source: CMWSSB

It may be noted that the number of consumers is expected to increase during the concession period at the rate of 0.68% per annum, mirroring the growth in the state population.

Financial feasibility analysis is necessary to adopt a bankable project structure that dovetails the financial interests of the Concessionaire and CMWSSB. This analysis includes presentation on the financials of the PPP developer and CMWSSB based on project expenditure and remuneration during the concession period under the HAM framework.

8.3. THE HYBRID ANNUITY MODEL

Under HAM, the PPP developer is required to undertake implementation of the project during the construction period and operate and maintain the project to provide required services to users based on agreed standards of performance. For this, the developer is remunerated with payments during the construction and operations period as follows.

8.3.1. Payments during Construction Period:

a. Construction period grant – Currently considered at 60% of the cost of project implementation – as milestone linked payments with each payment adjusted for inflation in project cost during the construction period. Payable upon achievement of physical progress over pre-defined milestones
b. O&M payments for operations and maintenance of the existing water distribution system – payable on a monthly basis.

8.3.2. Payments during Operations Period:

a. Balance of cost of project implementation – Currently assumed as 40% (100% - Construction period grant) of the Total Project Cost (Adjusted for inflation during the Construction Period) – Payable every quarter of the operations period together with interest on the unpaid balance of Total Project cost. The interest rate on unpaid annuities is currently assumed as 10.95% per annum which

represents a 2% spread over the Marginal Cost based Lending Rate (MCLR) of SBI which is presently 8.95%.

b. O&M payments for Operations and Maintenance of the upgraded water supply system as per agreed Key Performance Indicators (KPIs) are payable every quarter. There is an annual increase in this amount linked to inflation.

8.3.3. Bid parameter under HAM:

The bid under HAM comprises 3 elements, (i) the bid project cost (ii) the O&M during construction and (iii) the O&M during the operations period. All the amounts receivable by the developer over the Concession period shall be projected and the net present value (NPV) of these amounts shall be computed to arrive at the levelized NPV. The bidder with the lowest levelized NPV shall be the selected bidder.

8.3.4. The Concession Period:

The Concession period considered for the analysis is 17 years overall which includes 2 years of construction and 15 years of operations

8.3.5. Summary of financial analysis for PPP developer:

The project cost shall be financed by the developer as follows. The capital structure after excluding the construction grant of 60% works out to a debt-to-equity ratio of 2:1. However, when the construction grant is also considered, the capital structure comprises 13.37 percent equity, 26.74 percent debt and the balance 59.90 percent grant.

Table 8.3 Capital structure

Capital Structure	Overall	After excl. grant	INR Crore
Equity	13.37%	33.33%	36.99
Debt	26.74%	66.67%	73.99
Grant-Construction	59.90%		165.75
Total	100%		276.73

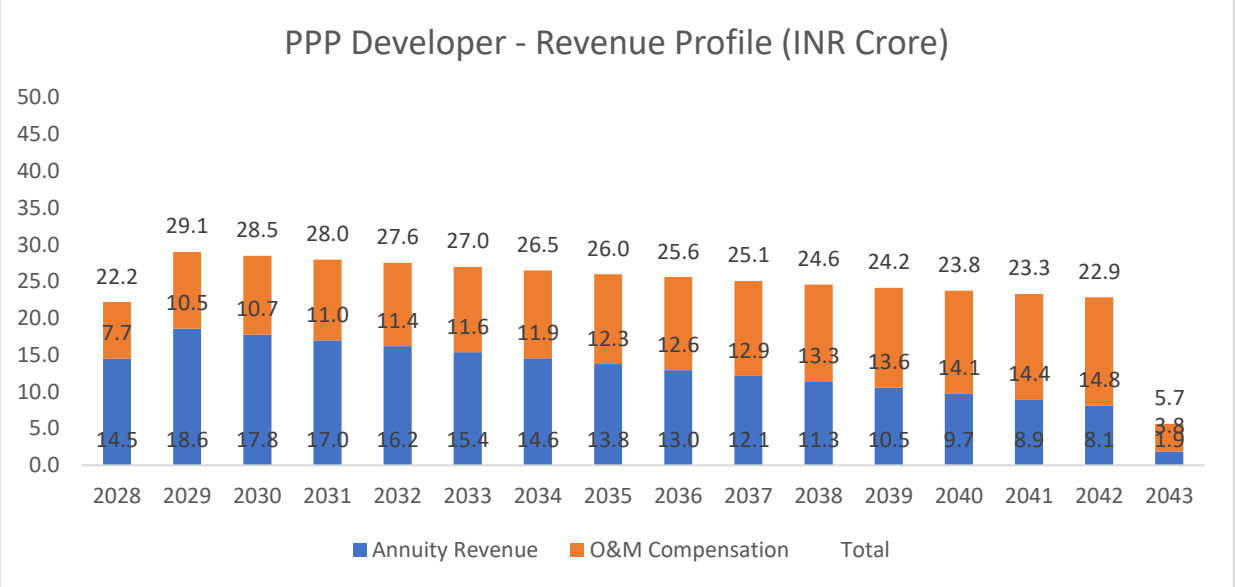
Source: Consultant Analysis

The debt facility is assumed to have a door-to-door tenor of 10 years, a moratorium period of 2 quarters post commercial operations date and an interest rate of 9.5 percent. Though the interest rates are typically variable, it has been considered as a constant for the purpose of analysis as the rates might either increase or decrease based on market conditions.

8.3.6. Revenue Profile:

The revenue profile of the developer is as follows. The revenue figures are around INR 20 to 30 crores per year. It is higher in earlier years and reduces over the concession period. This is due to the capex component of annuity being constant every year. Consequently, the interest component of annuity decreases while the O&M payment

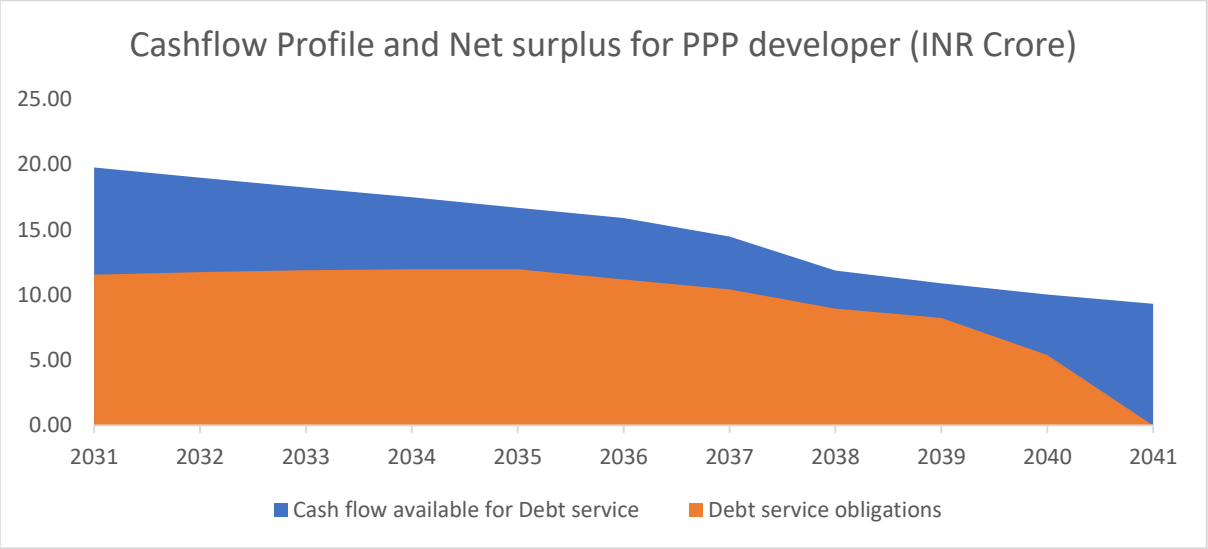
linked to inflation increases every year. Hence, the overall revenue to the developer is within the range i.e. INR 20~30 crore.



Source: Consultant Analysis

Figure 8.2 PPP Developer Revenue profile (INR Crore)

Consequently, the cashflow profile when compared with debt service obligations indicates a comfortable debt servicing profile. From the figure below, it is seen that the cash flow available for debt service after accommodating O&M obligations is higher than the debt servicing requirements.



Source: Consultant Analysis

Figure 8.3 Cashflow and net surplus profile for PPP developer (INR Crore)

8.3.7. Project financial returns:

The analysis indicates that the project financial returns for the PPP developer are comfortable with a project IRR of 10.29%, equity IRR of 12.28% and a minimum Debt Service Coverage Ratio (DSCR) above 1.32.

8.3.8. Analysis of CMWSSB financials:

CMWSSB cash flow profile is linked to income from consumers who are charged (i) water consumption charges and (ii) water tax. For residential consumers, the consumption charges are based on the tariff profile below.

Table 8.4 Water Tariff

Tariff - Residential Connection		Rate/KL/month in INR
From 0	to 10 KL	6
11	to 15 KL	18
16	to 25 KL	28
26	and above	45
Minimum Charges (INR)		100

Source: CMWSSB

For non-residential consumers, the tariff is charged at a flat rate of INR 90 per KL. The tariff is assumed to increase at the rate of 10% once every two years. The estimated average water consumption is 1 KL per day per residential consumer in Thiruvanmiyur and 0.74 KL per day per residential consumer in Pallipattu.

It may be noted that the construction grant for the project is supported by the Government of Tamil Nadu. Whereas, CMWSSB has to manage payments to developer during the operations period. These payments attract 18% GST which is a cost to CMWSSB as the input tax credit on the same is not available owing to CMWSSB's output services not being subject to GST.

Table 8.5: CMWSSB Project cashflow (INR Cr.)

CMWSSB - Project Cashflow Analysis	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36
Net Cash Realised by CMWSSB	5.87	7.58	58	65	65	72	73	80	81	90	90
Annual Payment Obligations											
Construction Grant	60	84	22	-	-	-	-	-	-	-	-
Annuity - Capex with Interest	-	-	17	22	21	20	19	18	17	16	15
Annuity - O&M Component with Interest	-	-	9	18	13	13	13	14	14	14	15
O&M during construction	10	14	4								
Energy Cost	5	5	5	6	6	6	6	6	6	7	7
Total Payment Obligations	75	103	57	46	40	39	39	38	38	37	37
Net Cashflow (INR Crore)	-70	-95	1	19	25	33	34	42	43	52	53
Net Cashflow (INR Crore) - Excl Capex but with O&M	-10	-12	23	19	25	33	34	42	43	52	53

CMWSSB - Project Cashflow Analysis	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46
Net Cash Realised by CMWSSB	100	101	111	112	124	125	138	-	-	-
Annual Payment Obligations										
Construction Grant	-	-	-	-	-	-	-	-	-	-
Annuity - Capex with Interest	14	13	12	11	11	10	2	-	-	-
Annuity - O&M Component with Interest	15	16	16	17	17	17	4	-	-	-
O&M during construction										
Energy Cost	7	7	7	8	8	8	8	-	-	-
Total Payment Obligations	37	36	36	36	35	35	15	-	-	-
Net Cashflow (INR Crore)	63	64	75	76	89	90	123	-	-	-
Net Cashflow (INR Crore) - Excel Capex but with O&M	63	64	75	76	89	90	123	-	-	-

Source: Consultant Analysis

The cumulative cash flows to CMWSSB and the Net Present Value (NPV) of the Cash flows to CMWSSB are as below:

Table 8.6: CMWSSB Cumulative Surplus and NPV of cashflows (INR Cr.)

Amounts in INR Crore

NPV of Cashflows*	**196.79**
NPV of O&M period Payments only	**341.62**
Cumulative Surplus/Deficit	**718.15**
Cumulative Surplus/Deficit (Excluding Construction Grant)	**883.89**

*Discount rate of 8% (~1% above 10 year G-sec yield of ~7% currently) considered for arriving at the Net present value

A comparison of the expected financial position of CMWSSB in the with and without project scenario is considered essential to justify the project. The above analysis indicates that the net cashflow to CMWSSB is positive even after providing for annuity related payment obligations. Further, it is observed that due to metering and subsequent enforcement of consumption linked payments, CMWSSB is likely to witness revenues increasing by about 150%. It is also noted that the construction grant payable to the developer is funded by the Government of Tamil Nadu. Consequently, the net cost implication on CMWSSB is limited to O&M costs under with and without project scenarios. Basis this, a comparison of cash flows for CMWSSB with and without the project was undertaken. The results are as follows:

Table 8.7: Comparison with and without the project (INR Cr.)

	With Project	Without project
Cumulative Cash surplus for CMWSSB	718.15	281.98
NPV of cash flows*	196.79	122.76

*Discount rate of 8% (~1% above 10 year G-sec yield of ~7% currently) considered for arriving at the Net present value.

From the above, it is observed that the project investment and the consequent change in billing approach have a net positive impact on CMWSSB financials. The detailed Financial Model is given at **Annexure 1**.

CHAPTER -09-OPERATION & MAINTENANCE

The overall objective of the "Drink from Tap" 24x7 water supply system is to deliver wholesome water to every consumer 24 hours a day, every day of the year at adequate residual pressure in sufficient quantity at the farthest /convenient points and achieve continuity and maximum coverage at affordable cost. The "Drink from Tap" 24x7 water supply system consists of a well-designed water distribution system that is continuously full and under positive pressure throughout all its pipelines and networks. To attain this objective the water supply organization has to evolve operating procedures to ensure that the overall system can be operated satisfactorily, function efficiently, effectively and continuously. The water distribution network is the front face to the consumers and people. The water is supplied through well-articulated network of pipelines with various appurtenances including valves collectively called as the water distribution system (WDS), which involves operation of network spread over a large area. Since, the WDS O&M task is human resource intensive and too many variables are involved in its successful operation, the well-trained O&M staff are the key to the overall success of the WDS operations and the water supply system as a whole, which are created with, generally, huge investments.

9.1. NORMAL OPERATIONS

The 24x7 operations are intended to maintain the required supply and pressure throughout the distribution system. Critical points are selected in a given distribution system for monitoring pressures, flow and quality by installation of pressure recorders, meters, gauges and sampling monitoring systems. These parameters are either measured manually and data records transmitted to the control station or automatically measured and transmitted by telemetry or by Supervisory Control and Data Acquisition (SCADA) systems to control station. Digital Twin Technology is used for analyzing data and taking decisions.

The distribution system is usually designed as a continuous system but mostly operated as an intermittent system. Intermittent supply creates doubts in the minds of the consumers about the reliability of water supply quantity and quality. This leads to limited use of the water supplied, which does not promote personal hygiene at times. During the supply period the water is stored in all sorts of vessels for use in non-supply hours, which might contaminate the water. Often, when the supply is resumed, the stored water is wasted and fresh water again stored. During non-supply hours polluted water may enter the supply mains through leaking joints and pollute the supplies. Further, this practice prompts the consumers to always keep open the taps of both public stand posts and house connections leading to wastage of water whenever the supply is resumed. Intermittent systems and systems which require frequent valve operations are likely to affect equitable distribution of water mostly due to operator negligence.

9.2. Monitoring of Flows, Pressures and Levels

It will be necessary to monitor regularly operational data concerning flows, pressures and levels to assess whether the system is functioning as per requirements. Analysis of data may reveal over drawl of water to some reservoirs and or bulk consumers. At such places appropriate flow control devices may be introduced to limit the supplies to the required quantity. A list of priority points in water supply system have to be identified such as installation of meters to measure flows, pressures and levels. A detailed map showing location for each measuring point has also to be prepared. The degree of sophistication of the devices used at each measuring point with regard to indication, integration, recording, transmission and reception of data depends mainly on the skills of O&M personnel.

9.3. Water Quality Management

Water quality management is of prime importance to test the performance of operation and maintenance of the distribution system in order to provide 'Drink from tap' and its ability to deliver water of acceptable/permissible quality to its consumers conforming to IS 10500 (2012). The most important potential consequences of improper and ill managed distribution system is health problems caused by presence of substances more than acceptable limit in the water. In order to ensure potable water supply for drinking purpose, it is essential to monitor water quality at various locations in distribution system as well as at consumer ends at regular interval/frequency for various physical, chemical and bacteriological parameters for which services of in-house or NABL accredited outsourced laboratories can be availed.

Table 10.1: Water quality Parameters & Test Frequency

S. No.	Parameters	Test Frequency
1	pH	Fortnightly
2	Turbidity	Fortnightly
3	Electric Conductivity	Fortnightly
4	Residual chlorine	Fortnightly
5	E.coli (faecal coliform)	Fortnightly

Table: shows Minimum routine monitoring frequency of water quality parameters in water distribution system.

Table: Minimum routine monitoring frequency of water quality parameters in water distribution system (Introduction to O&M of water distribution system: JE Val Zyl - Water Research Commission)

The water supply authority needs to ensure proper water quality management in distribution system.

9.3.1. System Surveillance

Surveillance of distribution system is done to detect and correct. Routine surveillance shall reveal:

- Sanitary hazards.
- Deterioration of distribution system facilities, (to detect).
- Encroachment of distribution system facilities by other utilities such as sewer and storm water lines, power cables, telecom cables etc. and
- Damages of the system facilities by vandalism. (Detecting and correcting).

In addition, checks are carried out under special circumstances for assessing damage of the system after flooding of streets following a heavy storm. All these checks are done for above ground water facilities such as valves and valve chambers or exposed pipelines. Some less frequent inspection of underground pipelines will also be required, wherein critical areas of the distribution system should be patrolled routinely so that the water utility can watch out for early warning of any adverse conditions of the distribution system. Any activity or situation that might endanger the water facility or water quality shall be investigated and corrective action is to be taken. Surveillance shall also include looking for unauthorized construction activity on or near the utility's pipelines, which may pose a physical threat to the mains. Any digging or excavation or blasting near the mains shall be closely supervised by the utility staff.

9.3.2. Staffing

The work and monitoring of the distribution system shall be conducted on a 24 hour per day, continuous basis, without interruption. The necessary supervision during the O&M period. Such supervision shall be given by a competent person having adequate knowledge of the operation and maintenance duties to be carried out including the methods and techniques required, the issues likely to be encountered and methods of preventing breakdown as may be required for the satisfactory working within the WDS. The number and details of personnel (minimum) to be employed by the employer shall be given as stated below. In addition, this adequate number of staff and unskilled personnel during the O&M period, may be deployed as and when required.

Table 10.2: Staffing

Designation	No of Staff	Category
Electrician Grade-I	2	High skilled
Mechanic- I class	2	Skilled
Pump Driver	6	Semi-Skilled
Plumber	2	Semi-Skilled
Fitter-I Class	4	Skilled
Helper	18	Semi-Skilled

Designation	No of Staff	Category
(mazdoor category I)		
SCADA Operator	1	High skilled
SCADA Operator Assistant Grade-II	3	High skilled
Watchman (For WDS) Time Keeper-II Class	6	Semi-Skilled
Staff for Water Quality Sampling Laboratory Assistant Grade-III (With Degree Qualification to work as works clerk)	3	High skilled
billing collector	4	Semi-Skilled
TOTAL MANPOWER	29.00	

9.3.3. Maintenance Schedule

Maintenance schedules can be designed considering points summarized below:

i.General

A maintenance schedule is required to be prepared to improve the level of maintenance of water distribution networks and house connections through improved co-ordination and planning of administrative and field work and through the use of adequate techniques, equipment and materials for field maintenance.

- The schedule has to be flexible so that it can achieve team action with the available vehicles and tools.
- Co-ordination of activities is required for spares and fittings, quality control of materials used and services rendered.
- Training of maintenance staff shall include training to achieve better public relations with consumers apart from the technical skills.

ii. Activities in Maintenance Schedule

The following activities are to be included in the schedule:

- Establishment of procedures for setting up maintenance schedules and obtaining and processing the information provided by the public and the maintenance teams.
- Formation of maintenance teams for each type of service with provision for continuous training.
- Establishment of repair procedures for standard services.

- Specification of appropriate tools.
- Allocation of suitable transport, tools and equipment to each team.
- Establishment of time, labour and material requirement and output expected; time required and other standards for each maintenance task, and monitoring the productivity of each team.

iii. Preventive Maintenance Schedule

A preventive maintenance schedule for Servicing of Valves and Maintenance of Valve Chambers, Maintenance of the pipelines: may include the tasks, set priorities, issue of work orders for tasks to be performed, list of scheduled tasks not completed, record of when the tasks are completed and maintaining a record of tools, materials, labour and costs required to complete each task.

a) Servicing Valves

Seating of valves which are subject to operations several times is likely to become leaky or pass the flow downstream even after closing tight. Periodical servicing will be required for valves on hydrants and public taps, flow meters and pressure gauges. Corrosion of valves is a main problem in some areas and can cause failure of bonnet and gland bolts. Leaks from spindle rods occur and bonnet separates from the body. Stainless steel bolts can be used for replacement and the valve can be wrapped in polyethylene wrap to prevent corrosion.

b) List of Spares

A list of spares required for the distribution system maintenance shall be prepared and shall be procured and kept for use. The list should indicate the minimum level at which action for replenishments should be initiated. The list of probable spares to be kept in stock may include the following: Spare check nuts and spindle rods and assorted bolts, nuts and washers for the flanged joints, gaskets for flanged joints for all sizes of sluice valves installed in the distribution system, spare manhole covers and consumables like the gland rope, grease, cotton waste, spun yarn, pig lead and lead wool, O rings, mechanical joints and fittings, etc.

c) List of Tools

The necessary tools to properly repair and correct both the routine problems and for facilitating repairs and replacements in a distribution system have to be identified and provided to the maintenance staff. Some of the tools for the maintenance work in a distribution system are: Key rods for operation of all sluice valves, hooks for lifting manhole covers, pipe wrench of appropriate sizes (200, 300 or 450 mm), Double ended (DE) spanner set, Ring spanner set, Screw Drivers, Pliers, Hammers, Chisels, caulking tools for lead and spun yarn, ladles and pans for melting and pouring lead joints, excavation tools such as crow bars, spades, iron baskets, buckets and de-watering pumps.

d) Maintenance of Valve Chambers for Appurtenances

Valve chambers are generally filled with leakage in the glands, shafts, etc. and the stagnant water if not drained properly can be sucked into the distribution system. Hence, these chambers required robust drainage arrangement and regular maintenance to keep that clean and hygienic. Valve chambers shall be checked to ensure that they are not damaged, nor filled up with earth nor buried in pavement. Covers of valve chambers are stolen or broken up by vandalism or by accident resulting in damage to the valves or may lead to accidental fall of a person into the open valve chamber. Such situations have to be corrected as a priority. Road improvement works require constant attention of water utility staff since the valves may be lost or at times the valve chambers in the roads have to be reconstructed to match the renewed road surface. Precaution shall be taken to provide the valves where absolutely essential because maintenance of valve chambers is an herculean task in the distribution system. These valve chambers are becoming dustbins and point of contamination of the water. Alternatively, valve chambers can be constructed based on the essentiality (access required for regular operation) otherwise, can be buried after inserting a pipe or similar type of any special above the spindle so that O&M team can access wherever there is requirement.

e) Operation under emergency Conditions

Operations other than routine viz. during breakdowns and emergencies have to be specified and should be carried out in specific circumstances when normal conditions change i.e., when flows, pressures and levels and operation of pumps change. A standard operating procedure for valves should be prepared and emergency conditions should be considered into it. The objective of developing a program for managing in times of shortage of water is to reduce the excessive use of water particularly when the source is limited due to adverse seasonal conditions. The water managers play an important role in managing the water supplies during emergencies. Their role can be fulfilled by:

(i) Giving an emergency condition notification so that people could get aware;
(ii) Define new policies to balance the demand and supply of water so that at least basic needs of every person can be fulfilled.
(iii) Water quality should be monitored properly by the water managers so that water should be safe
(iv) Water managers must see that emergency response plan includes a well-prepared communication strategy.
(v) A proper Vulnerability Assessment of every affected area should be done.
(vi) Special Monitoring, Vigilance and Response action team should be made to reduce the wastage and equitable distribution of water and verify that the policies made are properly followed.

(vii) Alternative water sources available near the affected area must be looked into.

f) Monitoring System Performance

Normally the managers of O&M of water utilities monitor levels in service reservoirs, pressures and flows in the distribution system and operation of pumps such as hours of pumping, failure of pumps and monitor water quality by measuring residual chlorine. The manager usually uses telephone line or wireless unit to gather the data, maintain records analyses, uses his discretion gained with experience and takes decisions to ensure that the system is operating with required efficiency. Manual collection of data and analysis may not be helpful in large undertakings if water utilities have to aim at enhanced customer service by improving water quality and service level with reduced costs. In such cases monitoring system performance can be done with use of Telemetry and SCADA and Digital Twins.

(i) Quality of Pipe Material for House Connection

The water utility shall ensure that the connection and communication pipe from the street main up to the consumer premises is laid as per correct plumbing practices and adopt improved methods for tapping the main. Strict quality control is required on the pipe material used for house connection. The bye Laws shall lay down rules for defining the ownership and responsibility for maintaining the point of connection and the communication pipe. In several utilities the communication pipes are leaking since they are corroded; however, these are not replaced by the consumer or by the utility particularly where the O&M responsibility for consumer pipe rests with the consumers.

(ii) Contamination Through House Connection

While laying the consumer connection pipes, there is a need to avoid contamination of water supplies. This can be achieved by maintaining horizontal and vertical separation between the water supply communication pipe and the sewer/drain. In some instances, a sleeve pipe may be required to be provided to the consumer pipes crossing a drain. It is always recommended to provide a non-corrodible pipe material for the consumer connection. Contamination by possible back flow can also be prevented by ensuring provision of double check/non-return valves at the consumer end.

(iii) Rules for Consumer Connections

The water utility shall formulate rules for sanction of consumer connection. Tapping the branch line and laying the connection piping. At no circumstances, a consumer connection is permitted from the mains. On unavoidable circumstances, a separate parallel pipeline/ rider pipeline has to be drawn from

the nearby existing distribution system. Water utility shall undertake inspection of the consumer premises before releasing the connection to ensure that the internal plumbing system of the consumer conforms to the National Building Code. Water utility shall supervise the process of drilling/tapping of the main for giving connection and laying of the consumer piping. The process of submission of applications for connections by consumers and carrying out the connection work through licensed plumbers is also prevalent in some utilities. In such cases the utility shall formulate procedures for licensing the plumbers including the qualifications to be possessed by the plumber, facilities and tools to be available with the plumber for the work to be undertaken by the plumber. The utility shall closely observe the quality of materials used and works done by him and he should act as per procedures laid down in the bye laws for approval of the connection works, renewal or cancellation of the plumbers' licenses or any other requirement depending on their performance or non-performance. For all the service connections, Ferrule should be provided/fixed with saddles and compression fittings to avoid leakages from the connection joint.

g) Records and Reports

(i) Record System

A record system has to be developed which should be realistic and apply to the operating problems involved in the distribution system. Management must be clear as to why the data/ information is collected, as to who will review the data and who will respond to the results of review. The most efficient way to keep records is to plan what data is essential and then prepare the formats followed by the persons concerned for filling of the data, frequency and to whom the record is to be sent for review and report. The agency should make a repository of real time data at the discretion of the authority in managing and taking an appropriate decision of the system. Sample records to be maintained are given below for guidance:

- Updated system map.
- Pressure and flow readings at selected monitoring points.
- Persistent low pressure or negative pressure areas.
- Age of pipes/quality of pipes.
- Pipelines to be replaced.
- Presence of corrosive water in the system.
- Water budget for each zone served by one SR.
- Number of connections given.
- Number of meters out of order.
- Status of fire hydrants and public taps.
- Quantity measured at outlet of reservoir.
- Quantity distributed/measured or billed.
- Source of leaks and persistent leak points.
- Status of bulk meters - function or not.

- Status of consumer meters.
- Facilities for repairs of consumer meters.
- Number of unauthorized connections.
- Residual chlorine levels at the pre-selected monitoring points.
- Bacteriological quality of the water sampling points.
- Persistent areas where residual chlorine is absent/ where bacteriological
  samples are unwholesome.
- Record on carrying out repairs on the following works and its cost:
- The pipe line leaks or replacement of pipes.
- Change of gland ropes of the valves in distribution system.
- Replacement of parts.
- Replacement of manhole covers.
- Record on man hours spent on routine operations in the distribution system in the previous year and the cost thereof.
- Record on total cost of repairs and replacements in previous year along with break-up of material cost and labour cost with amount spent on outside agencies for repairs and replacements.
- Record on when the exposed piping was last painted and the cost of materials and labour cost thereof.
- Record on the unserved areas - extension of pipelines- need for interconnections.

(ii) Reports

With the accumulation of all essential data a report can be prepared evaluating the O&M of the facility. The report can identify the deficiencies in the system and its appurtenances and then plan future repairs to the network or valves and other equipment or for replacement of defective valves or other equipment or additions and extensions to the distribution network.

(iii) Computerized Maintenance Management System (CMMS)

Computerized Maintenance Management System (CMMS), also known as Computerized Maintenance Management Information System (CMMIS), is a software package that maintains a computer database of information about an organization's maintenance operations. This information helps in maintenance of the system by determining which component (pipes, machinery, instruments, chemicals, manpower, etc.) requires maintenance and where the spare parts are. The CMMS System also keeps track of all the maintenance work involved by generating work orders, procurement orders, vendor orders, stores inventory, as well as the cost involved in all the activities thus help to accurately calculate the budget needed for O&M. CMMS also allows to keep record and geotagging of the components in the system which can be linked to GIS and network model, which in turn helps to analyze and keep track of various maintenance works.

CHAPTER -10-SOCIAL & ENVIRONMENTAL IMPACT ASSESSMENT

10.1. INTRODUCTION

Chennai formerly known as Madras, is the capital city of Tamil Nadu, the southernmost Indian State. It is the state's primate city both in area and population and is located on the Coromandel Coast of the Bay of Bengal. According to the 2011 Indian census, Chennai is the sixth most populous City in India. The population of Chennai Core city as per the 2011 census was 46,46,732, and the area is 176 Sq km. The city has 7 administrative areas, namely IV, V, VI, VIII, IX, X & XIII, covering 107 Wards/Depots.

Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) is responsible for the administration and operation, and maintenance of Chennai City's water production, treatment, storage, distribution, billing and revenue collection.

The present water supply system is intermittent due to various constraints in source, storage facilities and adequacy of the existing distribution system. The Chennai Core city's average per capita water supply is around 100 Liters Per Capita per Day (Lpcd).

It is observed that, despite of the fact that, water supply of 936 MLD is supplied for 8.38 lakh consumers of 7.4 million Population, 126 Lpcd water should reach every household. However, as reflected in the Area-XIII DPR, the average supply is around 100 Lpcd and there is a huge inequity in supply and some streets are not getting any water despite of water pipes laid in the street. The high rate of NRW is also apprehended.

Further, to improve the current water supply situation, the Chennai Metropolitan Water Supply and Sewerage Board is implementing a 400 MLD Sea Water Desalination plant at Perur, additional storage facilities and other allied works with JICA assistance.

Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB") has prepared a DPR from SMEC, Tata Consulting Engineers Limited, and NJS Consulting Engineers for Administrative Block X and XIII and submitted to funding agency (World Bank). World Bank has observed that it is suggested to replace 75% of existing pipelines to achieve target of 24X 7 water supply, which seems to be high and suggested to Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB") to take technical assistance from WATCO (Water Corporation of Odisha, Government of Odisha) who are executing 24X7 water supply in existing townships of Odisha. Chennai Metropolitan Water Supply and Sewerage Board ("CMWSSB") approached WATCO and after meeting with top management of both organizations, Project Management Consultancy Services has been awarded to WATCO for planning designing and implementation of 24X7 water supply to Administrative Block 10 and 13 of Chennai Metropolitan Water Supply and Sewerage Board.

10.1.1. Sources and Pattern of Water Supply

The overall water supply scenario of entire Chennai city is exhibited below.

Table 11.1: Water Supply Scenario of Chennai City

Operational Area	**426 sq.km**
Topography	Generally Flat
Current Population	7.4 millions
Current water supply	1015 mld
Water Treatment Capacity	1,494 mld
No. of Consumers	8.38 lakhs

10.1.2. Water supply sources for Chennai City

Table 11.2: Water supply sources for Chennai City

Source	**Quantity of water drawn in MLD**
City Reservoirs	690.00
Veeranam Pipeline (Bore wells, NLC mines & Paravanar)	163.00
Desalination Plants (Minjur & Nemmeli)	138.00
Well Fields	4.00
Added areas ground water	20.00
Total	**1015.00**

10.1.3. The water supply pattern of supplying 1015 MLD of water

Table 11.3: Water supply Pattern

Water Supply Pattern	**Distribution in MLD**
Piped Supply	936.00
Industrial and Bulk Supply	51.00
Water tanker Lorry Supply (3,543 trips through **408** lorries)	28.00
Total	**1015.00**

10.2. Structure of ESIA Report

The ESIA report for the project has been prepared complying country Acts, Policies and The World Bank Guidelines for Environmental and Social Assessment. The report has been structured in the following Chapters:

1. Introduction
2. Project Description
3. Legal and Regulatory Aspects
4. Environment and Social Baseline
5. Potential Environmental and Social Impacts and Mitigation
6. Environment and Social Management Plan
7. Stakeholder Engagement
8. Grievance Redressal Mechanism
9. Institutional Arrangement
10. ESMP Implementation Budget

10.2.1. Project Description

Urban water sector is facing the challenges of poor quality of water. Intermittent water supply often results in contaminated drinking water. During non-supply hours, there is a vacuum inside pipelines due to which outside dirt/contaminants find entry into the pipelines, thus, water gets contaminated. When supply of water starts, the contaminants are mixed with the treated water, further contamination takes place. In 24×7 water supply system, pipelines are pressurised and hence outside dirt cannot find entry inside, hence water retains its quality. People are not having trust on quality of municipal water because of contamination in supply, and they tend to purchase small reverse osmosis (RO) machines in their homes. Household treatment facility at their home and its maintenance, cost of electric power for its operation increases cost of living. As water supply is intermittent, people must keep water stored for daily needs put additional burden, and due to less pressure in distribution pipeline, lifting arrangement is required which increase further financial load on consumer. As RO is used by user to get good quality of water, 2/3rd of water received from is wasted as process waste of RO resulting in increase in water demand.

As Chennai Core City is having sufficiency in source of water, but due to inadequate distribution system, people are not getting enough water. The present water supply system is intermittent due to various constraints in source, storage facilities and adequacy of the existing distribution system. The Chennai Core city's average per capita water supply is around 100 Liters Per Capita per Day (lpcd).

CMWSSB has decided to provide 24X7 water supply to pilot area, administrative areas X and XIII on priority. Based on the client's requirement, DPR by a consortium

of consultants (SEMC, TCE, NJS, SMCE India) has been prepared and submitted to funding agency for approval execution purpose. The DPR was reviewed, and it was pointed out by funding agency that replacement of existing system proposed (75% replacement) in DPR seems on higher side. As WATCO has been working in 24X7 water supply in Odisha, CMWSSB has approached WATCO for technical assistance for assessing the necessity of replacement of existing distribution system.

10.2.2. Project Area

The project area is confined to administrative block 10 (X) and 13 (XIII) of Chennai Metropolitan Water Supply and Sewerage Board.

The area X (Kodambakkam) is shown in yellow, and Area XIII (Adyar) is shown in green are highlighted in the overall water supply zoning map of Chennai City as below.

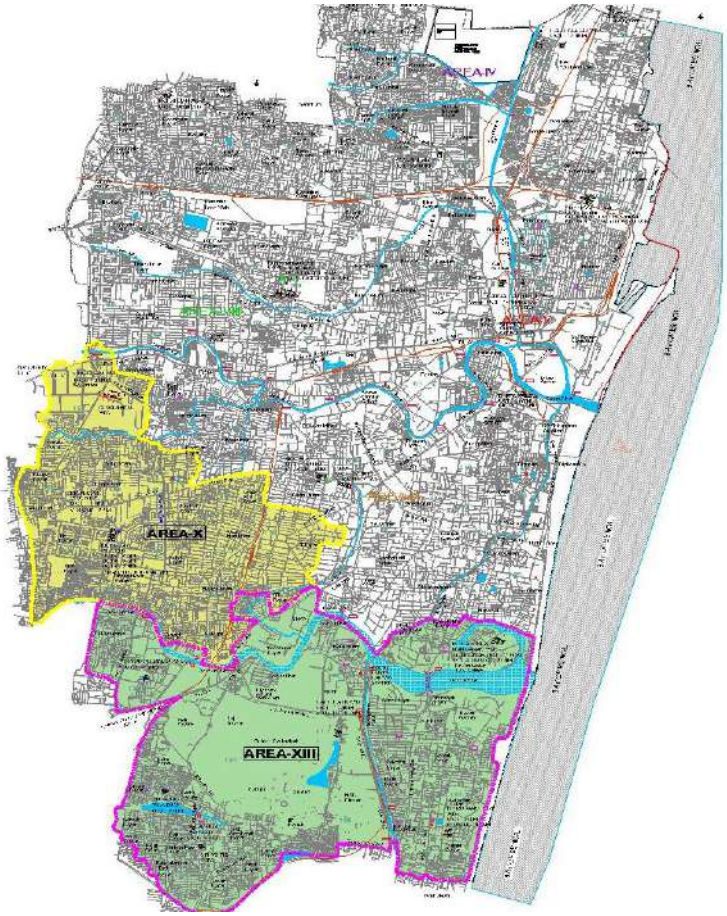


Fig 11.1: Map showing Area X & XIII

10.2.3. Project Objectives

The objectives of the project are:

i. Provide drink from tap quality drinking water (IS 10500 standard) to every home on round the clock (24X7) basis in area X and Area XIII of Chennai City.
ii. 100% house connections with metering.
iii. Equitable, sustainable and people-centric service provision with focus on the urban poor and middle-income people.
iv. Reduce citizens and household investments on individual household level water tank/reservoir, sump, motor pump, water filter and other private arrangements.
v. Implementation of Internet of Things (loT) driven smart water management for real time operation & management of the system.

10.2.4. Scope of Services of Consultant

The major scope for Administrative Block X & XIII, under Chennai Metropolitan Water Supply and Sewerage Board are:

i. Survey and investigations.
ii. Planning and design for converting the existing intermittent water supply to 24 X7 in all water distribution system of Areas -X and XIII of CMWSSB.
iii. Preparation of Detailed Project Report (DPR).
iv. Preparation of technical specifications and tender documents for the works.
v. Assisting the employer in bidding process and recommendation of the right bidder for award of the works contract for 24 X 7 sustainable water supply.
vi. To conduct Environment and Social Impact Assessment (ESIA) and prepare the Environment and Social Management Plan (ESMP).
vii. Services covering approval of detailed designs, coordination with the contractor, works monitoring, assist in dispute resolution, specialized techno-commercial advice during execution of work for ensuring completion of the work in a time bound manner.
viii. Assist the employer in commissioning of the works.

10.2.5. Project Components:

As per the study plan and design conducted the broad component of the project for administrative bock 10 & 13 are provided below:

10.2.6. Design of Transmission Main:

Table 11.4: Transmission Mains

S.I	Start Node	Stop Node	Length	Material	Additional required Diameter (in mm)
1	Nemmeli DSP	Akkarai Pumping Station	22273	DI-K9	1000
2	Akkarai Pumping Station	Thiruvanmiyur (New) WDS	9642	DI-K9	-
3.	Akkarai Pumping Station	JI	2720	DI-K9	1100
4.	JI	Valachery (Old) WDS	11942	DI-K9	1200
5.	Velachery (Old) WDS	J2	818	DI-K9	1000
6.	J2	Velachery(New) WDS	920	DI-K9	-
7.	J2	J3	1215	DI-K9	800
8.	Velachery (Old) WDS	Pallipatu WDS	5797	DI-K9	500
9.	J3	J4	3698	DI-K9	-
10	J4	Pallipatu WDS	800	DI-K9	-
11	J4	MRC Nagar Nandnam	6240	DI-K9	-

10.2.7. Pump Design Details

Pumps are designed to provide water from WDS to the operational zone, each pump set consists of three pumps out of which one remains as stand by.

Table 11.5: Pumping Details

S.I	WDS Name	Required Pump detail (Total HP)
1.	Pallipatu WDS	1460
2.	Thiruvanmiyur (New) WDS	250

10.2.8. Designed Distribution Pipe Details

Table 11.6

S.N	Diameter (In MM)	Total(Proposed-Pallipatu WDS (in Meter)	Total Proposed - Thiruvanmiyur WDS (in Meter)	Total
1	100	58377	12312	70689
2	110	0	0	0
3	125	0	0	0
4	150	19117	2871	21988
5	200	5909	1647	7556
6	250	3890	209	4099
7	300	579	140	719
8	350	50	987	1037
9	400	608	0	608
10	450	3560	266	3826
11	500	1230	0	1230
12	600	1718	230	1948
13	700	0	0	0
14	750	0	0	0
15	800	0	0	0
16	900	0	0	0
17	1000	0	0	0
	Grand Total	95038	18662	113700

10.3. LEGAL AND REGULATORY ASPECTS

This section explains the legal & regulatory requirements under different acts / rules and policies for social and environment safeguards. It also identifies the requirement of permits / licenses in the project under different rules /regulation at different stages of the project period. Further, an outline of the environmental and social safeguards policies of the World Bank with applicability to the project has been presented.

The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. These policies provide guidelines for Bank and borrower in the identification, preparation, and implementation of programs and projects. They also provide a platform for the participation of stakeholders in project design. In essence, the safeguard policies ensure that environmental and social issues are evaluated in decision making, help reduce and manage the risks associated with the project and provide a mechanism for consultation and disclosure of information.

10.3.1. Act & Policies

The different acts and policies which are most relevant in the context of this project are provided in the below table:

Table 11.7: Relevant Act and Policies

Act/Policies	Concerned Authority	Responsibility
Environment Protection Act, 1986	MoEF & CC	Client/Contractor
The Forest (Conservation) Act	MoEF&CC	Client/Contractor
Air (Prevention and Control of Pollution) Act, 1981	TNPCB	Contractor
Water Prevention and Control of Pollution) Act, 1974	TNPCB	Contractor
Noise Pollution (Regulation and Control Rules) 2000 and amendments	TNPCB	Contractor
Construction and Demolition Waste Management Rules, 2016	TNPCB	Contractor
Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2015	TNPCB	Contractor
Municipal Solid Waste Management Rule 2016	TNPCB	Contractor
Central Motor Vehicle Rules, 1989 and amendments till date	District / Regional Transport Office	Contractor
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Archaeological Survey of India (ASI)	Contractor
Building & Other Construction workers (Regulation of Employment &	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor

Act/Policies	Concerned Authority	Responsibility
Condition of Service) Act, 1996		
Contract Labour (Regulation and Abolition) Act, 1970	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor
The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor
The Child Labour (Prohibition and Regulation) Act, 1986	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor
Minimum Wages Act, 1948	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor
Workmen Compensation Act, 1923	Chief Labour Commissioner, Govt. of Tamilnadu	Contractor

Note: In addition to the above Acts and Rules, the Contractor must comply with the Factories Act, 1948; Employees State Insurance Act, 1948 etc.

10.3.2. Social Policy and Regulation

In this section, the policies and legislations of the Government of India are briefly discussed, that may have bearing on the Project. Later, at the end of the section, the World Bank Safeguard Policies and ESS are presented.

The Right to Fair Compensation and Transparency in Land Acquisition, Resettlement and Rehabilitation (RFCTLAR&R) Act, 2013, enacted by the Government of India is the latest legislation. This is in force and supersedes all other old acts for land acquisition and to determining R&R activities.

10.3.3. World Bank Operational Policy (OP)

Table 11.8: Operational Policy

Operational Policy	Objectives and Purpose
OP- 4.01 Environmental Assessment	The objective of this policy is to ensure that the Bank financed project is environmentally sound and sustainable.

OP- 4.04 Natural Habitat	The policy prioritises conservation of Natural Habitats for long term project sustainability.
OP- 4.11 Cultural property	The policy emphasises preservation of cultural property in the project area, restoration of archaeological monuments and unique environmental features.
OP– 4.12 Involuntary displacement and resettlement	The policy objective is to avoid involuntary displacement and resettlement as far as practicable by exploring viable alternatives. It also emphasises approach to improve the living standards of the displaced people, encourages community participation in implementation of resettlement activities and help the affected people regardless of their legal status on title of the land.
OP- 4.36 Forestry	The policy gives importance to restoration of forest eco-system, which entails management and conservation methods of forest flora fauna and wildlife.

10.3.4. WB-Environment Social Standard (ESS)

Table 11.9: Environmental Social Standard

Environment Social Standards	Applicability
ESS1: Assessment and Management of Environmental and Social Risks and Impact	Applicable
ESS2: Labor and Working Conditions	Applicable
ESS3: Resource Efficiency and Pollution Prevention and Management	Applicable
ESS4: Community Health and Safety	Applicable
ESS5: Land Acquisition, Restrictions on Land use and Involuntary Resettlement	Will be confirmed during final ESIA report submission.
ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Applicable
ESS8: Cultural Heritage	Not Applicable
ESS10: Stakeholder Engagement and Information Disclosure	Applicable

10.4. ENVIRONMENT AND SOCIAL BASELINE

Details of the baseline environmental parameters are required for decision making for the project design, implementation and operation from the environmental point of views. The data has been collected from the primary surveys and secondary sources. It is essential to establish the base line environmental status of the physical, natural and socio-cultural environmental parameters along the project and within the project influence area of 5 Kms.

The ESIA shall cover, the environmental and social impacts due to the project, concerning construction-related environmental and social impacts. The findings of ESIA will guide the effective development of the specific ESMP and facilitate the implementation of safeguard measures appropriately.

10.4.1. Scope of the ESIA/ESMP Study

The scopes of the EIA/EMP study are: -

- Baseline status of environmental and social parameters.
- Identification of the potential impacts during pre-construction, construction and operation phases.
- Developing mitigative measures to sustain and maintain the environmental scenario.
- Providing compensatory developments wherever necessary.
- Preparation of Environmental and Social Management Plan.
- Household surveys and focus group discussion.
- Review of policies and legal framework.

10.4.2. Standard methodology for ESIA study

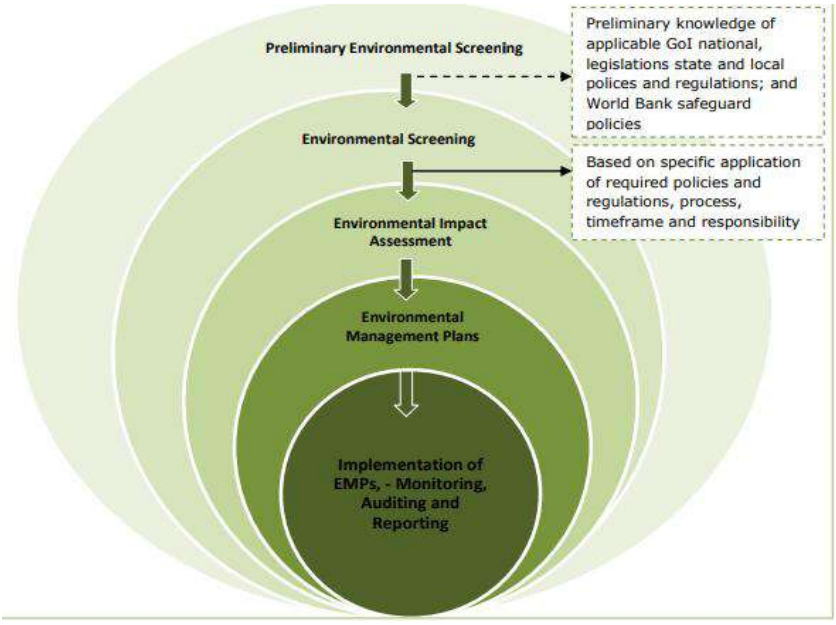


Fig 11.2- Standard Methodology

The area of direct influence is confined in a linear fashion along the corridor, where the construction activities take place. The area of direct influence of 1 Km on either side of PRoW has been considered. Secondary data have been collected within 05 km aerial distances.

10.4.3. ENVIRONMENT AND SOCIAL BASELINE

Meteorology

Chennai has a tropical wet and dry climate. The city lies on the thermal equator and is also on the coast, which prevents extreme variation in seasonal temperature. Meteorological data like monthly total rainfall, maximum & minimum temperature, wind rose and relative humidity of the Chennai for a period of Jan 2011 to Dec 2023 collected from IMD. The collected IMD data depict that the hottest part of the year is in the month of May with maximum temperature varies 41.0°C to 43.0°C. The coolest part of the year is January, with minimum temperature varies 18.7°C to 20.6°C.

Seismicity

As per seismic zoning map of India Tamil Nadu and Chennai are in Moderate Seismic Zone (Zone III–BIS: 1893 (2001)).The last reported tremor in Chennai was on 12 February 2019 due to earthquake measuring 5.1 Richter (Source: IMD) with epicentre 10 km deep in Bay of Bengal.

Topography

Chennai is located on the South–Eastern coast of India in the North–Eastern part of Tamil Nadu. It is situated on a flat coastal plain that's why it is also known as the Eastern Coastal Plains. The study area lies between Latitude of 13° 10' N to 12° 49' N and Longitude of 80° 10' E to 80° 14' E. Chennai is a low-lying area and the land surface is almost flat. It rises slightly as the distance from the seashore increases but the average elevation of the city is not more than 3 m above mean sea-level, while most of the localities are just at sea-level and drainage in such areas remains a serious problem.

Land Use

Land use along the alignment of area X and area XIII is predominantly mixed residential along with few commercial/industrial patches.

Soil and Geology

The recent sandy soil (Entisols) is immature soils and is predominant in the city and it occurs in small patches. The major soil in this region belongs to Alfisols and Entisols. Inceptisols and Vertisols are found in a very limited area only. These soils are generally poor in soil nutrients. They have medium to high permeability. They have low water holding capacity except in patches of clayey soils.

The geological formations in the region are from the Archaeans to the recent Alluvium (Table 4.5). The geological formations can be grouped into three units, namely (i) the

Archaean crystalline rocks, (ii) consolidated Gondwana with Tertiary sediments and (iii) the recent Alluvium. Most of the geological formations are concealed by the alluvial materials, except for a few exposures of crystalline rocks like charnockites along the railway track in Guindy area. The thickness of Gondwana shales is highly variable in the city.

Air Environment

Air pollution is caused due to both natural and manmade processes. The main source of air pollution is human induced/manmade, which includes industrialization and its by products, burning of timber, heat and light, rapid urbanization, vehicular pollution, plastics, burning of polymers and processing of various materials emitting obnoxious gasses, generation of smoke, dust and fine respirable particles due to construction activity and rapid burning etc. Vehicular emission is major source of air pollution now-a-day. Presently some patches of study area are in the locality of heavy traffic movement particularly at congested places i.e at major market areas and junctions, which may impact the ambient air quality of the area. During construction stage of the project, temporary air pollution arises due to movement of construction vehicles, dust emission due to excavation and demolition etc.

Ambient air quality is the most significant parameter that is required to quantify the impact on the natural and biophysical environment. The air quality parameters considered for the construction phase includes Particulate Matter 10 (PM10), Particulate Matter 2.5 (PM2.5), Nitrogen Oxides (NOx) Sulphur Di-oxide (SO2), and Carbon monoxide (CO).

Table 11.10: Ambient Air Quality Standard

Parameter	Technique	Technical Protocol	NAAQM Standards (24 hrs basis)
Particulate Matter (Size less than 10µm) or PM10, µg/m3	Respirable Dust Sampler (Gravimetric method)	IS-5182 (Part-IV)	100
Particulate Matter (Size less than 2.5µm) or PM2.5 , µg/m3	PM 2.5 APM 550 Fine Particle Sampler (Gravimetric method)		60
Sulphur Dioxide (SO2), µg/m3	Improved West and Gaeke Method	IS-5182 (Part-II)	80
Nitrogen Dioxide	Jacob and Hochheiser	IS-5182 (Part-IV)	80

Parameter	Technique	Technical Protocol	NAAQM Standards (24 hrs basis)
(NO2), µg/m3			
Carbon Monoxide (CO), mg/m3	Non – dispersive Infrared (NDIR) Spectroscopy	IS-5182 (Part-IV)	4

Water Resources

As the city lacks a perennial water source, catering to the water requirements of the population has remained an arduous task. Ground water levels from Jan 2022 to Jan 2023 were up to 10m below ground in pre-monsoon as well as post-monsoon seasons and rise in water level of up to 2m to 4m in all observation wells in Chennai district between pre-monsoon and post-monsoon months. From May 2016 and May 2022, the ground water levels were up to 4m in 77% of observation wells. (Source: Groundwater Yearbook of Tamil Nadu and UT Puducherry, 2022 – 23, Central Groundwater Board).

Drainage

Adyar River originates at the confluence (Thiruneermalai) of two streams that drains the upstream area of Chembarambakkam tank. It is a small river of 42 km length and a catchment of 800 Sq. km. The river carries flow all through 365 days of a year with an average discharge of 89.43 MCM/Year at Kathipara cause way. It drains the southern part of the district and remains flooded during monsoon. During the high tides, the backwater from the Bay of Bengal enters inland up to 3 to 4 km.

Cooum or Koovum (sometimes called Triplicane River) is the other main river flowing through the central part of the district and carries only drainage water, which is highly polluted. It originates from the surplus waters from the Cooum tank in Tiruvallore taluk and the tanks, which are in enroute, discharge their surplus water into the river during flood season. The flow of Cooum River at Korattur is 40.2 MCM/year for an average duration of 31 days in a year.

Otteri nala is another small stream flowing in the northern part of the city. Buckingham canal is the man made one for navigation purposes earlier, but now it acts as sewerage carrier in the city.

Noise

Noise can be defined as any sound that is undesirable because it interferes with speech and hearing and is intense enough to damage hearing or is otherwise annoying. Noise impacts can be of concern during construction phase.

Noise quality is an issue particularly at congested locations due to heavy traffic jams, horns and slow-moving traffic. The educational institutions, health care facilities, Court

etc along the project corridor comprise sensitive receptors with respect to noise pollution.

The Ambient Noise Quality Standards with respect to noise have been stipulated by Govt. of India vide Gazette Notification dt.14.02.2000.

Table 11.11: Ambient Noise Standards

Area Code	Category of Area	Limits in dB (A), Leq	
		Day time	Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone*	50	40

Solid Waste Management

In general, the main type of domestic solid waste generated from the household are food waste, Paper and polythene and waste generated from daily household activities. As the entire project area falls under urban/municipal area, almost every household uses a dust bin as the primary storage of waste and thereafter waste/garbage is being collected by the waste collector on daily basis.

Ecological Environment

Ecological resources are among the most important resources impacted by the infrastructure projects. The detailed baseline study of the ecological resources is essential to estimate the magnitude of potential impacts and to avoid or mitigate any loss caused by the proposed project.

No rare or endangered species of trees were noticed during field studies. The number of tree felling will be updated during the site clearance. For the affected trees as a compensatory measure, 1:10 trees shall be planted (as directed by the High court of Madras vide G.O no 704, dated 03/08/2010).

To minimize tree cutting it is proposed to transplant young trees to the extent possible. Local forestry officials will be consulted to transplant the trees at suitable locations.

Necessary mitigation measure will be implemented to reduce the impacts of project on overall ecology.

Socio-Economic Environment

Demography of Chennai: Chennai, along with Mumbai, Delhi and Kolkata, is one of the few Indian cities that are home to a diverse population of ethno-religious communities. According to the 2011 census Chennai then had a total population of 67,48,026 at a density of 15,840 per square kilometre spanning across an area of 426 km^2; the sex

ratio was 1025 females per 1000 males and literacy rate was 90.33%. The most widely spoken languages are Tamil and English.

Utilities: The project alignment (pipeline distribution) will pass through the urban area. The alignment will cross drains, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, traffic signals and streetlights etc. As per field study, no utilities will be impacted, in case any utility will be impacted during construction phase, suitable measures will be taken care in collaboration with concerned department.

Physical Cultural Resources (PCR): No protected archaeological monuments/sites nor heritage assets are located on or along the proposed alignment. Sensitive receptors which are located within either side of the alignment, mostly are of having religious and cultural values. No sensitive receptor and PCRs will be demolished.

10.5. POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION

During Planning and Design phase the project, construction details, materials of construction etc. ultimately decide the impacts during later phases are evaluated. Most of the impacts are occurred during construction and operation phase. While some of the construction phase impacts are temporary, others are permanent. Operation phase impacts are continuous in nature. The important criteria for identification of impact are the identification of the impact zone. For present screening studies, a direct Corridor of Impact (COI) within 500 m of pipeline distribution channel has been considered.
Environmental and Social parameters are broadly classified into three groups.

a) **Physical Environment includes** Water Resources, Water Quality, Air Quality, Noise and Land environment etc.
b) **Biological Environment includes** Terrestrial and aquatic biodiversity and Roadside Plantation etc.
c) **Social Environment includes** Employment, Agriculture, Housing, Culture etc.

10.5.1. Environmental & Social Impacts and Mitigation Measures

The assessment of potential environmental and social impact consists of comparing the expected changes in the environment with or without the project. The analysis predicts the nature and significance of the expected impacts. The details of potential impacts & mitigation measures are mentioned in the below table.

Table 11.12: potential impacts & mitigation measures

Sl. No.	Parameters	Potential Impact	Mitigation Measures Suggested
1	Topography and Soil	• Cut and fill operations during pipeline laying and distribution.	• The pipeline passes through mostly plain terrain and no substantial cut and fill operations are planned. Minimum cut will be ensured, and the cut material will be reused as per the suitability for backfilling.
		• Borrow earth	• Borrow earth will be procured from approved area. • IRC guidelines will be followed during excavation. • Topsoil will be preserved & stockpiled properly. • Borrow area redevelopment plan will be submitted prior to operation of the same. • Necessary clearance needs to be obtained prior to operation of the borrow area.
		• Quarries	• Operational and government licensed quarry have been identified, which will be used for procuring material. • Pollution Control Measures should be taken care. • Necessary clearance needs to be obtained prior to operation of the borrow area.
2	Air Environment	• Generation of dust	• Sprinkling of water a. Earth handling site. b. Borrow area. c. Construction site. d. Access road route • Air pollution control measures a. PPE for Workers. b. Necessary clearance needs to be obtained

Sl. No.	Parameters	Potential Impact	Mitigation Measures Suggested
			prior to operation of the borrow area. • Regulations of construction timings near sensitive receptors and settlements.
		• Gaseous Pollution	• Vehicles and machineries will be regularly maintained to conform to the emission standards. • Use of PPE by workers engaged in construction activities. • Responsibility of contractors and supervising officers that the workers use the PPE.
3	Noise Environment	• Noise level may likely to increase during construction phase	• Properly maintained equipment to be used. • Noise levels of machineries used shall confirm to relevant standard prescribed in Environment (Protection) Rules, 1986 • Ear plugs and muffs will be used by the workers as per requirement during construction activities. • Regulation of timing of construction work generating noise pollution near the sensitive areas
4	Water Environment	• Drainage pattern	• All the water bodies will be crossed suitably without affecting their original course and flow. • Stabilizing and turfing of slopes along the water bodies (If required).
		• Siltation of water bodies	• Silt fencing around water bodies during construction to avoid silt laden runoff

Sl. No.	Parameters	Potential Impact	Mitigation Measures Suggested
			entering water body (If required) • No solid/food waste will be dumped in or near the water bodies or rivers
		• Flooding due to siltation of drainage channel	• Excavated earth and other construction materials should be stored away from water bodies
		• Water for construction	• Water surface would be selected so that local availability is not affected.
		• Contamination from waste	• Provision of septic tanks to prevent any untreated sewage discharge from construction worker camps.
		• Contamination from fuel and waste	• Vehicle maintenance will be carried out in a confined area, away from water sources and it will be ensured that used oil or lubricants are not disposed to water courses
		• Sanitation and water use in construction camps	• Construction camp will be organized in a planned manner. • Proper sanitation facilities including toilets should be provided. • Camps will have separate water supply facilities so that local water sources are not affected.
5	Land Environment	• Loss of topsoil	• Topsoil on stripping shall be removed and stockpiled on sides to be used on the side slopes, for top cover of borrow areas and for plantation pits
		• Loss of topsoil from borrowing	• Arable lands will be avoided for earth borrowing. If

Sl. No.	Parameters	Potential Impact	Mitigation Measures Suggested
			needed, topsoil will be separated and refilled after excavation
		• Borrowing of fill material	• Excavation from pre-selected locations. After excavation • the borrow pits will be dressed to match with the surrounding
6	Waste Generation	• Waste generated from labor camp. • Waste oil released from machineries/vehicles/DG sets etc. • Generation of C&D waste • Overburden soil/earth from trench cutting	• The contractor shall provide garbage bins in the camps and ensure that these are regularly emptied and disposed of hygienically. • Toilets with septic tanks and soak pits to be provided in the labor camp. • Waste oil must be stored properly and disposed through authorized vendor. • Necessary precautionary measures to prevent the wastewater generated during construction from entering into streams, water bodies or the irrigation system must be taken care. • Avoid construction works close to the streams or water bodies during monsoon. • C & D waste and overburden will not be dumped in any forest/green area.
7	Biodiversity	• Loss of Tree and hunting of animals	• Minimum tree cutting should be ensured and with due permission by the forest department. • No animals will be hunted and harmed by the construction workers.
8	Rehabilitation and	• Land Acquisition	• Land acquisition not applicable.

Sl. No.	Parameters	Potential Impact	Mitigation Measures Suggested
	Resettlement (R & R)	• Loss of Structures and PCRs	• Proper compensation will be paid as per norms if required.

10.6. ENVIRONMENT AND SOCIAL MANAGEMENT PLAN

The environmental and social management measures shall be implemented during the various stages of the project viz: Pre-construction Stage, Construction Stage and Operational Stage. The environmental and social management plan for the project is described below.

10.6.1. Objectives

The Environmental and Social Management Plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operational phases of the project to eliminate adverse environmental impacts, to offset them, or to reduce them to acceptable levels. The main aim of the Environmental and Social Management Plan is to ensure that the various adverse impacts are mitigated, and the positive impacts are enhanced.

Pre-Construction Stage

Prior to the contractor mobilization, the PIU will ensure that a hindrance free corridor is handed over to enable the start of project work. Clearance involves for the following activities:

- Felling and removal of trees, which should be minimal with due permission.
- Relocation of common property resources and community assets like temples, telephone poles, electric poles and hand pumps etc.
- Modification (if any), of the contract documents by the Engineer of the PMC.
  Pre-construction stage involves mobilisation of the contractor and the activities undertaken by the contractor pertaining to the planning of logistics and site preparation necessary for commencing construction activities. The activities include:
- Joint field verification of ESMP by the Environment Expert of the PMC and Contractor.
- Identification and selection of material sources (quarry and borrow material, water, sand etc).
- Procurement of construction equipment / machinery and other construction equipment.
- Selection, design and layout of construction areas and labour camps etc.
- Apply for and obtain all the necessary clearances/ NOC's/ consents from the agencies concerned.
- Planning traffic diversions and detours including arrangements for temporary land acquisition (if required).

Construction Stage

Activities by the Contractor:

Construction stage is the most crucial stage in terms of activities that require careful management to avoid environmental and social impacts. There are several other environmental and social issues that have been addressed as part of good engineering practices.

Activities by the PIU/PMC

The PIU/PMC shall be involved in the smooth execution of the project and assisting the contractor during this phase. Their work shall include but not limited to:

- Monitoring and guiding the contractor on adopting good environmental and engineering practices.
- Arrangement of plantation through the Forest Department.
- Arranging training to the contractor and other stakeholders according to the needs arising; and
- Implementation of Environment and Social Management Plan.
- Making changes in the design if need so arises.

Operation Stage

The operational stage involves the following activities by PIU:

- Monitoring of environmental conditions through approved monitoring agency; and
- Monitoring of operational performance of the various mitigation/enhancement measures carried out during project cycle.

10.7. STAKEHOLDER ENGAGEMENT/CONSULTATION

Public Consultations were conducted to assess the perception of the people about the proposed project. The stakeholders selected included shop keepers, residents, owners/ workers of local commercial establishments, etc. Issues and concerns of the people about the project were discussed and their perception for the same were documented.

The consultations were conducted based on the following objectives.

- Overall features of the project and asked for the feedback of the people.
- Social and Environmental concerns.
- Suggestion to improve safety and environmental protection.

10.8. GRIEVANCE REDRESSAL MECHANISM

The Grievance Redressal Mechanism (GRM) is a formal or informal process that allows people to raise complaints or disputes and get them resolved. The GRM will be in place to redress social, environmental or any other project related grievances.

Persons having any grievances, will have the flexibility of conveying grievances/ suggestions by dropping grievance redress/suggestion forms in complaints/ suggestion boxes or through telephone hotlines at accessible locations, by e-mail, by post, or by writing in complaints register in PIU or CMWSSB offices.

Effective grievance redressal mechanism gives an opportunity to the organization to implement a set of specific measures to ensure good governance accountability and transparency in managing and mitigation of environmental and social issue of a particular project. This consists of defining the process for recording/receiving complaints and their redressal in respect of environmental and social matters.

PIU Safeguards officer will have the responsibility for timely grievance redress on safeguards for registration of grievances, related disclosure, and communication with the aggrieved party.

10.9. INSTITUTIONAL ARRANGEMENT

The Monitoring and Evaluation of the management measures envisaged are critical activities in implementation of the Project. The rationale for a reporting system is based on accountability to ensure that the measures proposed as part of the Environmental and Social Management Plan get implemented during the project cycle.

To manage and oversee implementation of the project, a dedicated State Project Management Unit (SPMU) and two Project Implementation Units (PIU) will be constituted.

Project Monitoring Cell will be set up in the PIU, which will act as the Contract Management Unit (CMU) and will be responsible for execution of the Projects.

10.9.1. Technical set up

It is proposed that an Environmental and Social Management Plan Implementation Unit (ESMP-IU) will be set up within PIU. The ESMP-IU will have an Environmental and Social Expert (ESE) who will be responsible for monitoring the implementation of the ESMP with the assistance of the Environmental and Social Safeguard Specialist of the Project Management Consultant (PMC) and the Contractor.

10.9.2. ESMP IMPLEMENTATION BUDGET

Component wise budgetary provision is provided in the ESMP report.

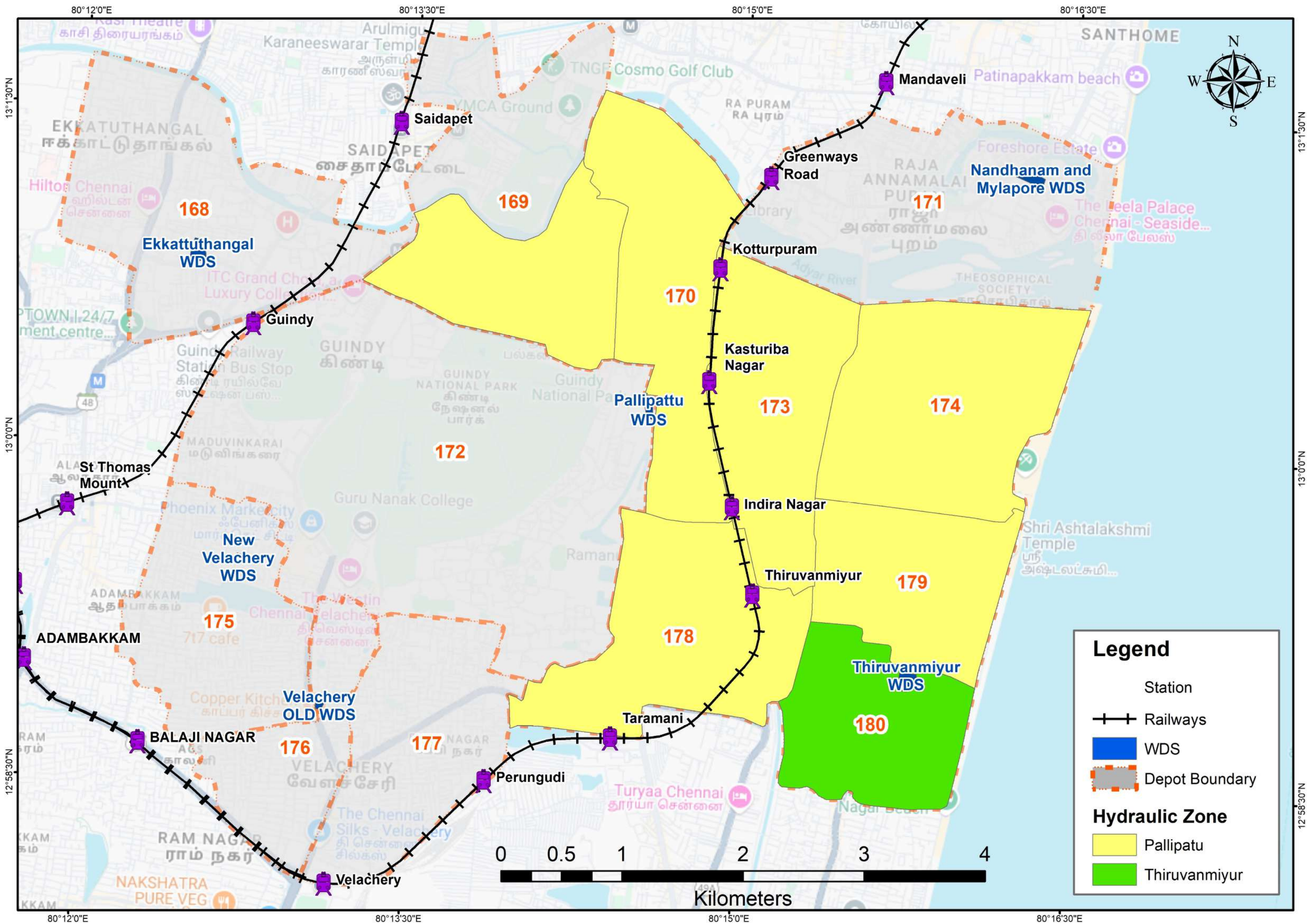
Chennai Metropolitan Water Supply and Sewerage Board

DRAWINGS & MAPS
For
Implementation of Continuous Water Supply in Pallipatu WDS & Thiruvanmiyur WDS under Area XIII of Chennai City under Hybrid Annuity Model (HAM)

RFP VOLUME – III
DRAWINGS & MAPS

VOLUME - III

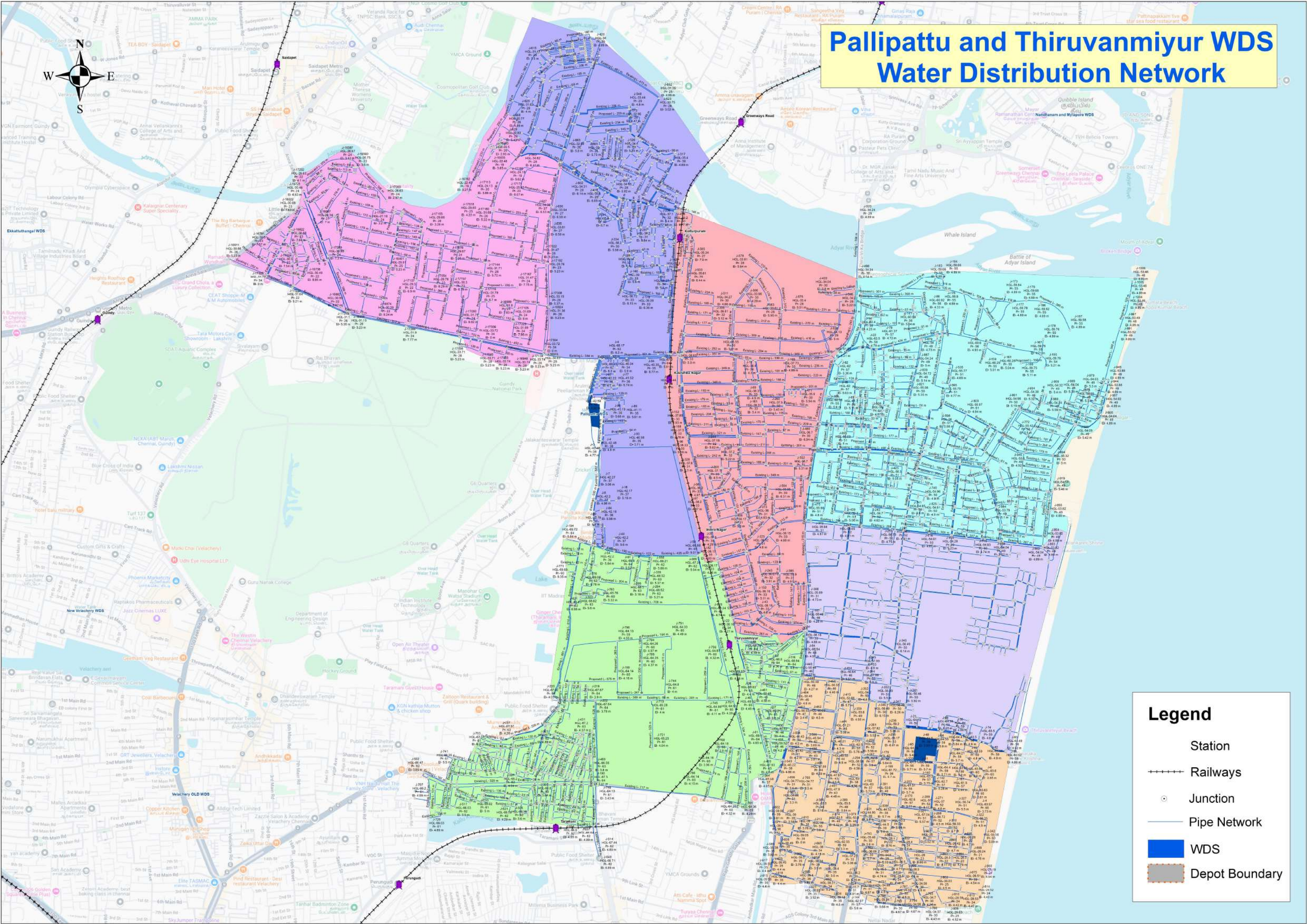
PROJECT AREA MAP (PALIPATTU & THIRUVANMIYUR WDS)


80°12'0"E
80°13'30"E
80°15'0"E
80°16'30"E
13°1'30"N
13°0'0"N
12°58'30"N
N
S
E
W
Saidapet
Guindy
St Thomas Mount
ADAMBAKKAM
BALAJI NAGAR
Velachery
Perungudi
Taramani
Pallipattu WDS
Kotturpuram
Kasturiba Nagar
Indira Nagar
Thiruvanmiyur
Mandaveli
Greenways Road
Nandhanam and Mylapore WDS
Ekkattuthangal WDS
New Velachery WDS
Velachery OLD WDS
Thiruvanmiyur WDS
168
169
170
171
172
173
174
175
176
177
178
179
180
SANTHOME
Patinapakkam beach
Cosmo Golf Club
YMCA Ground
RA PURAM
RAJA ANNAMALAI PURAM
Foreshore Estate
THEOSOPHICAL SOCIETY
Adyar River
GUINDY NATIONAL PARK
Guindy National Park
Guindy Railway Station Bus Stop
Guru Nanak College
Phoenix Marketcity
Shri Ashtalakshmi Temple
Turyaa Chennai
Nagar Beach
0 0.5 1 2 3 4
Kilometers
Legend
Station
Railways
WDS
Depot Boundary
Hydraulic Zone
Pallipatu
Thiruvanmiyur

VOLUME - III

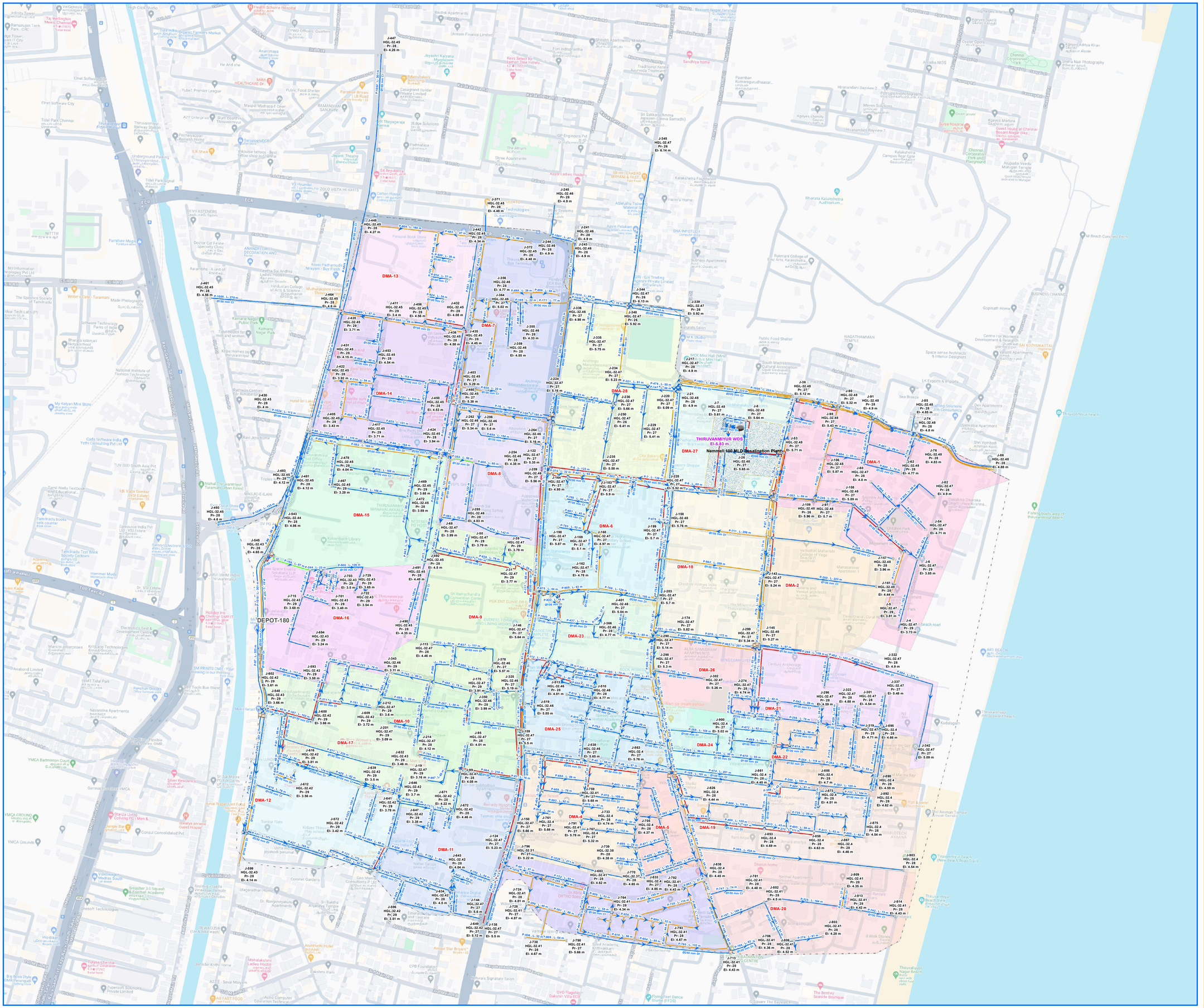
PALIPATTU WDS MAP

Pallipattu and Thiruvanmiyur WDS
Water Distribution Network



VOLUME - III

THIRUVANMIYUR WDS MAP

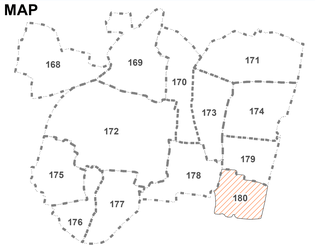


N

W E

S

KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- Replace PVC
- WATER DISTRIBUTION STATION

DMA

- DMA-1
- DMA-2
- DMA-3
- DMA-4
- DMA-5
- DMA-6
- DMA-7
- DMA-8
- DMA-9
- DMA-10
- DMA-11
- DMA-12
- DMA-13
- DMA-14
- DMA-15
- DMA-16
- DMA-17
- DMA-18
- DMA-19
- DMA-20
- DMA-21
- DMA-22
- DMA-23
- DMA-24
- DMA-25
- DMA-26
- DMA-27
- DMA-28

ADMIN BOUNDARY

DEPOT BOUNDARY (AREA-XIII)

Row Labels	100	150	200	250	300	350	450	600	700	Grand Total
Existing	21351	6011	3734	1740	3507	261	361	26	54	37050
CI	12729	1675	2235	238	1220					18097
DI	8622	4336	1499	1502	2287	261	361	26	54	18948
Proposed	1000	2611	464	209	140	987	266	230		5907
CI	1000	36								36
DI	1000	2575	464	209	140	987	266	230		5871
Replace		170								170
DI		170								170
Replace PVC	11307	90	1183							12580
DI	11307	90	1183							12580
Grand Total	33658	8882	5381	1949	3647	1248	627	256	54	55707

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 180/182 (OLD), AREA-XIII, CHENNAI

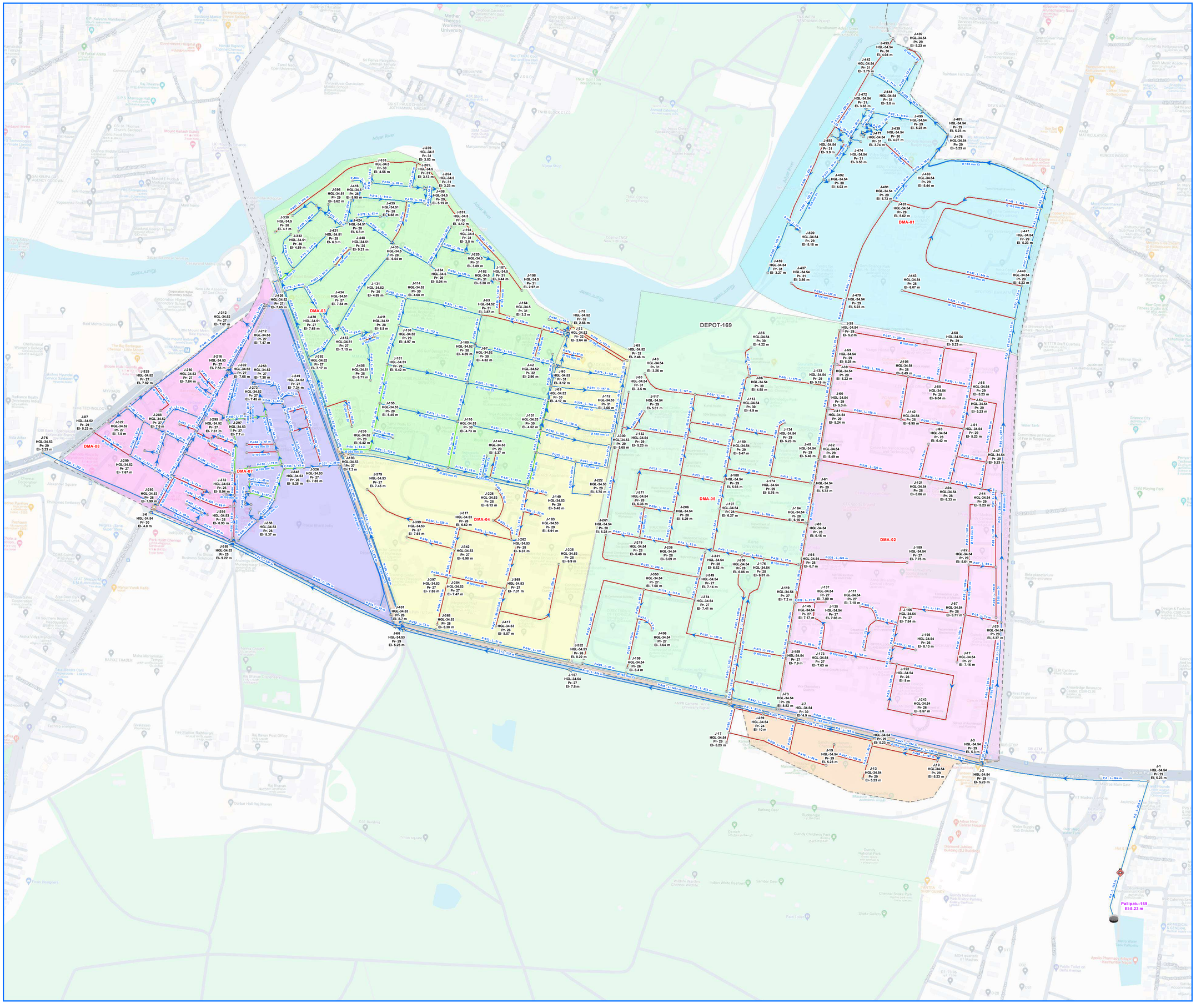
CONSULTANT:-

WATER CORPORATION OF ODISHA (WATCO)

Designed By:-	Signature/Stamp	Scale :-1:2,515
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 180/182 (OLD)

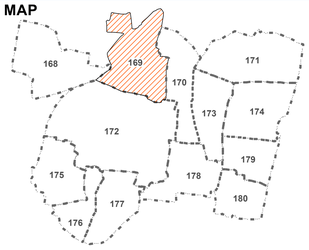
VOLUME - III

OZ NETWORK DRAWINGS / MAPS



N
W E
S

KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- WATER DISTRIBUTION STATION

DMA BOUNDARY

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08

ADMIN BOUNDARY

DEPOT BOUNDARY (AREA-XIII)

Depot-169 Abstract

Row Labels	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	Grand Total
Existing	11872	4994	1121	24	863	429	2096	982	364		209			103	23057
CI	11872	4994	931		863	429	2096	982	364						22531
DI			190	24							209			103	526
Proposed	17854	664	127	570											19215
DI	17854	664	127	570											19715
Replace		1125	77	3											1205
DI		1125	77	3											1205
Grand Total	29726	6783	1325	597	863	429	2096	982	364	0	209	0	0	103	43477

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

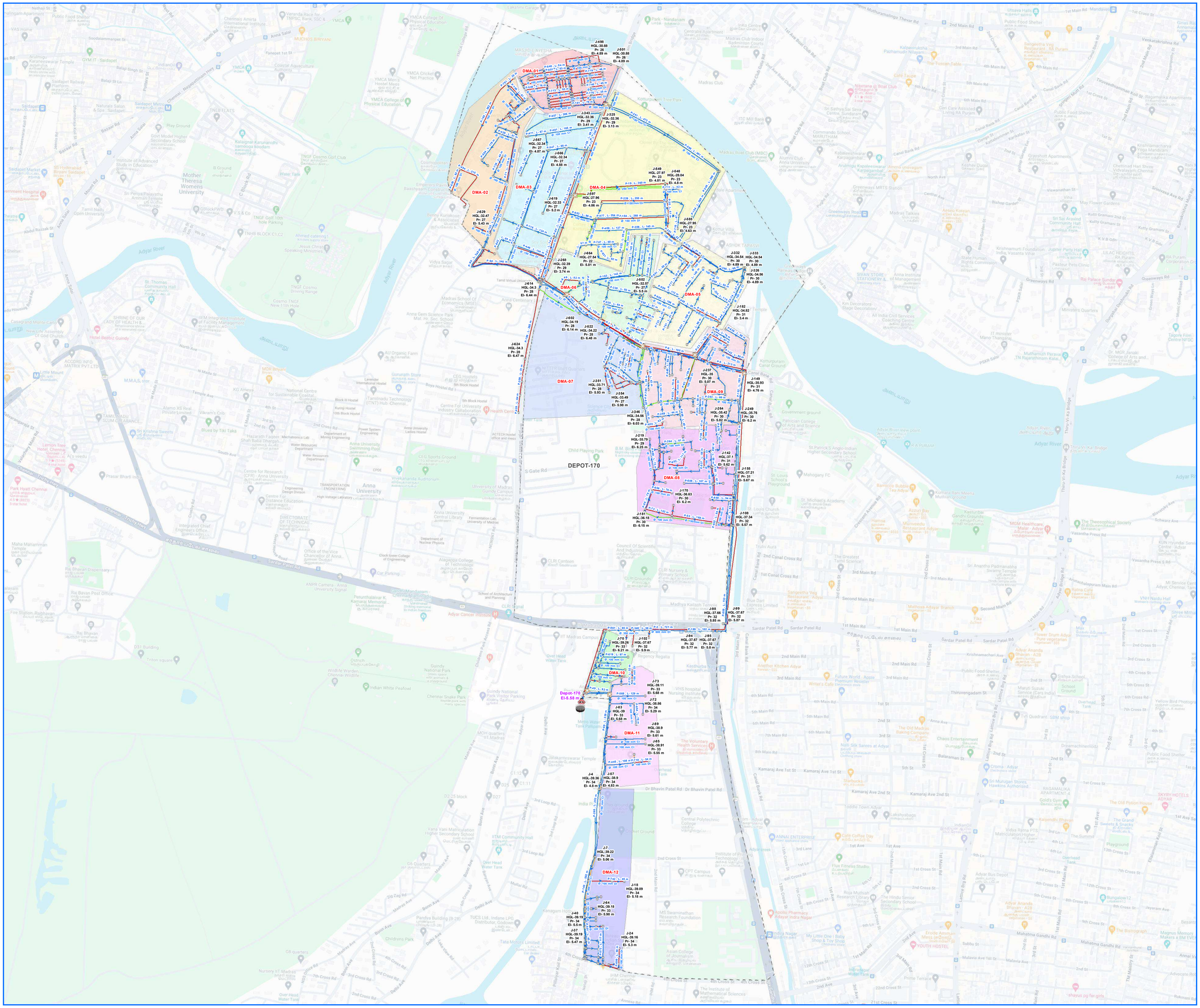
DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 169/171 (OLD), AREA-XIII, CHENNAI

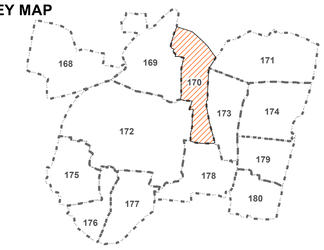
CONSULTANT:-

WATER CORPORATION OF ODISHA (WATCO)

Designed By:- S.M.DAS	*Signature/Stamp*	Scale :- 1:2,627
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 169/171 (OLD)



KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- Replace PVC
- WATER DISTRIBUTION STATION

DMA BOUNDARY

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08
- DMA-09
- DMA-10
- DMA-11
- DMA-12

ADMIN BOUNDARY

- DEPOT BOUNDARY (AREA-XIII)

Depot No-170 Abstract

Row Labels	100	150	200	250	300	350	400	450	500	600	Grand Total
Existing	18421	6935		43	1753	833	14				27999
CI	18421	6935		43	1753	463	14				27629
DI						370					370
Proposed	5808	5121	776	1142	74	50	608	527	408	1718	16232
DI	5808	5121	776	1142	74	50	608	527	408	1718	16232
PVC Replace	29	263									292
DI	29	263									292
Replace	945	649	6	727							2327
DI	945	649	6	727							2327
Grand Total	25203	12968	782	1912	1827	883	622	527	408	1718	46650

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

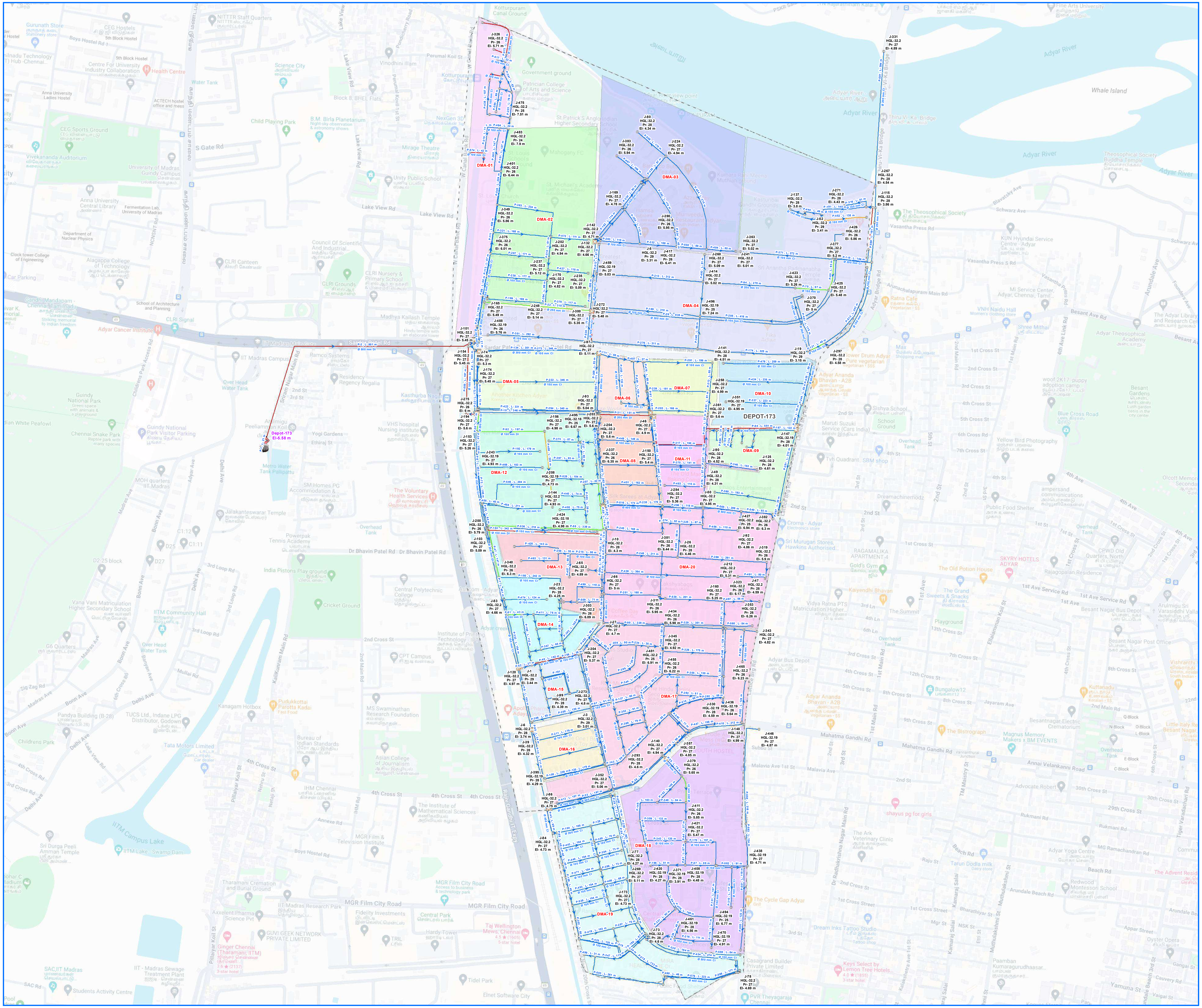
DRAWING TITLE :-

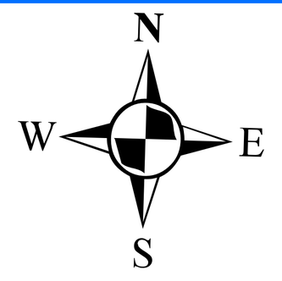
EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 170/172 (OLD), AREA-XIII, CHENNAI

CONSULTANT:-

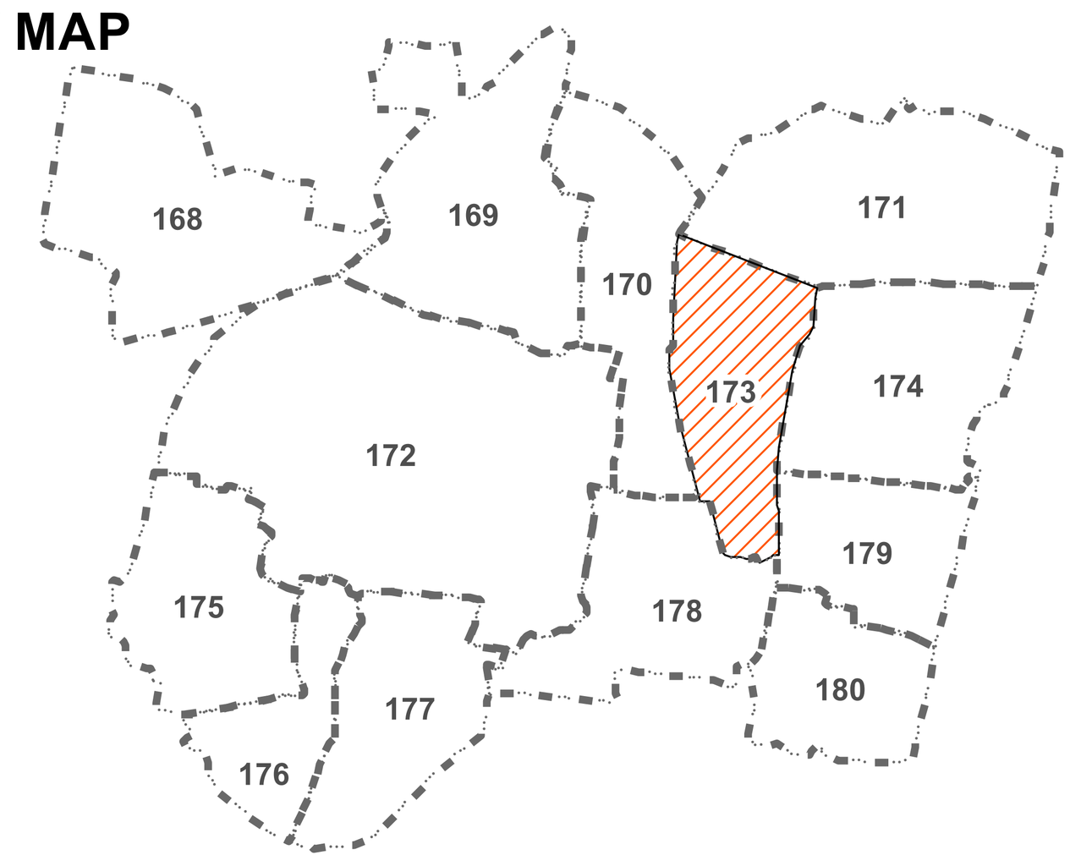
WATER CORPORATION OF ODISHA (WATCO)

Designed By:- S.M.DAS	Signature/Stamp	Scale :- 1:4,479
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 170/172 (OLD)





KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- Replace PVC

- WATER DISTRIBUTION STATION

DMA BOUNDARY

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08
- DMA-09
- DMA-10
- DMA-11
- DMA-12
- DMA-13
- DMA-14
- DMA-15
- DMA-16
- DMA-17
- DMA-18
- DMA-19
- DMA-20

ADMIN BOUNDARY

- DEPOT BOUNDARY (AREA-XIII)

Depot No-173 Abstract

Row Labels	100	150	200	250	300	400	450	500	600	700	Grand Total
Existing	**27400**	**11845**	**1200**	**1370**	**1375**	**35**	**649**	**1767**	**2945**	**40**	**48626**
CI	27400	11845	1200	1370	540	35	649	1767	2945	40	**47791**
DI					835						**835**
Proposed	**544**	**1287**	**387**		**30**			**822**			**3070**
DI	544	1287	387		30			822			**3070**
PVC Replace		**358**									**358**
DI		358									**358**
Replace		**968**	**280**	**416**							**1664**
DI		968	280	416							**1664**
Grand Total	**27944**	**14458**	**1867**	**1786**	**1405**	**35**	**649**	**2589**	**2945**	**40**	**53718**

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

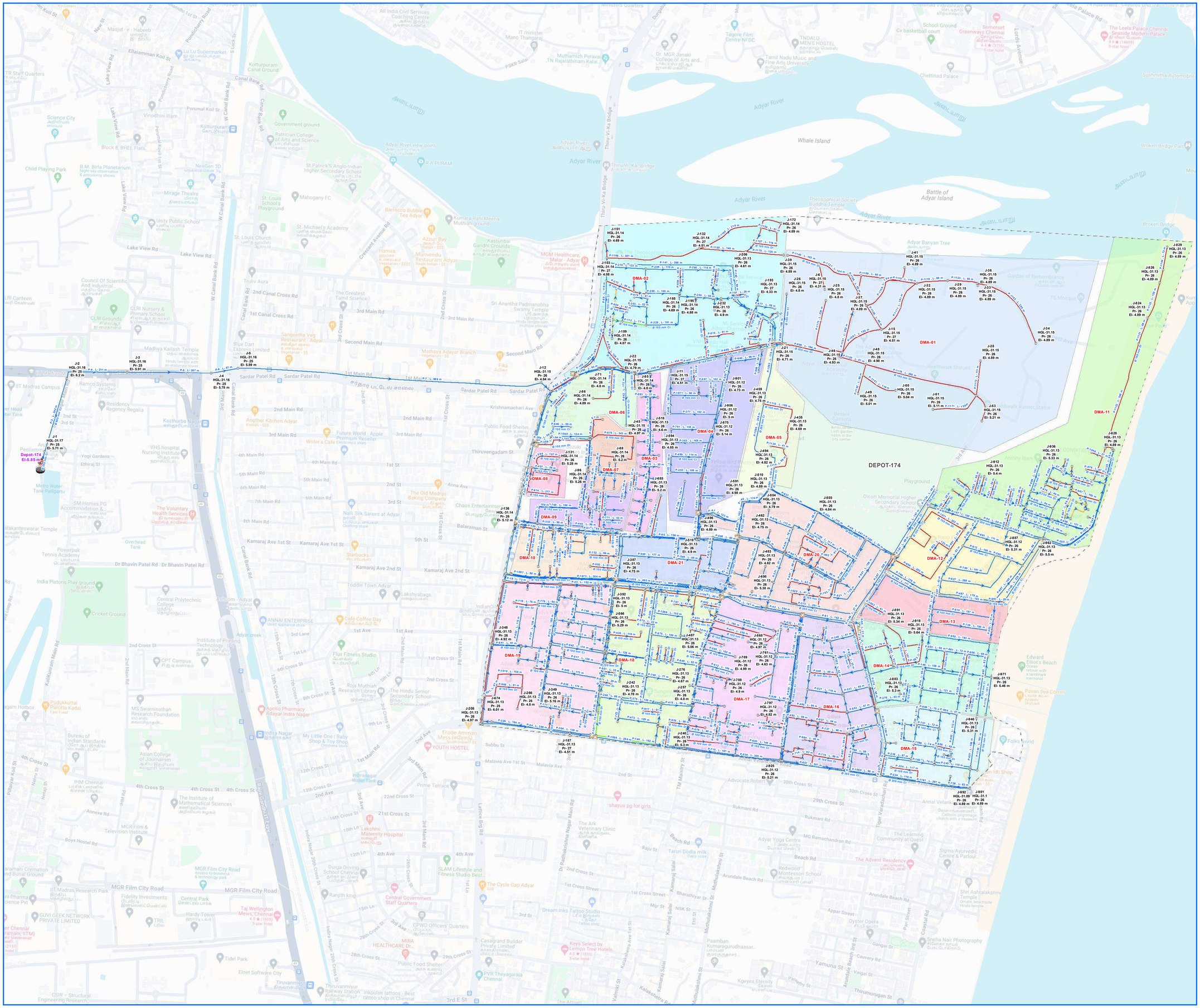
DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 173/175 (OLD), AREA-XIII, CHENNAI

CONSULTANT:-

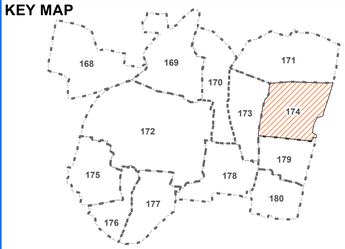
WATER CORPORATION OF ODISHA (WATCO)

Designed By:- S.M.DAS	Signature/Stamp		Scale :- 1:3,535
			Date:- 29-MAY, 2024
Checked By:-			Sheet:- 1
			Area:- XIII
Approved By:-			Zone:- XIII
			Depot:- 173/175 (OLD)



N
W E
S

KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- Replace PVC
- WATER DISTRIBUTION STATION

DMA BOUNDARY

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08
- DMA-09
- DMA-10
- DMA-11
- DMA-12
- DMA-13
- DMA-14
- DMA-15
- DMA-16
- DMA-17
- DMA-18
- DMA-19
- DMA-20
- DMA-21

ADMIN BOUNDARY

- DEPOT BOUNDARY (AREA-XIII)

Depot No-174 Abstract

Row Labels	100	150	200	250	300	350	450	500	600	700	Grand Total
Existing	30117	11748	1576	396	780	1532	5085	723	1842	56	53855
CI	29903	11484	1576	199	780	1532	5085	723	1842	56	53180
DI	214	264		197							675
Proposed	17955	3015	232	100	463						21765
DI	17955	3015	232	100	463						21765
Replace		528									528
DI		528									528
Replace PVC		536									536
DI		536									536
Grand Total	48072	15827	1808	496	1243	1532	5085	723	1842	56	76684

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

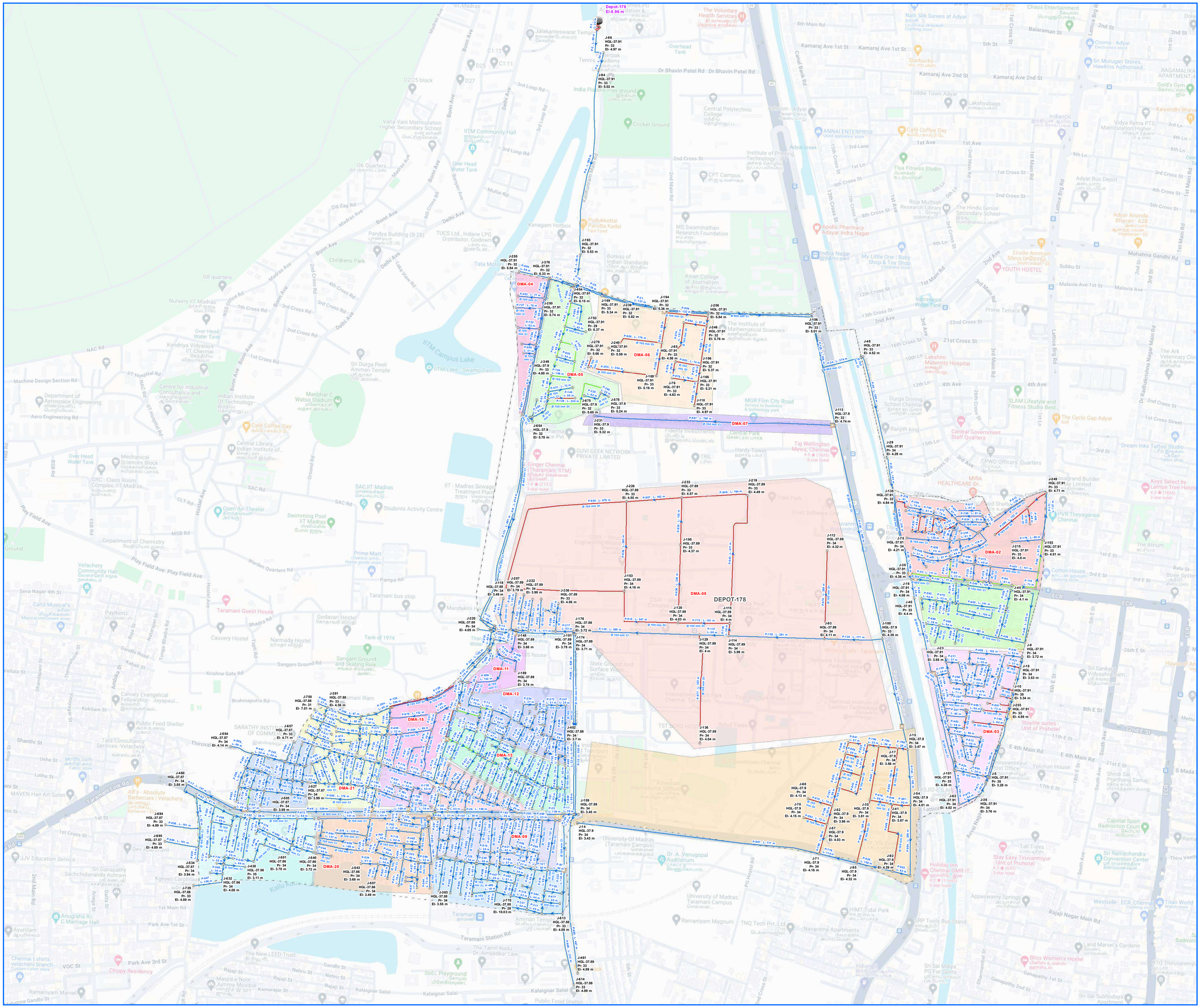
DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 174/176 (OLD), AREA-XIII, CHENNAI

CONSULTANT:-

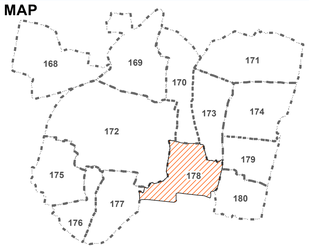
WATER CORPORATION OF ODISHA (WATCO)

Designed By:- S.M.DAS	Signature / Stamp	Scale :-1:3,840
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 174/176 (OLD)



N
W E
S

KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- WATER DISTRIBUTION STATION

DMA BOUNDARY

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08
- DMA-09
- DMA-10
- DMA-11
- DMA-12
- DMA-13
- DMA-14
- DMA-15
- DMA-16
- DMA-17
- DMA-18
- DMA-19
- DMA-20
- DMA-21
- DMA-22

ADMIN BOUNDARY

DEPOT BOUNDARY (AREA-XIII)

Depot No-178 Abstract

Row Labels	100	150	200	250	300	450	600	700	800	900	Grand Total
Existing	27783	5919	2467	235	1562	2640	972	312	723	811	43826
CI	27783	5919	2367	235	1562	2640	972	312	723	811	43324
DI			100								100
Proposed	7435	772			12						8219
DI	7435	772			12						8219
Replace		1258	541								1649
DI		1258	541								1649
Grand Total	35218	7949	3008	235	1574	2640	972	312	723	811	53442

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

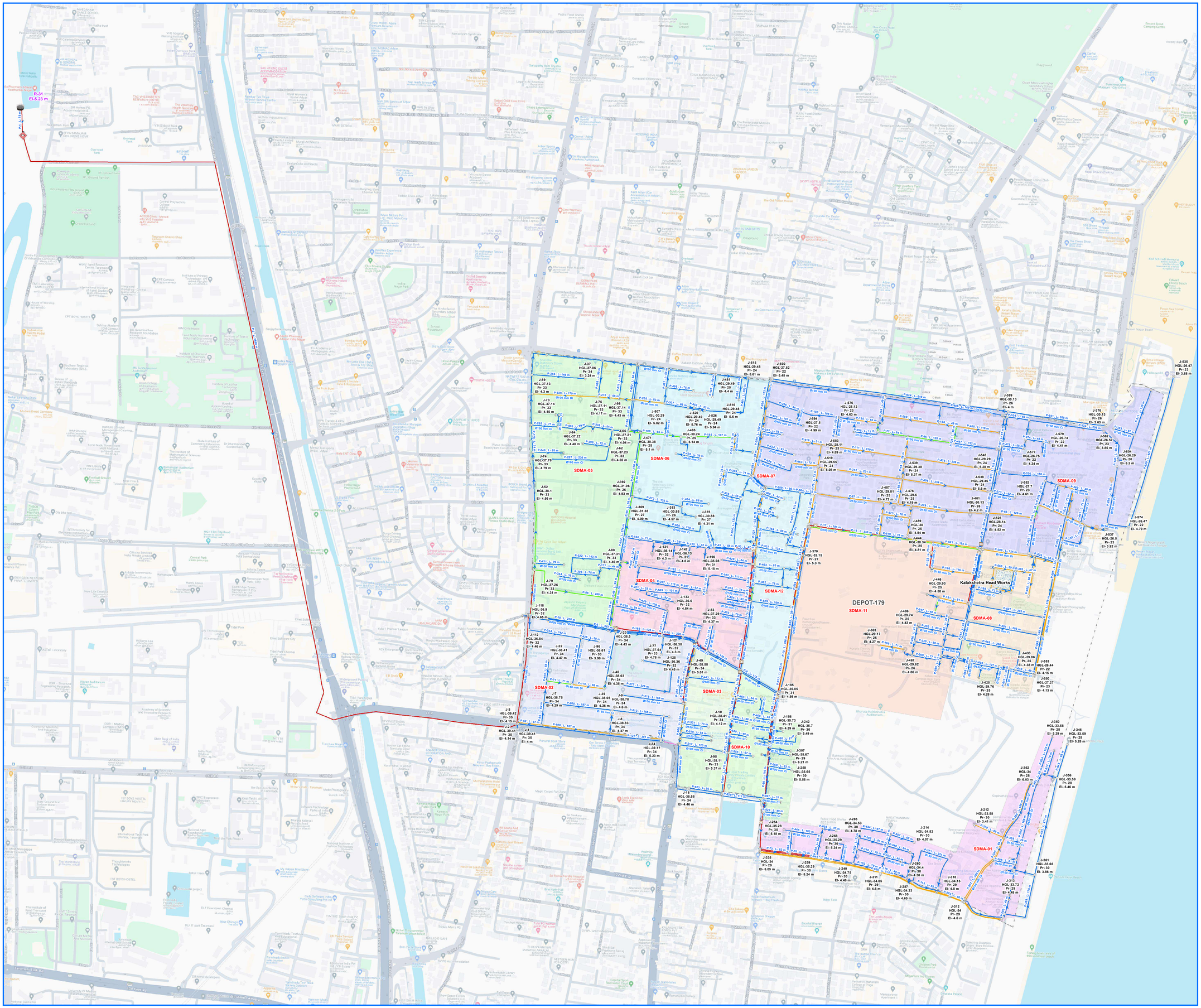
DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 178/180 (OLD), AREA-XIII, CHENNAI

CONSULTANT:-

WATER CORPORATION OF ODISHA (WATCO)

Designed By:- S.M.DAS	Signature/Stamp	Scale :- 1:3,541
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 178/180 (OLD)

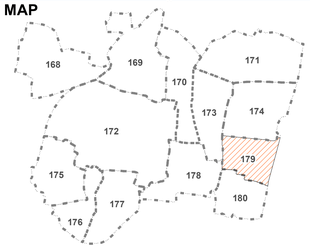


N

W E

S

KEY MAP



LEGEND

- PUMP
- JUNCTION
- CONTROL UNIT
- UGR

DISTRIBUTION NETWORK (DIA IN MM)

- Existing
- Proposed
- Replace
- Replace PVC
- DISTRIBUTION MAIN
- WATER DISTRIBUTION STATION

DMA DETAILS

- DMA-01
- DMA-02
- DMA-03
- DMA-04
- DMA-05
- DMA-06
- DMA-07
- DMA-08
- DMA-09
- DMA-10
- DMA-11
- DMA-12

ADMIN BOUNDARY

DEPOT BOUNDARY (AREA-XIII)

Row Labels	100	150	200	250	300	350	400	450	Grand Total
Existing	19237	5409	1908	563	253	1320	747	468	29859
CI	17002	1938	1708	563		915	747	468	23341
DI	2189	3471	200		253	405			6518
Proposed	1368	184	1202	467				3033	6254
DI	1368	184	1202	467				3033	6254
Replace		1701	50	465					2216
DI		1701	50	465					2216
Replace PVC	6439	688	2231						9358
DI	6439	688	2231						9358
Grand Total	27044	7982	5391	1495	253	1320	747	3501	47733

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEMS IN AREA-X & XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

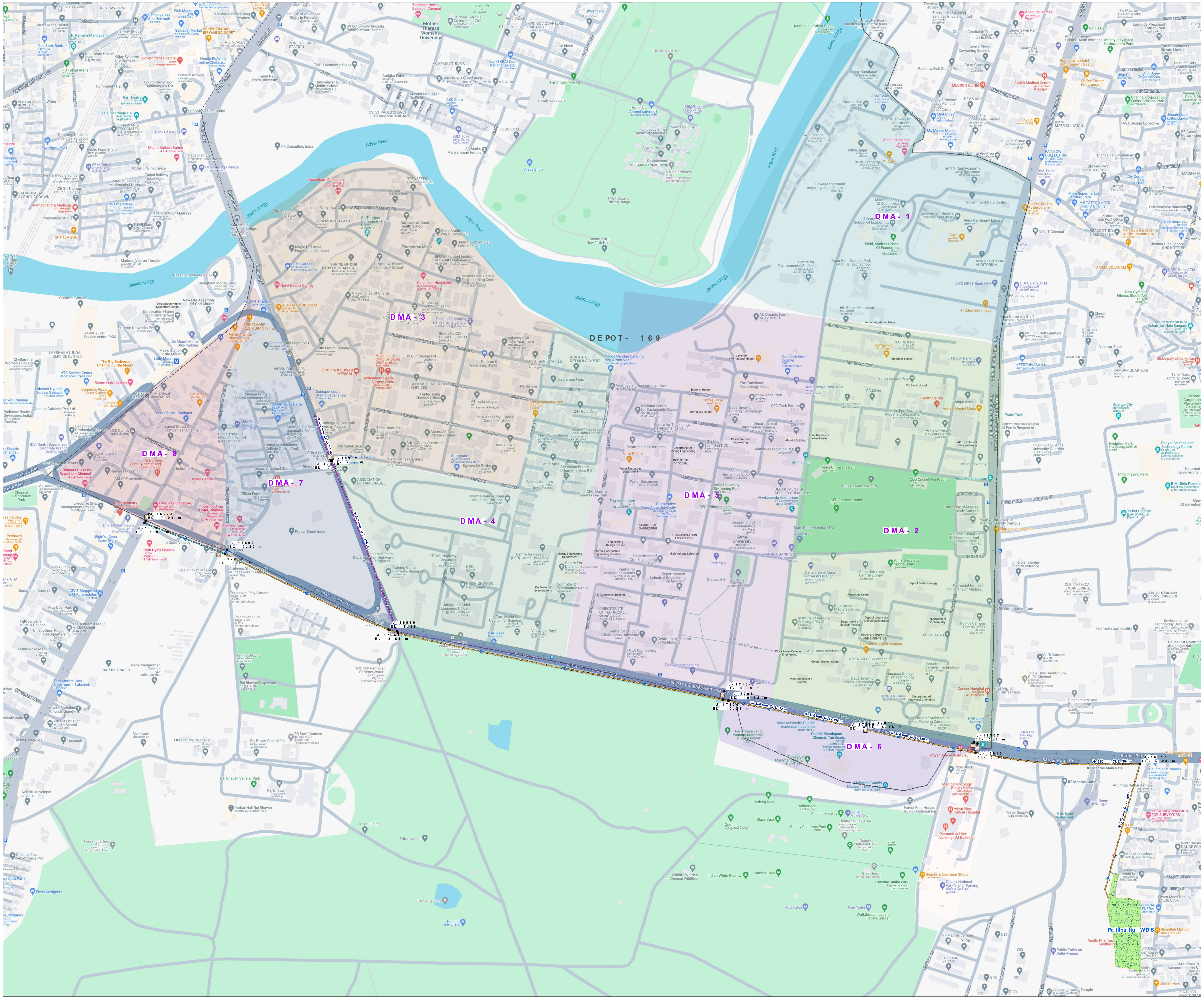
DRAWING TITLE :-

EXISTING & PROPOSED WATER SUPPLY NETWORK OF DEPOT 179/181 (OLD), AREA-XIII, CHENNAI

CONSULTANT:-

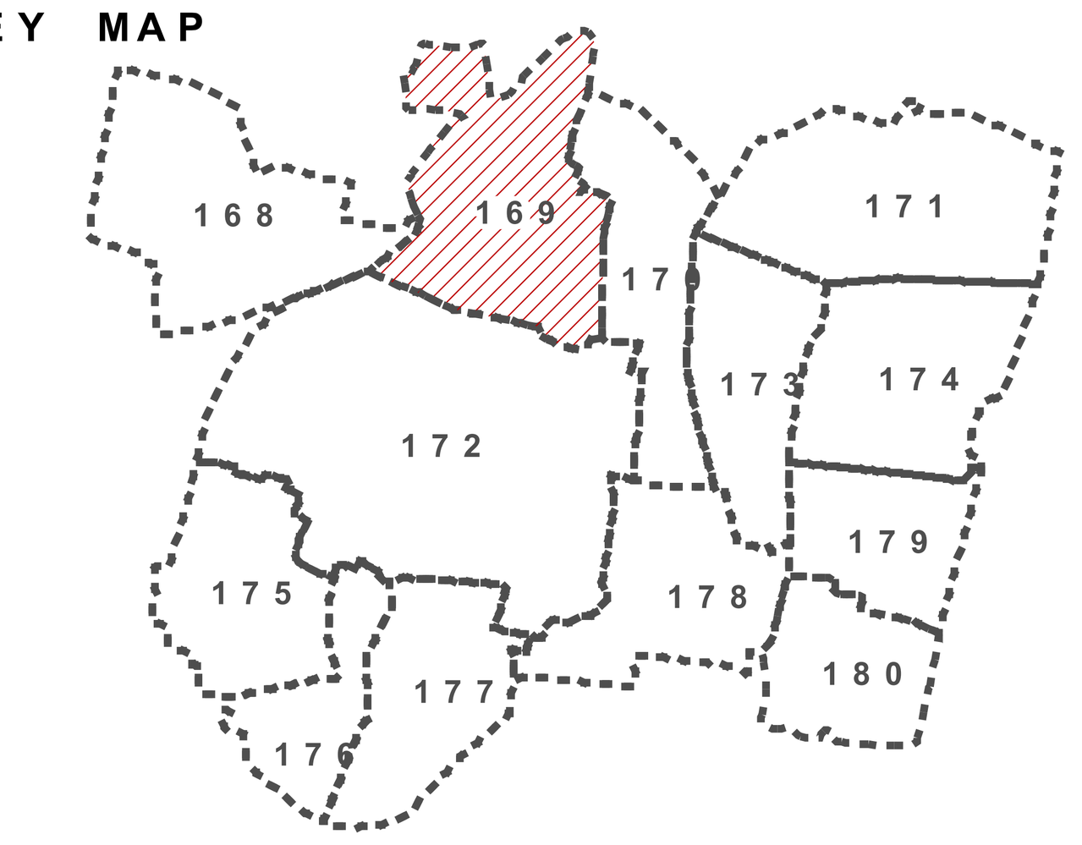
WATER CORPORATION OF ODISHA (WATCO)

Designed By:-	Signature/Stamp	Scale :-1:3,284
Checked By:-		Date:- 29-MAY, 2024
Approved By:-		Sheet:- 1
		Area:- XIII
		Zone:- XIII
		Depot:- 179/181 (OLD)



N
W E
S

KEY MAP



Legend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 100
- 150
- 200
- 300
- 350

THIRUVANMIYUR WDS

ADMIN BOUNDARY

CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- DMA-1
- DMA-2
- DMA-3
- DMA-4
- DMA-5
- DMA-6
- DMA-7
- DMA-8

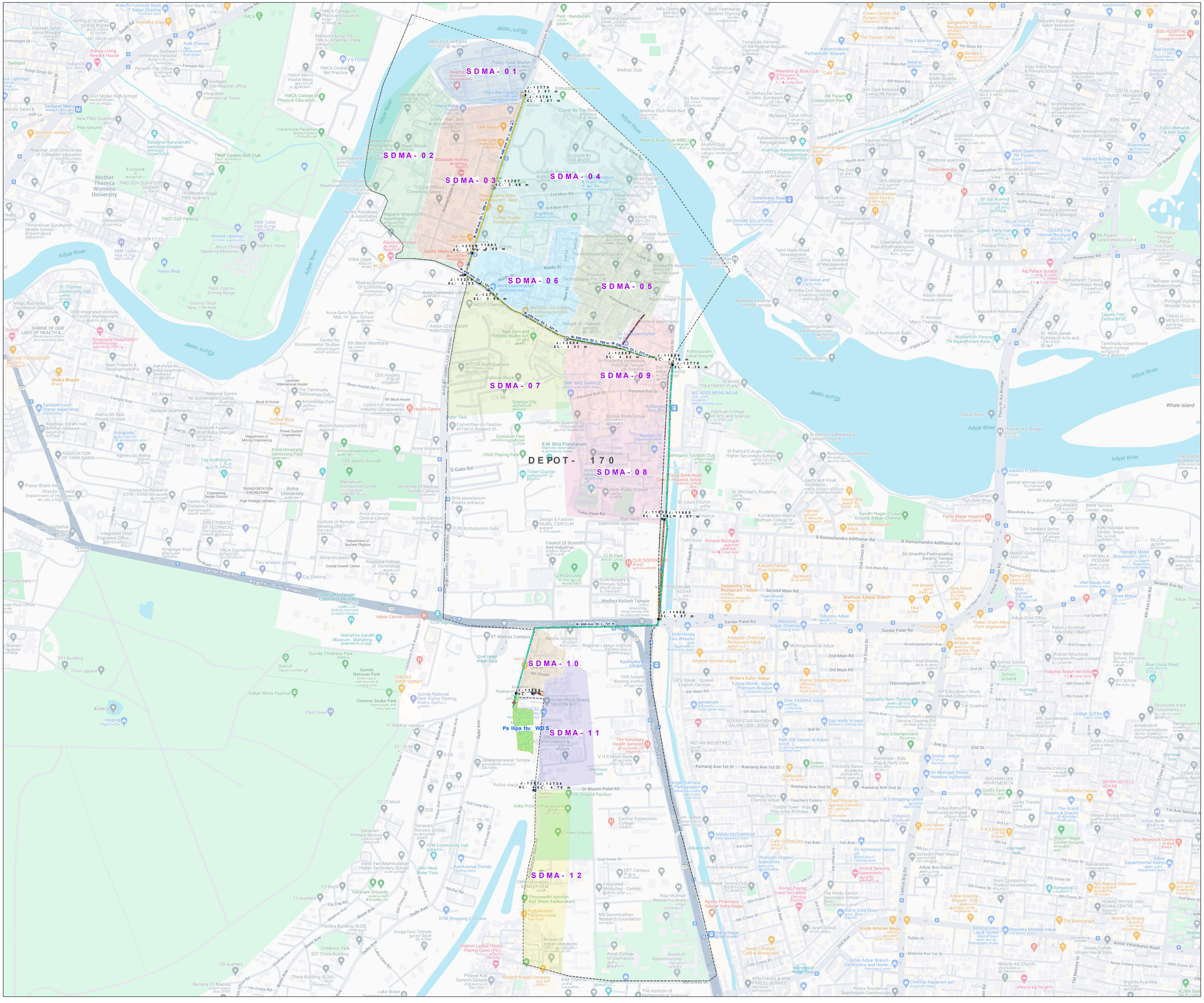
PROJECT :-
IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

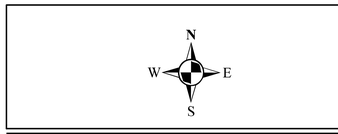
CLIENT :-
CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWING TITLE :-
EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 169
AREA XIII, CHENNAI

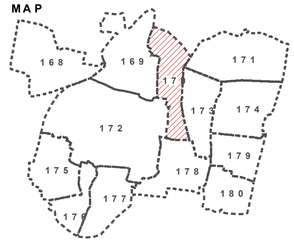
CONSULTANT :-
WATER CORPORATION OF ODISHA
(WATCO)

DESIGNED BY:-	SIGNATURE/ STAMP	SCALE :- 1:67,567
		DATE :- 2024
		SHEET :-
CHECKED BY:-		AREA :- XIII
		ZONE :- XIII
APPROVED BY:-		DEPOT :- 169 (NEW)





KEY MAP



L egend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DI A IN MM

- 150
- 250
- 300
- 350
- 400
- 450
- 500
- 600
- PALLIPATTU WDS

ADMI N BOUNDARY

- CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- SDMA-01
- SDMA-02
- SDMA-03
- SDMA-04
- SDMA-05
- SDMA-06
- SDMA-07
- SDMA-08
- SDMA-09
- SDMA-10
- SDMA-11
- SDMA-12

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

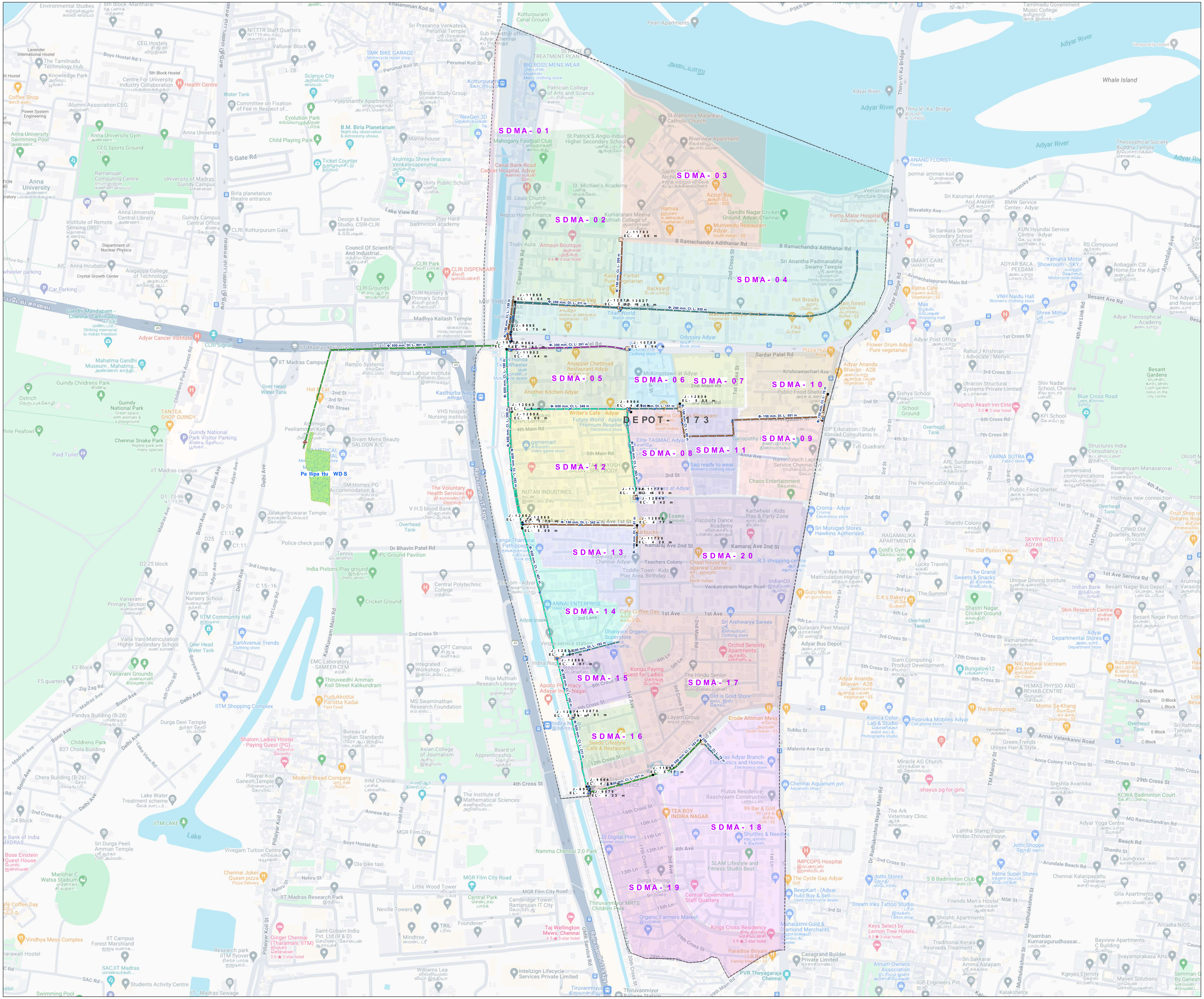
DRAWING TITLE :-

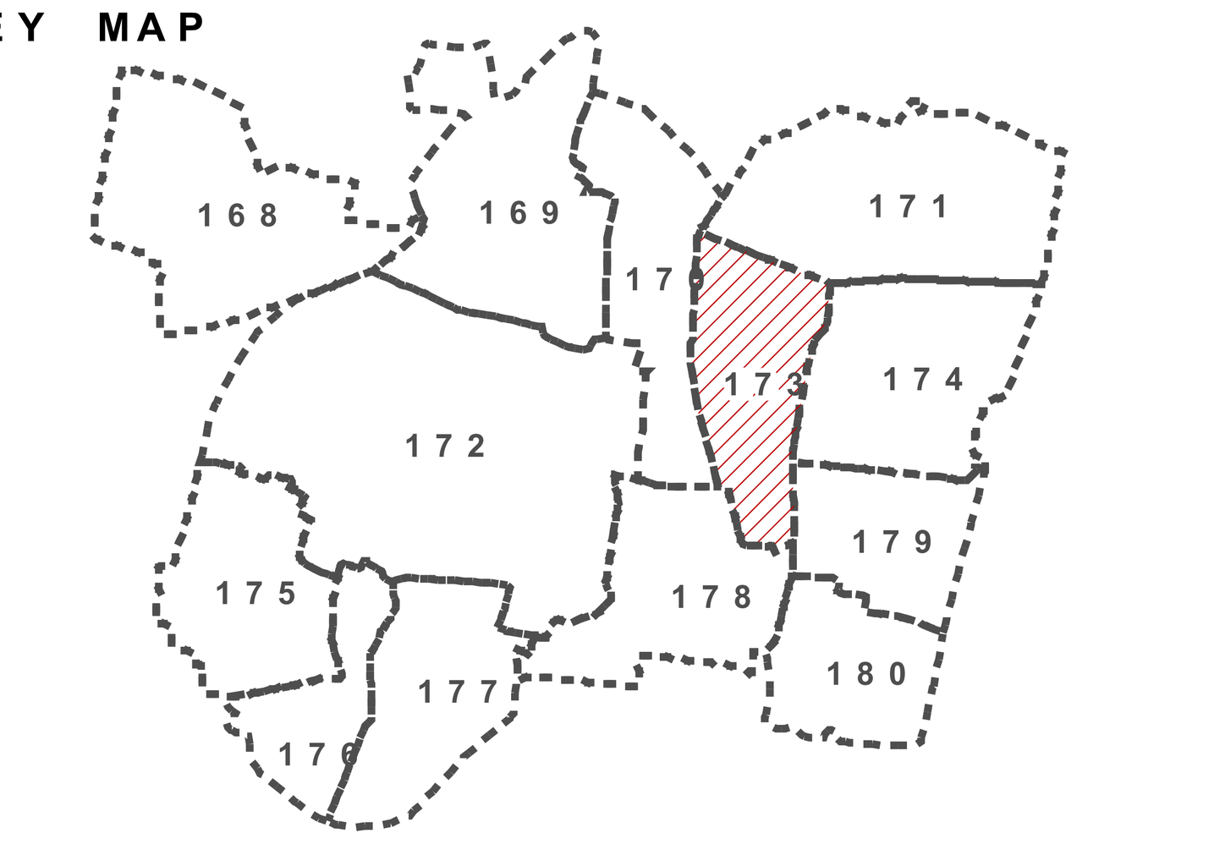
EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 170 AREA XIII, CHENNAI

CONSULTANT :-

WATER CORPORATION OF ODISHA (WATCO)

DESIGNED BY:-	SIGNATURE/ STAMP	SCALE :- 1:4,428
		DATE :- 20-01-2024
CHECKED BY:-		SHEET :- 1
		AREA :- XIII
APPROVED BY:-		ZONE :- XIII
		DEPOT :- 170 (NEW)





Legend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 150
- 200
- 250
- 300
- 450
- 500
- 600
- PALLIPATTU WDS

ADMIN BOUNDARY

CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

SDMA-01	
SDMA-02	
SDMA-03	SDMA-13
SDMA-04	SDMA-14
SDMA-05	SDMA-15
SDMA-06	SDMA-16
SDMA-07	SDMA-17
SDMA-08	SDMA-18
SDMA-09	SDMA-19
SDMA-10	SDMA-20
SDMA-11	SDMA-12

PROJECT :-
IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLIENT :-
CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWING TITLE :-
EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 173 AREA XIII, CHENNAI

CONSULTANT :-
WATER CORPORATION OF ODISHA (WATCO)

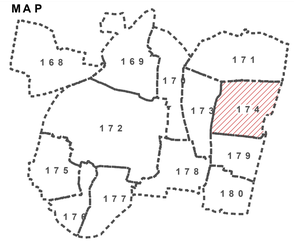
DESIGNED BY:-	SIGNATURE/ STAMP	SCALE :- 1:3,630
		DATE :- 20-01-2024
CHECKED BY:-		SHEET :- 1
		AREA :- XIII
APPROVED BY:-		ZONE :- XIII
		DEPOT :- 173 (NEW)

N

W E

S

KEY MAP



L egend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 100
- 150
- 200
- 250
- 300
- 350
- 400
- 450
- 500
- 600
- 700
- PALLIPATTU WDS

ADMI N BOUNDARY

- CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- SDMA-01
- SDMA-02
- SDMA-03
- SDMA-04
- SDMA-05
- SDMA-06
- SDMA-07
- SDMA-08
- SDMA-09
- SDMA-10
- SDMA-11
- SDMA-12
- SDMA-13
- SDMA-14
- SDMA-15
- SDMA-16
- SDMA-17
- SDMA-18
- SDMA-19
- SDMA-20
- SDMA-21

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

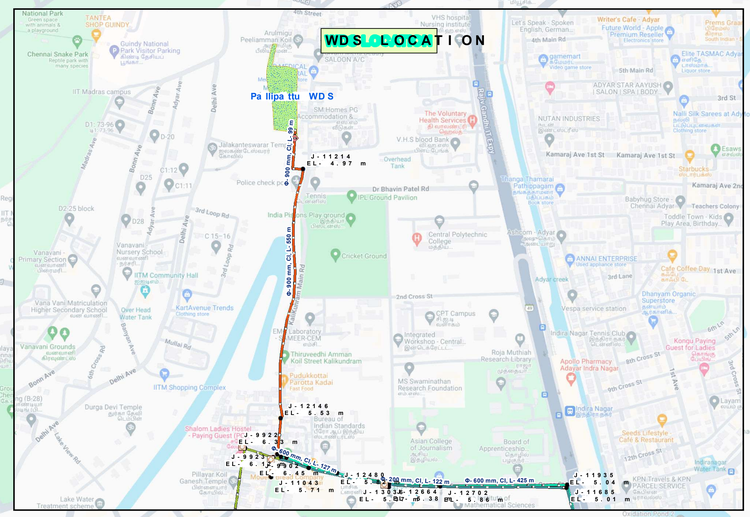
DRAWING TITLE :-

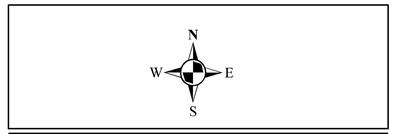
EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 174 AREA XIII, CHENNAI

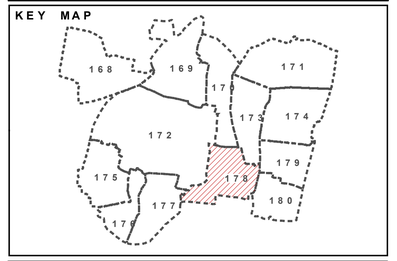
CONSULTANT :-

WATER CORPORATION OF ODISHA (WATCO)

DESIGNED BY: -	SIGNATURE/ STAMP	SCALE :- 1:2,481
CHECKED BY: -		DATE :- 20-01-2024
APPROVED BY: -		SHEET :- 1
		AREA :- XIII
		ZONE :- XIII
		DEPOT :- 174 (NEW)







L egend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 100
- 150
- 200
- 300
- 450
- 600
- 900
- PALLIPATTU WDS

ADMI N BOUNDARY

- CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- SDMA-01
- SDMA-02
- SDMA-03
- SDMA-04
- SDMA-05
- SDMA-06
- SDMA-07
- SDMA-08
- SDMA-09
- SDMA-10
- SDMA-11
- SDMA-12
- SDMA-13
- SDMA-14
- SDMA-15
- SDMA-16
- SDMA-17
- SDMA-18
- SDMA-19
- SDMA-20
- SDMA-21
- SDMA-22

PROJECT : -

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLIENT : -

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

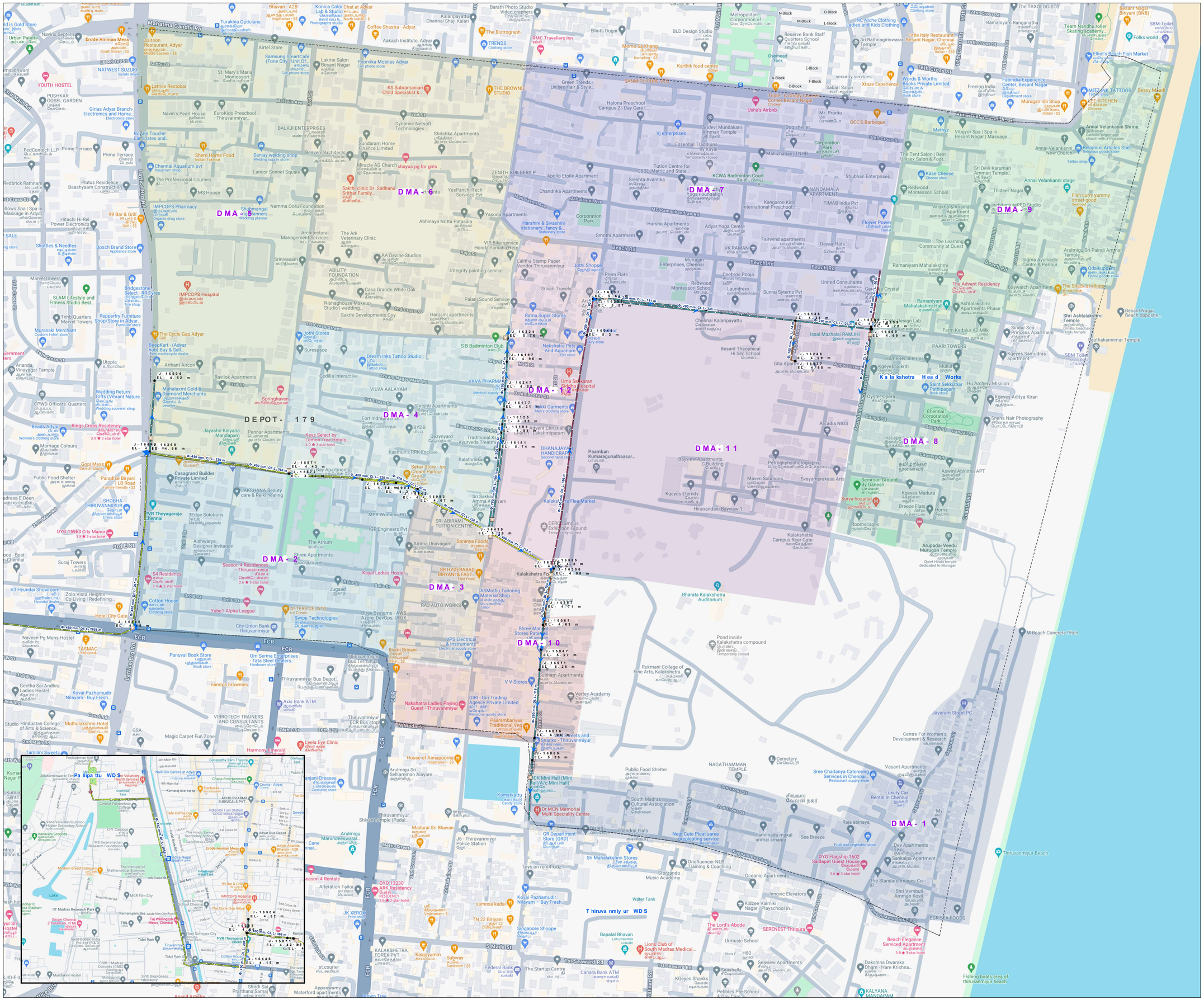
DRAWING TITLE : -

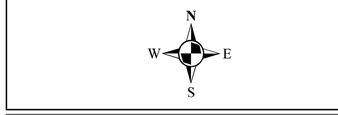
EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 178 AREA XIII, CHENNAI

CONSULTANT : -

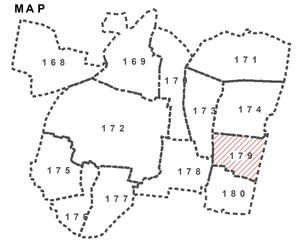
WATER CORPORATION OF ODISHA (WATCO)

DESIGNED BY: -	SIGNATURE/ STAMP	SCALE : - 1:2,597
		DATE : - 20-01-2024
CHECKED BY: -		SHEET : - 1
		AREA : - XIII
APPROVED BY: -		ZONE : - XIII
		DEPOT : - 178 (NEW)





KEY MAP



L egend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 150
- 200
- 250
- 350
- 400
- 450
- PALLIPATTU WDS

ADMI N BOUNDARY

- CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- DMA-1
- DMA-2
- DMA-3
- DMA-4
- DMA-5
- DMA-6
- DMA-7
- DMA-8
- DMA-9
- DMA-10
- DMA-11
- DMA-12

PROJECT : -

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLI ENT : -

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWING TITLE : -

EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 179 AREA XIII, CHENNAI

CONSULTANT : -

WATER CORPORATION OF ODISHA (WATCO)

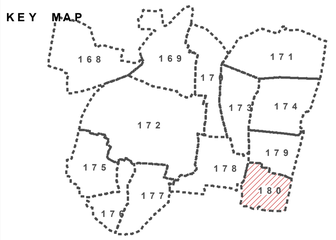
DESI GNED BY: -	SI GNATURE/ STAMP	SCALE : - 1:67,567
		DATE : - 11-01-2024
CHECKED BY: -		SHEET : - 1
		AREA : - XIII
APPROVED BY: -		ZONE : - XIII
		DEPOT : - 179 (NEW)

N

W E

S

KEY MAP



L egend

- Pump
- Junction
- CONTROL UNIT

FEEDER MAIN DIA IN MM

- 100
- 150
- 200
- 250
- 300
- 350
- 450
- 600
- 700
- THIRUVANMIYUR WDS

ADMI N BOUNDARY

- CMWSSB AREA XIII DEPOT BOUNDARY

SUB DMA BOUNDARY

- DMA-1
- DMA-2
- DMA-3
- DMA-4
- DMA-5
- DMA-6
- DMA-7
- DMA-8
- DMA-9
- DMA-10
- DMA-11
- DMA-12
- DMA-13
- DMA-14
- DMA-15
- DMA-16
- DMA-17
- DMA-18
- DMA-19
- DMA-20
- DMA-21
- DMA-22
- DMA-23
- DMA-24
- DMA-25
- DMA-26
- DMA-27
- DMA-28

PROJECT :-

IMPROVEMENT OF EXISTING WATER DISTRIBUTION NETWORK IN ALL THE WATER DISTRIBUTION SYSTEM IN AREA- X AND XIII OF CHENNAI CITY

CLI ENT :-

CHENNAI METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWI NG TI TLE :-

EXISTING TRANSMISSIOIN MAIN NETWORK OF DEPOT 180 AREA XIII, CHENNAI

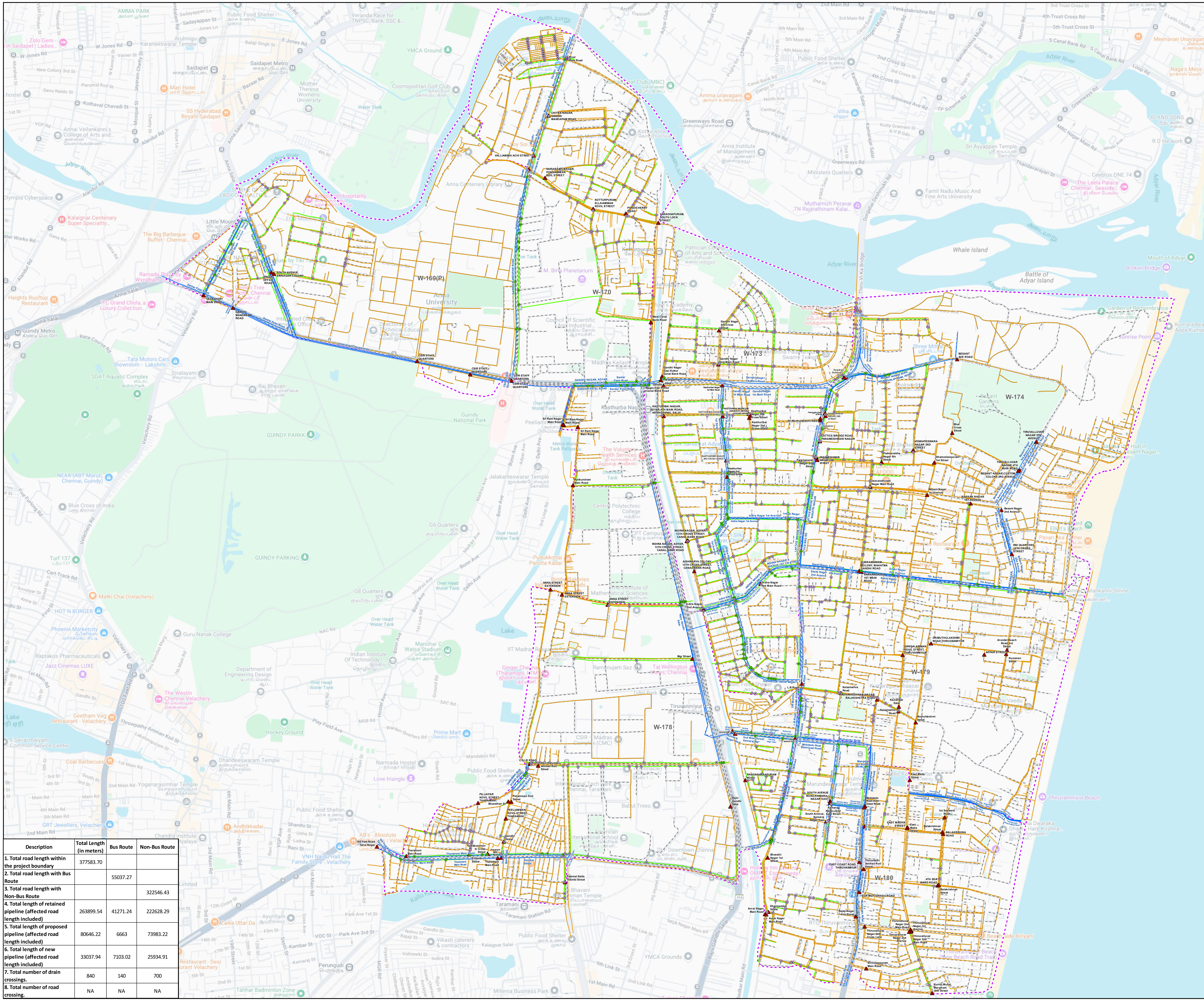
CONSULTANT :-

WATER CORPORATION OF ODISHA (WATCO)

DESI GNED BY: -	SI GNATURE/ STAMP	SCALE :- 1:2,033.78
		DATE :- AUG 2024
CHECKED BY: -		SHEET :- 1
		AREA :- XIII
APPROVED BY: -		ZONE :- XIII
		DEPOT :- 180 (NEW)

VOLUME - III

BUS / NON-BUS ROUTE MAP (PROJECT AREA)



Description	Total Length (in meters)	Bus Route	Non-Bus Route
1. Total road length within the project boundary	377583.70		
2. Total road length with Bus Route		55037.27	
3. Total road length with Non-Bus Route			322546.43
4. Total length of retained pipeline (affected road length included)	263899.54	41271.24	222628.29
5. Total length of proposed pipeline (affected road length included)	80646.22	6663	73983.22
6. Total length of new pipeline (affected road length included)	33037.94	7103.02	25934.91
7. Total number of drain crossings.	840	140	700
8. Total number of road crossing.	NA	NA	NA

PROJECT :-

IMPROVEMENT OF WATER SUPPLY SYSTEM IN PALLIPATTU & THIRUVANMIYUR WDS UNDER AREA XIII OF CHENNAI CITY

CLIENT :-

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

DRAWING TITLE :-

BUS ROUTE MAP, AREA-XIII, CHENNAI

CONSULTANT:-

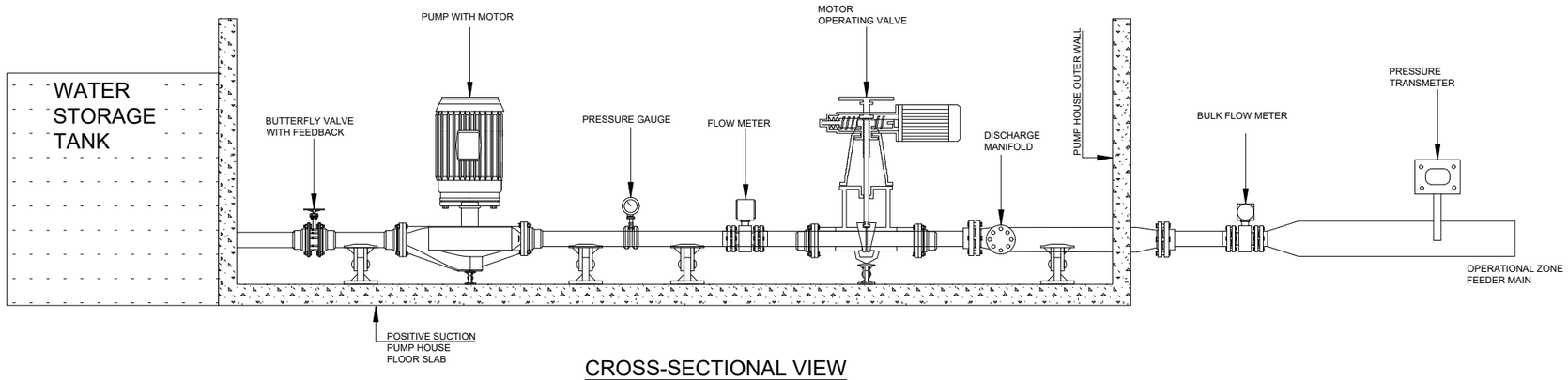
WATER CORPORATION OF ODISHA (WATCO)

Signature/Stamp				
Designed By:- AKASH	CMWSSB	WATCO	Ecometrix	Scale :- 1:7,127
				Date:- 14-03-2025
Checked By:- Pradip K Swain				Sheet:- 1
				Area:- XIII
Approved By:- Tarun Dubey				Zone:- XIII
				Depot:-

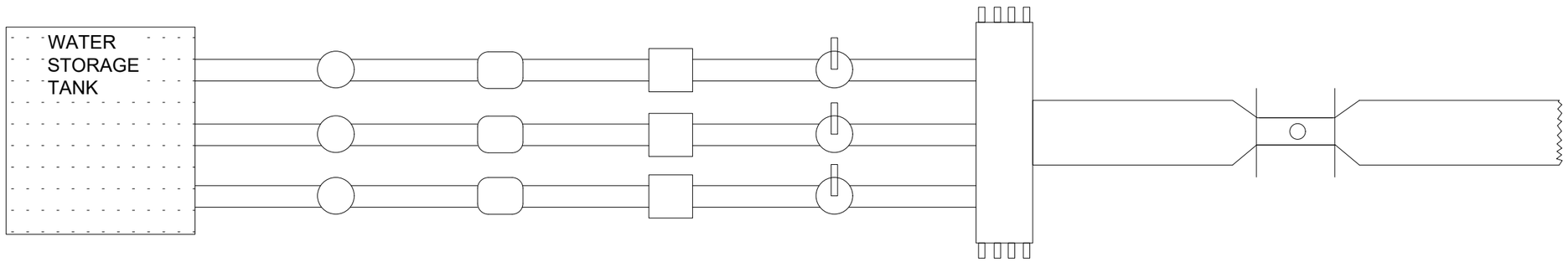
VOLUME - III

STANDARD DRAWINGS

TYPICAL DRAWING OF WDS PUMPING ARRANGEMENT WITH INSTRUMENTS



CROSS-SECTIONAL VIEW



TOP VIEW

CLIENT

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

CONSULTANT

WATER CORPORATION OF ODISHA (WATCO)

PROJECT

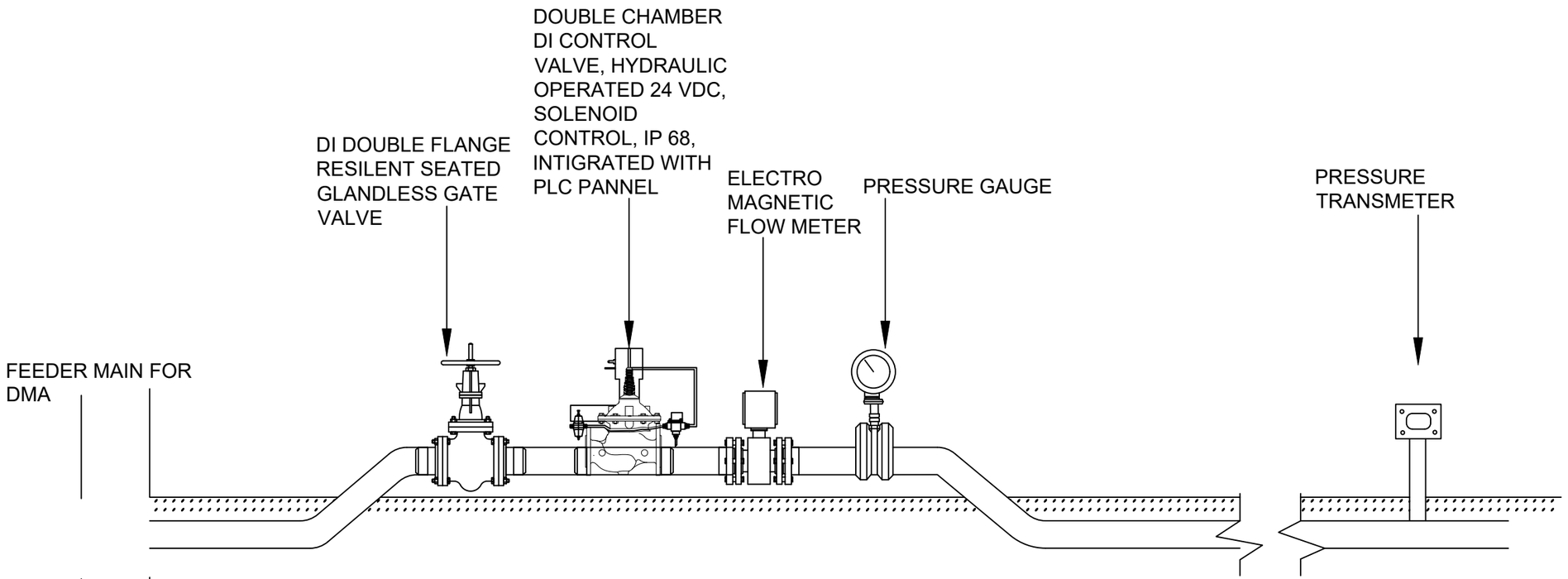
IMPROVEMENT OF WATER SUPPLY SYSTEM IN PALLIPATTU & THIRUVANMIYUR WDS UNDER AREA XIII OF CHENNAI CITY.

TITLE

TYPICAL DRAWING OF WDS PUMPING ARRANGEMENT WITH INSTRUMENTS

Scale	Drawn by	Checked by	Authorised by	Rev
NTS	Date:-	Date:-	Date:-	Sheet size
Drawing Number			Sheet No 01	A3

TYPICAL DRAWING OF DMA CONTROL UNIT



CLIENT

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

CONSULTANT

WATER CORPORATION OF ODISHA (WATCO)

PROJECT

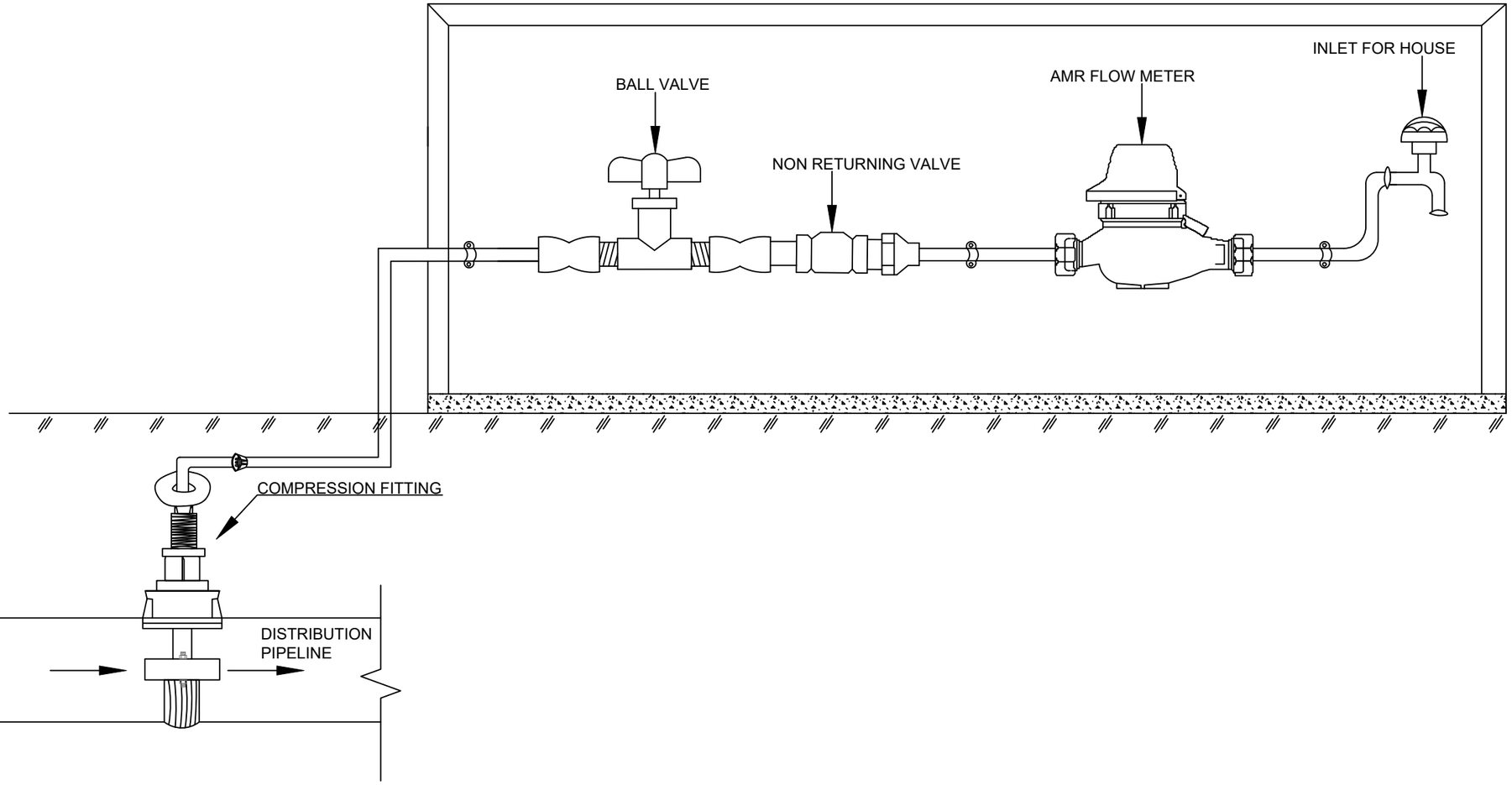
IMPROVEMENT OF WATER SUPPLY SYSTEM IN PALLIPATTU & THIRUVANMIYUR WDS UNDER AREA XIII OF CHENNAI CITY.

TITLE

TYPICAL DRAWING OF DMA CONTROL UNIT

Scale	Drawn by	Checked by	Authorised by	Rev
NTS	Date:-	Date:-	Date:-	
Drawing Number			Sheet No 01	Sheet size A3

TYPICAL DRAWING OF HOUSE SERVICE CONNECTION



N
W
E
S

CLIENT

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

CONSULTANT

WATER CORPORATION OF ODISHA (WATCO)

PROJECT

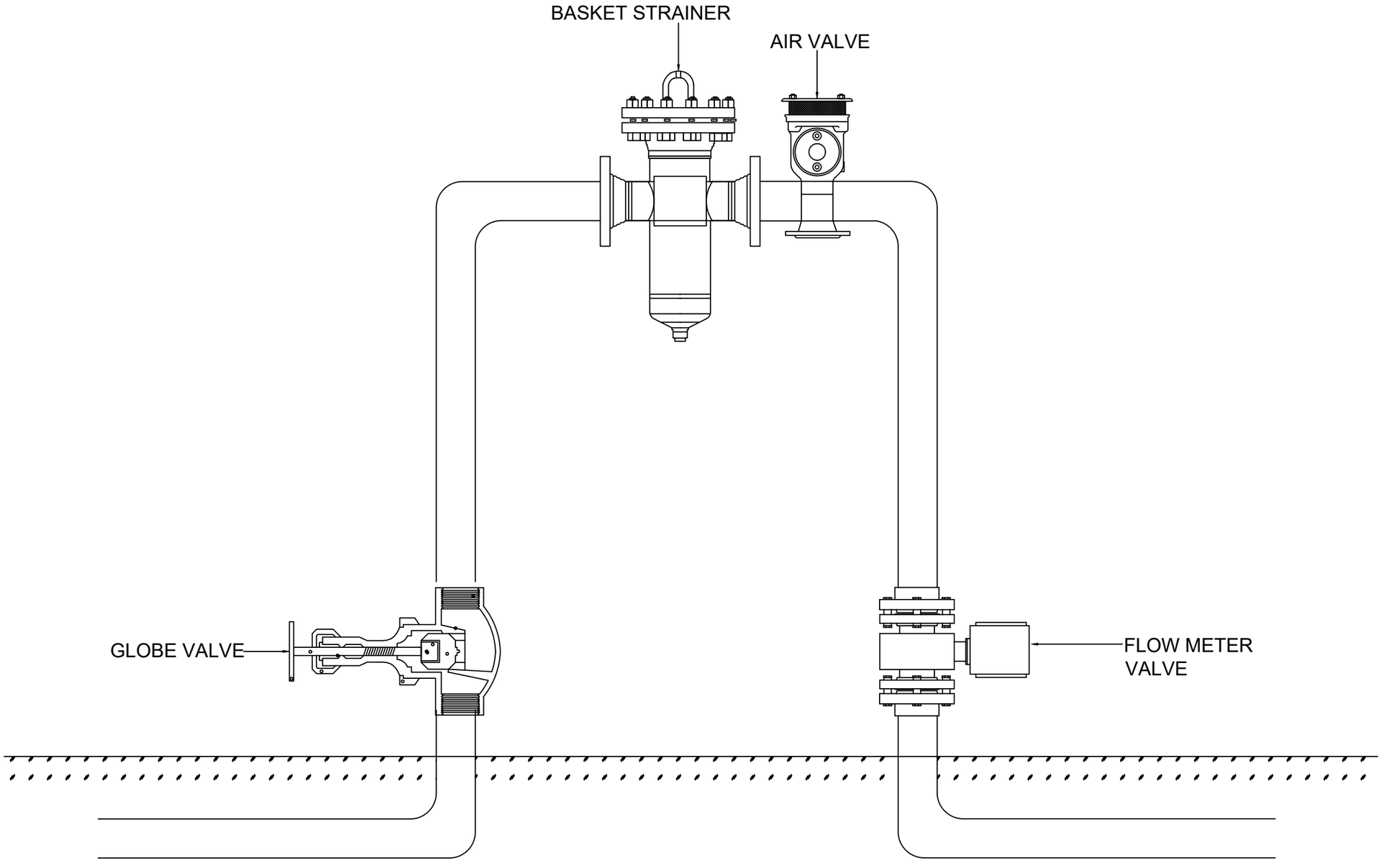
IMPROVEMENT OF WATER SUPPLY SYSTEM IN PALLIPATTU & THIRUVANMIYUR WDS UNDER AREA XIII OF CHENNAI CITY.

TITLE

TYPICAL DRAWING OF HOUSE SERVICE CONNECTION

Scale	Drawn by	Checked by	Authorised by	Rev
NTS	Date:-	Date:-	Date:-	
Drawing Number			Sheet No 01	Sheet size A3

TYPICAL DRAWING OF LANE TO SUBLANE CONTROL UNIT



N
W
E
S

CLIENT

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD (CMWSSB), CHENNAI, TAMILNADU

CONSULTANT

WATER CORPORATION OF ODISHA (WATCO)

PROJECT

IMPROVEMENT OF WATER SUPPLY SYSTEM IN PALLIPATTU & THIRUVANMIYUR WDS UNDER AREA XIII OF CHENNAI CITY.

TITLE

TYPICAL DRAWING OF LANE TO SUBLANE CONTROL UNIT

Scale	Drawn by	Checked by	Authorised by	Rev
NTS	Date:-	Date:-	Date:-	Sheet size
Drawing Number			Sheet No 01	A3

ANNEXURE-1

FINANCIAL MODEL

FINANCIAL MODEL FOR CMWSSB - WDS - Pallipattu and Thiruvanmiyur

All figures in Rs. Crore

ALL AUDIT
OK

Project Cost Estimation	Cost.(Rs. Crore)	
Construction Cost	202.36	
Physical and Price Contingencies	5.06	
Preliminary and Preoperative Expenses	13.15	
O&M during construction	-	
GST	41.41	
Price Index Impact	9.50	
Total EPC cost	**271.50**	
Interest During Construction (IDC)	5.23	
Total Project Cost	**276.73**	
O&M Cost Assumptions (FY 28 as base year)		**Rs. Crore**
Manpower		1.87
House Service connection		1.10
Automation, Instrumentation & Digital Water Management		0.83
Chlorine		0.51
Other O&M		4.52
Contingency - for O&M	2.500%	0.22
Corporate Overheads	0.000%	0.00
Total O&M		**9.04**
Energy		5.79
Total O&M (with Energy Cost)		**14.84**
Operating Margin	15.000%	1.36
O&M during construction (INR Crore)		6.89
First Year O&M Quote, for Bid Submission		**2.53**
Discount Factor for bid		11.00%
TPC Cap	644.25	OK
Cumulative payouts with GST	612.85	
Corporate Tax Rate	25.17%	
Energy Cost liability	CMWSSB	
Depreciation rates	**Comp. Act 2013**	**IT Act 1961**
Intangible Assets-Amortisation	Revenue proportion	25%

Capital Structure	Overall	After excl. gran	Rs. Crore
Equity	13.37%	33.33%	36.99
Debt	26.74%	66.67%	73.99
Grant-Construction	59.90%		165.75
Total	**100%**		**276.73**
Upfront Equity (% of Eq)	100%		
Financial assistance from CMWSSB/GoT			**Rs. Crore**
Grant-Construction	59.5%		158.86
Grant-Construction (Indexed)	60%		165.75
Annuity-Operations	40%		110.98

	Year 1	Year 2	Year 3
Construction Schedule	50%	50%	0%

Interest on Annuity				
Applicable MCLR	9.00%	1 YEAR SBI MCLR - Eff 15-Dec-2024		
Spread	2.00%			
Interest Rate				
Construction	9.50%			
Operations	9.50%			
Tenor	12 years			
Moratorium	2 quarters		Weightage	
Inflation	Annual	Monthly Value	Construction	O&M
CPI IW	4.60%	0.38%	30%	30%
WPI	1.89%	0.16%	70%	70%
Base date for Index	16-Dec-24			
Discount Factor for CMWSSB	8%			
O&M during Construction	Not part of TPC			

PIRR	EIRR	DSCR Min	DSCR Avg
10.29%	12.28%	1.32	1.82

Project Timelines - Development and Construction		
Bid date	01-Apr-25	
Time for Signing of Agreement	30	days
Signing of Concession	01-May-25	
Time for Financial Close	91	days
Appointed Date	31-Jul-25	
Concession period	17.00	
Construction start	31-Jul-25 `	
Construction period	730	days
Construction End	31-Jul-27	

End of Month	Date	FYE
Construction start	31-Jul-25	31-Mar-26
Construction end	31-Jul-27	31-Mar-28

Operations			
Start of Operations period	01-Aug-27	31-Mar-28	
Operations period	10	years	
End of Basic Concession	31-Jul-37	31-Mar-38	
Extended O&M period	5		
End of extended Concession pe	31-Jul-42	31-Mar-43	
First Month of Operation	31-Aug-27		
First year of Operation	244	days	
Last year of Operation	122	days	
Base year	31-Mar-28		
O&M Escalation	2.70%		
Penalty - KPI breach	0.00%		
Capex Annuity Pmts	Extended Concession Period		
End date for Capex Annuity Pm	31-Jul-42	31-Mar-43	
GST Rate	18.00%		
1 crore equals	10000000		

Repayment Schedule		
Drawdown Start date	28-Feb-26	31-Mar-26
COD	01-Aug-27	31-Mar-28
Tenor (years)	12	
Moratorium (months)	6	
	FYE	
Repayment starts	29-Feb-28	31-Mar-28
No of payments in the first year of repayr	2	
Repayment Ends	28-Feb-38	31-Mar-38
No of payments in the last year of repayn	11	

Repayment of Loan

Start date	FYE	Months	Rpmt %	Rpmt %	DSCR (A)	DSCR (M)
29-Feb-28	31-Mar-28	2	6.00%	6%	1.78	1.78
01-Apr-28	31-Mar-29	12	7.00%	7%	1.74	1.71
01-Apr-29	31-Mar-30	12	8.00%	8%	1.70	1.62
01-Apr-30	31-Mar-31	12	9.00%	9%	1.65	1.53
01-Apr-31	31-Mar-32	12	10.00%	10%	1.61	1.46
01-Apr-32	31-Mar-33	12	11.00%	11%	1.57	1.39
01-Apr-33	31-Mar-34	12	11.00%	11%	1.55	1.42
01-Apr-34	31-Mar-35	12	11.00%	11%	1.53	1.39
01-Apr-35	31-Mar-36	12	10.00%	10%	1.51	1.33
01-Apr-36	31-Mar-37	12	10.00%	10%	1.50	1.32
01-Apr-37	31-Mar-38	11		7%	1.52	1.86
01-Apr-38	31-Mar-39	0		0%	0.00	0.00
01-Apr-39	31-Mar-40	0		0%	0.00	0.00
01-Apr-40	31-Mar-41	0		0%	0.00	0.00
01-Apr-41	31-Mar-42	0		0%	0.00	0.00
01-Apr-42	31-Mar-43	0		0%	0.00	0.00
01-Apr-43	31-Mar-44	0		0%	0.00	0.00
01-Apr-44	31-Mar-45	0		0%	0.00	0.00
01-Apr-45	31-Mar-46	0		0%	0.00	0.00
01-Apr-46	31-Mar-47	0		0%	0.00	0.00

S. No	Physical Progress	Payment Milestone	Payment Due to the Concessionaire	Cumulative payment Due to Concessionaire
1	5%	1	6%	6%
2	10%	2	6%	12%
3	20%	3	6%	18%
4	30.0%	4	6%	24%
5	40.0%	5	6%	30%
6	50.0%	6	6%	36%
7	60.0%	7	6%	42%
8	70.0%	8	6%	48%
9	80.0%	9	6%	54%
10	90.0%	10	6%	59%

Financial Model for Hybrid Annuity Projects

OK **Capital Expenses - Percentages**

	Year No.		1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Construction Period Flag		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Month No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Month Ending		**31-Jul-25**	**31-Aug-25**	**30-Sep-25**	**31-Oct-25**	**30-Nov-25**	**31-Dec-25**	**31-Jan-26**	**28-Feb-26**	**31-Mar-26**	**30-Apr-26**	**31-May-26**	**30-Jun-26**	**31-Jul-26**	**31-Aug-26**	**30-Sep-26**	**31-Oct-26**	**30-Nov-26**	**31-Dec-26**	**31-Jan-27**	**28-Feb-27**	**31-Mar-27**	**30-Apr-27**	**31-May-27**	**30-Jun-27**	**31-Jul-27**	**31-Aug-27**	**30-Sep-27**	**31-Oct-27**	**30-Nov-27**	**31-Dec-27**	**31-Jan-28**	**29-Feb-28**	**31-Mar-28**	**30-Apr-28**	**31-May-28**	**30-Jun-28**	**31-Jul-28**	**31-Aug-28**	**30-Sep-28**	**31-Oct-28**	**30-Nov-28**	**31-Dec-28**	**31-Jan-29**	**28-Feb-29**	**31-Mar-29**	**30-Apr-29**	**31-May-29**
	EPC Cost Percentages																																															
100.0%	Construction Cost	202.36	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
100.0%	Physical and Price Contingencies	5.06	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
100.0%	Preliminary and Preoperative Expenses	13.15	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
100.0%	O&M during construction	0.00	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					
100.0%	GST	41.41	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	4.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					

Capital Cost

	FYE		31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-30	31-Mar-30
	Month Ending		31-Jul-25	31-Aug-25	30-Sep-25	31-Oct-25	30-Nov-25	31-Dec-25	31-Jan-26	28-Feb-26	31-Mar-26	30-Apr-26	31-May-26	30-Jun-26	31-Jul-26	31-Aug-26	30-Sep-26	31-Oct-26	30-Nov-26	31-Dec-26	31-Jan-27	28-Feb-27	31-Mar-27	30-Apr-27	31-May-27	30-Jun-27	31-Jul-27	31-Aug-27	30-Sep-27	31-Oct-27	30-Nov-27	31-Dec-27	31-Jan-28	29-Feb-28	31-Mar-28	30-Apr-28	31-May-28	30-Jun-28	31-Jul-28	31-Aug-28	30-Sep-28	31-Oct-28	30-Nov-28	31-Dec-28	31-Jan-29	28-Feb-29	31-Mar-29	30-Apr-29	31-May-29
	Month No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	EPC Cost																																															
	Construction Cost	202.36	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Physical and Price Contingencies	5.06	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Preliminary and Preoperative Expenses	13.15	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	O&M during construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GST	41.41	1.68	1.69	1.69	1.69	1.70	1.70	1.70	1.71	1.71	1.72	1.72	1.72	1.73	1.73	1.74	1.74	1.74	1.75	1.75	1.75	1.76	1.76	1.77	1.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Escalation due to price index	#########	0.15	0.17	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.41	0.43	0.45	0.47	0.49	0.51	0.54	0.55	0.58	0.60	0.62	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total EPC	**271.50**	**11.03**	**11.05**	**11.08**	**11.10**	**11.12**	**11.15**	**11.17**	**11.20**	**11.22**	**11.25**	**11.27**	**11.30**	**11.32**	**11.35**	**11.37**	**11.40**	**11.42**	**11.45**	**11.48**	**11.50**	**11.53**	**11.55**	**11.58**	**11.60**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Other Soft Costs																																															
0	IDC	5.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.10	0.17	0.21	0.24	0.27	0.29	0.36	0.41	0.44	0.47	0.50	0.50	0.53	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total of Other Soft Costs	**5.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.05**	**0.07**	**0.10**	**0.17**	**0.21**	**0.24**	**0.27**	**0.29**	**0.36**	**0.41**	**0.44**	**0.47**	**0.50**	**0.50**	**0.53**	**0.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Total Capex	**276.73**	**11.03**	**11.05**	**11.08**	**11.10**	**11.12**	**11.15**	**11.17**	**11.21**	**11.25**	**11.30**	**11.35**	**11.40**	**11.49**	**11.56**	**11.61**	**11.66**	**11.72**	**11.82**	**11.89**	**11.94**	**11.99**	**12.05**	**12.08**	**12.14**	**0.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Cumulative Progress		3.98%	7.98%	11.98%	15.99%	20.01%	24.04%	28.08%	32.13%	36.19%	40.28%	44.38%	48.49%	52.65%	56.83%	61.02%	65.24%	69.47%	73.74%	78.04%	82.35%	86.68%	91.04%	95.40%	99.79%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Milestone Achieved		0.00	1.00	2.00	2.00	3.00	3.00	3.00	4.00	4.00	5.00	5.00	5.00	6.00	6.00	7.00	7.00	7.00	8.00	8.00	9.00	9.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
	Payment Trigger (1 month lag)		0	0	1	2	0	3	0	0	4	0	5	0	0	6	0	7	0	0	8	0	9	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FYE		31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-30	31-Mar-30
Construction Grant Schedule		31-Jul-25	31-Aug-25	30-Sep-25	31-Oct-25	30-Nov-25	31-Dec-25	31-Jan-26	28-Feb-26	31-Mar-26	30-Apr-26	31-May-26	30-Jun-26	31-Jul-26	31-Aug-26	30-Sep-26	31-Oct-26	30-Nov-26	31-Dec-26	31-Jan-27	28-Feb-27	31-Mar-27	30-Apr-27	31-May-27	30-Jun-27	31-Jul-27	31-Aug-27	30-Sep-27	31-Oct-27	30-Nov-27	31-Dec-27	31-Jan-28	29-Feb-28	31-Mar-28	30-Apr-28	31-May-28	30-Jun-28	31-Jul-28	31-Aug-28	30-Sep-28	31-Oct-28	30-Nov-28	31-Dec-28	31-Jan-29	28-Feb-29	31-Mar-29	30-Apr-29	31-May-29
Opening Balance		0	0	0	5	10	0	5	0	0	5	0	5	0	0	5	0	5	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additions	166	0	0	16	16	0	16	0	0	16	0	17	0	0	17	0	17	0	0	17	0	17	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Utilisation	166	0	0	11	11	10	11	5	0	11	5	11	5	0	12	5	12	5	0	12	5	12	5	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Closing Balance		0	0	5	10	0	5	0	0	5	0	5	0	0	5	0	5	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	10%	20%	20%	29%	29%	29%	39%	39%	49%	49%	49%	59%	59%	69%	69%	69%	80%	80%	90%	90%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Index for Construction Grant		1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.08	1.08	1.08	1.08	1.09	1.09	1.09	1.09	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.12	1.12	1.12	1.12	1.13

Means of Finance

FYE		31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-30	31-Mar-30
Month Ending		31-Jul-25	31-Aug-25	30-Sep-25	31-Oct-25	30-Nov-25	31-Dec-25	31-Jan-26	28-Feb-26	31-Mar-26	30-Apr-26	31-May-26	30-Jun-26	31-Jul-26	31-Aug-26	30-Sep-26	31-Oct-26	30-Nov-26	31-Dec-26	31-Jan-27	28-Feb-27	31-Mar-27	30-Apr-27	31-May-27	30-Jun-27	31-Jul-27	31-Aug-27	30-Sep-27	31-Oct-27	30-Nov-27	31-Dec-27	31-Jan-28	29-Feb-28	31-Mar-28	30-Apr-28	31-May-28	30-Jun-28	31-Jul-28	31-Aug-28	30-Sep-28	31-Oct-28	30-Nov-28	31-Dec-28	31-Jan-29	28-Feb-29	31-Mar-29	30-Apr-29	31-May-29
Upfront Equity	36.99	11.03	11.05	0.00	0.00	0.82	0.00	5.99	8.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upfront Debt	73.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	3.02	0.00	3.05	3.07	0.00	3.10	0.00	3.13	3.16	0.00	3.19	0.00	3.22	-4.88	3.24	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance funds required (A)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.11**	**0.00**	**3.08**	**0.00**	**3.18**	**8.42**	**0.00**	**3.45**	**0.00**	**3.55**	**8.66**	**0.00**	**3.82**	**0.00**	**3.93**	**0.00**	**8.89**	**0.43**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Balance Equity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance Debt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	3.08	0.00	3.18	8.42	0.00	3.45	0.00	3.55	8.66	0.00	3.82	0.00	3.93	0.00	8.89	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Equity	36.99	11.03	11.05	0.00	0.00	0.82	0.00	5.99	8.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant	165.75	0.00	0.00	11.08	11.10	10.31	11.15	5.18	0.00	11.25	5.19	11.35	5.17	0.00	11.56	5.06	11.66	5.03	0.00	11.89	4.92	11.99	4.89	16.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Debt	73.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.00	6.10	0.00	6.23	11.49	0.00	6.55	0.00	6.68	11.82	0.00	7.02	0.00	7.16	-4.88	12.14	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Funds utilised	**276.73**	**11.03**	**11.05**	**11.08**	**11.10**	**11.12**	**11.15**	**11.17**	**11.21**	**11.25**	**11.30**	**11.35**	**11.40**	**11.49**	**11.56**	**11.61**	**11.66**	**11.72**	**11.82**	**11.89**	**11.94**	**11.99**	**12.05**	**12.08**	**12.14**	**0.58**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Drawdown Start-Flag		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Interest Calculation and Principal Repayment

FYE		31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-26	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-27	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-28	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-29	31-Mar-30	31-Mar-30
Month Ending		31-Jul-25	31-Aug-25	30-Sep-25	31-Oct-25	30-Nov-25	31-Dec-25	31-Jan-26	28-Feb-26	31-Mar-26	30-Apr-26	31-May-26	30-Jun-26	31-Jul-26	31-Aug-26	30-Sep-26	31-Oct-26	30-Nov-26	31-Dec-26	31-Jan-27	28-Feb-27	31-Mar-27	30-Apr-27	31-May-27	30-Jun-27	31-Jul-27	31-Aug-27	30-Sep-27	31-Oct-27	30-Nov-27	31-Dec-27	31-Jan-28	29-Feb-28	31-Mar-28	30-Apr-28	31-May-28	30-Jun-28	31-Jul-28	31-Aug-28	30-Sep-28	31-Oct-28	30-Nov-28	31-Dec-28	31-Jan-29	28-Feb-29	31-Mar-29	30-Apr-29	31-May-29
Repayment Flag		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Opening balance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	3.10	9.21	9.21	15.43	26.93	26.93	33.48	33.48	40.16	51.97	51.97	58.99	58.99	66.14	61.27	73.40	73.99	73.99	73.99	73.99	73.99	73.99	73.99	71.77	69.55	69.12	68.68	68.25	67.82	67.39	66.96	66.53	66.09	65.66	65.23	64.80	64.37	63.87
Additions	73.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.00	6.10	0.00	6.23	11.49	0.00	6.55	0.00	6.68	11.82	0.00	7.02	0.00	7.16	-4.88	12.14	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayment	73.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	2.22	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.49	0.49
Closing Balance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	3.10	9.21	9.21	15.43	26.93	26.93	33.48	33.48	40.16	51.97	51.97	58.99	58.99	66.14	61.27	73.40	73.99	73.99	73.99	73.99	73.99	73.99	73.99	71.77	69.55	69.12	68.68	68.25	67.82	67.39	66.96	66.53	66.09	65.66	65.23	64.80	64.37	63.87	63.38
Interest		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.10	0.17	0.21	0.24	0.27	0.29	0.36	0.41	0.44	0.47	0.50	0.50	0.53	0.58	0.59	0.59	0.59	0.59	0.59	0.59	0.58	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.51	0.51	0.51	0.50
IDC		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest-to P&L		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Yearly Repayment and Interest

FYE		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64
Opening Balance		0.00	3.10	58.99	69.55	64.37	58.45	51.79	44.39	36.25	28.11	19.98	12.58	5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Additions	73.99	3.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayment	73.99	0.00	0.00	4.44	5.18	5.92	6.66	7.40	8.14	8.14	8.14	7.40	7.40	5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance		3.10	58.99	69.55	64.37	58.45	51.79	44.39	36.25	28.11	19.98	12.58	5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest-P&L		**0.00**	**0.00**	**4.65**	**6.36**	**5.83**	**5.24**	**4.57**	**3.83**	**3.06**	**2.28**	**1.55**	**0.84**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Financing Plan

FYE	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34
Equity	36.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant	60.06	83.83	21.85	0.00	0.00	0.00	0.00	0.00	0.00
Debt	3.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**100.16**	**139.72**	**36.85**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Asset Addition Schedule

FYE	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34
Commercial Right - Intangible Asset	100.16	139.72	36.85	0.00	0.00	0.00	0.00	0.00	0.00
Total	**100.16**	**139.72**	**36.85**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Depreciation Schedule - Companies Act, 2013

OK	Commercial Right - Intangible Asset	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59
	No. of days of operation	**0**	**0**	**244**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**365**	**122**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Gross Block	0.00	40.10	95.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98
	Asset Value at the beginning of year	0.00	40.10	95.98	106.75	98.49	90.37	82.40	74.56	66.87	59.33	51.93	44.64	37.51	30.50	23.62	16.85	10.22	3.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Additions	40.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Depreciation	0.00	0.00	4.22	8.27	8.12	7.97	7.84	7.68	7.54	7.40	7.28	7.14	7.01	6.88	6.77	6.63	6.51	3.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Closing Balance	**40.10**	**95.98**	**106.75**	**98.49**	**90.37**	**82.40**	**74.56**	**66.87**	**59.33**	**51.93**	**44.64**	**37.51**	**30.50**	**23.62**	**16.85**	**10.22**	**3.71**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Companies Act, 2013	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**	**31-Mar-30**	**31-Mar-31**	**31-Mar-32**	**31-Mar-33**	**31-Mar-34**	**31-Mar-35**	**31-Mar-36**	**31-Mar-37**	**31-Mar-38**	**31-Mar-39**	**31-Mar-40**	**31-Mar-41**	**31-Mar-42**	**31-Mar-43**	**31-Mar-44**	**31-Mar-45**	**31-Mar-46**	**31-Mar-47**	**31-Mar-48**	**31-Mar-49**	**31-Mar-50**	**31-Mar-51**	**31-Mar-52**	**31-Mar-53**	**31-Mar-54**	**31-Mar-55**	**31-Mar-56**	**31-Mar-57**	**31-Mar-58**	**31-Mar-59**
Total Asset addition	40.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Depreciation	0.00	0.00	4.22	8.27	8.12	7.97	7.84	7.68	7.54	7.40	7.28	7.14	7.01	6.88	6.77	6.63	6.51	3.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

IT Act, 1961

OK	Commercial Right - Intangible Asset	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59
	Gross Block	0.00	40.10	95.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98	110.98
	Asset Value at the beginning of year	0.00	40.10	95.98	83.23	62.43	46.82	35.11	26.34	19.75	14.81	11.11	8.33	6.25	4.69	3.52	2.64	1.98	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Additions	40.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Depreciation	0.00	0.00	27.74	20.81	15.61	11.70	8.78	6.58	4.94	3.70	2.78	2.08	1.56	1.17	0.88	0.66	0.49	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Closing Balance	**40.10**	**95.98**	**83.23**	**62.43**	**46.82**	**35.11**	**26.34**	**19.75**	**14.81**	**11.11**	**8.33**	**6.25**	**4.69**	**3.52**	**2.64**	**1.98**	**1.48**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

IT Act, 1961	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**	**31-Mar-30**	**31-Mar-31**	**31-Mar-32**	**31-Mar-33**	**31-Mar-34**	**31-Mar-35**	**31-Mar-36**	**31-Mar-37**	**31-Mar-38**	**31-Mar-39**	**31-Mar-40**	**31-Mar-41**	**31-Mar-42**	**31-Mar-43**	**31-Mar-44**	**31-Mar-45**	**31-Mar-46**	**31-Mar-47**	**31-Mar-48**	**31-Mar-49**	**31-Mar-50**	**31-Mar-51**	**31-Mar-52**	**31-Mar-53**	**31-Mar-54**	**31-Mar-55**	**31-Mar-56**	**31-Mar-57**	**31-Mar-58**	**31-Mar-59**
Total Depreciation	0.00	0.00	27.74	20.81	15.61	11.70	8.78	6.58	4.94	3.70	2.78	2.08	1.56	1.17	0.88	0.66	0.49	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

0.006666667

Annuity No./Grant	% of Total Project Cost	Period Starts	Annuity Period Ends	FYE	Days in year	Annuity Component	Interest Component	Total Annuity payable	O&M Payment	O&M during construction	Total	Discounted Value of Payments (INR Crore)	levelised/NPV	Payment in case of Termination due to Authority Default	Concession Period Flag	% for CA 2013 Depreciation
Grant, const period	59.9%	31-Jul-25	31-Jul-27	31-Mar-28		165.75				6.885	172.63	172.63			1.00	
Operations period 1	0.67%	01-Aug-27	31-Oct-27	31-Mar-28	91	1.85	3.05	4.90	2.53		7.43	7.43		116.56	1.00	2%
Operations period 2	0.67%	01-Nov-27	31-Jan-28	31-Mar-28	91	1.85	3.00	4.85	2.60		7.45	7.45		114.73	1.00	2%
Operations period 3	0.67%	01-Feb-28	30-Apr-28	31-Mar-28	90	1.85	2.91	4.76	2.56		7.32	7.32		112.75	1.00	2%
Operations period 4	0.67%	01-May-28	30-Jul-28	31-Mar-29	91	1.85	2.89	4.74	2.59		7.33	6.61		110.91	1.00	2%
Operations period 5	0.67%	01-Aug-28	30-Oct-28	31-Mar-29	91	1.85	2.84	4.69	2.59		7.28	6.56		109.01	1.00	2%
Operations period 6	0.67%	01-Nov-28	30-Jan-29	31-Mar-29	91	1.85	2.79	4.64	2.66		7.30	6.58		107.18	1.00	2%
Operations period 7	0.67%	01-Feb-29	30-Apr-29	31-Mar-29	89	1.85	2.68	4.53	2.60		7.13	6.43		105.16	1.00	2%
Operations period 8	0.67%	01-May-29	30-Jul-29	31-Mar-30	91	1.85	2.69	4.54	2.66		7.20	5.84		103.38	1.00	2%
Operations period 9	0.67%	01-Aug-29	30-Oct-29	31-Mar-30	91	1.85	2.64	4.49	2.66		7.15	5.80		101.48	1.00	2%
Operations period 10	0.67%	01-Nov-29	30-Jan-30	31-Mar-30	91	1.85	2.59	4.44	2.73		7.17	5.82		99.65	1.00	2%
Operations period 11	0.67%	01-Feb-30	30-Apr-30	31-Mar-30	89	1.85	2.48	4.33	2.67		7.00	5.69		97.64	1.00	2%
Operations period 12	0.67%	01-May-30	30-Jul-30	31-Mar-31	91	1.85	2.49	4.34	2.73		7.07	5.17		95.85	1.00	2%
Operations period 13	0.67%	01-Aug-30	30-Oct-30	31-Mar-31	91	1.85	2.43	4.28	2.73		7.02	5.13		93.95	1.00	2%
Operations period 14	0.67%	01-Nov-30	30-Jan-31	31-Mar-31	91	1.85	2.38	4.23	2.81		7.04	5.15		92.13	1.00	2%
Operations period 15	0.67%	01-Feb-31	30-Apr-31	31-Mar-31	89	1.85	2.28	4.13	2.75		6.88	5.03		90.11	1.00	2%
Operations period 16	0.67%	01-May-31	30-Jul-31	31-Mar-32	91	1.85	2.28	4.13	2.81		6.94	4.57		88.33	1.00	2%
Operations period 17	0.67%	01-Aug-31	30-Oct-31	31-Mar-32	91	1.85	2.23	4.08	2.81		6.89	4.54		86.42	1.00	2%
Operations period 18	0.67%	01-Nov-31	30-Jan-32	31-Mar-32	91	1.85	2.18	4.03	2.88		6.92	4.56		84.60	1.00	2%
Operations period 19	0.67%	01-Feb-32	30-Apr-32	31-Mar-32	90	1.85	2.11	3.96	2.85		6.81	4.49		82.64	1.00	2%
Operations period 20	0.67%	01-May-32	30-Jul-32	31-Mar-33	91	1.85	2.08	3.93	2.88		6.81	4.04		80.80	1.00	2%
Operations period 21	0.67%	01-Aug-32	30-Oct-32	31-Mar-33	91	1.85	2.03	3.88	2.88		6.76	4.01		78.90	1.00	2%
Operations period 22	0.67%	01-Nov-32	30-Jan-33	31-Mar-33	91	1.85	1.98	3.83	2.96		6.79	4.03		77.08	1.00	2%
Operations period 23	0.67%	01-Feb-33	30-Apr-33	31-Mar-33	89	1.85	1.89	3.73	2.90		6.63	3.94		75.07	1.00	2%
Operations period 24	0.67%	01-May-33	30-Jul-33	31-Mar-34	91	1.85	1.88	3.73	2.96		6.69	3.58		73.28	1.00	2%
Operations period 25	0.67%	01-Aug-33	30-Oct-33	31-Mar-34	91	1.85	1.83	3.68	2.96		6.64	3.55		71.38	1.00	2%
Operations period 26	0.67%	01-Nov-33	30-Jan-34	31-Mar-34	91	1.85	1.78	3.63	3.04		6.67	3.56		69.56	1.00	2%
Operations period 27	0.67%	01-Feb-34	30-Apr-34	31-Mar-34	89	1.85	1.69	3.54	2.98		6.51	3.48		67.55	1.00	2%
Operations period 28	0.67%	01-May-34	30-Jul-34	31-Mar-35	91	1.85	1.67	3.52	3.04		6.57	3.16		65.75	1.00	2%
Operations period 29	0.67%	01-Aug-34	30-Oct-34	31-Mar-35	91	1.85	1.62	3.47	3.04		6.52	3.14		63.85	1.00	2%
Operations period 30	0.67%	01-Nov-34	30-Jan-35	31-Mar-35	91	1.85	1.57	3.42	3.13		6.55	3.15		62.04	1.00	2%
Operations period 31	0.67%	01-Feb-35	30-Apr-35	31-Mar-35	89	1.85	1.49	3.34	3.06		6.39	3.08		60.03	1.00	2%
Operations period 32	0.67%	01-May-35	30-Jul-35	31-Mar-36	91	1.85	1.47	3.32	3.13		6.45	2.80		58.24	1.00	2%
Operations period 33	0.67%	01-Aug-35	30-Oct-35	31-Mar-36	91	1.85	1.42	3.27	3.13		6.39	2.77		56.34	1.00	2%
Operations period 34	0.67%	01-Nov-35	30-Jan-36	31-Mar-36	91	1.85	1.37	3.22	3.21		6.43	2.79		54.52	1.00	2%
Operations period 35	0.67%	01-Feb-36	30-Apr-36	31-Mar-36	90	1.85	1.30	3.15	3.17		6.33	2.75		52.57	1.00	2%
Operations period 36	0.67%	01-May-36	30-Jul-36	31-Mar-37	91	1.85	1.27	3.12	3.21		6.33	2.47		50.72	1.00	2%
Operations period 37	0.67%	01-Aug-36	30-Oct-36	31-Mar-37	91	1.85	1.22	3.07	3.21		6.28	2.45		48.82	1.00	2%
Operations period 38	0.67%	01-Nov-36	30-Jan-37	31-Mar-37	91	1.85	1.17	3.02	3.30		6.31	2.47		47.00	1.00	2%
Operations period 39	0.67%	01-Feb-37	30-Apr-37	31-Mar-37	89	1.85	1.09	2.94	3.22		6.16	2.41		45.01	1.00	2%
Operations period 40	0.67%	01-May-37	30-Jul-37	31-Mar-38	91	1.85	1.07	2.91	3.30		6.21	2.19		43.20	1.00	2%
Operations period 41	0.67%	01-Aug-37	30-Oct-37	31-Mar-38	91	1.85	1.01	2.86	3.30		6.16	2.17		41.30	1.00	2%
Operations period 42	0.67%	01-Nov-37	30-Jan-38	31-Mar-38	91	1.85	0.96	2.81	3.39		6.20	2.18		39.49	1.00	2%
Operations period 43	0.67%	01-Feb-38	30-Apr-38	31-Mar-38	89	1.85	0.89	2.74	3.31		6.05	2.13	382.07	37.50	1.00	2%
Operations period 44	0.67%	01-May-38	30-Jul-38	31-Mar-39	91	1.85	0.86	2.71	3.39		6.10	1.93		35.69	1.00	2%
Operations period 45	0.67%	01-Aug-38	30-Oct-38	31-Mar-39	91	1.85	0.81	2.66	3.39		6.05	1.92		33.79	1.00	2%
Operations period 46	0.67%	01-Nov-38	30-Jan-39	31-Mar-39	91	1.85	0.76	2.61	3.48		6.09	1.93		31.98	1.00	2%
Operations period 47	0.67%	01-Feb-39	30-Apr-39	31-Mar-39	89	1.85	0.69	2.54	3.40		5.94	1.89		29.99	1.00	2%
Operations period 48	0.67%	01-May-39	30-Jul-39	31-Mar-40	91	1.85	0.66	2.51	3.48		5.99	1.71		28.18	1.00	2%
Operations period 49	0.67%	01-Aug-39	30-Oct-39	31-Mar-40	91	1.85	0.61	2.46	3.48		5.93	1.70		26.28	1.00	2%
Operations period 50	0.67%	01-Nov-39	30-Jan-40	31-Mar-40	91	1.85	0.56	2.41	3.57		5.98	1.71		24.47	1.00	2%
Operations period 51	0.67%	01-Feb-40	30-Apr-40	31-Mar-40	90	1.85	0.50	2.35	3.53		5.88	1.68		22.53	1.00	2%
Operations period 52	0.67%	01-May-40	30-Jul-40	31-Mar-41	91	1.85	0.46	2.31	3.57		5.88	1.51		20.67	1.00	2%
Operations period 53	0.67%	01-Aug-40	30-Oct-40	31-Mar-41	91	1.85	0.41	2.26	3.57		5.83	1.50		18.77	1.00	1%
Operations period 54	0.67%	01-Nov-40	30-Jan-41	31-Mar-41	91	1.85	0.36	2.20	3.67		5.87	1.51		16.97	1.00	2%
Operations period 55	0.67%	01-Feb-41	30-Apr-41	31-Mar-41	89	1.85	0.30	2.15	3.59		5.73	1.48		14.98	1.00	1%
Operations period 56	0.67%	01-May-41	30-Jul-41	31-Mar-42	91	1.85	0.25	2.10	3.67		5.77	1.34		13.17	1.00	1%
Operations period 57	0.67%	01-Aug-41	30-Oct-41	31-Mar-42	91	1.85	0.20	2.05	3.67		5.72	1.33		11.27	1.00	1%
Operations period 58	0.67%	01-Nov-41	30-Jan-42	31-Mar-42	91	1.85	0.15	2.00	3.77		5.77	1.34		9.47	1.00	1%
Operations period 59	0.67%	01-Feb-42	30-Apr-42	31-Mar-42	89	1.85	0.10	1.95	3.68		5.63	1.31		7.48	1.00	1%

Operations period 60	0.67%	01-May-42	30-Jul-42	31-Mar-43	91	1.85	0.05	1.90	3.77		5.67	1.18		5.67	1.00	1%
Operations period 61	0.00%	01-Aug-42	30-Oct-42	31-Mar-43	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 62	0.00%	01-Nov-42	30-Jan-43	31-Mar-43	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 63	0.00%	01-Feb-43	30-Apr-43	31-Mar-43	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 64	0.00%	01-May-43	30-Jul-43	31-Mar-44	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 65	0.00%	01-Aug-43	30-Oct-43	31-Mar-44	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 66	0.00%	01-Nov-43	30-Jan-44	31-Mar-44	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 67	0.00%	01-Feb-44	30-Apr-44	31-Mar-44	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 68	0.00%	01-May-44	30-Jul-44	31-Mar-45	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 69	0.00%	01-Aug-44	30-Oct-44	31-Mar-45	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 70	0.00%	01-Nov-44	30-Jan-45	31-Mar-45	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 71	0.00%	01-Feb-45	30-Apr-45	31-Mar-45	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 72	0.00%	01-May-45	30-Jul-45	31-Mar-46	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 73	0.00%	01-Aug-45	30-Oct-45	31-Mar-46	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 74	0.00%	01-Nov-45	30-Jan-46	31-Mar-46	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 75	0.00%	01-Feb-46	30-Apr-46	31-Mar-46	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 76	0.00%	01-May-46	30-Jul-46	31-Mar-47	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 77	0.00%	01-Aug-46	30-Oct-46	31-Mar-47	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 78	0.00%	01-Nov-46	30-Jan-47	31-Mar-47	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 79	0.00%	01-Feb-47	30-Apr-47	31-Mar-47	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 80	0.00%	01-May-47	30-Jul-47	31-Mar-48	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 81	0.00%	01-Aug-47	30-Oct-47	31-Mar-48	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 82	0.00%	01-Nov-47	30-Jan-48	31-Mar-48	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 83	0.00%	01-Feb-48	30-Apr-48	31-Mar-48	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 84	0.00%	01-May-48	30-Jul-48	31-Mar-49	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 85	0.00%	01-Aug-48	30-Oct-48	31-Mar-49	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 86	0.00%	01-Nov-48	30-Jan-49	31-Mar-49	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 87	0.00%	01-Feb-49	30-Apr-49	31-Mar-49	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%
Operations period 88	0.00%	01-May-49	30-Jul-49	31-Mar-50	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0%

PIRR	EIRR	DSCR Min	DSCR Avg
10.29%	12.28%	1.32	1.82

Audit
OK

Year of Operation		-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FY Ended		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
No. of days		0	0	244	365	365	365	365	365	365	365	365	365	365	365	365	365	365	122
Revenue																			
Annuity Revenue	203.40	0.00	0.00	14.51	18.60	17.79	16.99	16.20	15.37	14.56	13.76	12.96	12.14	11.34	10.53	9.73	8.91	8.11	1.90
O&M Compensation	186.62	0.00	0.00	7.70	10.45	10.74	11.03	11.36	11.63	11.94	12.27	12.63	12.94	13.29	13.65	14.06	14.40	14.79	3.77
Gross Revenue	389.99	0.00	0.00	22.21	29.05	28.53	28.01	27.56	27.00	26.51	26.02	25.60	25.08	24.62	24.17	23.78	23.31	22.89	5.67
Penalty for KPI breaches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Revenue	389.99	0.00	0.00	22.21	29.05	28.53	28.01	27.56	27.00	26.51	26.02	25.60	25.08	24.62	24.17	23.78	23.31	22.89	5.67
Expenses																			
O&M costs	166.10	0.00	0.00	6.05	9.29	9.54	9.80	10.06	10.33	10.61	10.90	11.19	11.50	11.81	12.13	12.45	12.79	13.14	4.51
Total O&M Expenses	166.10	0.00	0.00	6.05	9.29	9.54	9.80	10.06	10.33	10.61	10.90	11.19	11.50	11.81	12.13	12.45	12.79	13.14	4.51
EBITDA	223.92	0.00	0.00	16.16	19.76	18.99	18.21	17.50	16.67	15.90	15.12	14.40	13.58	12.82	12.05	11.33	10.52	9.75	1.16
Depreciation	110.98	0.00	0.00	4.22	8.27	8.12	7.97	7.84	7.68	7.54	7.40	7.28	7.14	7.01	6.88	6.77	6.63	6.51	3.71
EBIT	112.94	0.00	0.00	11.94	11.50	10.87	10.24	9.65	8.98	8.35	7.72	7.12	6.45	5.81	5.17	4.56	3.89	3.24	-2.55
Interest on Term Loan	38.44	0.00	0.00	4.65	6.36	5.83	5.24	4.57	3.83	3.06	2.28	1.55	0.84	0.23	0.00	0.00	0.00	0.00	0.00
Interest expense	38.44	0.00	0.00	4.65	6.36	5.83	5.24	4.57	3.83	3.06	2.28	1.55	0.84	0.23	0.00	0.00	0.00	0.00	0.00
EBT	74.51	0.00	0.00	7.29	5.14	5.04	5.01	5.09	5.15	5.29	5.43	5.57	5.60	5.58	5.17	4.56	3.89	3.24	-2.55
Corporate tax payable	19.39	0.00	0.00	1.83	1.29	1.27	1.26	1.28	1.30	1.33	1.37	1.40	1.41	1.41	1.30	1.15	0.98	0.82	0.00
Profit After Tax (PAT)	55.11	0.00	0.00	5.45	3.84	3.77	3.75	3.81	3.86	3.96	4.07	4.17	4.19	4.18	3.87	3.41	2.91	2.43	-2.55
Effective Tax Rate		0%	0%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	0%
Tax calculation		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
EBT		0.00	0.00	7.29	5.14	5.04	5.01	5.09	5.15	5.29	5.43	5.57	5.60	5.58	5.17	4.56	3.89	3.24	-2.55
Add: Book Depreciation		0.00	0.00	4.22	8.27	8.12	7.97	7.84	7.68	7.54	7.40	7.28	7.14	7.01	6.88	6.77	6.63	6.51	3.71
Sub: IT Depreciation		0.00	0.00	27.74	20.81	15.61	11.70	8.78	6.58	4.94	3.70	2.78	2.08	1.56	1.17	0.88	0.66	0.49	1.48
Taxable profits		0.00	0.00	-16.23	-7.40	-2.45	1.27	4.15	6.25	7.90	9.14	10.08	10.66	11.03	10.88	10.45	9.86	9.26	-0.33
Accumulated loss/profit		0.00	0.00	-16.23	-23.64	-26.09	-24.82	-20.67	-14.42	-6.52	2.62	12.70	23.36	34.39	45.26	55.71	65.57	74.83	74.51
Tax payable - IT Act	18.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.54	2.68	2.78	2.74	2.63	2.48	2.33	0.00
Corporate Tax calculation																			
EBT		0.00	0.00	7.29	5.14	5.04	5.01	5.09	5.15	5.29	5.43	5.57	5.60	5.58	5.17	4.56	3.89	3.24	-2.55
Accumulated loss/profit		0.00	0.00	7.29	12.42	17.46	22.47	27.55	32.71	38.00	43.44	49.01	54.61	60.20	65.37	69.93	73.81	77.06	74.51
Tax Payable	19.39	0.00	0.00	1.83	1.29	1.27	1.26	1.28	1.30	1.33	1.37	1.40	1.41	1.41	1.30	1.15	0.98	0.82	0.00
Deferred Tax Liability Calculation																			
EBT as per CA 2013		0.00	0.00	7.29	5.14	5.04	5.01	5.09	5.15	5.29	5.43	5.57	5.60	5.58	5.17	4.56	3.89	3.24	-2.55
EBT as per IT Act 1961		0.00	0.00	-16.23	-7.40	-2.45	1.27	4.15	6.25	7.90	9.14	10.08	10.66	11.03	10.88	10.45	9.86	9.26	-0.33
Tax as per Books		0.00	0.00	1.83	1.29	1.27	1.26	1.28	1.30	1.33	1.37	1.40	1.41	1.41	1.30	1.15	0.98	0.82	0.00
Tax payable		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	2.54	2.68	2.78	2.74	2.63	2.48	2.33	0.00
Deferred Tax Liability/Asset for the year		0.00	0.00	1.83	1.29	1.27	1.26	1.28	1.30	1.33	0.71	-1.13	-1.27	-1.37	-1.44	-1.48	-1.50	-1.52	0.00
Opening Balance		0.00	0.00	0.00	1.83	3.13	4.39	5.66	6.94	8.23	9.57	10.27	9.14	7.87	6.50	5.06	3.58	2.07	0.56
Additions		0.00	0.00	1.83	1.29	1.27	1.26	1.28	1.30	1.33	0.71	-1.13	-1.27	-1.37	-1.44	-1.48	-1.50	-1.52	0.00
Closing Balance		0.00	0.00	1.83	3.13	4.39	5.66	6.94	8.23	9.57	10.27	9.14	7.87	6.50	5.06	3.58	2.07	0.56	0.56
Effective Tax Rate		0.00	0.00	0.2517	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00
Cash Flow Statement																			
Year of Operation		-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cash inflows		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Equity inflow	36.99	36.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt inflow	73.99	3.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant during Construction	165.75	60.06	83.83	21.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Cash accruals	166.65	0.00	0.00	11.51	13.40	13.16	12.98	12.93	12.84	12.84	12.18	10.32	10.06	9.81	9.31	8.70	8.04	7.42	1.16
Total inflows	443.38	100.16	139.72	48.36	13.40	13.16	12.98	12.93	12.84	12.84	12.18	10.32	10.06	9.81	9.31	8.70	8.04	7.42	1.16
Cash outflows		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Investment in assets	110.98	40.10	55.89	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant Component in Assets	165.75	60.06	83.83	21.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt repayment	73.99	0.00	0.00	4.44	5.18	5.92	6.66	7.40	8.14	8.14	8.14	7.40	7.40	5.18	0.00	0.00	0.00	0.00	0.00
Total outflows	350.71	100.16	139.72	41.29	5.18	5.92	6.66	7.40	8.14	8.14	8.14	7.40	7.40	5.18	0.00	0.00	0.00	0.00	0.00
Net cash inflow	92.66	0.00	0.00	7.07	8.22	7.24	6.32	5.53	4.70	4.70	4.04	2.92	2.66	4.64	9.31	8.70	8.04	7.42	1.16
Promoter's sub-debt for neg. cash		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Opening Balance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0 Drawal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0 Repayment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance sheet																			
Source of funds		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Equity		36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99
Promoters Sub-debt		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt		3.10	58.99	69.55	64.37	58.45	51.79	44.39	36.25	28.11	19.98	12.58	5.18	0.00	0.00	0.00	0.00	0.00	0.00
Grant from Govt. (during Construction)		60.06	143.90	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75
Deferred Tax Liability		0.00	0.00	1.83	3.13	4.39	5.66	6.94	8.23	9.57	10.27	9.14	7.87	6.50	5.06	3.58	2.07	0.56	0.56
Reserves and surplus		0.00	0.00	5.45	9.30	13.07	16.81	20.62	24.47	28.44	32.50	36.67	40.87	45.05	48.91	52.33	55.24	57.66	55.11
Total		100.16	239.88	279.57	279.53	278.65	277.00	274.69	271.70	268.86	265.49	261.13	256.65	254.28	256.72	258.65	260.05	260.96	258.41
Application of funds		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Fixed Assets		40.10	95.98	106.75	98.49	90.37	82.40	74.56	66.87	59.33	51.93	44.64	37.51	30.50	23.62	16.85	10.22	3.71	0.00
Grant component of Assets		60.06	143.90	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75
Cash and Bank balances		0.00	0.00	7.07	15.30	22.53	28.85	34.38	39.08	43.78	47.82	50.74	53.40	58.04	67.35	76.05	84.08	91.51	92.66
Total		100.16	239.88	279.57	279.53	278.65	277.00	274.69	271.70	268.86	265.49	261.13	256.65	254.28	256.72	258.65	260.05	260.96	258.41
Cash Balance check	OK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BS check	OK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Project IRR Calculation																			
FYE		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Capex	-110.98	-40.10	-55.89	-15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash available before taxes	223.92	0.00	0.00	16.16	19.76	18.99	18.21	17.50	16.67	15.90	15.12	14.40	13.58	12.82	12.05	11.33	10.52	9.75	1.16
Tax	-18.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.66	-2.54	-2.68	-2.78	-2.74	-2.63	-2.48	-2.33	0.00
0.00 **Cash flow to the firm**	94.11	-40.10	-55.89	1.16	19.76	18.99	18.21	17.50	16.67	15.90	14.46	11.87	10.90	10.04	9.31	8.70	8.04	7.42	1.16
Project IRR		10.29%																	
		($7.38)																	
Equity IRR Calculation																			
FYE		31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43
Equity inflow	-36.99	-36.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash available before taxes	223.92	0.00	0.00	16.16	19.76	18.99	18.21	17.50	16.67	15.90	15.12	14.40	13.58	12.82	12.05	11.33	10.52	9.75	1.16

Year of Operation	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
FY Ended	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
No. of days	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Revenue																								
Annuity Revenue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M Compensation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Revenue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Penalty for KPI breaches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Revenue	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Expenses																								
O&M costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total O&M Expenses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EBITDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EBIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest expense	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EBT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corporate tax payable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profit After Tax (PAT)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Effective Tax Rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tax calculation	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
EBT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Add: Book Depreciation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sub: IT Depreciation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxable profits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Accumulated loss/profit	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51
Tax payable - IT Act	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corporate Tax calculation																								
EBT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Accumulated loss/profit	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51	74.51
Tax Payable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deferred Tax Liability Calculation																								
EBT as per CA 2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EBT as per IT Act 1961	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax as per Books	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax payable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deferred Tax Liability/Asset for the year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Opening Balance	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Additions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Effective Tax Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash Flow Statement																								
Year of Operation	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Cash inflows	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Equity inflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt inflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant during Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Cash accruals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total inflows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash outflows	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Investment in assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant Component in Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt repayment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total outflows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net cash inflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Promoter's sub-debt for neg. cash	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Opening Balance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0 Drawal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0 Repayment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance sheet																								
Source of funds	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Equity	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99	36.99
Promoters Sub-debt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant from Govt. (during Construction)	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75
Deferred Tax Liability	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Reserves and surplus	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11	55.11
Total	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41
Application of funds	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Fixed Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grant component of Assets	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75	165.75
Cash and Bank balances	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66	92.66
Total	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41	258.41
Cash Balance check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BS check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Project IRR Calculation																								
FYE	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Capex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash available before taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00 **Cash flow to the firm**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equity IRR Calculation																								
FYE	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56	31-Mar-57	31-Mar-58	31-Mar-59	31-Mar-60	31-Mar-61	31-Mar-62	31-Mar-63	31-Mar-64	31-Mar-65	31-Mar-66	31-Mar-67
Equity inflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash available before taxes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Interest	**-28.44**	0.00	0.00	-4.65	-6.36	-5.83	-5.24	-4.57	-3.83	-3.06	-2.28	-1.55	-0.84	-0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tax	**-18.83**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.66	-2.54	-2.68	-2.78	-2.74	-2.63	-2.48	-2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt repayment	**-72.99**	0.00	0.00	-4.44	-5.18	-5.92	-6.66	-7.40	-8.14	-8.14	-8.14	-7.40	-7.40	-5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash flow to equity	**35.67**	**-36.99**	**0.00**	**7.07**	**8.32**	**7.34**	**6.32**	**5.23**	**4.70**	**4.70**	**4.04**	**2.93**	**2.66**	**4.64**	**9.31**	**8.70**	**8.04**	**7.42**	**1.16**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

0.00 **Equity IRR** **12.28%**

IRR

DSCR calculation	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**	**31-Mar-30**	**31-Mar-31**	**31-Mar-32**	**31-Mar-33**	**31-Mar-34**	**31-Mar-35**	**31-Mar-36**	**31-Mar-37**	**31-Mar-38**	**31-Mar-39**	**31-Mar-40**	**31-Mar-41**	**31-Mar-42**	**31-Mar-43**	**31-Mar-44**	**31-Mar-45**	**31-Mar-46**	**31-Mar-47**	**31-Mar-48**	**31-Mar-49**	**31-Mar-50**	**31-Mar-51**	**31-Mar-52**	**31-Mar-53**	**31-Mar-54**	**31-Mar-55**	**31-Mar-56**	**31-Mar-57**	**31-Mar-58**	**31-Mar-59**	**31-Mar-60**	**31-Mar-61**	**31-Mar-62**	**31-Mar-63**	**31-Mar-64**	**31-Mar-65**	**31-Mar-66**	**31-Mar-67**
No. of months of Debt service	**0.00**	**0.00**	**8.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**11.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
No. of months of repayment	**0.00**	**0.00**	**3.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**12.00**	**11.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Net Cash Accruals	0.00	0.00	11.51	13.40	13.16	12.98	12.93	12.86	12.84	12.18	10.32	10.06	9.81	9.31	8.70	8.04	7.42	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Promoter's sub debt for cash shortfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest	0.00	0.00	4.65	6.36	5.83	5.24	4.57	3.83	3.06	2.28	1.55	0.84	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash Available for debt service	**0.00**	**0.00**	**16.16**	**19.76**	**18.99**	**18.21**	**17.50**	**16.67**	**15.90**	**14.46**	**11.87**	**10.90**	**10.04**	**9.31**	**8.70**	**8.04**	**7.42**	**1.16**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Interest	0.00	0.00	4.65	6.36	5.83	5.24	4.57	3.83	3.06	2.28	1.55	0.84	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Debt repayment	0.00	0.00	4.44	5.18	5.92	6.66	7.40	8.14	8.14	8.14	7.40	7.40	5.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Debt service requirement	**0.00**	**0.00**	**9.09**	**11.54**	**11.75**	**11.90**	**11.97**	**11.97**	**11.20**	**10.42**	**8.94**	**8.24**	**5.40**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
DSCR	NA	NA	1.78	1.71	1.62	1.53	1.46	1.39	1.42	1.39	1.33	1.32	1.86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ADSCR	NA	NA	1.78	1.74	1.70	1.65	1.61	1.57	1.55	1.53	1.51	1.50	1.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Average DSCR	**1.52**
Minimum DSCR	**1.33**

Assumptions and Survey Inputs	Consumers	
WDS Name	Residential	Institutional/Other
Pallipattu WDS	42999	6371
Thiruvanmiyur WDS	13306	1255
Total	56,307	7,626

Litres Per capita Per day (LPCD)	135.00	Source: CPHEEO
Days per month	30.42	

Consumption (KL)	KL Per Cap/Day	KL Per Cap/Month
Pallipattu WDS (KL)	0.74	22.50
Thiruvanmiyur WDS (KL)	1.00	30.42

Tariff - Consumption based - per Residential Connection per month (KL)	Rate/KL in Rs.	Full Slab value (Rs.)
Assume, in 10 KL	6	60
11 to 15 KL	18	156
16 to 25 KL	28	420
26 and above	45	
Minimum Charges (INR) and Unmetred	100	

Tariff - Consumption based - per non Residential Connection per month (K	Rate/KL in Rs.
From 0 above	90
Unmetred	853

Water Tax - Per Connection per annum		Avg Annual Value
Residential	6%	120000
Non-Residential	5%	180000

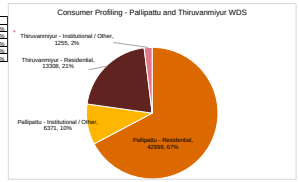
Source: https://cmwssb.tn.gov.in/tariff

Collection Efficiency		Period till
Efficiency Level	86%	31-Mar-25
	90%	31-Mar-26
	95%	31-Mar-27 and beyond

Growth Rates - Assumptions		Frequency (years)	Base year
Population	0.98%	1 years	31-Mar-23
Tariff	10%	2 years	31-Mar-25

O&M Cost factor for CMWSSB - BAU	80%

	No of Consumers	Percentage
Pallipattu - Residential	42999	87%
Pallipattu - Institutional / Other	6371	13%
Thiruvanmiyur - Residential	13306	71%
Thiruvanmiyur - Institutional / Other	1255	2%
Total	63931	100%



FYE			31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56
No of Operating Days			365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	0	0	0	0	0	0	0	0	0	0	0	0
Consumers - Nos																																
Pallipattu WDS																																
Residential			43882	44181	44481	44783	45088	45395	45703	46014	46327	46642	46959	47278	47600	47924	48250	48578	48908	49241	49575	49912	50252	50594	50938	51284	51633	51984	52337	52693	53052	53412	53775
Non Residential			6,502	6,546	6,591	6,635	6,681	6,726	6,772	6,818	6,864	6,911	6,958	7,006	7,053	7,101	7,149	7,198	7,247	7,296	7,345	7,395	7,446	7,496	7,547	7,599	7,650	7,702	7,755	7,807	7,860	7,914	7,968
Thiruvanmiyur WDS																																
Residential			13,581	13,674	13,767	13,860	13,955	14,049	14,145	14,241	14,338	14,435	14,534	14,632	14,732	14,832	14,933	15,035	15,137	15,240	15,343	15,448	15,553	15,658	15,765	15,872	15,980	16,089	16,198	16,308	16,419	16,531	16,643
Non Residential			1,281	1,289	1,298	1,307	1,316	1,325	1,334	1,343	1,352	1,361	1,371	1,380	1,389	1,398	1,408	1,418	1,427	1,437	1,447	1,457	1,467	1,477	1,487	1,497	1,507	1,517	1,528	1,538	1,548	1,559	1,570
Total Consumers			65,246	50,727	51,072	51,419	51,768	52,121	52,475	52,832	53,191	53,553	53,917	54,284	54,653	55,024	55,398	55,775	56,156	56,536	56,921	57,308	57,697	58,090	58,485	58,883	59,283	59,686	60,092	60,501	60,912	61,326	61,743
Total Consumption (KL/month)																																
Pallipattu WDS			9,87,349	9,94,063	10,00,822	10,07,626	10,14,480	10,21,378	10,28,323	10,35,318	10,42,356	10,49,444	10,56,582	10,63,765	10,70,998	10,78,282	10,85,614	10,92,996	11,00,428	11,07,911	11,15,445	11,23,030	11,30,667	11,38,355	11,46,096	11,53,890	11,61,736	11,69,636	11,77,589	11,85,597	11,93,659	12,01,776	12,09,948
Thiruvanmiyur WDS			4,13,146	4,15,954	4,18,782	4,21,630	4,24,497	4,27,383	4,30,290	4,33,216	4,36,161	4,39,127	4,42,113	4,45,120	4,48,147	4,51,194	4,54,262	4,57,351	4,60,461	4,63,592	4,66,746	4,69,919	4,73,114	4,76,331	4,79,570	4,82,831	4,86,115	4,89,420	4,92,748	4,96,099	4,99,472	5,02,869	5,06,288
Total			14,00,493	14,10,016	14,19,604	14,29,257	14,38,976	14,48,761	14,58,613	14,68,532	14,78,518	14,88,572	14,98,694	15,08,885	15,19,145	15,29,476	15,39,876	15,50,347	15,60,889	15,71,504	15,82,190	15,92,949	16,03,781	16,14,686	16,25,666	16,36,721	16,47,851	16,59,056	16,70,338	16,81,696	16,93,131	17,04,645	17,16,236
Revenue Estimation			31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56
Pallipattu WDS																																
Residential Consumers			43,882	44,181	44,481	44,783	45,088	45,395	45,703	46,014	46,327	46,642	46,959	47,278	47,600	47,924	48,250	48,578	48,908	49,241	49,575	49,912	50,252	50,594	50,938	51,284	51,633	51,984	52,337	52,693	53,052	53,412	53,775
Average consumption (KL/Connection/month)			23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Applicable Realisation / Connection/month (INR)			360	366	366	366	436	436	409	479	527	527	580	580	638	638	702	702	772	772	849	849	934	934	1,027	1,027	1,130	1,130	1,243	1,243	1,367	1,367	1,504
Billable Revenue per month (INR Crore)			2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	6	7	7	7	8	8
Billable Revenue per year (INR Crore)			19	21	21	23	24	26	26	29	29	33	33	36	36	41	41	45	45	50	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Tax			5.27	5.63	5.87	6.55	6.55	7.35	7.30	8.08	8.14	9.01	8.98	10.05	10.12	11.21	11.28	12.50	12.58	13.93	-	-	-	-	-	-	-	-	-	-	-	-	-
Non Residential Consumers			6,502	6,546	6,591	6,635	6,681	6,726	6,772	6,818	6,864	6,911	6,958	7,006	7,053	7,101	7,149	7,198	7,247	7,296	7,345	7,395	7,446	7,496	7,547	7,599	7,650	7,702	7,755	7,807	7,860	7,914	7,968
Average consumption (KL/Connection/month)			23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Applicable Realisation / Connection/month (INR)			2,025	2,218	2,218	2,450	2,450	2,695	2,695	2,965	2,965	3,261	3,261	3,587	3,587	3,946	3,946	4,341	4,341	4,775	4,775	5,252	5,252	5,778	5,778	6,356	6,356	6,991	6,991	7,690	7,690	8,459	8,459
Billable Revenue per month (INR Crore)			1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	7	7
Billable Revenue per year (INR Crore)			16	17	18	20	20	22	22	24	24	27	27	30	30	34	34	37	38	42	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Tax			1.17	1.30	1.30	1.45	1.46	1.81	1.62	1.80	1.81	2.00	2.02	2.23	2.26	2.49	2.51	2.78	2.80	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-
Thiruvanmiyur WDS																																
Residential Consumers			13,581	13,674	13,767	13,860	13,955	14,049	14,145	14,241	14,338	14,435	14,534	14,632	14,732	14,832	14,933	15,035	15,137	15,240	15,343	15,448	15,553	15,658	15,765	15,872	15,980	16,089	16,198	16,308	16,419	16,531	16,643
Average consumption (KL/Connection/month)			30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Applicable Realisation / Connection/month (INR)			674	741	741	815	815	897	897	987	987	1,085	1,085	1,194	1,194	1,313	1,313	1,445	1,445	1,589	1,589	1,748	1,748	1,923	1,923	2,115	2,115	2,326	2,326	2,559	2,559	2,815	2,815
Billable Revenue per month (INR Crore)			1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	3	3	4	4	4	4	4	4	5	5
Billable Revenue per year (INR Crore)			11	12	12	14	14	15	15	17	17	19	19	21	21	23	24	26	26	29	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Tax			1.83	1.80	1.80	2.01	2.01	2.26	2.26	2.26	2.80	2.52	2.78	2.81	3.11	3.11	3.47	3.89	3.87	4.31	-	-	-	-	-	-	-	-	-	-	-	-	-
Non Residential Consumers			1,281	1,289	1,298	1,307	1,316	1,325	1,334	1,343	1,352	1,361	1,371	1,380	1,389	1,398	1,408	1,418	1,427	1,437	1,447	1,457	1,467	1,477	1,487	1,497	1,507	1,517	1,528	1,538	1,548	1,559	1,570
Average consumption (KL/Connection/month)			30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Applicable Realisation / Connection/month (INR)			2,708	741	741	815	815	897	897	987	987	1,085	1,085	1,194	1,194	1,313	1,313	1,445	1,445	1,589	1,589	1,748	1,748	1,923	1,923	2,115	2,115	2,326	2,326	2,559	2,559	2,815	2,815
Billable Revenue per month (INR Crore)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billable Revenue per year (INR Crore)			4	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Tax			0.23	0.24	0.26	0.29	0.29	0.32	0.32	0.36	0.36	0.39	0.40	0.44	0.44	0.49	0.49	0.56	0.55	0.61	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Billable Revenue per year			58	61	61	69	68	76	76	85	85	94	95	105	106	117	118	131	132	146	-	-	-	-	-	-	-	-	-	-	-	-	-
Collection Efficiency			90%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Annual Revenue Realisation (INR Crore)			52	58	58	65	65	72	73	80	81	90	90	100	101	111	112	124	125	138	-	-	-	-	-	-	-	-	-	-	-	-	-
Population Index			*1.02*	*1.03*	*1.03*	*1.04*	*1.05*	*1.06*	*1.06*	*1.07*	*1.08*	*1.09*	*1.09*	*1.10*	*1.11*	*1.11*	*1.12*	*1.13*	*1.14*	*1.15*	*1.16*	*1.17*	*1.18*	*1.18*	*1.19*	*1.20*	*1.21*	*1.22*	*1.23*	*1.23*	*1.24*	*1.25*	*1.26*
Tariff Index			*1.00000000*	*1.10000000*	*1.10000000*	*1.21000000*	*1.21000000*	*1.33100000*	*1.33100000*	*1.46410000*	*1.46410000*	*1.61051000*	*1.61051000*	*1.77156100*	*1.77156100*	*1.94871710*	*1.94871710*	*2.14358881*	*2.14358881*	*2.35794769*	*2.35794769*	*2.59374246*	*2.59374246*	*2.85311671*	*2.85311671*	*3.13842838*	*3.13842838*	*3.45227121*	*3.45227121*	*3.79749834*	*3.79749834*	*4.17724817*	*4.17724817*
CMWSSB - Project Cashflow Analysis			31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	31-Mar-47	31-Mar-48	31-Mar-49	31-Mar-50	31-Mar-51	31-Mar-52	31-Mar-53	31-Mar-54	31-Mar-55	31-Mar-56
			2029	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056
Net Cash Realised by CMWSSB			5.99	7.71	58	65	65	72	73	80	81	90	90	100	101	111	112	124	125	138	-	-	-	-	-	-	-	-	-	-	-	-	-
Annual Payment Obligations																																
Construction Grant			60	84	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Annuity - Capex with Interest			-	-	17	22	21	20	19	18	17	16	15	14	13	12	11	11	10	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Annuity - O&M Component with Interest			-	-	9	18	13	13	13	14	14	14	15	15	16	16	17	17	17	4	-	-	-	-	-	-	-	-	-	-	-	-	-
O&M during construction			10	14	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy cost			5	5	5	6	6	6	6	6	6	7	7	7	7	8	8	8	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Payment Obligations			75	103	57	46	40	39	39	38	38	37	37	37	36	36	36	35	35	15	-	-	-	-	-	-	-	-	-	-	-	-	-