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1. STUDY OVERVIEW

1.1. Introduction

The boundary of Chennai City Corporation has been expanded from 176 sq.km. to426 sq.km by annexing the 42 adjacent local bodies which includes 9 Municipalities,8 Town Panchayat and 25 Village Panchayats. The Population of Chennai City Corporation was 6.7 million in 2011 and is projected as 7.6 million in the year 2020, 9 million in the year 2035 and 10.9 million in the year 2050.

The rest of the Chennai Metropolitan Area (CMA) comprises of 7 Municipalities, 12 Town Panchayats and 189 Village Panchayats. As per 2011 census the population in Rest of CMA was 2.3 Million and is expected to reach 3.6 million in the year 2020, 6.3 million in the year 2035 and 9.7 million in year2050.The total jurisdiction of entire Chennai Metropolitan Area (CMA) is 1189 Sq.km, and the projected population stands at 11.20 million for the year 2020, 15.48 million for the year 2035 and 20.68 million for the year 2050.

Rapid urbanization and migration to the Chennai Metropolitan Area from other parts of the State has resulted in significant increase in the population leading to substantial increase in the demand for water supply and other infrastructures. The growing needs which is a dynamic call for prudent utilization of the existing sources of water supply and the urgent need to improve/ augment the existing sources. The other infrastructures like road, sewerage facilities, etc are summarily inadequate to meet the present level of population and the increase in the coming years would definitely pose a mammoth problem to be tackled. To annihilate the despondency, proper planning and a road map to guide the future course of action is essential to the agency vested with the responsibility of implementing and maintaining the respective systems, viz. Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) in respect of water supply and sewerage disposal and the Corporation of Chennai and other local bodies in respect of roads and other facilities.

Government of Tamil Nadu is committed to provide adequate water supply and sewerage facilities to the entire area covered under Chennai Corporation and Chennai Metropolitan Area by either improving the existing water supply and sewerage facilities or by providing new water supply and sewerage facilities.

The need to improve the existing as well as to provide new infrastructural facilities commensurate to the growing needs of Water Supply and Waste Water Management for Chennai City and Chennai Metropolitan Area was engaging the attention of the planners and resultantly two Master Plans, one in the year 1978 and the other in the year 1991 were prepared. The present Master Plan has been prepared considering the works carried out based on the recommendations of the previous Master plans and outlines the detailed actions to be taken in respect of water supply and sewerage sectors in entire Chennai metropolitan area for the future requirement in the context of the expanded boundary of the Chennai City Corporation and the Chennai Metropolitan Area. .

1.2. Consultancy Assignment

The Tamil Nadu Government's initiative to draw a Master Plan for the purpose of wholesome coverage of the Chennai Corporation and Chennai Metropolitan Area was actively pursued by the TamilNadu Urban Infrastructure Financial Services Limited (TNUIFSL) and they have appointed a consultant M/S.Shah Technical Consultant Pvt. Limited, Chennai for the purpose of preparation of a Comprehensive Master Plan for Water Supply and Sewerage Sector for Chennai city including expanded areas and Rest of Chennai Metropolitan Area under the Grant II Funds.

1.3. Objective

The objective of the study would be to draw long term and short term plans for the purpose of providing adequate water supply and sewerage facilities and the study would be known as "Master Plan for Water Supply and Waste Water Management for Chennai Metropolitan Area".The purpose would be to develop systematic long term plans for the water supply and wastewater management system serving the CMA, and to delineate programmes for obtaining short time relief from current deficiencies in those systems.

The activities contemplated to accomplice the ***long term*** objectives would be:

- To ensure sustainable and reliable Water Supply, Improve sanitation and environmental conditions in CMA aiming towards improvement of public health and socio–economic conditions of the capital city.
- To provide institutional reform and long term planning for the water supply and sewerage system.
- Restructuring of organization to strengthen the managerial, administrative and financial functions for effective operation and maintenance of the assets created.
- Feasibility Studies to provide adequate, reliable water supply and sewerage systems in the areas under consideration for the projected design years.

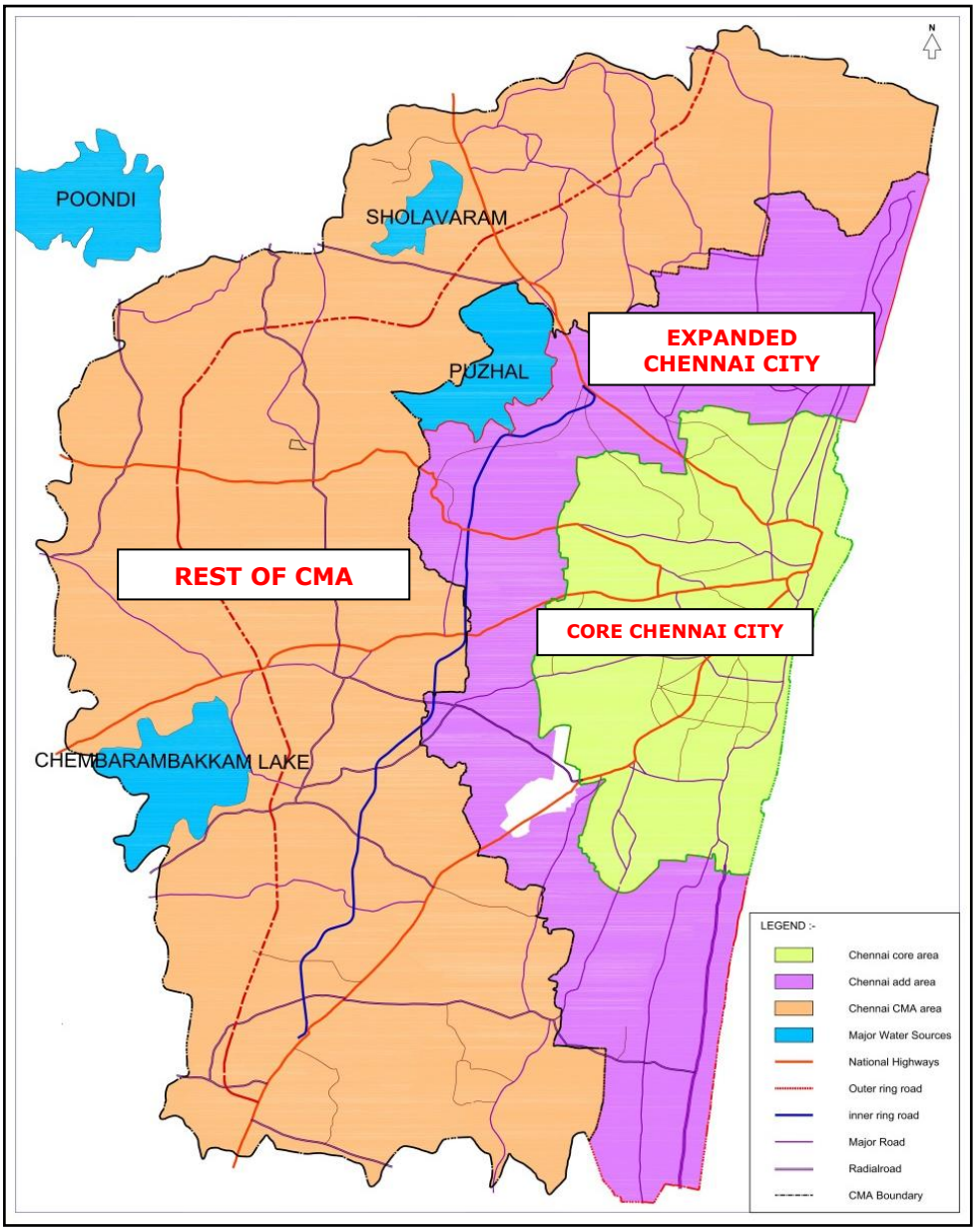


Figure 1-1 Project Area for the Master Plan - Water & Waste Water Sector of CMA

The activities contemplated to accomplish the ***short-term*** objective would be:

- To bridge the supply demand gap in respect of water supply
- Feasibility studies to rehabilitate the existing system of water supply and sewerage for optimum utilization
- To identify, recommend and design any possible immediate works to alleviate the current potable water shortage and to enhance the performance of the sewerage system.

- Recommend the programme for capacity building.
- Assessment of Financial condition of the organization and recommend necessary improvements to the financial system

1.4. Conduct of the study

Studies have been conducted in the past aiming at Augmentation of Chennai Water Supply and Improvement of Sewerage System and this included the preparation of two Master Plans for Chennai city, under City development plan (CDP) and CMDA's Second Master Plan. The report pertaining to these studies have been collected to the extent available and have been reviewed herein and this forms the basis for preparation of this Master Plan. An immediate works programme is also prepared along with, outlining most effective actions for improving the existing system that would be implemented within the funding capacity of Government agencies. The development of long term strategy has been formulated with phasing out the worn-out infrastructure taking into consideration the need of increasing population with preliminary engineering for the improvement programmes for the respective design years.

1.5. Base Map of Project Area:

Base Map of the entire CMA (Chennai Metropolitan Area) has been prepared for1189 sq.km in 1:1500 scale using high-resolution images. The same is enclosed in the Plan folio submitted with this report.

2. SITUATION ANALYSIS

This section of the report deals with the study area with particular reference to the water supply and sewerage management and the facilities comprising the water supply and sewerage system.

2.1. The Project Area

The Project Area is Chennai Metropolitan Area (CMA), which is located on the south east coast of India in Tamil Nadu State as shown in Fig.1.Chennai is the fourth largest Metropolitan city in India. Established in 1639 as a trading settlement on the eastern seaboard of South India by the East India Trading Company of British, it became the capital of a composite presidency, which extended over a large part of south India.

The topography of the area is almost flat, particularly in the central urban section, which has an average slope of less than a meter per kilometer. The climate is tropical with average rainfall of 1200mm, a mean annual temperature of over 30°C, and humidity which ranges over 90 percent during the monsoons. The city gets most of its seasonal rainfall from the north–east monsoon winds, from mid–October to mid–December. Cyclones in the Bay of Bengal at times torment the city. The highest annual rainfall recorded is 257 cm (101 in) in 2005. Prevailing winds in Chennai are usually south westerly between April and October and north-easterly during the rest of the year. There are no major rivers flowing through the Chennai city and historically, Chennai has relied on annual monsoon rains to replenish water reservoirs. Chennai has a water table at 2 metres for 60 percent of the year.

During reorganization of states, Chennai City (Erstwhile Madras) became the capital of the Tamil Nadu State. Originally, the city had an extent of 176sq.km and was locally administered by Chennai Municipal Corporation. The Chennai city has subsequently been expanded to an extent of 426Sq. km by annexing 42 adjacent local bodies which include 9 Municipalities, 8 Town Panchayats and 25 Village Panchayats. The total population as per the 2011 census is 66.67 Lakhs.

The Chennai city has further been expanded by adding adjacent and distant urban/rural areas of Thiruvallur and Kancheepuram Districts and this constitutes the Chennai Metropolitan Area (CMA).The total population of entire CMA was 89.31 lakhs as per the

2011 census. This area coming under Chennai Metropolitan Area constitutes the study area (project area) under this assignment.

Prior to 1972, each urban local body (ULBs) was the authority for land use planning and development controls within their own boundaries. In 1972, the State Government formed the Madras Metropolitan Development Authority (MMDA), [subsequently the nomenclature has been changed as Chennai Metropolitan Development Authority (CMDA)], a regional authority with sweeping powers to regulate land use and development within the CMA, and vested with the responsibility for coordinating and supervising area wide programmes.

The major economic activities in CMA are the production of textiles, electrical equipment, machinery and motor vehicles, besides seasonal agriculture. The port of Chennai is responsible for a significant amount of the area's economic activity, and the surrounding ocean, Bay of Bengal, supports a rapidly growing fishing fleet. Industrial employment, although slow in comparison with other metropolitan cities of India, has grown significantly in the last few decades. The relatively small industrial base is reflected in a per capita income which is substantially lower than that of other large urban areas in India.

2.2. Institutional Factors

The Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) [then Madras Metropolitan Water Supply and Sewerage Board (MMWSSB)before changing the name 'Madras' as 'Chennai'],was formed by an Act of the Tamil Nadu Legislature, exclusively to provide Water Supply and Sewerage facilities to Chennai Metropolitan Area.[The Madras Metropolitan Water Supply and Sewerage Act 1978 (Act No.28 of 1978.)]

Subsequently, the CMWSSB took over the water supply and sewerage services carried out by the Chennai Municipal Corporation and Tamil Nadu Water Supply and Drainage Board (TWAD Board), in respect of Chennai Corporation and CMA respectively.

2.3. Water Supply

2.3.1. Sources

The Source for Water Supply to Chennai City is surface water drawn from the four lakes of Chennai viz, Poondi reservoir, Sholavaram, Red hills and Chembrambakkam lakes. All these four reservoirs are extremely shallow and subject to high evaporation and seepage losses amounting to about 40% of the total inflow of water.

Control of surface water sources and operation of Poondi-Sholavaram-Redhills and Chembrambakkam lakes are the responsibility of Water Resource Department (WRD), a branch of the PWD of the Tamil Nadu State. Water impounded in Poondi, the largest of the four lakes, is transported via lined channels to Sholavaram, Red hills and Chembrambakkam.

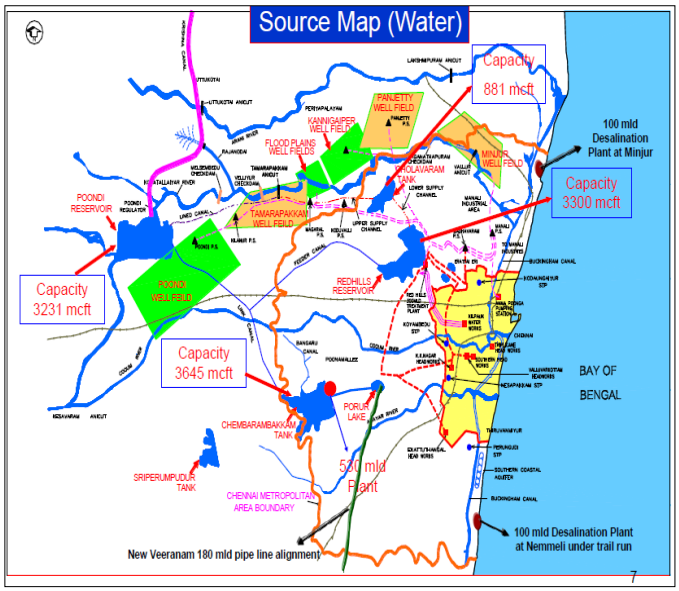


Figure 2-1 Source Map

Water is conveyed from Red hills Reservoir to the Kilpauk Treatment Plant through three brick – arch conduits. One of these conduits is in dilapidated condition and rehabilitation of this conduit is in progress. The designed capacity of the Water Treatment Plant at Kilpauk is 270 MLD. Abnormal increase in the population coupled with dwindling of the water sources resulting in lesser quantity of water availability has pushed the Chennai city to suffer acute from water scarcity periodically. Various industrial establishments have developed their own water supply system owing to inadequate water supply by the Chennai Water Supply and Sewerage Board.

Efforts have been made to augment the water supply to the Chennai City by tapping the surface water from distant sources like Veeranam Lake situated at a distance of more than 200 km from the city and from Kandaleru Reservoir located in erstwhile Andhra Pradesh State which now comes under the control of newly formed Andhra Pradesh.

Ground Water from Minjur, Panjetti and Tamarapakkam areas in the Arani-Kosatalayar River basin North west of the city was considerably more plentiful but this has not been used for domestic needs appreciably. Development of this ground water sources has benefitted mostly the industrial purposes. It was originally designed to draw 100 MLD of Water from this River basin, but depletion of ground water due to over extraction has restricted the yield of this source to 30 MLD.

During 2004, under Chennai City Water Supply Augmentation Project-1, New Veeranam Project was implemented. Under this project, 190 MLD of raw water from Veeranam Lake near Sethiathope, situated in Cuddalore District at about 230 km. from Chennai City, is being initially pumped to about 20 km. through the pipeline to Vadakuthu for treatment. After treatment, the treated water to a quantity of 180 MLD is pumped from Vadakuthu to the Break Pressure Tank located at Kadampuliyur ridge point at a distance of about 8 km. The water from Kadampuliyur ridge is conveyed over a distance of 200 km by gravity to the Water Distribution Station at Porur in Chennai.

Veeranam Lake is dependent on River Cauvery for its inflow and due to poor inflow from the Cauvery River, the scheme could not be operated to its full capacity throughout the year. During the periods of poor inflow into the Veeranam Lake, the supply of water to the city gets reduced to 100 MLD.

As a further step towards improving the water supply situation in the Chennai City, the CMWSSB has established two Sea Water Desalination Plants with capacity of 100 MLD each

The present water use in CMA is given in the following table

Table 2-1 The Present Water use in CMA

EXISTING FRESH WATER SUPPLY				
S. No	**Particulars**	**Potential Yield (in MLD)**	**Available in good years (in MLD)**	**Present availability (in MLD)**
1.	**SURFACE WATER SOURCES**			
	a) Poondi, Red hills, Cholavaram & Chembarambakkam lakes (surface sources)	200	125	75
	b) Telugu-Ganga Project	930	400	200
	c) Veeranam Lake Source	180	100	100
2.	**GROUND WATER/SUB-SURFACE WATER**			
	d) Northern well field /Southern Aquifer	100	25	25
	e) Sub Surface water sources in Rest of CMA	32	32	32
3.	**SEA WATER DESALINATION**			
	f) Minjur DSP	100	100	100
	g) Nemmeli DSP	100	100	100
	Total	**1642**	**882**	**632**

In addition to the above water availability from local sources, such as open wells/bore wells are about 110 MLD and 100 MLD in Chennai city and in rest of CMA respectively.

Apart from these, the CMWSSB supplies about 36 MLD of recycled sewage water for Industrial use.

2.3.2. Treatment Facilities

There are three Water Treatment Plants available at Kilpauk Water works, each of capacity 45 MLD, 90 MLD and 135 MLD, totaling to 270 MLD.

A 300 MLD WTP was established in Year 1996 at Red hills for treatment of raw water received from Telugu-Ganga Krishna project.

A 530 MLD WTP at Chembrambakkam was established in 2007 for treatment of raw water from the own catchments of Chembrambakkam Lake as well as from Telugu-Ganga Krishna project.

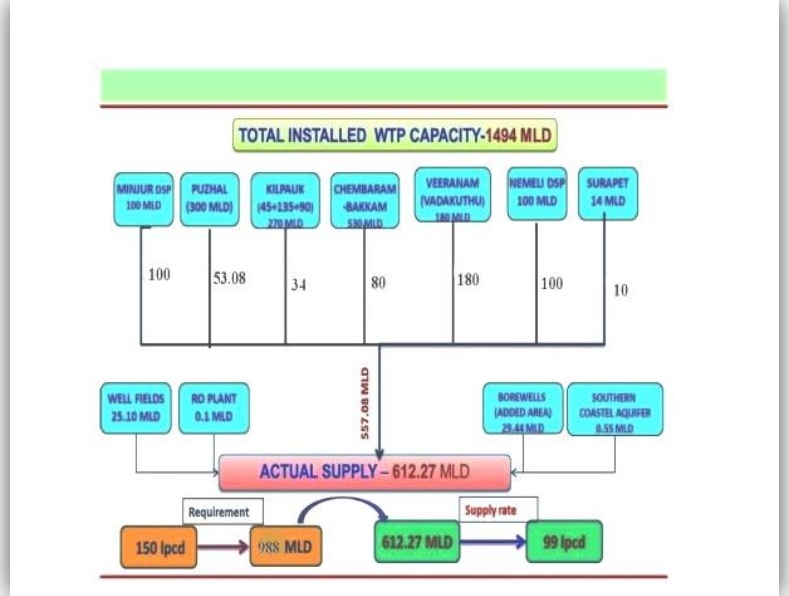


Figure 2-2 Flow Diagram of Capacities of WTPs

2.3.3. Transmission Mains

The clear water transmission from WTP to WDS, from Red hills treatment plant comprises of three mains viz, North Chennai Main, Central Chennai Main and South Chennai Main, each of 1000mm diameters with designed carrying capacity of 100 MLD each and these three mains, serve the core areas of the city of Chennai.

2.3.4. Storage Facilities /Distribution Main

Storage Reservoirs (underground reservoirs) are provided for each of 16 Distribution zones for Chennai city. In 7 WDSs, overhead reservoirs are also provided.

The existing distribution system for Chennai city consist of 18 distribution zones, approximately with a network of about 4000km of CI/DI/MS pipes, ranging from 100-1200mm diameter.

The distribution system has been rehabilitated to prevent the leakages in the main and the house service connections pipes have been replaced with MDPE pipes to minimize the losses. A flat rate is being collected as water charges and only few consumer supply points have been metered.

2.4. Waste Water Collection and Treatment

2.4.1. Sewerage System

The sewerage system for the old city is divided into five drainage zones or macro systems. Zone I &II drain to the north of the city to Kodungaiyur sewage treatment plants.

Zone III and IV drains towards west to Koyambedu and Nesapakkam Treatment plants. Zone V drains to south towards Perungudi sewage treatment plant. A small part of zone 2 conveys its sewage to Villivakkam treatment plant.

The existing sewerage system covers about 100 percent of the core city and out of 42 annexed ULBs,two ULBs were provided with conventional sewerage system and for 16 ULBs works are in various stages of progress and for the rest of the ULBs systems, the proposals are in planning stage. The whole system has been divided into five zones based on the STPs viz, Kodungaiur two zones, Koyambedu, Nesapakkam and Perungudi. The sewage of core Chennai city has been collected in 226 nos of pumping stations through sewer network of each zone and conveyed through

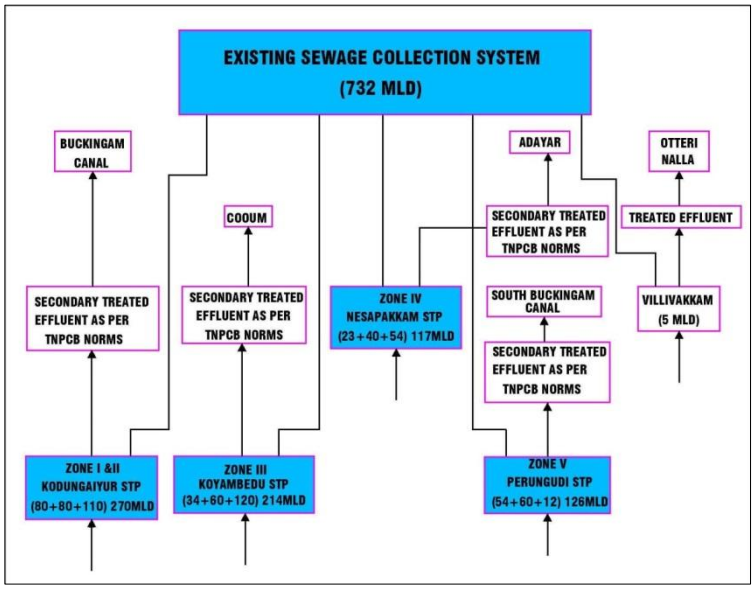


Figure 2-3 Existing sewerage zones

force main to the respective STPs for treatment. The treated effluent is discharged into nearby water bodies.

2.4.2. Sewer Transmission Mains

The sewage collected from five zones of sewerage zones of erstwhile Chennai city is conveyed through force mains and gravity mains to the respective STPs situated at Kodungaiyur, Koyambedu, Nesapakkam and Perungudi. The details are discussed in the main report.

2.4.3. Sewage Treatment Plants

The sewerage system for the erstwhile Chennai city is divided into five drainage zones or macro zones. Zone I & II drain to the north of the city to Kodungaiyur sewage treatment plants. Zone III & Zone IV drains towards west to Koyambedu and Nesapakkam Treatment plants. Zone V drains to south towards Perungudi sewage treatment plant. A small part of zone 2 conveys its sewage to Villivakkam treatment plant. The diagram depicting the existing sewage zones is shown in the Figure.2.2

3. PLANNING FORECAST

A Thirty Year planning period is adopted in developing the planning forecast and the period of 2020 – 2050 is the time frame for consideration.

3.1. Population and Land Use:

The design population has been estimated, taking into account all the factors governing the future growth and development of the project area in the industrial, commercial, educational, social, and administrative spheres.

The CPHEEO manual has recommended the various methods under clause No.2.2.7. The details on the methods given in the Manual are furnished in the main report.

DESIGN PERIOD

The following Design periods are adopted for projecting the population:

Base year	:	2020
Intermediate Stage	:	2035
Ultimate Stage	:	2050

With these available data, population projection has been worked out for 2020 (Base year), 2030, 2035 (Intermediate Stage), 2040, 2050 (Ultimate Stage).

The core city was subsequently expanded by adding adjacent urban and rural local bodies, viz. 9 Municipalities, 8 Town Panchayats and 25 Village Panchayats and the extent of the present Chennai Corporation are is 426 sq.km.

The rest of CMA comprises of 7 Municipalities, 12 Town Panchayats and 189 Village Panchayats in 10 Panchayat Unions. The total extent of CMA is 1189 sq.km.

Decade wise population for the last 5 decades, for each local body is available. Population projection for the design period was worked out for each of the urban local bodies separately by various methods. In respect of village panchayats the decade wise total population in respect of each union was considered and the population projections worked out.

The densities of the projected population for intermediate and ultimate stages were duly considered, for finalizing the design population.

3.2. The population Density considered for adoption

i. The City's population is based on realistic factors, taking into account the actual growth potential, rather than merely going by the projection of past trends.

ii. For expanded city, the density of population matching with projected population of 500-800 per hectare is considered for adoption.

iii. For rest of the CMA the density of population matching with projected population has been considered at the rate of upto 450-600 per hectare for areas adjacent to Chennai City, density ranging from 200-350 per hectare for distant Urban areas and density ranging from 150-250 per hectare for rural areas.

iv. The areas of primary residential, mixed residential & urbanisable areas (in Hectare) as per the land use pattern indicated in CMDA Master Plan for the year 2026, have been considered for purpose of computation of population density per Hectare, for the design years.

The following figures 3.1, 3.2 & 3.3 illustrate the areas with density of population (low & high) proposed to be accommodated in the design years of 2020, 2035 & 2050.

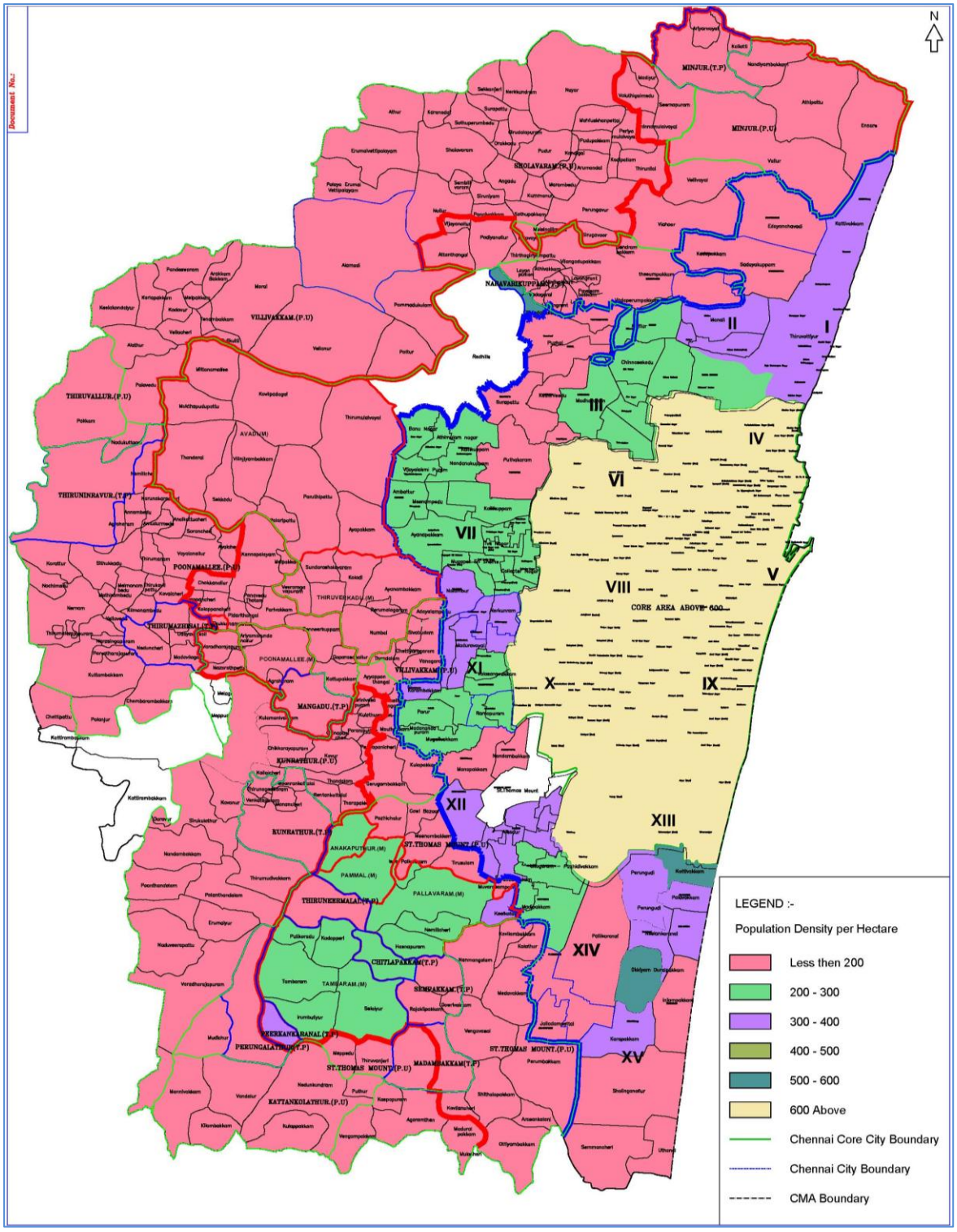


Figure 3-1 Density projected during 2020

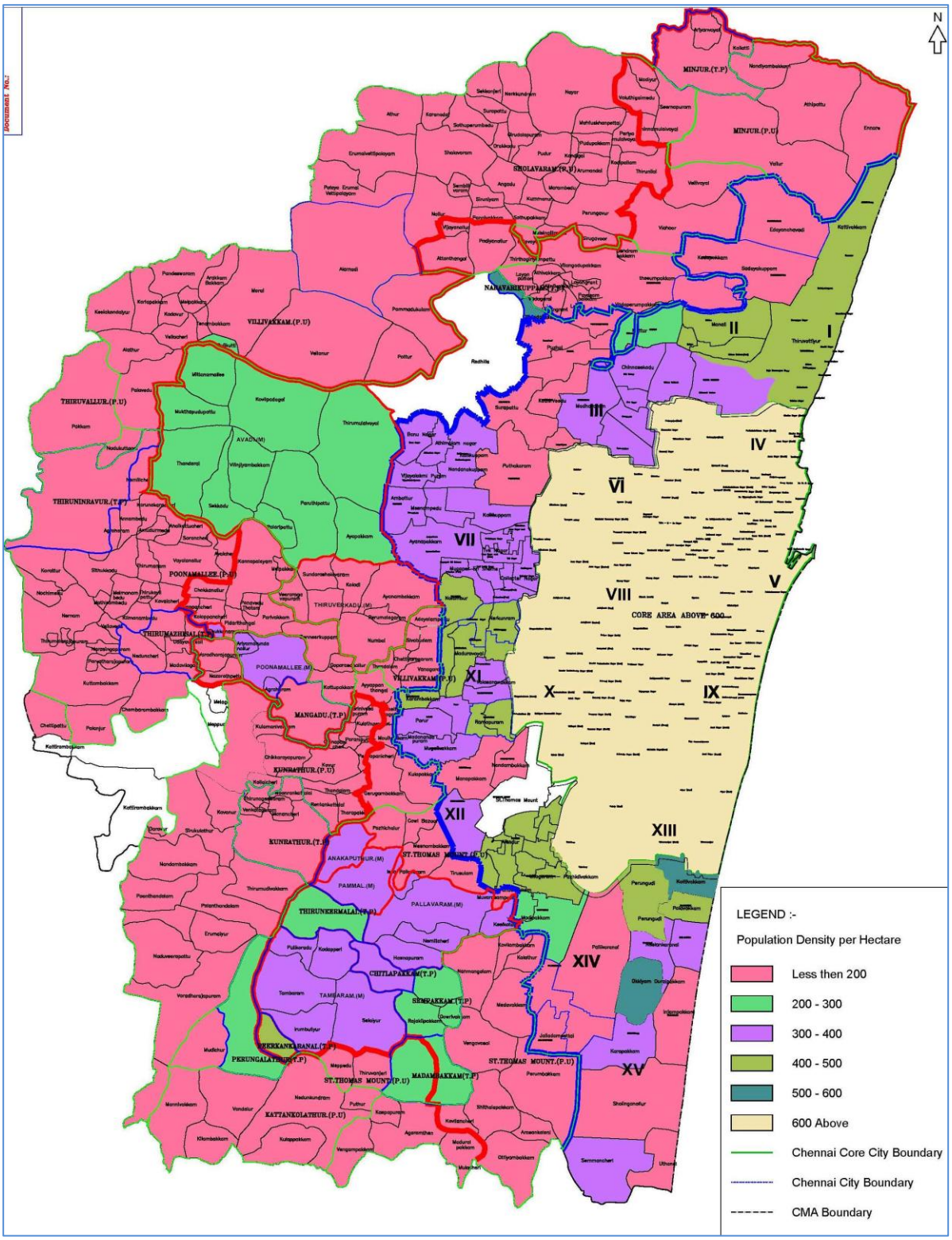


Figure 3-2 Density projected during 2035

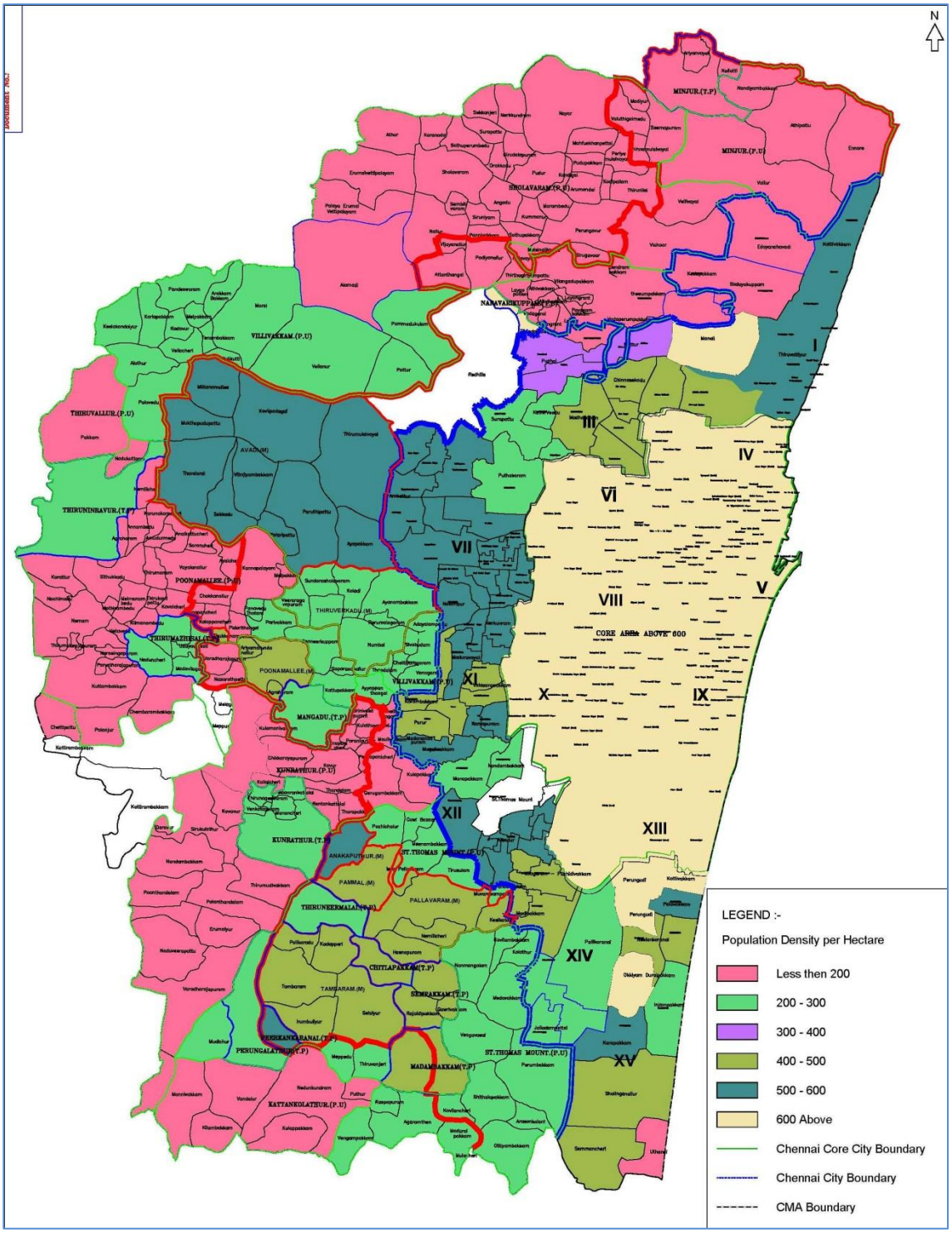


Figure 3-3 Density projected during 2050

Based on the projected density as above, the population for each urban local body for the Design years has been arrived as shown in the examples for core city and expanded areas as under:

Projected Population:

Total Area of Kodambakkam Zone (as per CMDA Master Plan): 1300 Hectares

Residential Area of Kodambakkam Zone (as per CMDA Master Plan): 616 Hectares

Table 3-1 Example for projecting population by Density Method- Kodambakkam

Year	Population Density per Hec. (Based on Total area)	Projected population in LAKHS	Population Density per Hec. Based on Residential area
1.	2.	3. *(col.2 x 1300)*	4. *(col.3*100000/616)*
2020	388	5.044	819
2035	408	5.304	862
2050	428	5.564	904

Population Projection in Other Areas:

For example in respect of Kathivakkam (previously a Municipality) which has been added to the Chennai Corporation the previous decade wise population is as given below:

Table 3-2 Decade wise population of Kathivakkam

CENSUS FIGURES	
DECADE-YEAR	**POPULATION IN THOUSANDS**
1971	16.14
1981	22.10
1991	27.17
2001	32.59
2011	36.52

The total area and residential areas as given in the land use pattern of CMDA Master Plan are 475 hectares and 107 hectares respectively.

The population projection arrived for the design period are given below

Table 3-3 Example –Population projection by various methods for Kathivakkam

METHOD	Proj.Pop.in Thousands			Pop. Density per Hectare of Residential area
	BASE YEAR POP	INT. STAGE	ULT. STAGE	
	2020	2035	2050	
1. Arithmetic Increase Method	41.106	48.748	56.391	525
2. Incremental Increase Method	40.165	44.440	46.465	432
3. Geometrical Progression Method	43.435	57.992	77.426	720
4. Line Of Best Fit Method	46.473	62.980	85.349	794
5. Exponential Method	40.466	48.012	56.966	530
6. Population Forecast By Semi log graphical Method	40.840	48.520	56.200	523
7. Growth Rate Method	43.76	58.9	79.27	738

The density for the urban areas, located in the expanded city, has been fixed as 500-600. The population was computed based on Arithmetic method, Exponential Method and Semi log Graphical Method, of which the population projected based on Arithmetic Increase Method has been adopted for Kathivakkam.

Similar analyses have been made for all other urban and rural local bodies separately and the density arrived through various methods. The method which gives a value that falls within the density range fixed for that area has been adopted.

If no method gives a value that falls in the expected range, then a value which will be in that range, is considered and this value multiplied by the residential area of that local body has been considered as the population of the respective area.

Based on the above illustrated methods, the population projections for Chennai core area and for the other areas of entire CMA has been arrived at for the Design Years 2020 (Base Year), 2035 (Intermediate Stage) and 2050 (Ultimate Stage). The total populations projected are as given below:

Table 3-4 Projected population in design years for Project Area

Design Year	Projected population in Thousands			
	Core City	Expanded City	Rest of CMA	Total for entire CMA
2020	4830	2727	3646	11204
2035	5138	4042	6300	15480
2050	5437	5536	9712	20684

Local body wise projected population is annexed in the main report.

The proposed land use plan proposed by the CMDA in their second Master Plan serves as the basis for estimating the distribution of population and commercial activities within the project area. Six land use categories (sl.no: 1-5 & 9) were identified and this has been significant in terms of water requirements and waste water generation. The present land use classification in the project area is shown in the table below:

Table 3-5 Current land use in CMA

LANDUSE FOR THE PROJECT AREA (CMA)		
S.No.	**Type of Use**	**Area in Hectares**
1.	Primary Residential	37119.02
2.	Mixed Residential	15929.99
3.	Commercial	1594.59
4.	Institutional	6757.82
5.	Industrial	7961.62
6.	Special and Hazardous Industrial	3546.75
7.	Open Space Recreational	1393.51
8.	Agriculture	8115.41
9.	Non-Urban	2446.23
10.	Reserved forest	2495.12
11.	IAF (Indian Air force)	117.58
12.	Coastal Regulatory Zone	820.29
13.	RCA	6118.19
14.	Urbanisable	2075.89
15.	Water Body	15451.11
16.	Usages	86940.85
17.	Others	31975.27
	Total Extent	**118916.12**

3.3. Water Demand and Waste Water Generation

The population of the project area for the respective design year has been estimated and presented in the Table below:

Table 3-6 Population Projected for the Horizon years

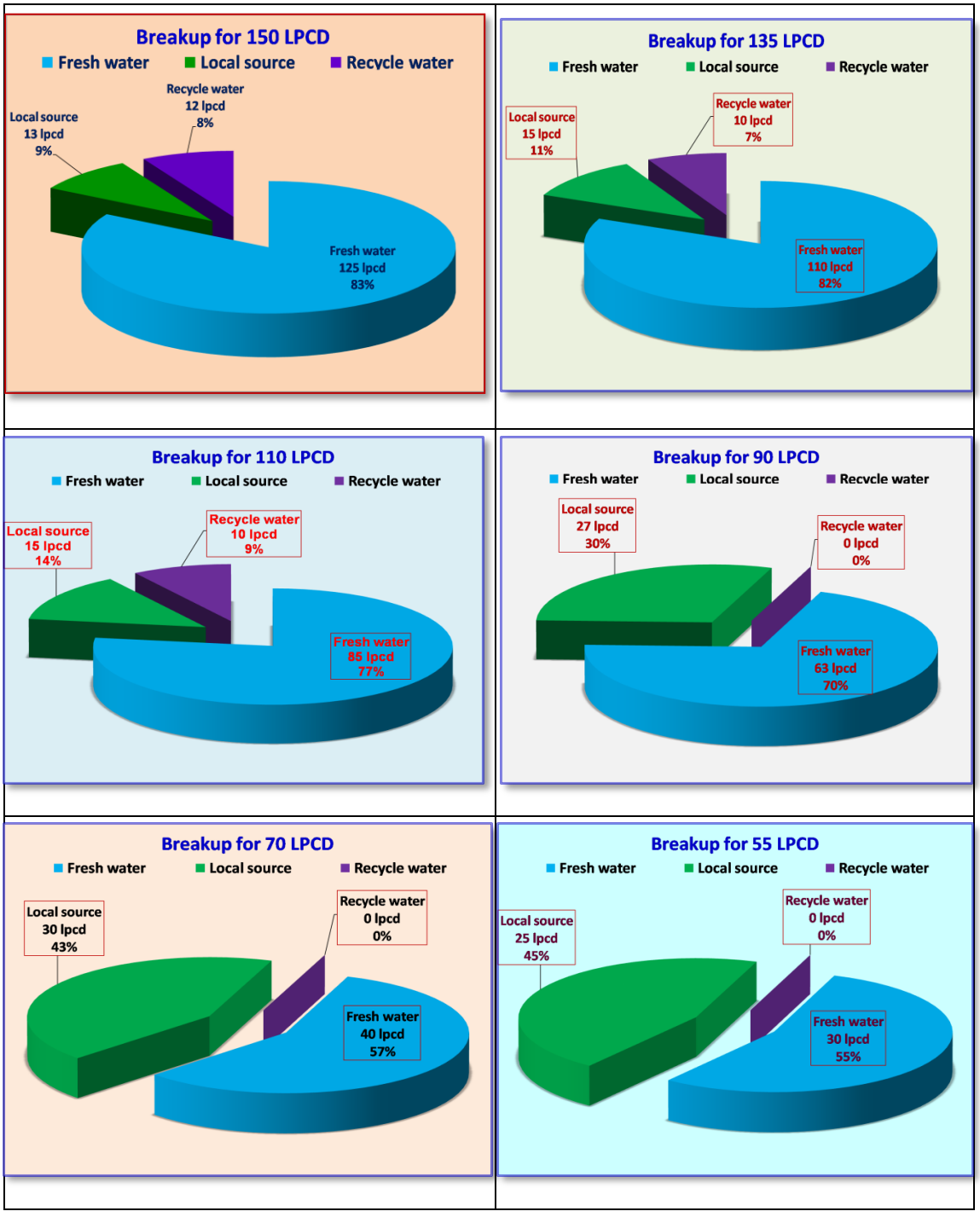
Description	2011	2015	2020	2035	2050
	(Population In lakhs)				
Chennai Corporation	66.66	70.54	75.57	91.80	109.73
Rest of CMA	22.64	28.83	36.46	63.00	97.32
Total	**89.31**	**99.37**	**112.04**	**154.80**	**206.84**

3.4. Per Capita Water Supply

The consumption of water differs between cities, towns and villages. The pattern of water consumption for domestic purposes is much higher in urban areas than rural areas. Therefore quite naturally, the per capita supply of water will also vary from Chennai City and rest ULBs of CMA areas.

The per capita water supply of 150 lpcd is considered for adoption to Chennai Corporation, based on, its classification and life style of the inhabitants as well as the possible changes due to the growth potential of the city. The rest of the CMA is categorized into Urban and Rural; for the urban Area, 135 lpcd upto Intermediate stage (2035) and 150lpcd for Ultimate stage (2050),has been considered. Taking into account degree of urbanisation in the city and the nearness to the core city, etc.; in respect of Rural area, the per capita has been considered at 55lpcd to 110lpcd upto Intermediate year of 2035 and 70 to 135lpcd for Ultimate years for adoption, taking into account probable the growth potential of the locality.

The pattern of water consumption is illustrated in the following charts



Accordingly, Water Supply demand is arrived at and indicated below:

Table 3-7 Total Water Demand for Corporation and Rest of CMA

Description	2015	2020	2035	2050
	(in Mld)			
Chennai Corporation	922	1333	1702	2178
Rest of CMA	214	387	821	1568
Total	**1136**	**1720**	**2523**	**3746**

At present 600 MLD of fresh water is available from various sources in respect of Chennai City and 32 MLD of fresh water from surface sources in respect of other areas of CMA. In addition the local sources such as open wells/bore wells in individual residences, institutions etc. supplement the water demand to an extent of 110 MLD to Chennai city and 100 MLD to other areas of CMA.

Table 3-8 The Present Water use in CMA

EXISTING FRESH WATER SUPPLY				
S. No	**Particulars**	**Potential Yield (in MLD)**	**Available in good years (in MLD)**	**Present availability (in MLD) (as on October 2015)**
1.	**SURFACE WATER SOURCES**			
	a) Poondi, Red hills, Cholavaram &Chembarambakkam lakes (surface sources)	200	125	75
	b) Telugu-Ganga Project	930	400	200
	c) Veeranam Lake Source	180	100	100
2.	**GROUND WATER/Sub Surface water**			
	d) Northern well field /Southern Coastal aquifer	100	25	25
	e) Sub Surface water sources in Rest of CMA	32	32	32
3.	**SEA WATER DESALINATION**			
	f) Minjur DSP	100	100	100
	g) Nemmeli DSP	100	100	100
	Total	**1642**	**882**	**632**

In addition to the above water availability from local sources, such as open wells/bore wells are about 110 MLD and 100 MLD in Chennai city and in rest of CMA respectively.

Table 3-9 Projected Demand vs Existing Supply (as on October, 2015)

Year (1)	Total Demand (2)	Present Availability (3)	Gap (4)=(2-3)
	(in MLD)		
2015	1136	632	504
2020	1721	632	1089
2035	2522	632	1890
2050	3746	632	3114

There are widespread shortages of drinking water in various parts of the city. This problem could be attributed to the unsatisfactory patterns in the distribution and the current use patterns of fresh water in the city. The distribution system comprises old pipes in many areas and also shows a high percentage of NRW in various zones.

It is important to discourage the use of fresh water for non-drinking purposes like gardening, car washing, floor cleaning, toilet flushing, etc., and this assumes importance in the context of dwindling fresh water sources in and around the city. Hence, it is suggested that water supply to the CMA shall consist of 3 categories viz Fresh water supply from the WTPs, Ground water sources including (From individual sources open/bore wells) and recycled waste water. Accordingly, the contribution percentage of each of these categories with reference to per capita supply is given below:

Table 3-10 Category wise allocation in %

per capita supply		Fresh water	Local source	Recycle water
lpcd	150	125	13	12
in %		83%	9%	8%
lpcd	135	110	15	10
in %		81%	11%	7%
lpcd	110	85	15	10
in %		77%	14%	9%
lpcd	90	63	27	0
in %		70%	30%	0%
lpcd	70	40	30	0
in %		57%	43%	0%

The detailed demand assessment statements are been given in **Annexures 6.1 to 6.5 in chapter 6 of volume II**

The Abstract statement for the entire project area about source deficits with reference to present supply level is given below:

Table 3-11 Source Deficits-Projected for the Horizon Years for the Project Area

Sl. No.	Year	Total Demand	Fresh Water	Local Domestic Sources	Recycled Water	Existing Fresh Water Supply	Deficit in Fresh Water
		(in MLD)					
1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8. (4-7)*
1	2015	1136	825	240	28	632	193
2	2020	1721	1259	251	157	632	627
3	2035	2522	1870	314	265	632	1238
4	2050	3746	2844	397	405	632	2212

For Detailed Calculations Refer to **Annexure 6.5 of Chapter 6 of Volume II**

3.5. Supply Management for fresh water availability and use

Supply management is required to conserve the existing fresh water sources as well as to locate alternate new sources through enhanced storage and equitable distribution of fresh water.

To bridge the gap between fresh water demand and supply, it is proposed to augment the water supply system by identifying additional sources to supplement the requirement to the Chennai Corporation and rest of CMA. Proposals for usage of local domestic sources in the various design years and for the indigenous utilization of recycled water for non-domestic uses have been described in the main report.

The following Table shows the development of Internal and External, Surface/Ground water sources to fill the gap between demand and supply. Though by improving the local sources may be suffice to meet the ultimate demand the external sources identified will provide as supplemental sources of water during the scarcity periods, due to failure in the internal sources. These external sources will also reduce the over extraction of ground water in CMA.

Table 3-12 Development of sources to meet the projected fresh water demand

S.No	Description of sources	Existing Yield (mld)	Augmented Quantity	Total Yield that will be available after Augmentation (mld)
	A) Surface/Ground Water Sources:-			
1	Local 4 Lake Sources (Internal)	125	75	200
2	Veeranam Lake Source	100	80	180
3	Telugu Ganga Project	400	530	930
4	Northernwell fields	25	75	100
5	Existing Water sources in CMA (As per data collected)	32		32
6	New Mettur Project		700	700
	Total Fresh water from surface sources	**682**	**1460**	**2142**
	B) Sea water Desalination			
1	Minjur DSP	100		100
2	Nemmeli DSP	100	150	250
3	Peru DSP		400	400
	Total DSP supply	**200**	**550**	**750**
	Total Fresh water Supply	**882**	**2010**	**2892**
	C) External Sources			
a.	Madurantagam Lake		25	25
b.	Chengalpattu Lake		35	35
c.	Abandoned Quarries		10	10
d.	New surface storage projects		20	20
e.	Palar Source		30	30
f.	Neyveli Aquifer		25	25
g.	By Harvesting Rain Water in Off Stream Lakes		30	30
h.	River Cauvery (Infiltration Wells near Thiruvidaimaruthur)*		80	80
	Total capacity of External sources		**175**	**175**
	Total capacity of sources that will be available after augmentation		**2185**	**3067**

* To supplement Veeranam Source. Hence not counted in total.

Table 3-13 Augmentation of Local Ground water Sources

S.No	Description of sources	Existing Yield (mld)	Augmented Quantity* (at the end of 2050)	Total Yield that will be available after Augmentation (mld)
	LOCAL SOURCES			
1	Source in Individual Dwellings (Bore wells & Open wells) in Chennai City	110	100	210
2	Source in Individual Dwellings (Bore wells & Open wells) in Rest of CMA	100	100	200
	Total Ground Water sources	**210**	**200**	**410**

*Augmentation of the ground water sources by various artificial recharge techniques have been given in the main report.

Brief descriptions of the projects for developing sources are furnished below:

3.5.1 Telugu Ganga Project

Based on an agreement between three states Karnataka, Maharashtra and Tamilnadu, the quantity of water allotted for Chennai from Krishna river is 15 TMC per year at the source or 12 TMC at Tamilnadu border allowing for losses in transmission and so far, a maximum of 8.0 TMC of water per annum has alone been received at the receiving point from the date of commissioning of the scheme. On an average, about 400 mld of water has been realized from the above project, for the city water supply. Steps have to be initiated to receive additional 530 mld quantity of water from this source for supplementing the requirements of Chennai.

3.5.2 Augmentation of Surface Water from Lakes in and around Chennai

The water supply for Chennai is mainly derived from surface storage at Poondi, Red hills, Cholavaram and Chembarambakkam lakes which have been operational since the last century. Protected and partially protected catchment areas are well demarcated and gazetted and no pollution-causing activities are allowed in such areas. At present, half of the catchment areas are either encroached or misused by miscreants. These land area is considered to be protected and partly protected catchment. It is suggested that there has to be an increasing emphasis on catchment management, to restore the original catchment for all the water sources.

3.5.3 Lake Management Programme:

Immediate steps should be taken for restoration of urban lakes and their supply channels from encroachments & misuse / pollution etc by appropriate revival and rehabilitation methodologies and these revived lakes may be used for enhancing water supplies through ground water recharge, in the surrounding areas. These lakes will also facilitate water storage during rainy seasons through appropriate storm water harvesting of the nearby river/canal courses, abandoned quarries, and reclaimed water from STPs. The basin receives sufficient rainfall, but all that water cannot be stored at present. However, opportunities exist for improving storage of rainwater, renovated temple tanks and cleaning waterways. All of these can contribute to improving ground water recharge.

A lake conservator may be appointed in CMWSSB/ PWD to protect all the lakes within CMA and to exploit them for domestic / non domestic water uses.

3.5.4 Catchment Management programme:

The Protection of water spread areas of Chennai lakes catchment area by preventing pollution of water inflows, indiscriminate disposal of solid waste and debris, rehabilitation and improvisation of Supply channels so as to facilitate receipt of more water from the catchment as well as chain of other tanks.

3.5.5 Desilting & developing the existing lakes of Chennai

The de-silting of existing Chennai lakes, removal of debris and scrubs, strengthening and heightening of bunds etc., shall facilitate to increase the capacity of the existing lakes. Similarly, the supply channels of upstream feeding tanks shall be restored and rehabilitated for free flow of water by minimizing the transmission losses of seepage and wastages. The water storage can be increased in Sholavaram Lake by raising the bund levels, to an extent of 1.0TMC.

The safe yields of all lakes are reported to be 125-142 MLD as per previous study. The probability of increasing the yield to 200 MLD has to be appears to be reasonable, with the above measures.

3.5.6 Desalination Plants

Desalination is becoming an important component for augmenting available water sources. The CMWSSB has established two DSPs with capacity of 100 MLD each to increase its availability of source. The process used is reverse osmosis and it has a capacity of 100 million litres per day (MLD). Proposals are in the pipeline for establishing 150MLD DSP at Pattipulam/Nemmeli and 400 MLD DSP at Perur for supplementing the water supply needs of Chennai.

3.6. Cauvery water supply

3.6.1. Augmentation of Water from Mettur Reservoir

In order to meet the growing needs of the Chennai city through new source of water supply, CMWSSB has already initiated moves for augmenting Chennai city water supply from river Cauvery, as a long term measure. Keeping in view the growing requirements of the city and dwindling the state of the existing supplies, a source for the 9.0 TMC (700 mld) Water Supply Augmentation Project for Chennai has been identified in River Cauvery and the proposal is under consideration.

3.6.2. Subsurface Water from Cauvery

In order to strengthen this Veeranam Project to full designed capacity, a collector well is proposed near Tiruvidaimarudur in Cauvery river downstream of Trichy Town to draw sub surface water of 80MLD,and to resort to pumping upto Kadampuliyur ridge point and then convey the water through the existing Veeranam main upto Chennai. This arrangement will also afford flexibility in the drawal of surface/subsurface water, depending upon the availability of water in the lake, stabilise the yield from Veeranam lake and will also stabilise the supplies during summer.

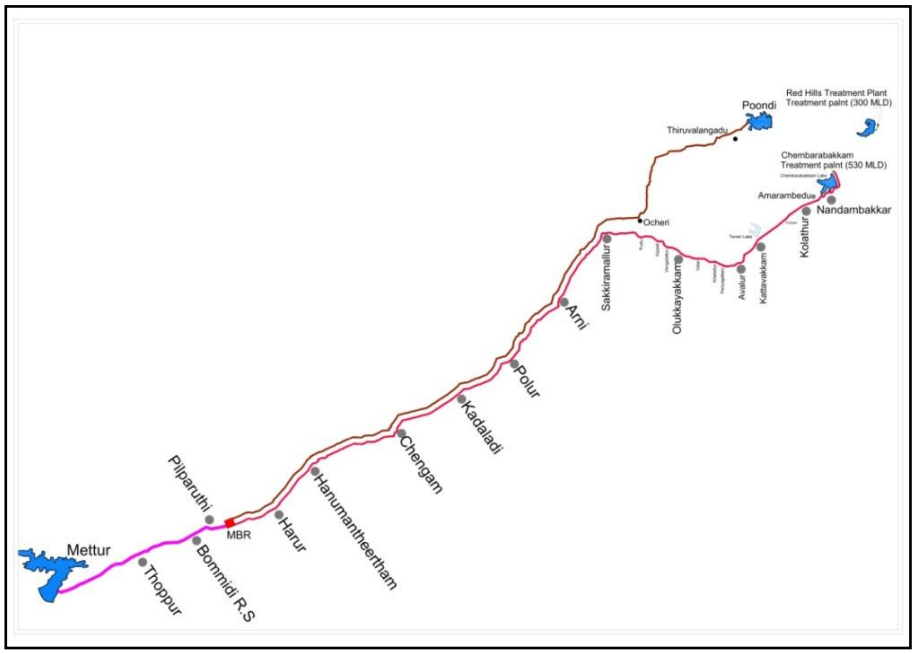


Figure 3-4 Proposed alignment of transmission main from Mettur to Poondi/Chembrambakkam.

3.6.3. Supply of water from off stream Reservoirs

A feasibility study and Master Plan for Storm Water Drain in Chennai was done by M/s.Mott Mac Donald International during 1992. This study suggested creation of small storages at eight locations around Chennai across local drains/river. These were conceived as supplementary surface sources to serve for a few months immediately after monsoon. The idea is to harvest rain water during monsoon, pump it to the proposed off-stream storage facilities and use it as immediately as possible. A total of 50 Mm^3 storage was envisaged under these schemes. Based on the preliminary engineering,

approximate storages for each location have also been arrived at. The details are as below:

Table 3-14 The details of Storage Schemes location with Catchment Area

Scheme	Catchment area (sq.km)	Storage MM^3
Alattur	200	10
Kovalam	197	6
Vanianchavadi	158	7
Pallikaranai	108	7
Manali	54	5
Kattur	41	5
Edayankulam	7	5
Thirupalaivnam	55	5
	Total	**50**

Though Manali pumped storage scheme was not assigned high priority, due to its proximity to the industries, where raw water consumption was immediately possible, detailed engineering was taken up with a view to implement the project. However, the high cost of the scheme seems to have come in the way of its implementation.

The second scheme proposed at Pallikkaranai with high priority has been included in a project formulated by the Public Works Department, and an outline proposal combined with Okkium Madagu has been formulated by the Director, Water Institute. If these schemes are given priority for implementation, overlooking marginally prohibitive cost elements a safe extraction of 20 mld is quite probable, besides solving many eco-sensitive issues. The remaining schemes are to be taken up for detailed study and viable proposals can be implemented for augmenting supplies in the CMA.

3.7. Supply management for future demand

The year wise (at 5 years interval-2020 to 2050) consolidated statement of balancing the demand and supply, by augmentation of existing sources and by developing new sources, as given in the Table 3.15, are given in the Table below.

Table 3-15 Supply Management for Future Demand (Considering the supply during normal periods i.e. 882 mld)

SUPPLY MANAGEMENT TO MEET OUT FUTURE FRESH WATER DEMAND-ENTIRE C M A																	
Quantity in MLD																	
Year	Fresh Water Demand	Normal Supply			Cumulative Qty. of Sources Developed	Total Sources available	Balance	Capacity of Sources to be Developed									
								DSP		Surface/Ground Sources							
		Surface	DSP	Total				Nemmeli	Perur	Telugu Ganga	Veeranam Sub Surface	By Harvesting Rain Water in Off Stream Lakes	New Mettur Project	OWN Sources Local 4 Lake Sources (Internal)	External Sources (Maduranthagam/Chengalpattu/Abanded Quarries/New surface storage projects/Palar source/Neyveli Aquifer)	Northern well fields	Total
					Total Augmented up to 2050			**150**	**400**	**530**	**80**	**30**	**700**	**75**	**145**	**75**	**2185**
1.	2.	3.	4.	5. (3+4)	6. col.16+ value above	7. (5+6)	8. (7-2)	9.	10.	11.	12.	13.	14.	15.	16.	17.	18. Add. Col.9 to 17
2015	**825**	682	200	882	0	882	57	-	-	-	-	-	-	-			0
2020	**1259**	682	200	882	425	1307	48	**150**	**100**	**100***				**40**	**10**	**25**	425
2025	**1341**	682	200	882	650	1532	191			**100***	**80**				**20**	**25**	225
2030	**1718**	682	200	882	1055	1937	219						**350**		**30**	**25**	405
2035	**1870**	682	200	882	1190	2072	202			**100**					**35**		135
2040	**2041**	682	200	882	1355	2237	196			**100**		**15**		**25**	**25**		165
2045	**2577**	682	200	882	1920	2802	225		**100**	**65**		**15**	**350**	**10**	**25**		565
2050	**2844**	682	200	882	2185	3067	223		**200**	**65**							265
							TOTAL	**150**	**400**	**530**	**80**	**30**	**700**	**75**	**145**	**75**	**2185**
*If supply is not obtainable from DSP, the supply will be augmented from Telugu Ganga vice versa														Total including existing sources			**3067**
Simultaneously action to be taken for implementation of Mettur Scheme														Balance available over ultimate demand of 2844			**223**
Note: The detailed description of the component work to be taken up during the various years is furnished in the main report.																	

3.7.1 Schedule of implementation of the various projects

The schedule of implementation of the various projects as mentioned in the Table 3.14 for the development of additional sources, based on the Demand of the respective years are given in the Table below.

Table 3-16 Suggested commissioning schedule of the proposed projects to meet the Additional & Fresh Water Demand

Sl. No.	Source	Quantity to be Augmented in MLD	Probable Year of commissioning
	DSP sources		
1.	Nemmeli	150	2020
2.	Perur	400	2020,2045,2050
	Surface/Ground water Sources		
3.	Telugu Ganga	530	2020, 2025, 2035, 2040, 2045, 2050
4.	Veeranam Sub Surface (Cauvery sub surface source)	80	2025
5.	By Harvesting Rain Water in Off Stream Lakes	30	2040, 2045
6.	New Mettur Project	700	2030, 2045
7.	OWN Sources Local 4 Lake Sources (Internal)	75	2020, 2040, 2045
8.	***External Sources*** (Maduranthagam/Chengalpattu/Abanded Quarries/New surface storage projects/Palar source/Neyveli Aquifer)	145	2020, 2025, 2030
9.	Northern well fields	75	2020,2025,2030
	Total	**2185**	

3.7.2 Reclamation and Reuse of Renovated waste water

Faced with the strategic issue of water security, it is suggested that the possibility of recycling wastewater (or used water) after necessary treatment for utilising for non-domestic uses would be a prospective initiative to reduce stress on the large scale fresh water consumption and this will also serve the purpose of avoiding the discharge of the waste water into the sea. About 405 MLD of waste water after treatment is proposed to be utilised for non- domestic purposes as well for industrial needs.

3.7.3 Water Conservation Measures

Besides, fresh water conservation could be achieved for future use by utilising the renovated waste water for industries and other non-domestic uses.

The supply of water to the city can be conserved by following methods

- Storing rain water/storm water runoff in lakes for fresh water addition/augmentation and use.
- Rainwater harvesting for bore well recharging and ground water recharging.
- Recycling of Grey water for landscaping/gardening.
- Recycling of wastewater for indirect potable and non-potable applications.
- Public awareness to prevent the use of fresh water for watering garden/lawn/cleaning cars and on the advantages of reuse of water.

3.8. Proposed WTP Works

In tune with the augmentation of water supply inflows for the city system, it becomes necessary to plan for capacity additions in WTPs

For Planning Year 2020

Following works related to WTP are suggested for the year 2020

a) Up gradation of existing WTPs - Creation of Backwash water recycling system at following existing plants

- ✓ Kilpauk 135 and 90 MLD capacity Plant
- ✓ Redhills 300 MLD capacity Plant
- ✓ Veeranam 180 MLD capacity Plant

b) Improvements in process methodologies for enhanced efficacy, including a profitable sludge management plan.

c) Creation of New treatment Capacity at following Location

Based on water demand for the Chennai Corporation and other local bodies in CMA, requirement of additional WTPs, to treat both surface water and sea water, phase wise, is shown in the Table.

Table 3-17 Additional Capacity of WTP Requirement

Sl. No.	Existing /Proposed Treatment Plant Site	Existing Capacity of WTP in MLD	Capacity to be phased out	Balance capacity available	New WTP Proposed							Total New WTP/DSP	Cumulative WTP/DSP Capacity in MLD						
					2020	2025	2030	2035	2040	2045	2050		2020	2025	2030	2035	2040	2045	2050
1.	Kilapuk	270	45	225	135							**135**	**360**	**360**	**360**	**360**	**360**	**360**	**360**
2.	Redhills	300	0	300				150		150		**300**	**300**	**300**	**300**	**450**	**450**	**600**	**600**
3.	Surapet	14	14	0									**0**	**0**	**0**	**0**	**0**	**0**	**0**
4.	Chembaramba kkam	530	0	530					160	180		**340**	**530**	**530**	**530**	**530**	**690**	**870**	**870**
5.	Sholavaram	0	0	0	25*			50*		70*		**145**	**25**	**25**	**25**	**75**	**75**	**145**	**145**
6.	Veeranam (Vadakuthu)	180	0	180								**0**	**180**	**180**	**180**	**180**	**180**	**180**	**180**
	Total WTP	**1294**	**59**	1235	**160**	**0**	**0**	**200**	**160**	**400**	**0**	**920**	**1395**	**1395**	**1395**	**1595**	**1755**	**2155**	**2155**
	Desalination Plants			0															
7.	Minjur DSP	100	0	100								**-**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
8.	Nemmeli DSP	100	0	100	150							**150**	**250**	**250**	**250**	**250**	**250**	**250**	**250**
9.	Perur	0	0	0	100					100	200	**400**	**100**	**100**	**100**	**100**	**100**	**200**	**400**
	Total DSP	**200**	**0**	200	**250**	**0**	**0**	**0**	**0**	**100**	**200**	**550**	**450**	**450**	**450**	**450**	**450**	**550**	**750**
	Total	**1494**	**59**	1435	**410**	**0**	**0**	**200**	**160**	**500**	**200**	**1470**	**1845**	**1845**	**1845**	**2045**	**2205**	**2705**	**2905**

*Additional 25 MLD Plant is optional for Sholavaram system. WTP of 25 MLD may be proposed if the well Field water of 25 MLD is not available. When well field water is not available, required Raw water may be diverted from Poondi to Sholvaram lake and accordingly the allocation for Redhills and Chembarambakkam lakes may have to be revised.

Design Norms for new Water treatment Plants:

Design norms in respect of Water Treatment Plants are tabulated in Chapter 9 of Volume II.

Pumping Plants- replacements and new Pumping Plants

Design parameters/norms for pumping plants are detailed in Chapter 12 of Volume II.

Details of proposals for Replacement of Raw Water Pumps in Existing WTPs narrated in the Chapter 12 of Volume II.

3.9. Water System and Transmission mains

The entire CMA has been divided into number of zones/areas to facilitate the design of distribution of water supply system from the main water sources. The existing 18 zones of core Chennai city are retained as it is for the core city. The newly added 42 local bodies have been divided into 12 areas. The rest of CMA has been divided into 17 areas. The Figure below shows the zones/areas.

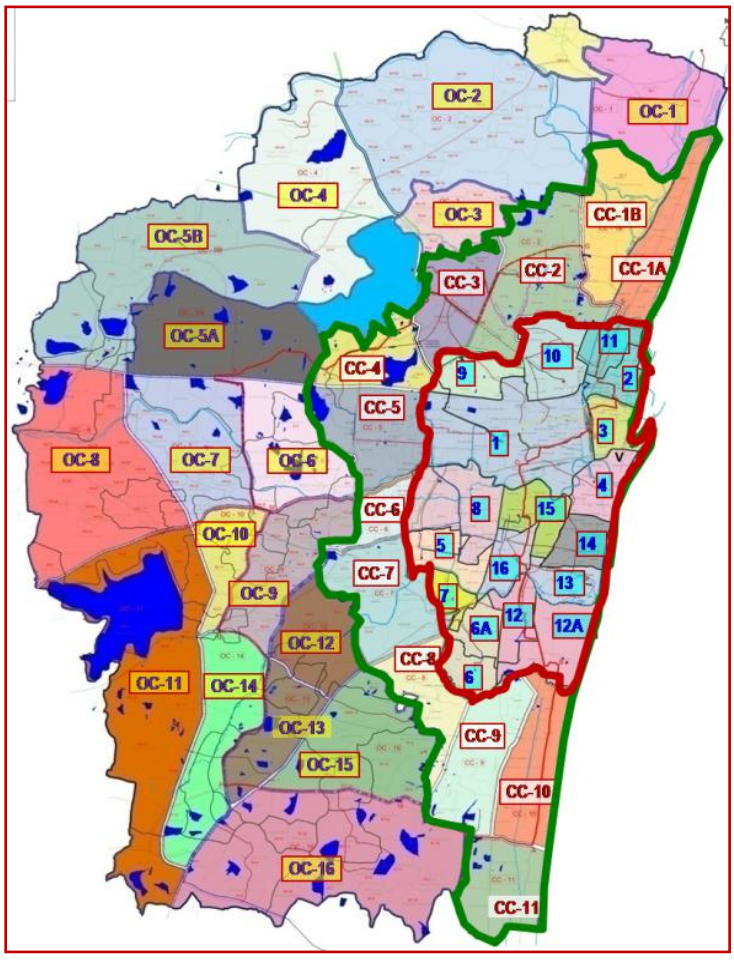


Figure 3-5 zones/areas.

Table 3-18 Area with their zones/ Group Nos.

Area	Zone/Group Nos.
Core City (erst while Corporation)	1-6, 6A, 7-12, 12A, 13-16 (18 Zones)
Expanded City (Added Area in Chennai Corporation-CC)	CC-1A, CC-1B, CC-2 to CC11 (12 Areas)
Rest of C M A (Outside Corporation-OC)	OC1-4, OC5A, OC5B, OC-6 to OC-16 (17 Areas)

The local bodies covered in each zone are given in the Tables 13.1, 13.2 & 13.3 of Volume II-Water Sector.

Water System of the entire project area has been divided into 7 Major water supply systems based on the source of supply and treatment plant locations. The systems are:

i. Redhills water supply system
ii. Sholavaram water supply system
iii. KPS Water Supply System
iv. Chembarambakkam water supply system
v. Veeranam (Porur WDS) Water supply system
vi. Minjur DSP water supply system
vii. Nemmeli DSP water supply system

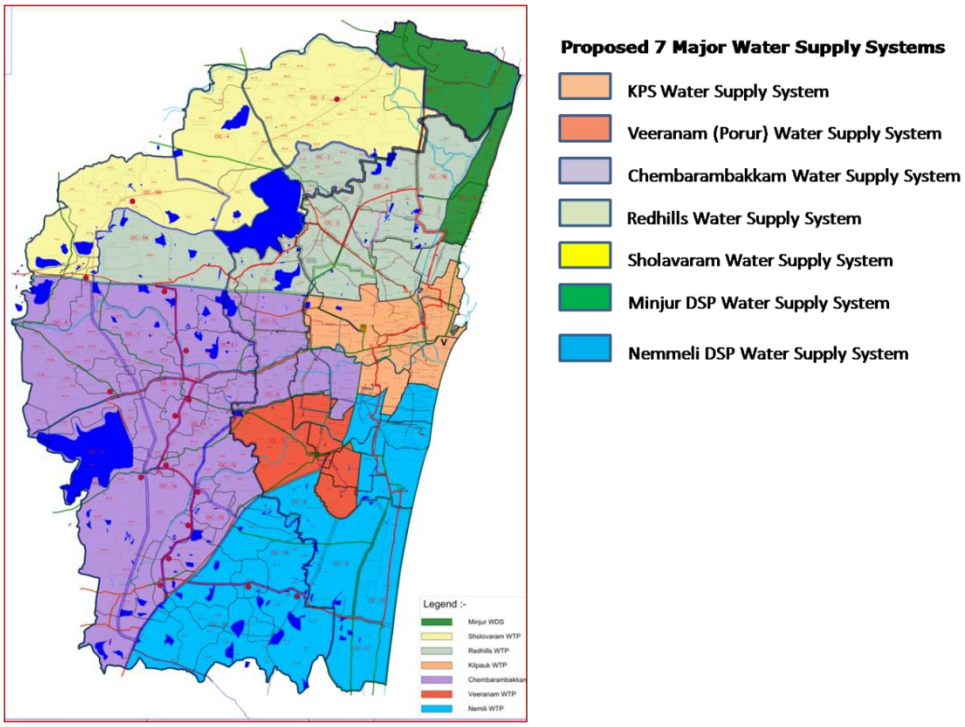


Figure 3-6 Proposed 7 Major Water Supply Systems

3.9.1 Red Hills Water Supply System

Raw water source to this system is from Puzhal Lake. The capacity of the tank is about 93.52mcm and water spread area of this tank is 26.86sq. meter. This apart water from Poondi reservoir is being received for treatment process. The water drawn from this lake by intake arrangements is treated in the WTP of capacity of 300 MLD. Already a small WTP at Surapet of 14 MLD capacity which was taken over from TWAD is also under use. In total, Redhills system comprises of 314 MLD WTP.

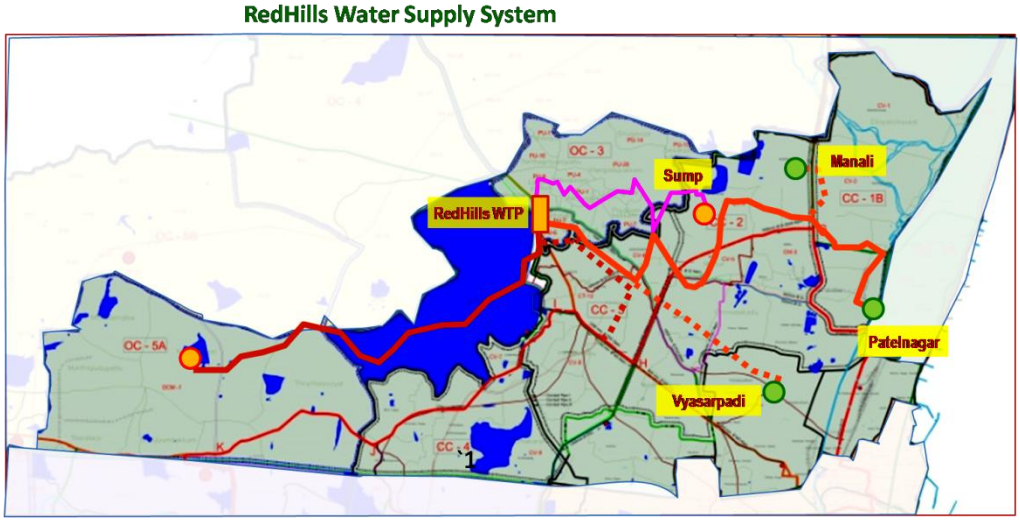


Figure 3-7 Red hills Water Supply System

It is proposed to cover under this system 3 exiting zones - (Kolathur), 10-(Vyasarpadi), 11-(Patel Nagar) of Core city, 4 areas viz., CC-1B, CC2, CC3, CC4, of Expanded City and 3 areas viz., OC3, OC-5A in Rest of CMA.

3.9.2 Sholavaram Water Supply System

Sholavaram is a tank of capacity 881 Mcft which is fed by its own catchment and from Poondi reservoir by a linking canal. Since there is no serving area at present, no WTP is available. However, a new WTP is proposed near the tank for the commanding area proposed.

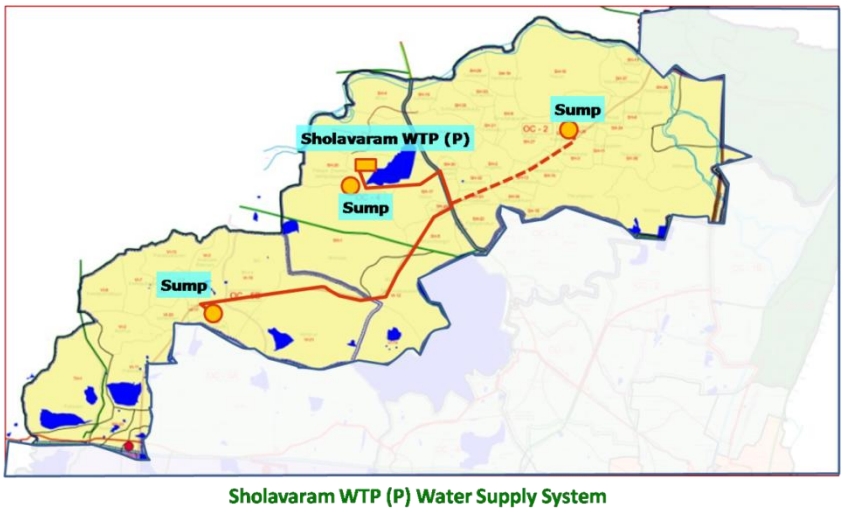


Figure 3-8 Sholavaram WTP (p) Water Supply System

In this master plan the proposed areas that will be covered under this Sholavaram System are 3 areas viz., OC2, OC4, OC-5B in Rest of CMA.

3.9.3 Kilpauk Water Supply System

Kilpauk water system is more than 100 years old. The first filter water supply was commissioned during 1914. Raw water from Puzhal Lake is being conveyed through three numbers of closed conduits with carrying capacity of 100 Mld each to the Kilpauk water treatment plant of capacity 270 Mld. The raw water after treatment is being supplied to the areas of Chennai City.

This covers the areas coming under the erstwhile Corporation of Chennai. Subsequent additions of local bodies and increase in population have increased in drinking water demand. Development of additional sources viz., Redhills, Veeranam, Chembarambakkam supplement the additional requirement of water.

In this master plan it has been proposed to cover under KPS Water System , viz. existing 5 Zones viz., 1- (KPS), 2-(Anna Poonga),3-(KannapparThidal), 4- (Triplicane) and 15-(ValluvarKottam).

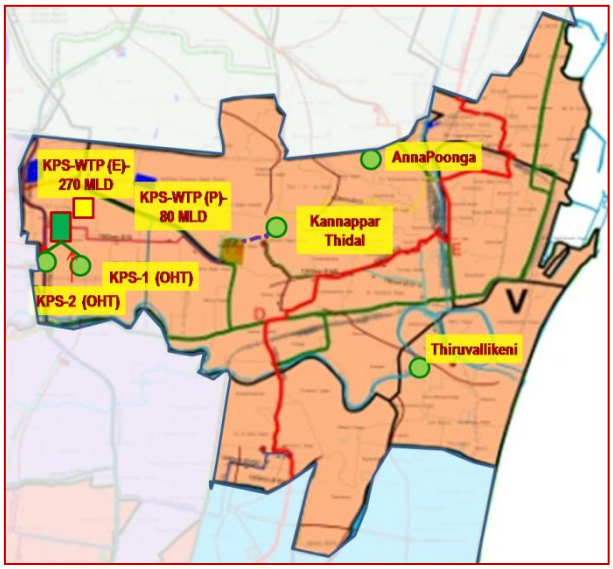


Figure 3-9 Kilpauk Water Supply System

3.9.4 Chembarambakkam Water Supply System

The Chembarambakkam Lake was earmarked as a water supply source in the year 2005. The capacity of the tank is 3646 MCFT and water spread area is 25.51 sq.km. The minor irrigation is being allowed from this tank; due to rapid urbanization the size of agriculture land is being reduced. In addition to the water from own catchment, water from the Poondi reservoir has been diverted. In order to treat the water received from Krishna water source under the Telugu Ganga Project, 530 MLD water treatment plant at Chembarambakkam was constructed. The plant was commissioned in July 2007.

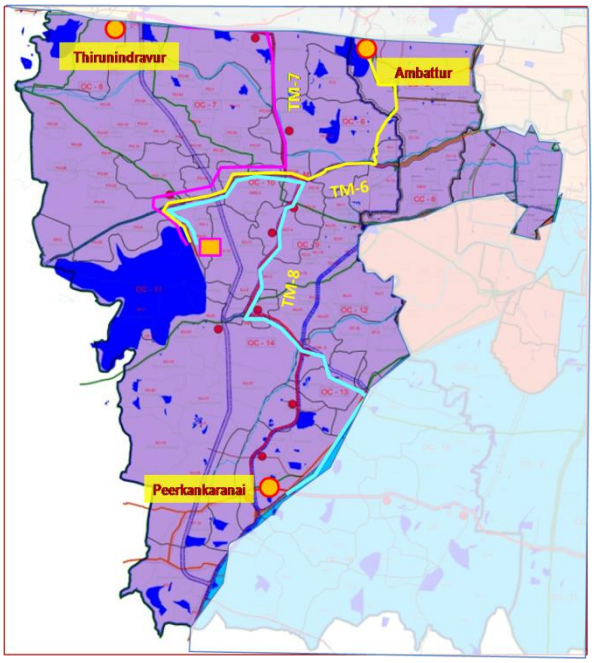


Figure 3-10 Chembrambakkam Water Supply System

The proposed commendable areas to be covered under this Chembarambakkam System are 1 zone viz., 8-(Choolaimedu) of Core City, 2 areas viz., CC5, CC6, of Expanded City and 8 areas viz., OC6, OC8, OC9, OC10, OC11, OC12, OC13, OC14 in Rest of CMA.

3.9.5 Veeranam Water Supply System

The Veeranam Water Supply Project was implemented as an additional source of water to Chennai City. The Project was commissioned in the year 2004 to supply 180 MLD of water to Chennai City by drawing water from Veeranam Lake. This lake receives water from Cauvery river system through Kollidam, Lower Anicut and Vadavar Canal besides rainwater from its own catchment area. The capacity of the lake is 1465 Mcft. The lake water is treated at Vadakuthu Water Treatment Plant by pumping raw water over a distance of 20 km. from Sethiathope to Vadakuthu through 1775 mm dia mild steel pipe. The treated water is then pumped over a distance of 8 km. to Break Pressure Tank at Kadampuliyur through 1750 mm dia mild steel pipe and from there the water is conveyed over a distance of about 200 km. through the mild steel pipe of 1875 mm and 1500 mm dia by gravity to Porur Water Distribution Station near Chennai. From this Distribution Station, water is pumped to a distance of 1.2 km. and distributed to Chennai City through Trunk mains and Water Distribution Stations.

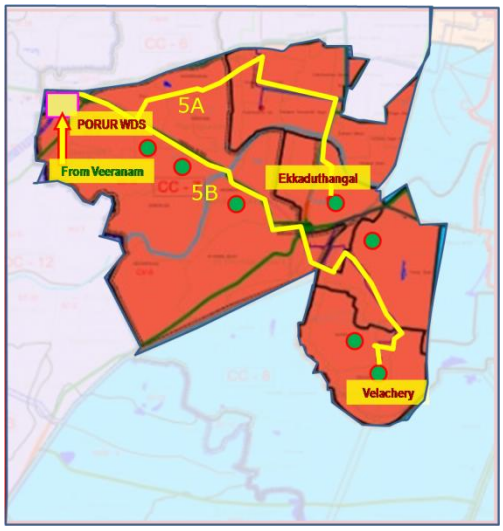


Figure 3-11 Veeranam Water Supply System

In this master plan it has been proposed to cover under this Veeranam WTP (Porur WDS) source are, existing 4 existing Zones viz., 5-(KK Nagar (Old & New)), 6-(Velachery), 6A- (Velachery-New), 7-(Ekkaduthangal) and 1 area viz., CC7 of Expanded City.

3.9.6 Minjur DSP Water Supply System

A Desalination plant of 100mld capacity has been commissioned on 31.07.2010 at Kattupalli Village near Minjur. The plant was constructed by DBOOT (Design, Build, Own, Operate & transfer) basis by M/s. Chennai Water Desalination Ltd (CWDL) and metro water has entered bulk water purchase arrangements with the firm for 25 years.

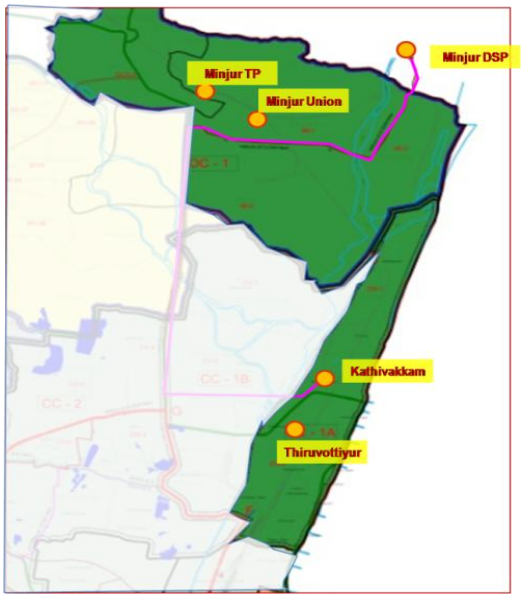


Figure 3-12 Minjur DSP Water Supply System

In this master plan it has been proposed to cover under this Minjur DSP the areas viz., CC-1A of expanded city and 1 area viz., OC1 in Rest of CMA.

3.9.7 Nemmeli DSP Water Supply System

The Nemmeli Desalination Plant is a reverse osmosis desalination plant located at Nemmeli, on the coast of the Bay of Bengal about 35 km south of the Chennai, along the East Coast Road. The plant is the second desalination plant in the city after the DS plant at Minjur and has also a capacity of 100 MLD. The plant commissioned during February 2013, was built to provide piped water to residents of south Chennai and the newly merged areas.

New Plants of capacity of 150 MLD and 400 MLD plants have been proposed at Nemmeli and Perur (near Nemmeli) respectively.

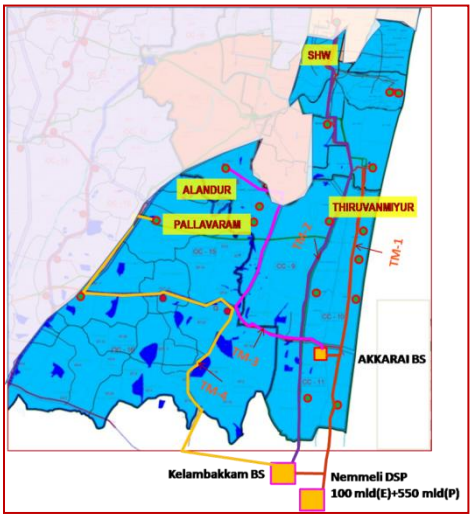


Figure 3-13 Nemmeli DSP Water Supply System

It has been proposed to cover under this Nemmeli WS system, 4 zones viz.,12, 12A, 13, 14 of core city, 4 areas viz., CC8, CCC9, CC10, CC11 of Expanded City and 2 areas viz., OC15, OC16 of Rest of CMA.

3.10. Transmission Main System

Three numbers of clear water transmission mains have been provided from 300 MLD Water Treatment Plant at Red hills viz., North Chennai Main, Central Chennai Main & South Chennai Main each carrying 100MLD.

i. **North Chennai Main:** The 1200mm dia MS/PSC main from WTP at Red hills to Vysarpadi- Anna Poonga was laid to cater to the needs of North Chennai.
ii. **Central Chennai Main:** The 1200mm dia MS/PSC main from WTP at Redhills to Choolaimedu southern head works was laid to cater to the needs of Central Chennai.
iii. **South Chennai Main:** The 1200mm dia MS/PSC mains from WTP at Red hills to SIDCO industrial area, Velachery, Mylapore & MRC Nagar was laid to cater to the needs of south Chennai.

This apart, the transmission mains from Desalination Plant (DSP) from Nemmeli and Minjur units, the transmission main under Veeranam project have been provided to supply water to Chennai City.

The carrying capacities and the condition assessment of existing mains have been examined for carrying the proposed design quantity of water from the respective WTPs to WDS of the systems. Most of the mains are observed to be of adequate capacity to carry the designed quantity. Only in some of the reaches, the mains require duplication with same or smaller sizes. In some other reaches, based on the physically/site conditions, replacement with new pipes is required. The details are discussed in the following paragraphs.

3.10.1 Chembrambakkam Transmission System

Already two mains of size 2000mm dia were laid from WTP to WDS aligning the main from Chembrambakkam WTP to junction of Poonamallee high road and Mount-Poonamallee road (Near Saveetha Dental College). From there, one main aligned along the Poonamallee high road and other along the Mount – Poonamallee road.

Additional main of size 1200mm dia from the junction of Saveetha Dental College location to Tambaram town has been proposed and work is under progress. For the way-side towns viz, Mangadu, Anakaputhur and Pammal, necessary provision for tapping arrangements have been proposed and the works are under progress.

The Chembrambakkam water system is delineated into three micro zones and accordingly the transmission main is proposed for each zone. The details of the transmission mains are indicated below

a) The first main is designated as T.M.6, from existing Chembrambakkam WTP to Ambattur Headworks. The proposed main is designed to carry 256 MLD, the total requirement of Thiruverkadu Municipality (Part), Nolambur (VP), Madhuravoyal,

Nerkundram, Choolaimedu and part of Ambattur. The existing main of size 2000 mm dia and 1900mm dia shall be utilized for carrying the designed quantity of above said beneficiaries. The hydraulic design calculation and flow diagram of this main are appended in main report

b) The second main is designated as T.M- 7, from existing Chembrambakkam WTP to Thirunidravur H.W. The proposed main is designed to carry the total flow of 230MLD, which serves the requirements of Thriverkadu Municipality, Nolambur (VP), Madhuravoyal, Nerkundram, Choolaimedu and part of Ambattur. The exsiting main of 2000mm dia from exsiting WTP to Junction of Poonamallee bypass road and then from there it has been proposed to be aligned along Poonamallee-Avadi road and terminates at Thirunindravur Town Panchayat.

The sizes of the main from the junction of Poonamallee bypass road to Thirunindravur varies from 1400 to 800mm dia MS pipe. From the same junction point, branch main is proposed to feed the requirements of Poonamallee and Villivakkam union village Panchayats. The hydraulic design calculations and the flow diagram of this main are appended in main report.

c) The third main is designated as T.M.8, from existing Chembrambakkam WTP to Peerkankaranai H.W. The proposed main is designed to carry the total flow of 267 MLD which serves the requirements of Mangadu, Kundrathur Town panchyats, Senthomas Mount village panchayats, Anakaputhur, Pammal, Pallavaram, Tambram Municipalities, Thiruneermalai, Perungalathur and Peerkankaranai TP and Katankulathur Union Village panchayats. The diameter of the proposed main varies from 2000mm to 500mm MS pipe to a total length of 32.15km. The hydraulic design calculations and the flow diagram of this main are appended in the main report.

3.10.2 Red Hills Transmission System:

From the existing WTP at Red hills, 3 mains were provided namely North Chennai Main, Central Chennai Main and South Chennai Main and each main has been designed to carry the total quantity of 100MLD each.

The Red hills water system is delineated into four micro zones and accordingly the transmission main is proposed for each zone. The details of the transmission mains are indicated below:

a) **Chennai North Main:** This main is designated as T.M.9, from existing 300mm WTP to Patel Nagar WDS. The proposed main is designed to carry the total flow of 107MLD which catered to the needs of Vyasarpadi, Manali and Patel Nagar of Chennai city. The diameter of the proposed main varies from 1500mm dia to 750mm dia MS pipe and length of the main is about 24.17km.

b) **Chennai Central + South Common Main:** The common main is designated as T.M.10, that is from LS: 0 to LS: 3.45km. The existing main of 1500mm dia is retained in addition to this another 1500mm dia main provided as duplication of existing main till LS: 3.45km.

c) **Chennai Central Main:** This main is proposed from junction of common main at LS: 3.45km and terminates at Kolathur WDS. The total length of this main is 8.30km and diameter of this main varies from 1500 to 800mm.

d) **Chennai South Common Main:** This main is proposed from junction of common main at: 3.45km and terminates at Avadi. The designed capacity of this main is 246MLD and it serves the areas of Ambattur and Avadi Municipality. The diameter of the pipe varies from 1900mm to 1200mm.

The hydraulic design calculation and flow diagram of these mains are appended vide Annexure in the main report.

(i) **Soorapattu Main:** This main is designated as T.M.11 and is proposed from WTP at Soorapattu Village Panchayat. The designed carrying capacity of this main is 15.67MLD which catered the needs of Soorapattu, Kathirvedu and Puthagaram. The hydraulic design calculation and flow diagram of these mains are appended vide Annexure in the main report.

(ii) **Transmission Main T.M.12:** It is proposed to carry the designed quantity of 260MLD from proposed WTP at Red Hills to Sump proposed at Sadayankuppam. The diameter of this proposed main varies from 1300 to 1000mm MS pipe. This main caters to the needs of Madhavarm, Vadapermbakkam, Puzhal union village panchayats, Thiyambakkam, Mathur, Chinnasakkadu, Edayanchavadi, Sadayankuppam. The hydraulic design calculations and flow diagram of these mains are appended vide Annexure in the main report.

3.10.3 Minjur DSP Transmission System:

The transmission main for this system is designated as T.M.14. Proposed from DSP unit to Kathivakkam Headworks and design to carry the capacity of 100MLD. The existing main of 1000mm dia MS pipe has been examined for carrying capacity of the proposed water requirement of Minjur Union Village Panchayats, Minjur TP, Kathivakkam

Municipality and Thiruvottiyur Municipality and based on the design analysis, the main is proposed to be retained. The total length of the main is about 31km. The hydraulic design calculation and flow diagram of these mains are appended vide Annexure in the main report.

3.10.4 Sholavaram Transmission System:

The two transmission mains from this system is proposed and designated as T.M.13. The transmission main 1 is proposed from new WTP at Sholavarm to Thirunindravur TP (part) and second transmission main is proposed from new WTP to Sholavarm union village panchayats (Erumavettipalayam) which is designed for 130MLD. The hydraulic design calculation and flow diagram of these mains are Annexed in the main report.

3.10.5 Kilpauk Transmission System:

The Kilpauk water system is delineated into 4 micro zones which catered the needs of core city of the Chennai. The transmission system has been designated as T.M.15 to T.M. 18b. The hydraulic design calculation and flow diagram of these mains are Annexed in the main report.

3.10.6 Nemmeli DSP Transmission System:

The Nemmeli water system is delineated into 4 micro zones which cater the needs of Sothern part of Chennai city and part of St. Thomas Mount and Kattankulathur unions. The transmission system has been designated as T.M.1, T.M.2, T.M.3 and T.M.4.

The Nemmeli system consists of existing 100MLD DSP, proposed 150MLD DSP, and proposed 400 MLD DSP at Perur. From the proposed 150MLD, transmission main of 1500 mm MS pipe has been proposed it has been proposed up to Kelembakkam Junction. The branch main of 1200mm will carry a quantity of 94MLD will feed Kelembakkam Sump. From the Kelembakkam junction 1000mm MS pipe will carry 56 MLD will feed Akkarai Sump.

The details of the transmission mains are furnished below:

a) **Transmission Main T.M.1:** It is proposed to carry the designed quantity of 100 MLD from proposed WTP at Nemmeli to Thiruvanmiyur WDS. The existing transmission main of 1000mm DI pipe from Nemmili DSP to Akkarai Junction for a length of 22.52kms.is proposed to be utilized. From the Akkarai junction, parallel main of size 900mm MS pipe proposed along the existing 700mm DI pipe for a length of 9.64km. The transmission main will feed requirements of Uthandi, Injambakkam, Neelankarai,

Paalavakkam and Kottivakam and Thiruvanmiur WDS zone 12A. The hydraulic design calculation and flow diagram of these mains are annexed in the main report.

b) **Transmission Main T.M.2:** It is proposed to carry the designed quantity of 259.3 MLD from Kelambakkam Booster Station to Southern H.W. The existing transmission main of 500mm DI pipe from KelambakkamBooster Station to Pallipattu WDS for a length of 26.53km is proposed to be utilized and parallel main of size 1600mm MS pipe has been proposed along existing 500mm DI pipe. The existing transmission main of 1000mm from the Pallipattu WDS to Sardar Patel Road for a length of 0.65km. and existing transmission main of 1300mm from Sardar Patel Road junction to Alwarpet junction for a length of 2.03km is proposed to be utilized and 800mm MS pipe from Alwarpet junction to Southern H.W. is proposed as new main for a length of 3.52km. The transmission main will serve the requirements of Semanchery, Shozhinganallur, Karapakkam, Okkiyam-Thuraipakkam, Perungudi, Pallikaranai, Pallipattu WDS, Mylapore, Nandanam and Southern H.W. The hydraulic design calculation and flow diagram of these mains are annexed in the main report.

c) **Transmission Main T.M.3:** It is proposed to carry the designed quantity of 121.24 MLD from Akkarai Booster Station to Alandur H.W. The existing transmission main of 900mm DI pipe from Akkarai Booster Station to Sholinganallur junction for a length of 2.03km and 800mm DI pipe from Sholinganallur junction to Velachery WDS for a length of 10.27 km is proposed to be utilized. For additional quantity proposed for the area, two parallel main of size 900mm MS pipe is suggested.

The transmission main of 500mm MS pipe from Velachery WDS to Alandur H.W. for a length of 5.2km as new main is proposed. The transmission main will feed the requirements of Medavakkam, Jallamdianpet, Madipakkam, Ullagaram, Velachery WDS and Alandur. The hydraulic design calculation and flow diagram of these mains are annexed in the main report.

d) **Transmission Main T.M.4:** It is proposed to carry the designed quantity of 251.29 MLD from Kelambakkam Booster Station to Tambaram. The transmission main proposed comprises of 1900mm MS pipe for a length of 2.6 km from Kelembakkam Booster Station to Sholinganallur Junction, 1800mm MS pipe for a length of 14.2km from Sholinganallur Junction to Mambakkam Junction, 1600mm MS pipe for a length of 4.9 km from Mambakkam Junction to Sembakkam, 1500mm MS pipe for a length of 1.3 km from Sembakkam to St Thomas Mount Union Junction, 1200mm MS pipe for a length of 9.7km from St Thomas Mount Union Junction to Tambram. The transmission main will feed the requirements of 5 Village Panchayat of Kattankulathur Union, 20

Village Panchayat of St. Thomas Mount Union, Peerkankaranai, Madambakkam, Sembakkam, Chitlapakkam, Tambram and Pallavaram. The hydraulic design calculation and flow diagram of these mains are appended vide annexure in the main report.

The mains are designed based on the CPHEEO norms and Peak factor of 1.2 considering the reason that the pumping hours is restricted to 20 hours instead of 24 hours, to carry the design quantity of water. The Transmission mains were optimized for economic cost with interest rate at 9%.

3.11. Branch Mains

Branch mains from TMs are designed considering the available residual head at tapping point, MWL of Sump, length of branch main and the rate of flow The diameter of pipes ranging between 300mm to 2000mm MS pipes used for Transmission Mains for a length of 204.125 Km and 800mm, 1100mm, 2200mm MS pipes were used for Pumping Mains for a length of 42.50 Km.

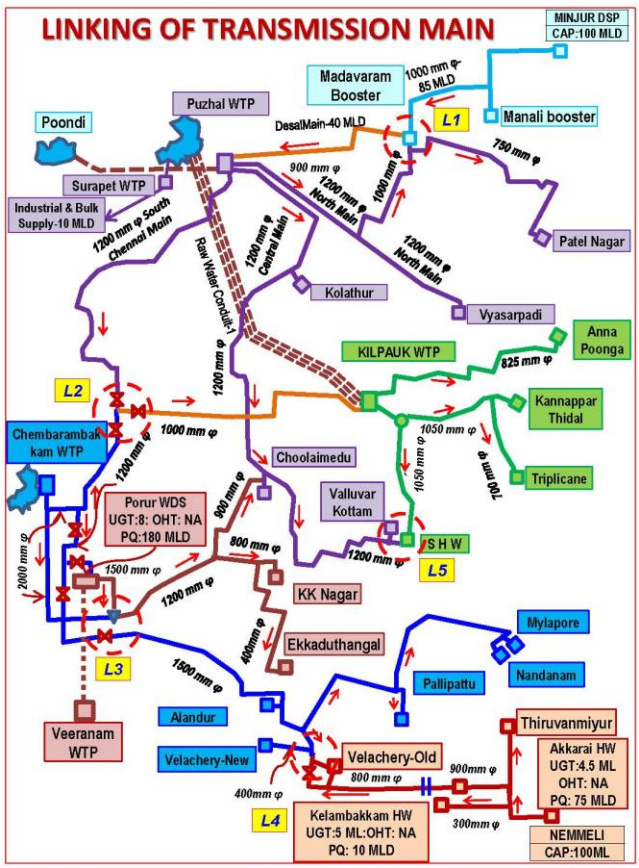
The details of each main narrated in this chapter are furnished vide Appendix 10.2 to 10.20 (Volume II-a)

3.12. Interconnecting Transmission mains:

In order to give stability to the supply pattern in the eventuality of decreasing supplies from one or multiple sources, all the 7 water supply systems are proposed to be interconnected so that the transmission main will form a ring like cover. When sufficient supply is not available in one system from its source/WTP, the adjacent system will supplement the deficit through the ring mains system, by proper controlling of valves.
This ring main will utilize existing pipes, wherever they are already functioning as transmission mains and would include some new pipes. Wherever transmission pipes are required to form the ring main system. Wherever the existing transmission main are suitable in respect of size & type, as per the design to carry the design flow during the horizon year 2050, they will be retained. Where the existing lines sizes or materials (example: PSC) are not suitable, the same will be replaced with size and material as per the design.

Where there are no existing lines in the proposed ring main alignment, suitable pipes are proposed as per the design.

The ring main system will also have suitable control valves at appropriate locations (ie) at the beginning and at the end of each water supply system, to control the flows.



EXISTING DISTRIBUTION STATIONS AND TRANSMISSION MAINS				
Source (MLD)	Supply To	Zone	UGT (ML)	OHT (ML)
Minjur DSP Cap: 100	Manali Booster			
	Madavaram Booster			
	From Madav.Boost to Puzhal WTP (CWS)			
Kilpauk WTP Cap: 270	KPS	1		6.8+9.0
	AnnaPoonga	2	22.50	2.52
	Kannappar Thidal	3	16.	NA
	Triplicane	4	10	2.40
	SHW	16	24.72	4.50
Puzhal WTP Cap: 300	PatelNagar	11	13	NA
	Vyasarpadi	10	22	NA
	Kolathur	9	20	NA
	Choolaimedu	8	43	NA
	Valluvar kottam	15	15	3
Chembarambakkam WTP Cap: 530	Alandur	Add. Area	7	NA
	Velachery-New	6	2	NA
	Pallipattu	12	17	0.75
	Mylapore	14	24.59	NA
	Nandanam	13	11.52	NA
Veeranam (Porur WDS) Cap: 180	KK Nagar	5	23	4.32
	Ekkaduthangal	7	4.50	NA
Nemmeli DSP Cap: 100	Thiruvanmiyur	12A	3.8	0.70
	Velachery-New	6 A	7.30	NA

Existing Linking Between System to System

L1-Linking between Minjur and Redhills Systems

L2-Linking between Redhills and Chembarambakkam and Kilpauk Systems

L3- Linking between Chembarambakkam and Veeranam (Porur WDS) Systems

L4- Linking between Chembarambakkam and Nemmeli Systems

L5-Linking between Redhills and Kilpauk Systems

1

Figure 3-14 Shows linking of main as the ring main system

3.13. Sumps

Sumps are proposed at the end of transmission mains and branch mains for a detention time of one hour except in the existing Water Distribution Stations for Chennai Core City and Head works in added area. Details of capacity of Sumps are furnished in Table no.10.17 (Volume II). The total capacity of sumps works out to 93 ML.

3.14. Storage Reservoirs and Pumping Stations

- Underground Storage Reservoirs (underground reservoirs) are provided for each of 16 Distribution zones for Chennai city. In 7 water distribution stations, overhead reservoirs are also provided.
- Pumping stations are also provided at water distribution stations to pump water into Distribution Systems.

Details of pumping stations in water supply systems in Chennai Corporation are as below.

- ❖ Kilpauk Water Works:
  - I. Raw Water Pumping plant : 03
  - II. Treated Water Pumping plants : 04
- ❖ Redhills
  - I. Raw water Pumping plant : 01
  - II. Treated Water Pumping plant : 01
- ❖ Chembarambakkam
  - I. Raw water Pumping plant : 01
  - II. Treated Water Pumping plant : 01
- ❖ Water Distribution station pumping plants : 18
- ❖ Sub WDS Pumping plants/Booster stations : 42
- Total : 71

Total Installed capacity of pumps : 38391 KW

Total Working capacity of pumps : 25377 KW

Details of all pumping stations with storage capacity, working and standby pumps, OHTs available are presented in Annexure -4.1 of the Main Report

3.15. Distribution system

In respect of Chennai core city, the existing distribution Zones are retained with proposal to rehabilitate/replacing the worn-out/age old existing mains. For the uncovered areas of the core city and the expanded city, new mains are proposed.

Similarly for the rest of CMA, through reconciliation survey and also interaction with the ULBs authorities, existing distribution mains are to be examined to assess the condition of the main. Based on this survey, the mains are either suggested for rehabilitation or proposed for replacement.

Proposed distribution of treated water from various WTPs and DSPs to existing WDSs in Chennai Corporation and proposed booster stations for other local bodies in CMA are shown in the Chart below. Group sumps are proposed, from where, required quantity of water will be pumped to various WDSs, local bodies through existing/proposed

transmission mains. Pumping plants will be located near the sumps and details of these pumping plants are as below.

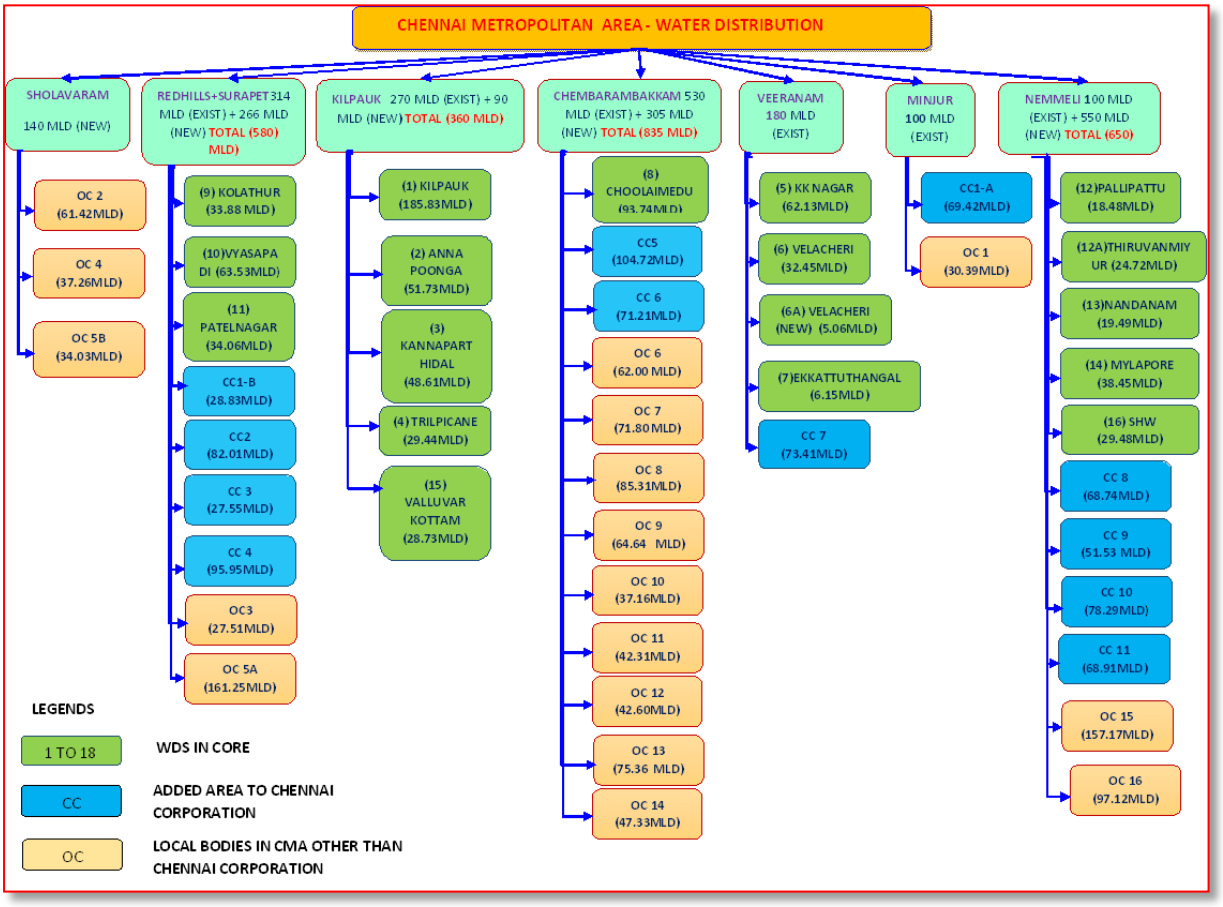


Figure 3-15 Proposed Schematic Diagram of WDS for Entire CMA

3.16. Reclamation and Reuse of Renovated waste water

Faced with the practical issue of water security, it is observed that recycling wastewater (or used water) for non- domestic uses to reduce stress on the large scale fresh water consumption, after proper treatment of the used waste water, instead of discharging them into the water bodies or the sea. About 405 Mld of waste water after treatment is proposed to be utilised for non- domestic purposes as well as for industrial needs.

The table indicates the probable location of the tertiary treatment plant and the quantity of waste water proposed to be re used after Tertiary Treatment.

Table 3-19 Probable location of the tertiary treatment plant and the quantity of waste water

Sl. No	Location of STP	Secondary Treatment Plant Capacity Mld	Tertiary Treated Plant Capacity in Mld
1	Perungudi	180	140
2	Sholinganallur	211	50
3	Pallavaram	160	165
4	Selaiyur	45	45
5	Tambaram	35	10

From the above table, it can be safely deduced that the max requirement of Industrial requirement and non- domestic requirement of 25 Mld, 54 Mld and 85 Mld for the years 2020, 2035 and 2050 can be met.

3.16.1. Usage of Reclaimed Water through Dual Distribution System

Surface or ground water is used for potable purposes after usual treatment. The non – potable supply generally consist of reclaimed waste water after advanced treatment such as the following:

Wastewater ⟶ Primary + Biological treatment + Tertiary treatment in the form of coagulation, filtration and disinfection ⟶ non-potable supply for distribution through separate network.

The supply of reclaimed water may be a good alternative to consider for small, specific areas of large cities where reclaimed water can be supplied to relieve pressure on ground water supplies. The key advantage of distribution system is that it reduces the need to pump out fresh water for regular supply. The areas in the proximity of the STPs indicated in the table above could be tried out for usage of treated waste water for non-potable purposes through dual distribution system.

3.16.2. Recycling of waste water for Indirect Potable and Non-potable applications

Chennai city is having a well-developed sewerage system in the core area. In Chennai 5 STPs exist and for added adjoining local bodies, other STPs are proposed, where some locations are adjacent to the existing STPs. The total existing capacity of the STPs is 727 MLD. It is possible to use tertiary treated water for industrial purpose. CMWSSB is currently supplying tertiary treated water for industrial and non-domestic use.

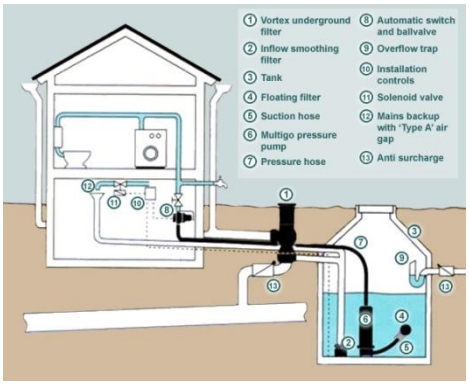


Figure 3-16 Recycling of waste water for Indirect Potable and Non-potable applications

3.16.3. Treated Waste water for Irrigation

Management of water, soil, crop and operational procedures including precautions to protect farm workers, play an important role in the successful use of sewage effluent for irrigation. Most treated waste waters are not very saline, salinity levels usually ranging between 500 to 200 mg/l.

At the farm level, the following basic conditions should be met to make irrigated farming a success:

- ✓The required amount of water should be applied.
- ✓The water should be of acceptable quality.
- ✓Water application should be properly scheduled.
- ✓Appropriate irrigation methods should be used.
- ✓Salt accumulation in the root zone should be prevented by means of leaching.
- ✓The rise of water table should be controlled by means of appropriate drainage.
- ✓Plan nutrients should be managed in an optimal way.

The above requirements are equally applicable when the source of irrigation water is treated wastewater. Nutrients in municipal wastewater and treated effluents are a particular advantage of these sources over conventional irrigation water sources and supplemental fertilizers are sometimes not necessary. However, additional environmental and health requirements must be taken into account when treated wastewater is the source of irrigation water.

It is suggested that quantity of waste water available at the following treatment plant sites as given in the Table below; can be advantageously used for irrigation purposes,

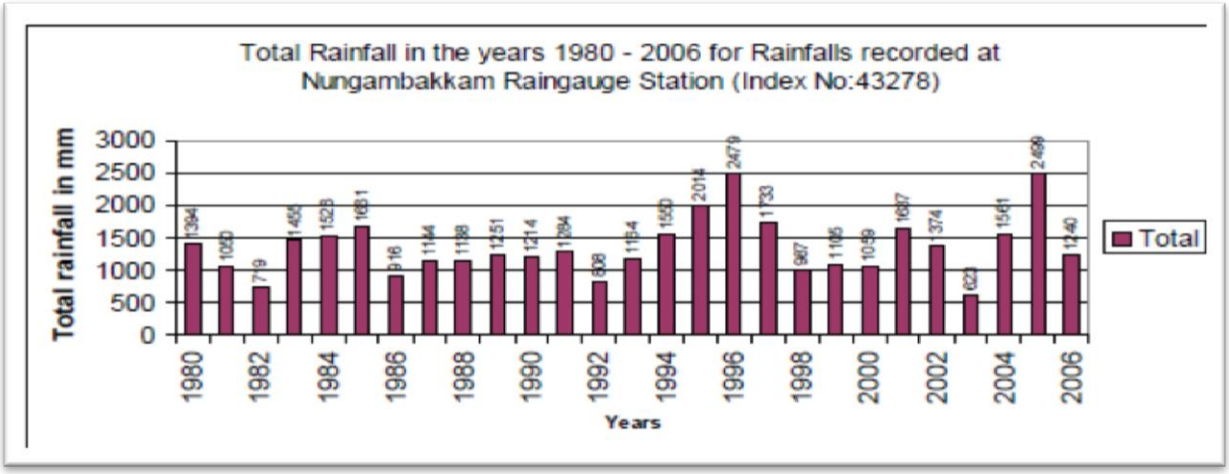
on a trial basis and the successful results of the models, after due evaluation can be replicated in other STPs.

Table 3-20 Tertiary treated waste water for agriculture use-Qty with reference to STP

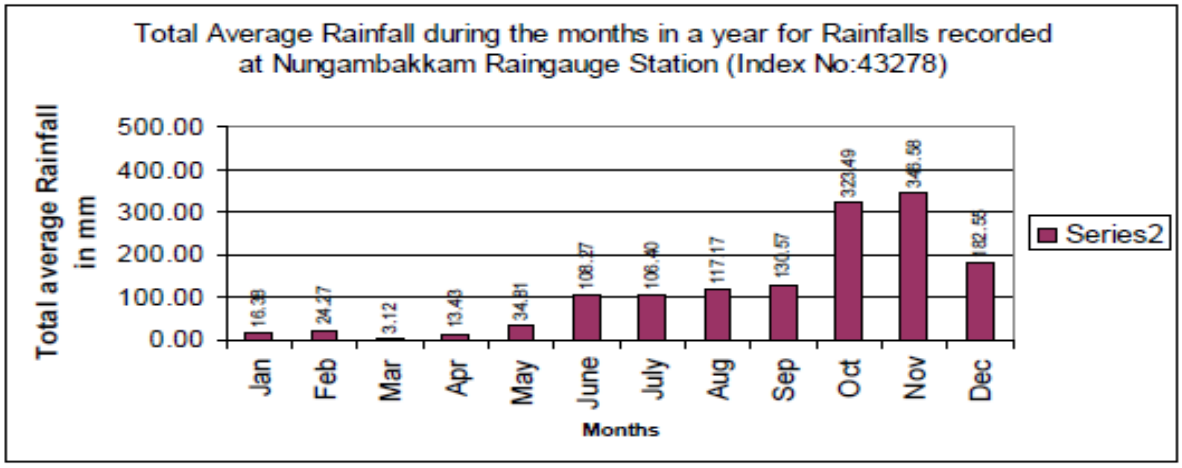
Sl.No.	Name of Sewage Treatment Plant	Capacity MLD	Agriculture Use MLD
1.	Avadi	68	32
2	Thirumazhisai	4	-
3.	Kovilpadagai	90	40
4.	Koladi	36	36

3.17. Storing rain water runoff in lakes for reuse

Rainwater Harvesting in urban residential areas is the process of collecting, filtering and using of rainwater, which falls on the rooftop (terrace or tile roof) and in the portico of the house. Such rainwater harvesting is beneficial in three ways. These are (i) recharging of bore wells in the house, (ii) recharging of ground water sources and collection of rainwater for reuse. There is sufficient rainwater potential available in Chennai city. 27 years rainfall data is given below and the average annual rainfall of 1361 mm over the area of 1189sq. km. yield 950 million m3 of water per year. The minimum rainfall recorded was 623 mm in the year2003 which yields a minimum of 610 million m3 of water per year and the maximum rainfall recorded was 2499mm in the year 2005 which yield a maximum of 1750 million m3 of water per year.



MONTHWISE AVERAGE RAINFALL IN THE PAST 27 YEARS(1980 - 2006)												
Months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
RAIN FALL IN mm	16.38	24.27	3.17	13.43	34.81	108.27	106.40	117.17	130.57	323.49	346.58	182.55



Standard deviation for the above data is 104mm, so after deducting the deviation from the mean value to get the lower side value is 84 mm. If we can consider 20% of the rainfall can be harvested, it amounts to 240 million m3 per year (665MLD). At present most of this water flow away from the residential areas, and at times gets contaminated by sewage from the disposal bodies in both ways viz quantitative & quantitative. The efficient harvest of rain water at the house hold premises reduces the pollution load on disposal water bodies, both quantitatively and quantitatively by about 15 years. (not all the rain water which falls on roof top / portico / open spaces can be harvested 100% and a 5% loss is assumed) This quantitative augmentation of the in-house bore well / open wells in the house helps to supplement the water supply to the house hold purposes.

The rain water that falls on the other public places, streets, large open spaces, etc flow through drains, either small or large in every street or road and flow towards natural water courses like canals, ponds, tanks, lakes etc and mingle with the storages available within them. It is this quantum of rain water which is of considerable quantity and deserves consideration for cities like Chennai, which suffer from periodic water scarcities due to deficient rainfalls frequently.

The topography of Chennai has supported the creation of large number of manmade lakes. The total storage capacity of the existing lakes in Chennai city is about 63 MCM. It means only 63 MCM can be harvested through these lakes and excess 180 MCM requires additional storage facility for efficient harvesting of rain water. Presently 41 lakes are in Chennai city and out of which only 32 lakes are alive. Out of these 32 lakes 5 lakes have potential more than 10 MLD, and mostly free from sewage contamination. Therefore these 5 Lakes could be advantageously used for storing rainwater in the first

instance, after improvements in the existing structure to recharge ground water for indirect potable use with minimum treatment.

Most of the lakes in Chennai are environmentally deteriorating and the storage capacities have been reduced because of silting and solid waste and garbage dumping. There is no maintenance of tank bunds and spillways. In some places, the untreated/overflowed sewage water is flowing into the lakes directly. Therefore, the following rehabilitation works have to be done to improve the storage capacity and quality of water.

- ✓ De-silting and De-weeding
- ✓ Strengthening of tank bunds and spillway structures
- ✓ No access to the public near to the lakes
- ✓ No sewage water should be allowed without proper treatment and control of solid waste.

3.18. Rainwater harvesting for bore well recharging and ground water recharging

Rainwater Harvesting in urban areas is the process of collecting, filtering and use of rainwater, which falls on the area, should be done to prevent them from drying up and improve their water table. It is usually done by the following method. There are no restrictions for constructing residential bore wells till now. For that reason the ground water table is going down rapidly in the city. So ground water recharge is required to maintain the ground water table.

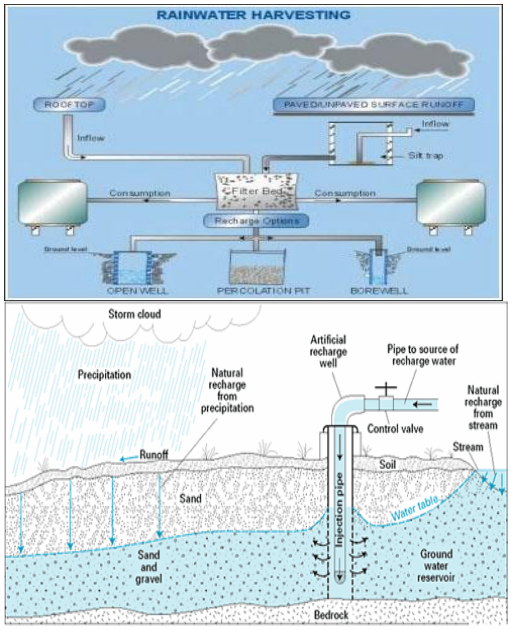


Figure 3-17 Rain Water Harvesting & bore well recharging

We can recharge our bore wells and keep them alive always. Those having open wells too can adopt this system. By directing the filtered rainwater to the open wells, the water table could be improved.

Ground water recharging in urban areas is done by collecting the rainwater from the rooftops and the portico of the house and by making it easily absorbed within the veranda space.

3.19. Creation of additional storage in the project area

3.19.1. To augment water resources besides mitigating floods.

It is a complex phenomenon to mitigate floods in heavily urbanized cities. It can no longer be construed as a problem within the study area but the problem of the overall river catchments. Hence basin wise approach to augment the ground water resources and to mitigate the flood well, before it enters the flat city terrain is required. With this approach creation of additional surface storage in the less urbanized / rural upland /upstream river basin will be best options, provided the facilities are available. A new approach to increase the storages of existing water bodies utilizing the recent advanced technology is essential. A specific sample pilot project indicated by DHV India Consultants in the Prefeasibility Study report for Rehabilitation of Chennai waterways in 2009 could be considered by the Water Resources Department for the Adyar and Cooum basins.

The three rivers and one man made canal drains the entire CMA extending over an area of 1189 sq.km. The catchment area and the length of travel in the CMA etc. is given in the table below.

Table 3-21 Salient details of main waterways in CMA

Name of Waterway	Width of the river in CMC in meters	Length in CMC in km	Length in CMA in km
River Kosasthalayar	Nil	Nil	16.0
River Cooum	25-60	18.0	23.0
River Adyar	60-500	12.2	24.0

The flood accruing from 2013.6 sq.km of Kosasthalayar catchment is in the order of 1.1 lakh cusecs at Poondi regulator, which when reaching the estuary near Ennore is around 1.5 lakh cusecs. The flood accruing from 502 sq.km of Cooum catchment is in the order of 15,000 cusec at Korattur Anaicut at the fringes of the CMA near Thirumazhishai, which when reaching the estuary near Napier Bridge is around 25,000 cusecs.

The flood accruing from 1081.4 sq.km of Adyar catchment is in the order of 10,000 cusecs before Chembarambakkam surplus course confluences and it swells to 53,000 cusecs at Maraimalai Adigalar Bridge which while reaching the estuary near Thiru-vi-ka Bridge is in the order of 63,000 cusecs.

The above data clearly indicates that these rivers have to convey a large amount of upstream floods coming from the upper catchments through the thickly populated urbanized Chennai city. This flood interfered by the obstruction in the river bed besides generation of afflux caused by the inadequate vented bridges rises its maximum flood level inundating the major portion of the city. Due to the rise of water above the MFL, the local storm water which fall into the rivers are unable to enter the river during heavy floods and reverse flow of river water occurs in the drains, thus aggravating inundation in the adjoining areas. This situation indicates that the flood could be moderated by creating additional surface storages in the upland catchment itself where availability of land for water spread is not as worse as in the case of Chennai city and nearby suburbs.

With this in mind, a few reservoir proposals have been mooted out long back at Ramancheri, Thirukandalam across Kosasthalayar, Thiruneermalai across Adyar, JameenKorattur across Cooum etc. None of them seem to have been pursued, may be due to huge objections from the public living in the respective project affected areas. With this background, it is considered worthwhile to go in for the following two approaches namely, a) creation of storages within river banks by check dams, b) augmenting the storage of existing reservoirs and tanks in the catchment of the above rivers. In this approach, the storages of Chennai city drinking water supply reservoirs namely, Poondi, Redhills and Chembarambakkam have been raised by two feet after acquiring the necessary additional water spread area. Of course the same approach cannot be adopted now after nearly three decades as the land demand in the city and suburbs have reached a peak stage making the acquisition of lands almost impossible. Under these circumstances rising the storage level/ full tank level by 0.3 m to 0.5 m and at the same time not enlarging the water spread area can be a next option. This could be achieved by erecting foreshore bund at the fringes of the water spread area of the existing tanks with vent ways for incoming water at suitable locations. We have the precedence of raising the FTL of Veeranam tank by two feet for this purpose of adding drinking water storage for Chennai city. It is understood that recently the DHV (India) consultants have recommended a project on the same lines. A few tanks under Cooum and Adyar which have command to feed Chembarambakkam and Red Hills tank were selected on trial basis for augmenting the drinking water storages by about 1 TMC at a cost around 100 corers.

Table 3-22 Sample tanks for detailed Analysis – Adyar catchment

Sl. No.	Name of tanks	Capacity (MCM)	Water Spread (sq.km)	Bund length (km)
1.	Pillaipakkam	3.45	3.50	3.66
2.	Porur	1.29	3.20	3.10
3.	Manimangalam	6.37	3.42	7.14
4.	Sri Preumputhur	4.93	2.95	3.60
5.	Nemam	7.28	12.88	4.59
	Total	**23.32**	**25.95 or 26 sq.km**	**22.09 or 24 km**

The above tanks in Adyar basin are chosen as pilot projects with a reported total capacity of 22.09 MCM. But due to siltation in the last six decades the storage capacity of the tanks at present would be 30% less i.e. 16.32 MCM would be the reported capacity. While restoring their original capacity by raising their preset F.T.L by 0.5 m without enlarging their water spread area (using foreshore bund with gated inlets at the fringe of the existing water spread limits) their preset storage can be augmented by 13 MCM over their total water spread of about 26 sq.km. This water spread area as existing at the field at present can be precisely measured in the Orthophoto and proposal fine-tuned.

3.20. Demand Management

The water demand includes the following:

I. Domestic or residential
II. Commercial
III. Industrial
IV. Public service
V. Un-accounted system losses & leakage.

Several factors influence the residential and non-residential demand of water. In the aggregate, per capita water demand is very stable. Residential water usage is largely a function of basic demographics, particularly household size, property size, life styles, and income. Non-residential usage of water varies substantially according to the type of industry. The production of some goods (Such as food and beverages, paper products, and microchips) is highly water intensive.

Demand management deploys various techniques for conserving water and improving the efficient use of water by end users. Improvements to economic efficiency are achieved whenever the total benefits of a measure are outweighed by the total costs of implementation. Demand management evolved in the context of least-cost or integrated resource planning, which balanced supply and demand management

considerations. Managing demand can complement or supplant traditional and emerging supply-management option for CMWSSB.

Demand management involves measures that promote the efficient use of water including load management and load reduction or conservation. Water conservation also can be understood as the economically and / or socially beneficial reduction of water withdrawals, water use, or water waste. Conservation can forestall future supply-capacity needs; it can be implemented on the supply side as well as the demand side; and it can consist of both temporary measures, abused during emergencies and permanent measures as used to improve long-term efficiency. Demand management or strategic load management complements supply management because controlling the level and timing of demand can improve overall efficiency of system operations and help eliminate, reduce, or defer the need for an investment in new capacity by the CMWSSB. Reductions in peak and off-peak demand affect the total capacity requirements of the system and thus the total cost of providing water service.

All demand management activities that decrease the demand which affect supply management since existing system capacity is released for other customers and other uses. That is the freed or redirected utility capacity can be compared to that provided by more traditional means. Thus, the benefits of demand management can be measured in terms of avoided costs, or the incremental savings associated with not having to produce additional units of water or water service. Avoided cost can be used to compare demand management and supply management options and encourage CMWSSB to seek out least-cost alternatives for meeting future water needs.

Although demand management should be equated with drought management, the experience of CMWSSB and the experience of drought customers in implementing efficient lifestyle practices can be beneficial during periods of water shortage. Some of the basic demand management techniques can be accelerated during supply emergencies or droughts.

3.20.1. Supply development Vs Demand management - paradigm shift

The traditional approach of public health Engineers & Geologist are focus on the supply side and the assessment of available water resources. The water supply Engineers shall address both supply &demand sides to enable this paradigm shift towards demand management rather than focusing only on supply management.

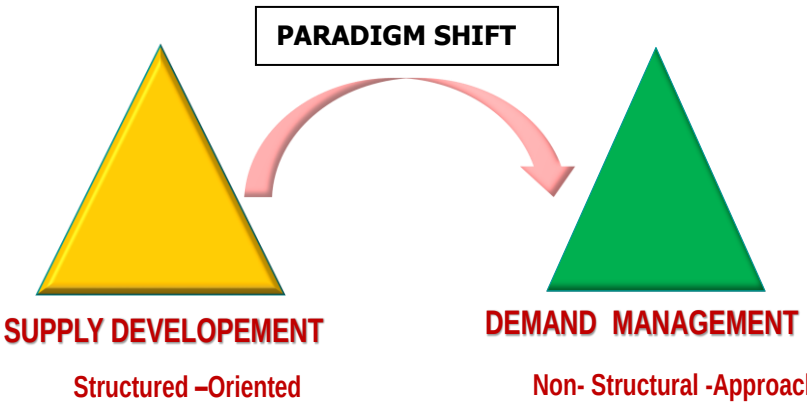
Table 3-23 Structured & Non-Structured Approach

Structured Approach	Non-Structured Approach
Engineering and Technical Expertise:	Excessive Water use leads to over capitalization of infrastructure
Source Augmentation	Water conversation Technologies are not usually capital intensives or high technology
System Improvement	To improve accounting via metering data management and reporting
Installation of district meters	Awareness and Information, Education & Communication and effluent reuse
Pressure Management	Implementing water rationing during drought.
Leak detection and Repairs	Distribution system optimization

3.21. Demand management by optimal use of fresh water

The optimal use of fresh water consists of

- Per capita supply reduction in Fresh water.
- Minimization of water uses.
- Minimization of water Losses.



3.21.1. Per Capita Supply Reduction

3.21.1.1. Fresh Water Supply Reduction

Stage 1: Domestic Level

i. Fresh water supply – Reduce to 125 lpcd(from-150 lpcd)

ii. (Usage of local source and grey water recycling) -25 lpcd

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Total **150 lpcd**

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i) Local Sources water can be need for the following household activities.
   a) Portion of washing water
   b) Portion of vessels cleaning water
   c) Portion of house & car cleaning water.

ii) Recycled grey water can be used for the following day-to-day functions.
   a) Landscaping & gardening
   b) Toilet flushing

3.21.1.2. Fresh Water Consumption Reduction

- ✓ Use of low flow type fixtures (Dual Flush)
- ✓ Close tap, when not in use (Tooth brushing, shaving vessels cleaning
- ✓ Use buckets instead of shower while bathing
- ✓ Close showers while soaping
- ✓ Attend all leaks
- ✓ Use water saving fixtures in washing machines
- ✓ Use de frost water of the refrigerator for vessels cleaning.

3.21.1.3. Reducing Water Consumption:

- ✓ Use Less water using cooking utensils
- ✓ Use Less water using food items
- ✓ Less water using house-hold machineries
- ✓ Less water using Industries
- ✓ Less water using life styles-reduce bath times and timings.

3.21.2. Minimization of water uses

In our everyday life knowingly or unknowingly we misuse the water, which tantamount to gross wastage of water. Some of the examples are given below.

Table 3-24 Minimization of water uses

S.No	Misuse	Proper Use	Saving	Remark
1.	Full Flushing Toilet – 9 Litrs	Half Flushing Toilet – 4.5 Litrs	Save – 4.5 Litrs	Use Half flush for liquid waste.
2.	Dish Washing under running tap for 5 mins – 60 Litrs	Dish Washing using filled sink – 12 Litrs	Save – 48 Litrs	Use filled sink to wash vegetables or dishes.
3.	10 Minutes bath under running shower – 90 Litrs	10 Minutes bath with the tap off while soaping up – 30 Litrs	Save – 60 Litrs	Turn off the tap while soap up or shampoo.
4.	Brushing teeth tap running for 5 mins – 45 Litrs	Brushing with teeth using mug/glass – 0.5 Litrs	Save – 44.5 Litrs	Use glass to rinse mouth.
5.	Washing Cars using hose/nozzle – 50 Litrs	Washing Car using bucket water – 10 Litrs	Save – 40 Litrs	Use bucket water to wash the water

S.No	Misuse	Proper Use	Saving	Remark
6.	Watering the lawn everyday 10mx10m – 300 Litrs	Washing the lawn once in a week – 50 Litrs	Save – 250 Litrs	Don't water garden/lawn unnecessarily and follow a fixed schedule.
7.	Washing Car Daily – 350 Litrs	Washing Car once in a week – 50 Litrs	Save – 300 Litrs	Don't wash more than once a week. Wipe it off regularly.

To minimize the water loss due to mis-utilization public awareness is required. Fixing leaking taps, pipes, etc., immediately and checking regularly for leaks should be given priority. Teaching and educating people on the value of water for a better tomorrow, is a necessity now.

3.21.2.1. Gadgets that minimize water use include:

i) Install flow restrictions (if not already installed) to reduce the amount of water coming through the tap. These are particularly good for kitchen and bath rooms.

ii) The "Every Drop Shower Saver" fits to the shower and enables fast and simple way to switch on or off the water while soaping up or washing hair.

iii) The red water valve fits to the hot water tap plumping close the outlet and simply diverts the cold water in the pipe (before the hot water gets to the tap) to another place, often a water tank of some kind.

iv) If a dual flush toilet is not available,, fill a 1 litre plastic bottle with water and put it into the cistern this will save one litre/flush or you could upgrade it, rebates still apply for this.

v) There are waterless urinals, available which are gaining popularity.

vi) Composting toilets are available and they provide great fertilizer, but many are not prepared to install them.

vii) Installing a new washer or tightening of screws should fix any dripping taps.

viii) In the gardens, mulch well and use water crystal and water directly to the roots at night, to minimize the water need. Moisture censors can also be installed to irrigation systems, that only waters when needed.

ix) In a pool or spa, ensure the cover is on, when not in use. This helps keep it clean and reduces evaporation. Top it up using water from rain water tank, if it is feasible.

x) Choose water efficient appliances (i.e.) dish washers and washing machines) and only use them with a full load.

Figure 3-18 Water savings in consumer end

3.21.2.2. Smart Gadgets:

i) Mains water monitoring is generally simple to install, (but we would recommend a plumber) and many work wirelessly (like the energy monitors) and monitor the water use.

ii) Water leak detection: The Aqua trip is fitted by a plumber and is an early leak detection device that monitors water flow. It can differentiate between normal use and a leak or pipe failure and automatically switches the water off.

3.21.2.3. Water Recycling and collection Gadgets:

i) The humble bucket has been a feature in many bath rooms over hot summers to collect and redistribute shower or bulk water to the garden.

ii) The "Huggie sink" fits into the kitchen sink and is great for catching water used for rinsing vegetables etc., which can then be poured into the garden.

iii) Mobile wheelie bins or buckets can be used to collect and redistribute rain water from open down pipe.

iv) Grey water recycling units can take water from laundry and or bath room areas and divert water to garden areas .

v) Rain water tanks that are plumbed into a toilet and or laundry also provide good water reuse. It can be used for topping up pools, ponds and spas as well. There are of all shapes, sizes and types these days and so there is sure to be one that suits the situation.

vi) Dual flush toilets with built in hand basin at the top are good for recycling the hand wash water into the cistern for flushing.

3.21.2.4. Protection of Water Sources:

A sustained effort by the public and a political will to improve the status of water sources alone and protect them from illegal activities will help improve water availability.

3.21.2.5. Pollution of Water Sources:

Though individually people do not treat a water source with disrespect, people have collectively contributed to the pollution of water sources. The effects of polluting the river with activities such as sand mining and encroaching on the river bed, have not also been rightly understood by the people.

3.21.2.6. Judicious Use of ground Water:

The only way to increase the ground water availability is to recharge the ground water by judicious use and curtailing of over extractions and maintaining the water balance in the ground water aquifers.

3.21.3. Minimization of water Losses

Minimization of water loss is reduction in UFW. The major contributor to the UFW is the Leakages in the system. Presently UFW is 40% in Chennai based on pilot study conducted @ MMDA colony. This means CMWSSB is generating revenue from the 60% of the total water it produces. So, by reducing UFW, that not only more revenue will be generated but CMWSSB will also be able to meet additional water demand in the city.

System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non-Revenue Water
			Unbilled Unmetered Consumption	
	Water Losses	Commercial Losses	Unauthorized Construction	
			Customer Meter Inaccuracies and Data Handling Errors	
		Physical Losses	Leakage on Transmission and Distribution Mains	
			Leakage and overflows from the utilities storage tanks	
			Leakage on service Connections up to the customer meter	

Reduction of NRW is done by dividing the total distribution network into smaller hydraulic isolated areas within the characteristic of each district area can be monitored, accessed and inflow and outflow across the boundaries are metered is called District Metering Area (DMA). DMAs may be further subdivided into smaller area. A DMA establishment is done by pressure Zero Test (PZT). For DMA model and fig refer previous page:

After establishing the DMAs, the UFW reduction is done by the methods mentioned below;

- Minimum Night Flow (MNF) Approach
- Mobile Tanker and Pump Approach
- Metering Illegal Consumption
- Metering Error
- Replacing Inaccurate and Damaged Consumer Meters
- Metering Public Taps
- Network Modeling
- Public Awareness

After the leakage level is reached, the same is maintained in the future. Successful implementation of UFW project minimizes water loss and demand can better satisfied with the same supply.

3.22. Awareness Campaign

3.22.1. Public awareness for rain water harvesting for watering garden/lawn/cleaning cars/reuse of water

Public awareness about use/misuse of water is one of the major factors for water demand and supply management. Public should get the proper knowledge about the value of water the need for conservation of water.

This subject is a matter of great significance for the residents of Chennai City and it is CMWSSB or Government's duty to educate people not to misuse the water and propagate the various methods adopted for water conservation. Rainwater harvesting can be made compulsory for each household and Government should encourage putting up rainwater harvesting structures and properly maintaining it and give some subsidy for those who practice direct use of harvested rainwater for non- domestic purposes in their premises.

Individual household can do rain harvesting when water falling on a flat rooftop should be made to run through a pipe connected to the roof and prevented from running off to the drainage on the roadside. This is one time investment for individuals and the return in long term is much higher than the initial investment. Also the water supply of CMWSSB to those individuals will be reduced and CMWSSB can serve more demand with the same supply.

Youth Water Clubs

In order to educate the younger generation on the significance of water judicious use and its conservation, student water clubs and youth water clubs may be formed in educational institutions in the city and the state. There is a scope for saving 25-50 litres of water per house-hold propagate.

These water clubs can propagate the following things:

- ✓ Water scarcity and its impact
- ✓ Pollution
- ✓ Water Wastage
- ✓ Rain water harvesting for direct use.
- ✓ Water conservation.

4. WASTE WATER MANAGEMENT

4.1. Sewage Generation:

The sewage generation has been computed taking 80% of domestic + industrial +

Commercial supply would be converted as sewage and adding for 5% of the above supply towards as infiltration. The sewage generation for the horizon design years of 2020,2035 and 2050 are 1272MLD,1865MLD and 2769MLD respectively.

Table 4-1 Sewage Generation in MLD

Description	YEAR			
	2015	2020	2035	2050
CHENNAI OLD CORPORATION				
Population (in thousands)	4728	4830	5138	5437
Water Supply- Domestic +Industrial + Commercial (MLD)	598	833	887	939
Sewage generation at 85% of Water supply	**508**	**708**	**754**	**798**
EXPANDED CITY AREA				
Population (in thousands)	2326	2727	4042	5536
Water Supply- Domestic +Industrial + commercial (MLD)	204	326	593	955
Sewage generation at 85% of Water supply	**174**	**277**	**504**	**812**
Total for Chennai corporation	**682**	**985**	**1258**	**1610**
REST OF CMA				
Municipalities				
Population (in thousands)	1110	1299	2096	3414
Water supply- Domestic +Industrial + commercial (MLD)	90	135	266	530
Sewage generation at 85% of Water supply	**76**	**115**	**226**	**450**
Town Panchayats				
Population (in thousands)	516	664	1150	1727
Water supply- Domestic +Industrial + commercial (MLD)	38	64	137	252
Sewage generation at 85% of Water supply	**33**	**55**	**116**	**214**
Village Panchayats				
Population (in thousands)	1257	1683	3055	4570
Water supply- Domestic +Industrial + commercial (MLD)	58	138	312	582
Sewage generation at 85% of Water supply	**50**	**117**	**265**	**495**
Total for CMA outside corporation				
Population (in thousands)	2883	3646	6300	9712
Water supply- Domestic +Industrial + commercial (MLD)	186	337	715	1364
Sewage generation at 85% of Water supply	**158**	**286**	**607**	**1159**
ENTIRE CMA				
Population (in thousands)	9937	11204	15480	20684
Water supply- Domestic +Industrial + commercial (MLD)	989	1496	2195	3258
Sewage generation at 85% of Water supply	**840**	**1272**	**1865**	**2769**

4.2. Collection system

The sewage collection system for the Project area is categorised into two units,

- Chennai City and
- Rest of the CMA.

The added areas of ULBs have been delineated into six zones and sewage collection from each zone shall be conveyed to the existing STPs of the core city and Thiruvottiyur STP. The capacity of the existing STPs has been enhanced to accommodate the additional flow of sewage from core area and proposed added area of city. The rest of CMA has been divided into 10 sewerage Zones and the sewage flow from each zone will be treated either at the new or existing STPs. The exiting STPs capacity will be increased to accommodate the proposed sewage flow from the contributing zone. The details of contributing area under each zone and collection of sewage in the 226 nos of pumping stations with preliminary treatment units are discussed in this chapter. As per the proposals in the earlier Master Plan, about 133Km existing sewer mains were rehabilitated and 143Km length of sewer mains were newly laid. Now, the un-sewered areas of expanded city and rest of CMA are proposed with collection system. (Sewermain, pumping station and force main/ gravity main)

Of the 226 SPS, 153 SPSs are with independent collection system (Category I), 67 SPSs have independent collection systems and also act as relay pumping stations, (Category II) and 6 SPSs totally act as Relay SPS without any independent collection system (Category III).

CMWSSB have under taken to replace the existing sewage pumps which have outlived their useful lives. However, most of the sewage pumps would have outlived their useful lives at the base year 2020. Hence it is proposed to replace these pumps based on the sewage generated for the years 2035 and 2050 in the respective collection areas. The delineation of proposed sewerage zones of the project area is illustrated in Fig - 15

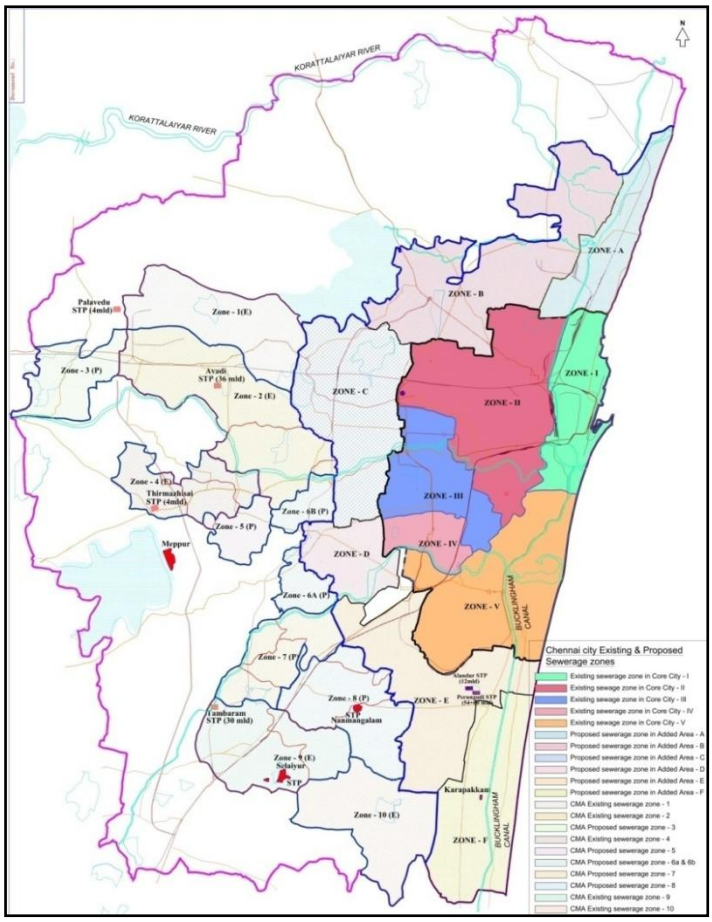

Figure 4-1 Collection Systems

4.3. Sewage Treatment Plants:

The existing details of sewage Treatment Plants with location and outfall of effluent are shown in the Fig. below

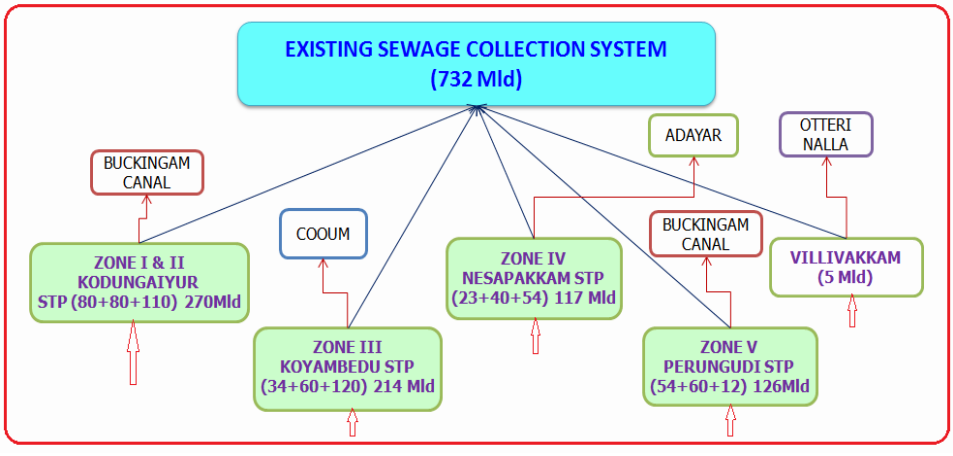

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Figure 4-2 Existing Sewage Collection System

The condition of the sewer mains and pumping stations, the proposed replacement /Rehabilitation required for the horizon design years are discussed in this chapter.

4.4. Current status of Sewerage system in extended areas and other local bodies in CMA

The sewerage schemes in the 42 extended areas to the Chennai Corporation are under various stages of execution and (or)in the stage of preparation of DPR by CMWSSB. Out of 42 ULBs,2 ULBs has been completed and 18 are under execution and 22 are under preparation level .The sewage generated will be collected in the existing STPs located nearby in Chennai Corporation limits.

4.5. Observation made in Sewage Treatment Plants

In this Chapter, the physical and working condition of the existing plants, the scope for expansion of its capacity and the proposed process designed of each existing STP are discussed in detailed. Similarly for the rest of the CMA, delineation of proposed Sewerage zones, pumping stations and the proposed sewerage treatment plants with the locations and their area of operation, are also discussed.

4.6. Additional Sewage Treatment Plants

The capacity of the existing Sewage Treatment plants is not sufficient to serve the entire population in the project Area, particularly expanded city areas and CMA. For improved sanitation, STP infrastructure is proposed to be expanded and up graded. Expansion / Up gradation and improvement of sewage Treatment facilities is proposed under following components;

i. Improving performance of plants at existing sites
ii. Creation of additional capacity at Existing Treatment Plant site.
iii. Creation of STP facilities at new locations
iv. Providing Septage management facilities to areas that are not served by underground sewerage system
v. Creation of package-type Sewage treatment facilities on river banks for rejuvenating rivers and nearby water bodies, by intercepting waste water inflows.

The proposed STPs and its Capacity, Locations are tabulated and annexed in the main report.

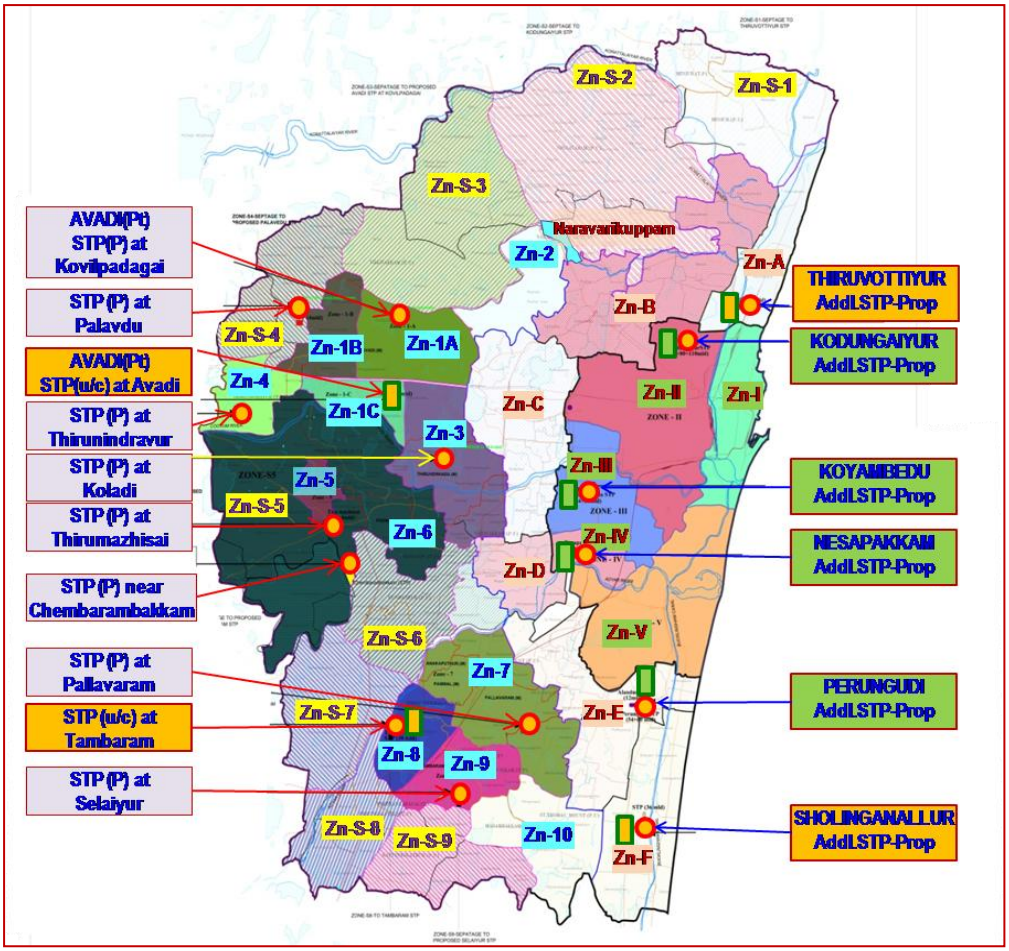
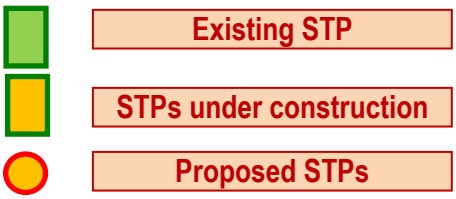


Figure 4-3 Additional Sewage Treatment Plants



Zones I,II,III,IV,V	Exiting 5 Zones of Core City
ZONES-A,B,C,D,E,F,	6 Proposed zones of Expanded City
Zones-1A,1B,1C,2,3,4, 5,6,7,8,10	12 Zones Proposed in the Rest of CMA for providing UGSS
Zones-S1, S2,S3,S4, S5,S6, S7,S8,S9	9 Areas covered under septage management

4.7. Treatment Facilities for areas not covered by Under Ground Sewerage

Some areas have not been found suitable for providing underground sewerage systems facilities. On site sanitation will be practiced in these areas. As per the Advisory Note

issued By Government of India, such areas will be provided with septage management facilities.

4.7.1. Septage Management

Septage or septic tank sludge is a term used in some countries to describe the partially treated sludge stored in a septic tank. It is one type of faecal sludge. Septage is a by-product from the pre-treatment of household wastewater in a septic tank where it accumulates over time. Generally, septic tanks are provided in independent/ small development households, situated in non- sewerage scheme areas, but it is also observed that in Chennai city & CMA, some of the commercial/ institutional /factory premises do also have septic tanks for collection of waste water emanating from their premises. Therefore, the septic tanks can be residential or non-residential. Non-residential sources can include wastewater from commercial/industrial developments.

Septage is pumped out of a septic tank or onsite sewage facility with a vacuum truck. Households in the areas that are not connected to underground sewerage system will have on site sanitation by providing Septic Tank and Soak Pits or Septic Tank and small bore sewer system. Septage collected in the septic tank will have to be periodically removed by vacuum trucks for treatment in the STP of that Area.

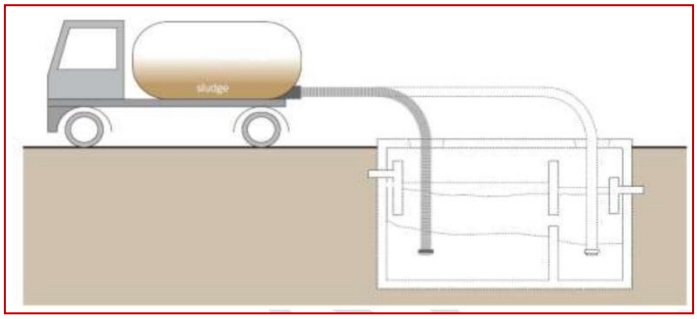


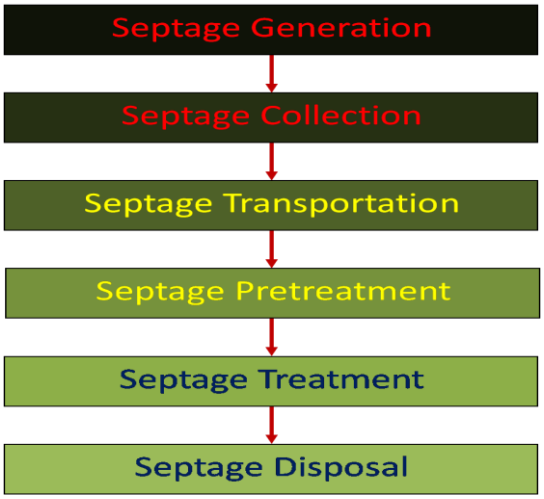
Figure 4-4 Septage Management

4.7.2. Essential Elements of Septage Management

Following are required to be meticulously planned for effective septage management

a) Collection of Septage
b) Transport to Treatment Site
c) Appropriate Treatment
d) Safe Disposal

Septage Management stages are shown below:



Stages of Septage Management

4.8. Treatment Options

The septage treatment required depends on the types and sources of domestic wastewater and faecal sludge. The domestic wastewater and faecal sludge often contains high concentration of organic matter and pathogens. Hence it is important to provide environmentally suitable technological options for collection, transport, treatment and disposal/reuse of faecal sludge/septage. The treatment and disposal methods of septage can be conventional or non-conventional. The conventional methods are the most widely used and they serve the purpose of treatment of sludge and effluent.

List of areas and populations to be covered under septage management is given in main report. In those areas, households will have septic tanks. A viable treatment to consolidate/stabilize the settled sludge is suggested and the same is also detailed in the main report. Treated effluent from the septic tank will be either allowed to go in the soak pit or into storm water drains. Provision of small bore sewer scheme is recommended, wherever feasible.

Septage from septic tank will be periodically collected by vacuum trucks and transported to nearest STP for treatment. Population and Number of households from different areas that are proposed to be covered for septage management are listed separately.

5. OPERATION AND MAINTENANCE

5.1. Operation and maintenance of various components

5.1.1. Major water supply facilities under operation and maintenance

- Surface water sources- Reservoirs and Lakes for impounding Raw water
- Intake system
- Water Treatment Plants
- Conveying mains
- Water Distribution Stations
- Raw Water and Treated Water Pumping Plants.
- Distribution system
- Metering system

Surface Water Sources - The following raw water sources are being maintained by Water Resources Organization of Public Works Department.

- Poondi Reservoir
- Cholavaram tank
- Redhills lake
- Chembarambakkam lake
- Veeranam lake

5.1.2. Water Treatment Plants

The following water treatment plants are maintained by Metrowater, either by their own staff or through private parties.

(a) Reverse Osmosis Plants for treating raw brackish water from bore wells

- Nochikuppam, : (0.15MLD)

(b) Water Treatment Plants for treating surface water

- Redhills : 300 MLD (O&M by Pvt.)
- Kilpauk : 270 MLD (45+135+90), -3 Plants O&M by Metro water)
- Chembarambakkam : 530 MLD (O&M by Pvt.)
- Surapet : 14 MLD (O&M by Metrowater)
- Vadakuthu (Veeranam): 180 MLD (O&M by Pvt.)

(c) Desalination Plant for treating sea water which are operated and maintained by private parties.

- Minjur desalination Plant, : (100 MLD) (Rs.48.66 /KL)
- Nemmeli desalination Plant : (100 MLD) (35.00/KL)

5.1.3. Pumping Stations in Water Supply Sector

The following pumping plants are being maintained by CMWSSB, either by their own staff or through private parties.

- Kilpauk Water Works:
  - a) Raw Water Pumping plant : 03
  - b) Treated Water Pumping plants : 05
- Redhills
  - a) Raw water Pumping plant : 01
  - b) Treated Water Pumping plant : 01
- Chembarambakkam
  - a) Raw water Pumping plant : 01
  - b) Treated Water Pumping plant : 01
- Water Distribution station pumping plants : 18
- Sub WDS Pumping plants/Booster stations : 42

Total : 72

5.1.4. Transmission, feeder mains and Distribution system

The following transmission mains, feeder mains distribution mains are being maintained by CMWSSB

(i) Raw Water Transmission Mains

The Tube wells in the following Northern Well Fields are being maintained by CMWSSB at present Details are furnished in this chapter.

Apart from the above, the following Tube/bore wells within Chennai Corporation are being maintained by CMWSSB

- Tube/bore wells with Hand pumps : 6882Nos
- Tube/bore wells with power pumps : 975 Nos.

The following raw water conduits from Jones Tower at Redhills lake to Kilpauk Water Works are maintained by CMWSSB.

- Conduit I :11 kM long, 5' x4' size, 104 ML carrying capacity
- Conduit II :11 kM long, 6'6"x4' size, 146 ML carrying capacity
- Conduit III (Under refurbishing):11 kM long, 7'x 4'6" size, 190 ML carrying capacity

(ii) Clear Water Transmission Mains

a) Total length of Transmission mains : 174.65 km

b) Total length of feeder mains : 411.44 km

(iii) Distribution System

a) Total length of distribution mains : 4224.81 km

b) Public Fountains : 23104 Nos.

5.1.5. Organization for O&M of the infrastructure

The chart showing the present organization chart for the O&M of all infrastructures, both in Water supply and sewerage sectors is enclosed in the main report.

The following field staffs are available at present for the supervision/operation & maintenance

- Engineering staff/Supervisory staff : 263 Nos.
- Supporting staff in office : 227 Nos.
- Field Maintenance Staff (various categories) : 1776 Nos.

5.1.6. Operation and Maintenance of all infrastructures

Detailed operation and maintenance schedules of all the above infrastructures are presented in this chapter as below.

- Daily maintenance schedule
- Weekly maintenance schedule
- By-monthly and monthly maintenance schedule
- Quarterly maintenance schedule
- Annual Maintenance schedule

Registers & Training

Registers to be maintained and trainings to be imparted to the maintenance staff are detailed.

5.2. Water Safety Plan

The main objective of the water security plan (WSP) is to supply water of quality that will allow health based targets to be satisfied. WHO guidelines for Drinking Water Quality (GDWQ) stipulated a more effective risk assessment and risk management approach for drinking water quality and its control. The conventional approach of water quality and safety management is to be focused on testing of drinking water before

contamination takes place. In the WSP approach, the study is focused on vulnerable points and remedial measures within the water distribution system which prevents the contamination before it reaches the consumer.

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

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

5. The hazards that the water supply is exposed to and the level of risk associated with each.
6. Control of each hazard
7. Monitoring the means of control
8. Means to indicate lost controls
9. Remedial actions required to restore control
10. Assessing the effectiveness of the whole system

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

WSP will increase the amount of time that the staff spends in the field for inspecting the system and undertaking physic-chemical analysis and reduce the dependence on analyzing samples of water for micro-organisms in laboratory. In metro water, about 6 numbers of laboratories were established in the treatment plants of both sewage and water. The random samples shall be collected from the risk prone area and analyzed for Physical and Chemical contaminations, for water quality monitoring surveillance mechanism. Crucially the WSP enables the operators to get to know their system more

effectively as they spend more time to identify and control risks rather than just analysing them.

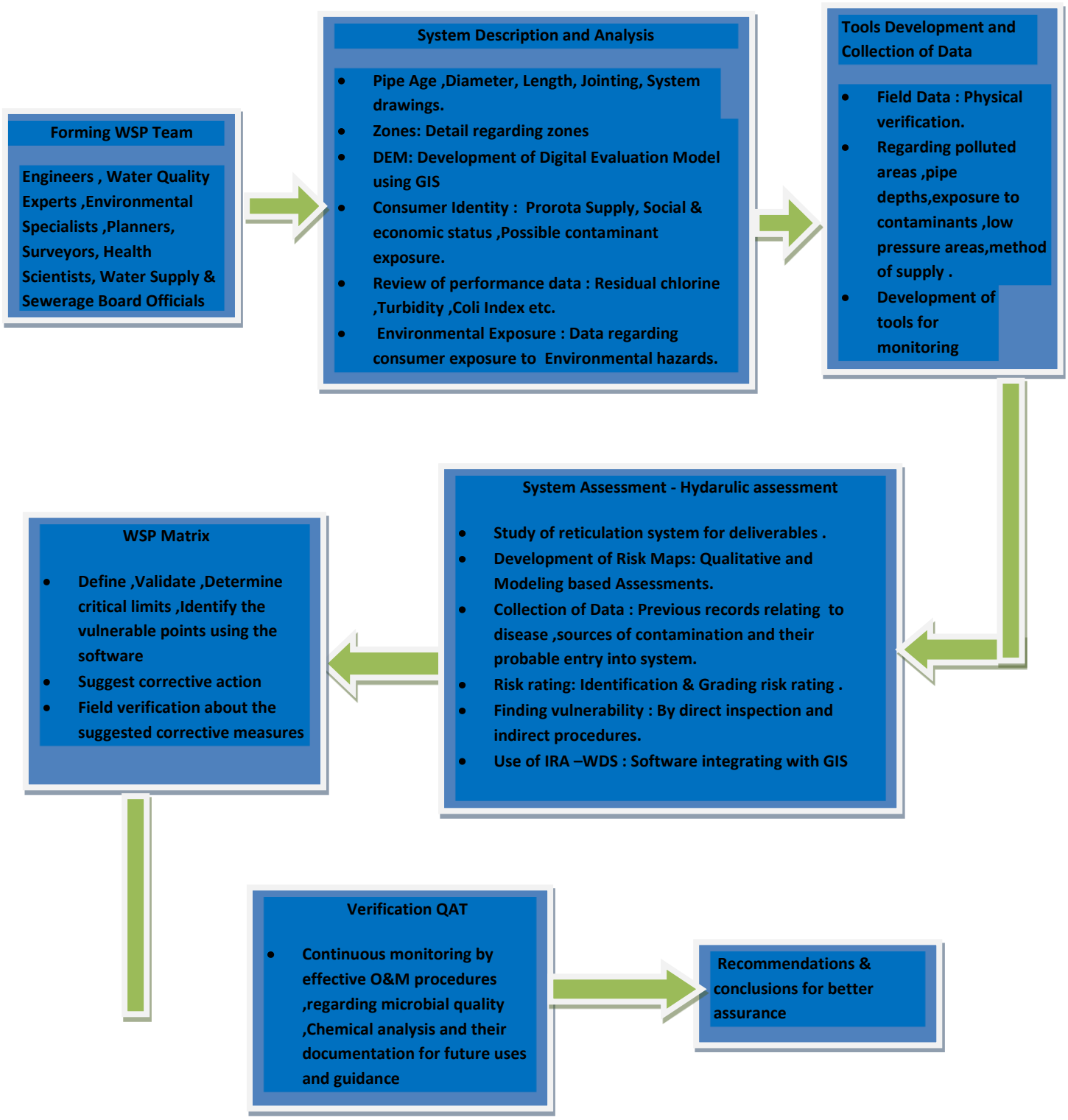


Figure 5-1 Methodology for WSP Model

5.3. Water Audit & District Metering Area to reduce NRW

Water audit is an important management tool for effective conservation of water. Water auditing provides an effective means of managing water system operations and essential data for system performance studies, facility planning, and the evaluation of conservation measures. Water audits evaluate the effectiveness of metering and meter reading systems, as well as billing, accounting, and loss control programs. Metering consumption of all water services provides a basis for assessing users equitably and encourages the efficient use of water. Water audit presents a detail picture of the quantum of water distributed and where in the system the water is lost.

5.3.1. Implementing Water Audit

- A separate cell may be constituted to conduct Water Audit
- Form District Metered Area by suitably dividing each distribution zones in to number of small areas, which are hydraulically separated and provide flow meters in each area at entrance points and pressures gauges at strategic points
- Continuously monitor the flows & pressures by installing data loggers
- Conduct Water Audit annually, using the free software by AWWA,
- Compile the water Audit on annual Basis
- Use the Water Audit findings to guide the loss control strategy to contain effectively the NRW

5.3.2. Controlling Real Losses:

- Arrest visible leakages in valves/pipes joints/pumps
- Conduct leak detection test to locate non-visible leakages in the pipe lines/distribution system by forming District Metering Area (DMA) and take remedial measures to plug the leakages
- Rehabilitation and replacement of pipes which has served its life
- Provide public taps, wherever essentially necessary
- Implement Automated Water Reading (AMR)

5.3.3. Controlling Apparent Losses:

- Customers meters must be calibrated at regular interval for accuracy
- Attend immediately the repaired/non-functional meters
- Remove all unauthorized connections in the pumping/feeder mains feeding the WDSs
- All unauthorized connections in the distribution system must be removed

- All motorized connection in the distribution system for sucking water shall be identified and removed.

Detailed procedure for conducting energy audit is presented so as to reduce the energy cost in water supply sector, especially the pumping plants.

5.4. Public-private Partnership (PPP) proposals for O&M

The PPP structure for the project is a performance based management contract for integrated source to tap water supply management for the Chennai City. The suggested project contracting structure is detailed for WDS, distribution system and up to consumer metering system. This proposal is aimed at to improve not only the O&M aspect, but also the revenue of the CMWSSB. The proposals are shown the Chart below.

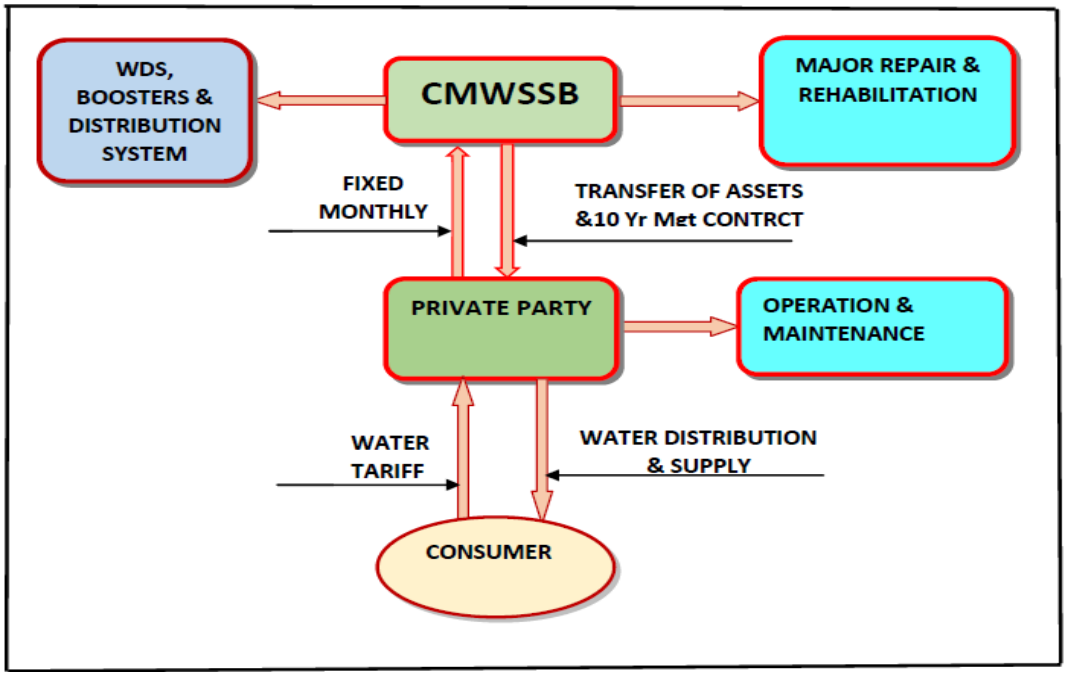


Figure 5-2 PPP structure

5.4.1. Instrumentation, Automation and SCADA in W.S.

5.4.1.1. Proposal for Instrumentation, Automation and SCADA System

Providing Instrumentation, Automation and SCADA system in water supply sector ensures:

- Optimum utilization of limited water resources by improving the efficiency of the water supply system and its equipment
- It helps in preventive maintenance and provides the accurate database for plant optimization
- It provides information on NRW
- It prevents theft of water
- It helps to improve Revenue
- Maintain quality and quantity of water

Details are prescribed in the main report.

5.5. Energy Audit

5.5.1. Conducting Energy Audit

Energy Audit is to reduce the cost towards the electricity bill. Energy usage and costs for maintenance of sewerage system are increasing due to many factors, including electricity regulations, treatment technology complexity, aging infrastructure, supply challenges, tariff revision, etc and growth. While Metrowater have begun to recognize the importance of containing and actually reducing energy consumption and costs, it would be advisable to follow the best options available to them to achieve the same are not fully implemented. The approach to energy audit would not be one of fault finding but the approach shall be to improve the system to be more energy-efficient.

5.5.1.1. Implementation for Energy Audit

As detailed in water supply sector for energy audit, the procedure recommended by Bureau of Energy Efficiency (BEE), International Finance Corporation (IFC) and Alliance to saving Energy may be adopted to reduce the energy cost at least by 20% to 30%.

5.5.1.2. Procedure for Energy Audit

The procedure shall include Collection of Baseline data, details of measurements to be done, analysing reasons for poor efficiency of the pumping system, Remedial measures and Energy Efficiency Recommendations.

It is strongly recommended that Metrowater may immediately arrange to call for tenders based on the BEE documents at least for all existing major relay sewage pumping stations (Category III) so as to reduce the power consumption and thus saving energy.

As for new pumping plants suggested for 2035 and 2050 year requirement, energy audit may be conducted as below as suggested by CPEEHO.

Large Installations	: Every year
Medium Installations	: Every two years
Small Installations	: Every three years

5.5.2. Present O&M status of plants maintained by Private Parties.

5.5.2.1. Treatment Plants

The Treatment plants maintained by private parties who designed and executed the same are being well maintained and good condition, producing very good results. The main reasons for these successful operations are the following:

- Well trained and knowledgeable operators are being engaged for O&M.
- Routine and Preventive maintenance are regularly followed to keep the components in good condition
- Strict tender conditions with follow-up actions by Metro water

5.5.2.2. Sewage pumping plants

In case sewage pumping plants, it is just the opposite resulting in poor results. The main reasons are

- Qualified trained staff are not engaged by the private operators
- Even if qualified staff in education is engaged, they do not have required knowledge of the component's operation and maintenance due to lack of training.
- Required number of staff are not engaged as per agreement
- Preventive maintenance as per recommendation of manufacturers are not carried out regularly
- No history register of all equipment are maintained.

5.5.3. Instrumentation and SCADA in sewerage Sector

5.5.3.1. Instrumentation in Sewage sector and Automation &SCADA for Sewerage Sectors

It is suggested to implement the above in two phases as noted below.

- Phase-1 -Instrumentation & Automation of sewage pump stations and Sewage Treatment Plants
- Phase 2 - Providing SCADA system for data acquisition and monitoring all the units in entire sewerage sectors

5.5.3.2. Instrumentation in Sewage Pump stations

Flow meters shall be provided at the locations shown in the Figs. in all SPSs along with transmitters to have flow pattern in a day and also total quantum of sewage collected and delivered in the SPS.

5.5.3.3. Instrumentation in Sewage Treatment Plant

The following parameters shall be measured in a typical sewage treatment plant and the instruments along with transmitters shall be located at places shown in the fig.

i) Dissolved Oxygen for monitoring & Control
ii) Total Suspended solids for monitoring & Control
iii) Interface Analysers

5.5.3.4. Automation & SCADA

The whole process is automated using SCADA system to improve operation efficiency and effluent quality. Three major components of SCADA system are:

a) PCs—Personal Computers run operator interface software. PCs provide a graphical view of the process to the operator, which enables him to monitor and control the process. Computers display historical data for analysis at any time.
b) PLCs –Programmable Logic Controllers that runs a ladder logic program. They control the outputs based on the inputs being monitored, in the desired sequence. PLC also communicates with other computers.
c) Radio modem or Telephone modem is used to communicate from the plant to the remote site. This system is more reliable and faster than the old telemetry system.

Three important benefits offered by SCADA systems at the wastewater treatment plants are:

(i) Centralised management and control – It enables the operator to control, monitor and receive information from both on-site and off-site facilities. The operator therefore has complete real-time and historical data to take the corrective action remotely.

(ii) Decision-support information-- This tool replaces recorders with trend charts, annunciates with alarm screens and indicators with graphs. This information attempts to produce reports and records, in addition to real time and historical

data. The automated generation of reports also saves significant time and is helpful to those responsible for plant operations, municipal officials and consulting engineers.

(iii) Enhanced reliability through solid- state electronics-- PLC functionally takes the place of relays, timers, process controllers and other devices. The PC also takes the place of switches, lights and displays.

Therefore, fewer components are required to run the operations. Longer-life equipment and fewer components enhance reliability.

5.6. Implementation plan for instrumentation/automation in W.S & sewerage sectors

It is suggested to implement the system in two phases. Phase- 1is planning for providing instrumentation and telemetry system in the water supply sector as detailed below to achieve the above goals. Phase 2 is planning for providing instrumentation in sewerage sector and automation in water supply and sewerage sectors with SCADA.

5.6.1. Phase 1- Instrumentation in Water Supply Sector

a. Instrumentation at raw water intake, WTP , CWPS and WDS & Booster stations

b. Instrumentation at all SPSs and STPs

c. Automatic Meter Reading (AMR) and transmitting system by providing 100% metering

d. Telemetry system to receive the data collected from the above units.

5.6.2. Phase 2- Instrumentation in Sewage sector and Automation &SCADA for WS & Sewerage Sectors

a. Automation of raw water intake, WTP , CWPS and WDS & Booster stations

b. Automation of sewage pump stations and Sewage Treatment Plants

c. Providing SCADA system for data acquisition and monitoring all the units in both the sectors.

5.7. Stakeholder Consultation Meeting

Stakeholder Consultation meeting for preparation of Master Plan of Chennai City and rest of CMA was held on 07.05.2015 at CMWSS Board conference hall, Chennai to seek consensus on a variety of issues that would go into preparation of Master Plan such as

vision for city and CMA and priorities for development. The deliberations of the meeting and the follow-up actions needed are narrated in this chapter.

5.8. Institutional Frame Work:

The development and optimization of the institutional framework in the water & Waste Water sector of the CMWSSB is essential for effective, output driven water quality monitoring.

The roles and responsibilities of each player are to be redefined and the same is emphasized for the generation of monitoring data's and information's also to the desired level of improvement in water supplies and waste water collection system. These are discussed in this chapter.

5.9. Financial Analysis

It is concluded with recommendations that:

- The pattern of the existing demand and supply of water suggests that current solutions are inadequate, despite the high financial and environmental costs being incurred.
- The present financials of CMWSSB are weak on account of a new increasing costs and static revenues. On the one hand the cost of supply of water is increasing on account of desalination plants and the new sources of water being located far away from the Chennai city. On the other hand, the revenues of CMWSSB are remaining static as the tariffs have not been revised for the past several years. The deficits are being met through grants and subsidies from the Government.
- Both the revenue grants and capital grants have increased several folds over the last 5 years, implying the increasing dependence of CMWSSB on Government for executing new capital works.
- As per the present statistics on operation & maintenance expenses, the cost of sourcing water from Desalination Plants is much higher than sourcing water from traditional sources. The cost of sourcing water from Desalination Plant is more than 10 times higher than the traditional sources. Reducing water loss through the piped water system and 100% metering must complement the impending technological approaches to improving the quantity of water available
- Considering the above, it would be advisable that the future water requirements of Chennai City and adjoining areas shall preferably be drawn, from distant sources, only after fully considering supplies available from augmentation of traditional

water sources like lakes, rivers, well fields and bore wells to the maximum extent possible.

5.10. Environmental and Social Impacts

Environmental and Social assessments of all the upgrading works and new works have been made in accordance with specification and guidelines provided. The details are discussed in these chapters.

6. RECOMMENDED PLAN

6.1. Recommended Plan for Water Supply

The existing quantum of water Supply currently made available to the Chennai City distribution system is inadequate to meet the demand within Chennai city presently due to inadequacy and non-reliability of the existing sources and hence, water supply has been restricted once in 2 days for 3 to 4 Hours of supply hours in the day of supply. The existing traditional sources are to be stabilised/strengthened for sustaining the present / designed supplies and new sources are to be identified for meeting the gap between the demand and supply in the horizon years. The water demand of added areas in Chennai city with about 5.5 million populations during 2050, is also proposed to be met from the existing sources of Chennai city. Similarly, for the urbanising areas adjacent to the present city limit, (Rest of CMA) which are proposed to be served by the extension of existing water supply arrangement of Chennai city, the existing supplies are inadequate to meet the present and future demand and it is obvious therefore that until the quantity of supply through augmentation of sources is increased, the new service areas can't be provided with adequate water supply.

Unless significant efforts are made to improve the sources & their inflows into the existing Chennai water supply system is made it may be impractical to cope up with the Water Supply demand of Project area, in future years. The efforts shall include the following programmes on priority

1. Supply Management Programme

a) Persistent efforts with the Andhra Pradesh government to make available the committed and agreed quantum of water supply from the T.G. project. The Andhra Pradesh Government may be persuaded to disconnect/prevent illegal tapping's enroute T.G. canal and adopting modern water saving irrigation practices in the intervening adjacent areas. An interstate monitoring authority may be constituted for monitoring flows and Telugu –Ganga canal being an interstate canal, may be declared as a National drinking water supply canal and the right of all states involved may be got protected through appropriate legislative safeguards.

b) The dedicated transmission main from Kandaleru resevoir to Poondi through pipeline along the right of corridor of existing KP canal is proposed to avoid fill farrage of water and transmission losses.

c) Immediate efforts to implement the new fresh water augmentation proposals including Desalination projects be taken up on priority. A water importation scheme utilizing Cauvery Water from Mettur, about 700 Mld (9.0 TMC) and 80 Mld from river Coleron should be implemented.

2. Lake Management Programme :

Immediate steps should be taken for restoration of urban lakes and their supply channels from encroachments & misuse / pollution etc by appropriate revival and rehabilitation methodologies and these revived lakes may be used for enhancing water supplies through ground water recharge, in the surrounding areas. These lakes will also facilitate water storage during rainy seasons through appropriate storm water harvesting of the nearby river/canal courses, abandoned quarries, and reclaimed water from STPs. The basin receives sufficient rainfall, but all that water cannot be stored at present. However, opportunities exist for improving storage of rainwater, renovated temple tanks and cleaning waterways. All of these can contribute to improving ground water recharge.

A lake conservator may be appointed in CMWSSB/ PWD to protect all the lakes within CMA and to exploit them for domestic / non-domestic water uses.

3. Catchment management programme:

The Protection of water spread areas of Chennai lakes catchment area by preventing pollution of water inflows, indiscriminate disposal of solid waste and debris, rehabilitation and improvisation of Supply channels so as to facilitate receipt of more water from the catchment as well as chain of other tanks.

4. Initiating awareness programme amongst the residents of Chennai City and rest of CMA on Water conservation efforts and use of recycled water at domestic house hold level.

5. Leak Detection Programme:

Optimisation of distribution main with focus on conservation of existing water supplies through metering and leak detection programmes in Chennai city and the rest of CMA.

6. Recycling and Reuse programme:

The industrial waste water reclamation scheme to supply water to industries in the Manali Area, Thirumazlisai and Sriperumbuthur area must be implemented. This will reduce the fresh water demand and serve as a low cost option for augmenting water supplies. Treated waste water may be supplied to the parks maintained by

the Corporation educational institutions / Golf courses/ racing clubs etc. for landscaping / gardening purposes for meeting 50% of their total requirements.

7. Storm Water Harvesting Programme

Investigate the feasibility of developing a storm water harvesting methodology to provide augmentation of drinking water supply to meet the growing water demands of Chennai, by installing package type waste recycling plants at the final collection/ disposal points.

8. Ground Water Management Programme

- There is ample scope for widened ground water recharge through construction of check dams in the Arniar, Kosasthaliar, Cooum and Adyar river systems and provisions of percolation ponds in suitable lake beds.
- The ground water aquifers in North Madras. South Madras are to be rejuvenated and revitalized by natural recharging measures through appropriate catchment development and by artificial recharging by fresh water/ treated waste water from pumped storages in constructed wetlands in the catchment zones. Controlled extraction measures have to be streamlined and guidelines for the same have to be developed.
- Revival of existing spot sources.
- Development of mini-power pump schemes using ground water.
- Regular and periodical monitoring of quality of ground water and ground water levels.

9. Water Conservation Awareness Programme

Initiating awareness programme amongst the residents of Chennai City and rest of CMA on Water conservation efforts and use of recycled water at domestic household level, with dual plumbing systems in buildings.

- This awareness programme should be followed up by an action programme for water conservation methods through pricing, incentives and water recycling should be effectively promoted rather than aiming at 100% meeting of the total requirement of the city from the existing sources/proposed sources from far distant locations.
- Comprehensive regulations for ground water extractions @ domestic level

10. Asset Enhancement / Improvisation Programme

- Installation of virtual ring main system to compensate the need of deficiency of any source in the system.

- Up gradation of water treatment plants, pumping stations, plants and equipment's and pumping machineries etc…
- Replacement of old mains / unserviceable transmission mains.
- Optimization of distribution main with its strong orientation towards conservation of existing water supplies through metering and leak detection programmers in Chennai City and rest of CMA.
- Dispensing the existing arrangement of providing tapping arrangements to the newly added areas and rest of CMA from dedicated transmission main of Chennai city. A group sump at every tapping point should be provided.

11. Storage Facilities : Underground Sump/Overhead Tanks

It is recommended to propose ESR (Elevated Service Reservoir) at all zones where there are no ESR are available, to maintain constant water pressure in the D system and to maintain equable distribution of water in all areas. The proposed ad ditional / new ESRs for Chennai city 207.5 ml.

12. NRW & District Metering Area

In the core city area, there are 16 water supply zones with 18 WDSs, covering 7 Nos. of administrative Area. These water supply zones shall be divided into 80 sub-zones for monitoring the leakage reduction programme.

District Metering Area

Establishing a series of DMAs not only targets NRW reduction but it also improves asset condition and customer service.

The water meter will be insists

In Phase – I: The water service connections of commercial establishments, Industrial & institutions will be insisting to provide water meter for accountability.

In Phase-II: For domestic service connection, water meter will be provided in all HSC connection under phased manner.

13. DROUGHT MANAGEMENT PROGRAMME

- Periodic / Regular Replacement of ground water aquifers by natural / induced recharge thro lakes / canals / aquifers using storm water / rain waste water.

- Rejuvenation of river regimes of Cooum / Adyar to supplement ground water replenishment of recharge.
- Artificial recharge of ground water using heated waste water through bore wells in the banks of Buckingam canal to mitigate effects of sea water information.
- Artificial recharge of ground water using heated waste water through basins / ponds on the banks of Bunckingam canal near marsh lands.
- Rejuvenation of revival of spot sources (Hand pumps / Solar operated mini pumps etc…)
- Implementation of water restrictions.
- Reduction of fresh water supplies to Industries Commercial Establishments / Hotel / Offices etc…
- Opening of water booths in Parks / Playgrounds.
- Conveyance of water through Lorries from and to the identified spots and appropriate traffic regulations in those areas.
- Operation & maintenance of solar based brakish water desal plants in select locations to feed mini OHTs / HDPE Tanks.

14. Dispensing with the existing arrangement of providing tapping arrangements to the newly added areas and rest of CMA from dedicated transmission main of Chennai city. A group sump at every tapping point should be provided.

15. Implementing pilot projects on dual water supply in residential houses and in select areas adjacent to the location of tertiary treatment plants of the Waste treatment system.

16. Extending the existing rainwater harvesting programme by improved O&M methodologies and through new techniques for large industrial/institutional premises and by framing appropriate regulations for fresh water use by these institutions.

6.2. Recommended Plan for Wastewater System

The recommended plan for waste water management system envisages the following major components:

1) Collection System :

i. The un-sewered areas of expanded city/left over portion of the core city will be provided with a sewer system.

ii. Rehabilitation and replacement of dilapidated sewer mains and manholes will be taken up as immediate works.

2) Treatment Plants

i) The collection system within the core city limit will be retained with the same general drainage orientation (ie five major sewerage zones flowing to five existing STPs.)

ii) Whenever necessary, depending upon location of the outfalls, convenient subzones will be demarcated for the saturated zones and package type mini STPs will be located. The areas of the expanded city also will be drained into this existing STPs by increasing the capacity of treatment plants either by allowable new additions in the same premises or by a change to modern process design without additional land requirement.

3) Pumping Stations

i. Priority will be given to upgrading the existing pumping stations and an intensive maintenance programme will be stressed, aimed at periodical cleaning and restoring the existing gravity collection system including manholes.

4) Recycling and reuse programme

i. The Industrial waste water reclamation scheme to supply treated waste water to industries in the Manali area, Thirumazlisai, Sriperumbudur and other industrial layout area must be implemented. This reduces the fresh water demand and represents the low cost option for augmenting water supplies to the industries.

ii. Treated waste water may be supplied to all parks maintained by the Chennai Corporation/other educational institutions/Golf courses/Racing Clubs etc. for landscaping/gardening purposes for meeting 50% of their total requirements.

i. Implementing pilot water supply projects on dual water supply in residential houses in areas adjacent to the location of tertiary treatment plants of the Waste treatment systems.

5) Sludge management plan

The Quantity of Sludge generation from the existing as well as proposed STP has been assessed and it will be disposed for revenue generation after treatment.

7. PROPOSED PHASING OF PROJECT

Within the frame work of the forgoing recommendations and existing financial constraints, the project proposals have been delineated into three Phases as follows:

PHASE I (IMMEDIATE)

a.) Water Sector:

1. Construction of Additional Desalination Plants at Nemmeli-150MLD (Stage I).
2. Development of other potential Surface water sources around CMA -Provision of Strom water/rainwater harvesting
3. Linking of existing Transmission mains to formulate Ring Main
4. Construction of Additional Water Treatment Plants -160MLD
5. Rehabilitation of pump rooms in the existing Redhills and Kilpauk WTPs
6. Rehabilitation of pump room in the Existing WDS.
7. Providing distribution mains in the expanded city and rest of CMA.
8. Improvements to the Catchment Areas of Existing reservoirs via removing the encroachments if any, strengthening the water ways.

b.) Sewerage Sector:

1. Rehabilitation/Replacement of Existing sewer mains
2. Rehabilitation/Replacement of Transmission Mains & Gravity Trunk Mains
3. Rehabilitation of existing Sub Pumping Stations
4. Pumping Plants-
    - Replacing existing sewage pumps including electrical accessories under Category-I
    - Providing grit pumps with accessories in all SPSs
    - providing/replacing sluice gates & Screens at inlet in SPSs
    - Refurbishing the civil structures in all SPSs.

PHASE-II

a) Water Supply System:

i. Augmentation of existing sources/restoration and rehabilitation.

ii. Augmentation of fresh water projects.

a. The Conveyance of water from the distant source ie, from Mettur Reservoir should be implemented as early as possible, on priority, since this may take a longer implementation, period and as the relief expected from this project will be considerable. (Stage-I -350 MLD)

b. Construction of Additional Desalination Projects at Nemmeli 200 MLD(Stage-II).
c. Drawal of sub-surface water from Cauvery River and conveyance upto Vadakuthu and Carrying Intake arrangements.

iii. Augmenting supply from T.G. Ganga project by 530 Mld. Appropriate legislations for Joint patrolling the T.G canal to prevent illegal tapping, giving preference to drinking water supply and adoption of water saving measures in the irrigation ayacuts in AP reaches are some measures to be suggested to the AP Government.
iv. Construction of Additional Water Treatment Plant -200 MLD Capacity.
v. Providing Infrastructure for DMA to check water losses.
vi. Construction of elevated service reservoirs in the WDSs inside the core city area, as recommended in the previous Master plans to effect the water supply with adequate pressure head in the distribution mains. Supply through the ESR only may be implemented.
vii. Modification of existing transmission main and interlinking of mains to form a ring main system to facilitate flow of water from one system to other system, if one source of water becomes inadequate or fails.
viii. Strengthening & stabilising the existing RWH programme & implementing modified RWH programme.

b) Sewerage System

i. Providing sewage pumping stations inside the core city not covered under a immediate works programme and construction of new pumping stations, force mains, and provision / up gradation of treatment plants to added areas and rest of CMA.
ii. Construction of Tertiary Treatment Plant and provisions for Dual water supply system.

PHASE-III

a. Water Supply System:

i. Augmentation of fresh water projects.
a. The Conveyance of water from the distant source ie, from Mettur Reservoir should be implemented as early as possible, on priority, since this may take a longer implementation, period and as the relief expected from this project will be considerable. (Stage-II -350 MLD)

b. Construction of Additional Desalination Plants at Nemmeli-200MLD (Stage III).

i. Construction of Additional Water Treatment Plant -160 MLD Capacity
ii. Providing Infrastructure for DMA to check water losses.
iii. Replacement of the existing PSC transmission main and feeder mains.
iv. Implementation of Water Management plants.

b) Sewerage System

- Sewage collection system in un-sewered areas of Added Areas of city and rest of CMA shall be implemented.
- Construction of Sewage Treatment Plants (STPs) for Unsewered Area.

PHASE-IV

a.) Water Supply System:

i. Construction of Additional Water Treatment Plant-400 MLD.

b.) Sewerage System

i. Rehabilitation & replacement of dilapidated sewer systems.
ii. Up gradation of treatment plants to tertiary /quaternary plants.

The estimated capital costs and phasing of projects are summarised in the Tables below:

BLOCK COST ESTIMATE -WATER SECTOR

Table 7-1 Master plan for Chennai city & Chennai metropolitan area

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II (2020-30)	Phase III (2030- 40)	Phase IV (2040-50)
1	**Source Augmentation**						
1a)	Surface Water - To bring Mettur water to Chennai (As per separate estimate)	700 Mld	57580.00		30000.00	27580.00	
1c)	Construction of Additional Desalination Plants at Nemmeli	550 Mld	41250.00	11250.00	15000.00	15000.00	
1d)	Telugu Ganga conveyance of water through closed conduit (2 rows of pipeline) from kandelaru to poondi		46671.00		46671.00		
1e)	Provision for Rainwater Harvesting / Strom Water Harvesting	L.S	500.00	500.00			
1f)	Augmentation of Chennai City water supply- drawal of sub-surface water from Cauvery River and conveyed up to Vadakuthu during depletion of Veeranam Lake .2025-30		6810.00		6810.00		
1g)	Interconnection between exisitng mains to from Ring Main	L.S	100.00	100.00			
2)	**WATER TREATMENT PLANT-** Construction of proposed **WTPs** including all electro-mechanical components	920 Mld	3220.00	560.00	700.00	560.00	1400.00
3	**Pumping Plants** including cost of pumpsets, construction of pumphouse, electrical & mechanical works etc. for WTPs, Conveying Mains and Feeder Mains (Details as per Annexure 12.6)						
3a)	Replacement of exising Raw water Pumps in WTPs including electrical accessories complete		1180.80		1180.80		
3b)	Replacement of exising Treated water Pumps in WTPs including electrical accessories etc complete		476.19		476.19		
3c)	New Raw Water Pumps at Proposed WTPs including		489.99		183.06	306.93	

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II (2020-30)	Phase III (2030- 40)	Phase IV (2040-50)
	electrical accessories, pump room etc complete						
3d)	New Treated Water Pumps at Proposed WTPs including electrical accessories, pump room etc complete		506.09		177.53	328.57	
3e)	Replacement of existing pumps in WDSs including electrical accessories etc complete		832.33		832.33		
3f)	Replacement of existing pumps in Booster stations & sub-WDSs in core area including electrical accessories complete		40.00		40.00		
3g)	New pumps at Group sumps in CMA including electrical accessories, pump room etc complete		1242.93		1242.93		
3h)	Rehabilitation of pump rooms in the existing Redhills and Kilpuak WTPs		9.00	9.00			
3i)	Rehabilitation of pump rooms in the existing WDS's		27.00	27.00			
3j)	Water Audit for Chennai Core area including forming DMA, 100% metering etc complete		785.00		523.33	261.67	
3k)	Water Audit for 42 local bodies added to Chennai city including forming DMA, 100% metering etc complete		537.00		358.00	179.00	
3l)	Instrumentation, SCADA		180.00		30.00	150.00	
4	Supplying, laying, jointing and testing of Conveying Mains, Feeder Mains & Branch Mains including the cost of Fittings, Fixtures, Appurtenances and other accessories						
4a)	**Conveying Mains** using MS Pipes (Qty as per Appendix 10.20)						
	Diameter of pipes ranging from 800mm to 2200mm	42500 m	1294.35		592.11	702.24	
4b)	**Feeder Mains** using MS pipes (Qty as per Appendix 10.23)						
	Diameter of pipes ranging from 300mm to 2000mm	233895 m	7426.57		4258.72	3167.84	
4c)	**Branch Mains** (Qty as per Appendix 10.24)						
	i) DI Pipes						
	Diameter of pipes ranging from 200mm to 400mm	62000 m	296.99	118.80	178.20		

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II (2020-30)	Phase III (2030- 40)	Phase IV (2040-50)
	ii) MS Pipes						
	Diameter of pipes ranging from 500mm to 1300mm	89380 m	1201.20	480.48	720.72		
5	Construction of **Sump** using RCC M30 grade of Concrete including the cost of reinforcement, cantering, shuttering etc. (Details as per Appendix10.10)	930 LL	464.75		464.75		
6	Construction of **Service Reservoirs** using RCC M30 grade of Concrete including the cost of reinforcement, cantering, shuttering etc.	537 LL	988.08		988.08		
7	Supplying, laying, jointing and testing of **Distribution Mains** including the cost of Fittings, Fixtures, Appurtenances and other accessories (upto 200mm dia HDPE Pipe and above 200mm dia DI pipes)						
7a)	Core Area Existing Distribution Mains	1860883 m					
	Optimization of Distribution Mains including Replacement/Rehabilitation of Existing length of mains Diameter of pipes ranging from 150mm to 400mm	558266 m	1107.46	1107.46			
	Proposed Distribution Mains for the leftout length Diameter of pipes ranging from 150mm to 400mm	980994 m	1692.21		1692.21		
7b)	Added Area Existing Pipeline	2270358 m					
	Optimization of Distribution Mains including Replacement/Rehabilitation of Existing length of mains Diameter of pipes ranging from 150mm to 350mm	681107 m	1155.33	1155.33			
	Proposed Distribution Mains for the leftout length Diameter of pipes ranging from 150mm to 350mm	733632 m	1082.11		1082.11		
7c)	Rest of CMA Area	4850000 m					
	Proposed Distribution Mains for rest of CMA area Diameter of pipes ranging from 150mm to 350mm	4850000 m	7153.75		7153.75		
8	Pilot Project for use of Recycle water for Non-Domestic purpose	L.S	1000.00		1000.00		

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II (2020-30)	Phase III (2030- 40)	Phase IV (2040-50)
9	Improvements to the Catchment Areas of Existing reservoirs via removing the encroachments if any, strengthening the water ways		1000.00	1000.00			
10	Water Management Plan	L.S	500.00			500.00	
	Sub Total		**188800.15**	**16308.07**	**122355.83**	**48736.25**	**1400.00**
11	Price Contingencies @10%		18880.02	1630.81	12235.58	4873.63	140.00
12	Physical Contingencies @ 3%		5664.00	489.24	3670.68	1462.09	42.00
13	Supervision Charges @ 5%		9440.01	815.40	6117.79	2436.81	70.00
	Total Cost in Millions		**222784.18**	**19243.52**	**144379.88**	**57508.78**	**1652.00**
	Total Cost in Crores		**22278.00**	**1924.00**	**14438.00**	**5751.00**	**165.00**

Incremental Cost per year @ 16% of Base year cost

BLOCK COST ESTIMATE - SEWERAGE SECTOR

Table 7-2 Master plan for Chennai city & Chennai metropolitan area

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II	Phase III	Phase IV
1	Supplying, laying, jointing and testing of **Sewer Mains** including the cost of jointing materials and other accessories						
1a)	Core Area Existing Sewer Mains	1765100.0 m					
	Replacement/Rehabilitation Required @30% of Existing length of mains Diameter of pipes ranging from 200mm to 1100mm	529530 m	2866.35	2866.35			
	Proposed Sewer Mains for the leftout length Diameter of pipes ranging from 200mm to 1100mm	1023429 m	5539.82		5539.82		
1b)	Proposed Sewer Mains for the leftout length of Added Area Diameter of pipes ranging from 200mm to 1000mm	1460990 m	6533.55		6533.55		
1c)	Proposed Sewer Mains for the Rest of CMA area Diameter of pipes ranging from 200mm to 1000mm	4850000 m	16766.45			16766.45	
1d)	Add 30% cost for construction of Manholes		9511.85	859.90	3622.01	5029.94	
1e)	Add 25% cost for laying of mains in different depths		7926.54	716.59	3018.34	4191.61	
2	Supplying, laying, jointing and testing of **Transmission Mains & Gravity Trunk Mains** including the cost of jointing materials and other accessories	37800 m					
	Replacement/Rehabilitation Required @30% of Existing length of mains Diameter of pipes ranging from 200mm to 900mm	11340 m	140.92	140.92			
3	Rehabilitation of existing Sub Pumping Stations	226 Nos	678.00	678.00			
4	Construction of Proposed Sub Pumping Stations including the cost of pumping machinery, electrical and mechanical components etc.						

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II	Phase III	Phase IV
	For Added Area	150 Nos	825.00		825.00		
	For Rest of CMA Area	85 Nos	467.50			467.50	
5	Supplying, laying, jointing and testing of Pumping Mains using DI K9 pipes including the cost of Fittings, Fixtures, Appurtenances and other accessories Diameter of pipes ranging from 250mm to 900mm	750000 m	9635.25			9635.25	
6	**Pumping Plants** including cost of pumpsets, construction of pumphouse, electrical & mechanical works etc. for Sub Pumping Stations						
6a)	Replacing existing sewage pumps including electrical accessories under Category-I		4305.69	3.00	2870.46	1432.23	
6b)	Replacing existing sewage pumps including electrical accessories under Category-II		3286.21		1643.11	1643.11	
6c)	Replacing existing sewage pumps including electrical accessories under Category-III		2760.64		2760.64		
6d)	Providing grit pumps with accessories in all SPSs		147.50	147.50			
6e)	providing/replacing sluice gates & Screens at inlet in SPSs		86.60	86.60			
6f)	Refurbishing the civil structures in all SPSs		112.20	74.80	37.40		
7	Construction of proposed **STPs** including all electro-mechanical components. (Details vide separate sheet)						
	Expansion in existing STP	1118 mld	5981.78		2116.81	1623.65	2241.32
	New STP	598 mld	3416.71		986.22	941.75	1488.73
8	Construction of proposed Tertiary Treatment Plant including all electro-mechanical components	650 mld	1702.00		476.66	557.69	667.645
9	Miscellaneous items like Sewer Cleaning equipment, safety equipment, minor tool kits and other major equipment	L.S	500.00		250.00	500.00	
10	Construction of Tank within tank in selected Water Bodies	L.S	1000.00		1000.00		
11	Provision of Dual Water Supply System	L.S	1000.00		1000.00		
	Sub Total		**85190.56**	**5573.66**	**32680.02**	**42789.18**	**4397.71**
12	Price Contingencies @10%		8519.06	557.37	3268.00	4278.92	439.77

Sl. No	Description	Qty	Amount in Millions	Phasing of Project in Millions			
				Phase I (Immediate)	Phase II	Phase III	Phase IV
13	Physical Contingencies @ 3%		2555.72	167.21	980.40	1283.68	131.93
14	Supervision Charges @ 5%		4259.53	278.68	1634.00	2139.46	219.89
	Total Cost in Millions		**100524.8**	**6576.92**	**38562.4**	**50491.23**	**5189.29**
	Total Cost in Crores		**10052.00**	**658.00**	**3856.00**	**5049.00**	**519.00**

Incremental Cost per year @ 16% of Base year cost

8. FINANCIAL OPERATING PLAN FOR CMWSSB

8.1. New Water Supply Project

The proposed project cost has been arrived considering the requirements of Chennai Corporation, Expanded City Areas, nearby Municipalities, Town Panchayats and Village Panchayats up to Year 2050.

The capital costs include provision for water supply, sewerage and house service connections and the same works out as below:

`(Rs. In Crores)

Particulars	Phase I (Immediate) 2016-19	Phase II 2020-30	Phase III 2030-40	Phase IV 2040-50	Total
Water Supply	1924.00	14438.00	5751.00	165.00	22278.00
Sewerage	658.00	3856.00	5049.00	519.00	10082.00
Total	**2582.00**	**18294.00**	**10800.00**	**684.00**	**32360.00**

Thus the total project cost exclusive of price inflation and at current rates works out to Rs. 32360 crores.

The above cost includes price contingencies @ 10%, physical contingencies @ 3% and supervision charges @ 5%.

The Project Cost has been further split in to Chennai City including expanded area and rest of CMA for the purpose of financial analysis as given below:

(Rs. In Crores)

Particulars	Phase I (Immediate)	Phase II	Phase III	Phase IV	Total
Water Supply	***2016-19***	***2020-30***	***2030-40***	***2040-50***	
Chennai CMA	1298.07	8910.92	3282.66	87.64	13579.29
Rest of CMA	626.28	5527.07	2468.22	77.57	8699.13
Total	**1924.35**	**14437.99**	**5750.88**	**165.20**	**22278.42**
Sewerage	***2016-19***	***2020-30***	***2030-40***	***2040-50***	
Chennai CMA	443.65	2380.02	2882.09	275.28	5981.04
Rest of CMA	214.05	1476.22	2167.03	243.65	4100.95
Total	**657.69**	**3856.24**	**5049.12**	**518.93**	**10081.99**
Net Total	**2582.00**	**18294.00**	**10800.00**	**684.00**	**32360.00**

Thus the project cost of Chennai CMA alone works out to around 61% and the rest of CMA works out to 49%.

The water supply project cost as a % of total cost works out to 69% and the sewerage project cost works out to 31%.

8.2. Phasing of Project

The Project shall be executed in 4 phases comprising Phase I (Immediate-2016-19), Phase II (2020-30), Phase III (2030-40) and Phase IV (2040-50). Thus the implementation of the entire project cost would be completed in the year 2050.

The capital cost of the project on application of price inflation of 6% works out and furnished in the main report.

The costs are inclusive of 6% price inflation per annum.

Thus the total capital cost of the project inclusive of 6% p.a. price inflation works out to Rs. 77373.23 crores

The phasing of the project has been carried out by considering the various priority requirements.

The water supply project after price escalation works out to 64% of total cost and sewerage cost after price escalation works out 36% of total cost.

8.3. Capacity Added by the Project

The project shall result in increasing the water supply capacity of CMWSSB by around 2500 MLD per day or 912500 ML per annum.

The project will aim to provide 24 x 7 supply to households, commercial and institutional consumers. It will not only provide water of high quality but will also provide increased supply to consumers whose consumption is expected to increase.

Considering the fact that around 15% of the water supply would be unaccounted water, the chargeable water works out 775625 ML per annum @ 85%.

It is assumed that the CMWSSB would strive to reduce the unaccounted water over a period of years. But the same has not been factored in the financial projections.

8.4. Operation & maintenance costs

Operation & Maintenance costs are directly related to the level of production, and hence have been increased in line with the level of production.

The present operation & maintenance charges works out to Rs. 354 crores per annum as given below and the same are assumed to increase @ 6% per annum:

Existing Operation & Maintenance Expenses	Rs. In Crores
Water Supply	230.10
Sewerage	123.90
Total	**354.00**

The additional operation & maintenance expenses on account of the implementation of the proposed capital works has been determined and the same shall be as below :

(Rs. In Crores)

Details	Year 2035	Year 2050
Salaries & Payment to DSP	535.43	785.08
Power & Fuel	80.01	101.64
Consumables	2.81	391.88
Equipment Hire	0.07	0.07
Maintenance	56.85	54.78
Total Annual O&M Costs	**675.17**	**1333.45**

The breakup of Operation & Maintenance Costs in to Water Supply and Sewerage is as below:

Breakup :	Year 2035	Year 2050
Water Supply	392.49	953.16
Sewerage	282.68	380.29
Total	**675.17**	**1333.45**

The Operation & Maintenance Cost has been further split in to Chennai City including expanded area and rest of CMA for the purpose of financial analysis as given below:

Rs. In Crores)

	Year 2035			Year 2050		
Particulars	**Chennai City**	**Rest of CMA**	**Total**	**Chennai City**	**Rest of CMA**	**Total**
Water Supply	235.49	156.99	392.48	514.71	438.46	953.17
Sewerage	169.61	113.07	282.68	205.36	174.93	380.29
Net Total	**405.10**	**270.07**	**675.17**	**720.07**	**613.39**	**1333.46**

It is assumed that the additional operation & maintenance expenses shall also increase @ 6% per annum.

The operation & maintenance costs after completion of water supply improvement project over the next 50 years has been estimated and furnished in main report

8.5. Breakeven tariff

The breakeven cost of the project for the purpose of ascertaining the proposed tariff, works out as below:

S. No	Particulars	2035	2050	Increase
1	***O&M Expenses of Water Supply***			
	Chennai City and Added Areas	Rs. 672.17 crs	Rs. 3520.94 crs	Rs. 2848.77 crs
	Rest of CMA	Rs. 448.11 crs	Rs. 2999.30 crs	Rs. 2551.19 crs
2	***Total No. of Connections***			
	Chennai City and Added Areas	13,77,000	16,45,950	268,950
	Rest of CMA	9,45,150	14,56,650	5,11,500
3	***Break Even Tariff (Fixed Tariff per Month)***			
	Chennai City and Added Areas	406.78	1782.63	10.35% p.a.
	Rest of CMA	395.10	1715.87	10.29% p.a.
4	***Total Water Consumed (MLD)***			
	Chennai City and Added Areas	1480.00 MLD	1894.00 MLD	414.00 MLD
	Rest of CMA	715.00 MLD	1364.00 MLD	649.00 MLD
5	***Break Even Tariff (Rs. per MLD)***			
	Chennai City and Added Areas	4.54	18.59	9.85% p.a.
	Rest of CMA	6.27	21.99	8.73% p.a.

Thus the Break Even Fixed Tariff per month works out to around Rs. 400/- per month and based on volume consumed works out to Rs. 5/- per month for the year 2035.

But the break even tariff increases by around 10% p.a. with the increase in operation & maintenance expenses.

8.6. Proposed Tariff

Based on the Break Even Tariff calculations, it is proposed that the existing water tariff shall be revised as below for the Chennai Corporation and Added Areas to make the project viable:

a) Scenario I - Single Fixed Tariff

Category	Rs. Per Month
Domestic	Rs. 250/- per Month
Industrial	Rs. 2500/- per Month
Commercial	Rs. 1500/- per Month

b) Scenario II - Fixed Slab Rates

Category	Rs. Per Month
Domestic	
Up to 500 Sq.Ft	Rs. 100/- per Month
500 - 1200 Sq.Ft	Rs. 200/- per Month
1200 - 2400 Sq.Ft	Rs. 300/- per Month
> 2400 Sq.Ft	Rs. 500/- per Month
Industrial	
Up to 10000 Sq.Ft	Rs. 1000/- per Month
10000 to 25000 Sq.Ft	Rs. 3000/- per Month
> 25000 Sq.Ft	Rs. 10000/- per Month
Commercial	
Up to 1000 Sq.Ft	Rs. 500/- per Month
1000 - 5000 Sq.Ft	Rs. 1500/- per Month
> 5000 Sq.Ft	Rs. 5000/- per Month

c) Scenario III - Water Tariff based on Consumption

(Rs. / KL)

S.No	Consumption (L)	Existing Tariff	Existing Delhi Water Tariff	Proposed Water Tariff
I	**Domestic**			
1.	Up to 10000	2.50	2.50	4.00
2.	10001 to 15000	10.00	4.00	10.00
3.	15001 to 25000	15.00	20.00	15.00
4.	> 25000	25.00	33.50	30.00
II	**Industrial**			
1.	Up to 15000	Rate ranges	13.31	20.00
2.	15001 to 40000	Between	66.55	50.00
3.	40001 to 100000	Rs. 20 per KL to	106.48	75.00
4.	> 100000	Rs. 80 per KL	133.10	150.00
III	**Commercial**			
1.	Up to 15000	Rate ranges	13.31	12.00
2.	15001 to 40000	Between	66.55	30.00
3.	40001 to 100000	Rs. 20 per KL to	106.48	45.00
4.	> 100000	Rs. 80 per KL	133.10	90.00

The sewerage charges shall be 33% of the water tariff collected.

The Water Tariffs under all the 3 scenarios shall be increased @ 15% every 3 years. Besides, the following connection charges shall be collected under all the 3 scenarios:

The above water tariffs have been arrived based on the Break Even Tariff for recovery of operation & maintenance expenses, 30% of capital cost and interest cost on 30% of capital cost.

8.7. Water tariff for dedicated lines

At present CMWSSB provides dedicated water supply to large residential communities, commercial complexes and industries. The same constitutes around 5-7% of the total water supply. The water tariff levied for the dedicated water supply lines is Rs. 60/- per KL.

It is assumed that CMWSSB shall continue provide such dedicated water supply facilities at the same tariff. The water tariff shall be increased @ 15% every 3 years.

8.8. Connection charges

At present CMWSSB levies connection charges of Rs. 7500/- per connection for water supply and Sewerage.

It is assumed that the above connection charges shall stand revised as below:

New Water Connection Charges

New Water Connection Charges shall be levied @ Rs. 10000/- per connection for Domestic consumers, Rs. 20000/- per connection for industrial consumers and Rs. 15000/- per connection for commercial consumers with 5% hike every 3 years.

New Sewer Connection Charges

New Sewer Connection Charges shall also be levied @ Rs. 10000/- per connection for Domestic consumers, Rs. 20000/- per connection for industrial consumers and Rs. 15000/- per connection for commercial consumers with 5% hike every 3 years.

8.9. Proposed tariff for rest of CMA

CMWSSB supplies bulk water to rest of CMA, but the collection of user charges from the end consumers is the responsibility and income of the concerned urban local body. So CMWSSB shall collect bulk water supply charges from the concerned urban local bodies for the quantum of water supplied to them.

Presently, CMWSSB charges Rs. 26/- per KL of bulk water supplied to rest of CMA, with provision to increase the same @ 8% per annum.

New Tirupur Area Development Corporation Limited (NTADCL) a specialized body formed for the purpose of water supply to Tirupur and nearby towns / villages presently supplies water to the local bodies at the following rates:

Particulars	Rs. Per KL
Tirupur Corporation and nearby Village Panchayats	Rs. 10.65/- per KL
Industries	Rs. 78.50/- per KL

The rates charged by NTADCL are based on the Agreement entered with Tirupur Corporation and Government of Tamilnadu for recovery of operation & maintenance expenses and other overheads excluding finance charges and depreciation. As per the Agreement, the tariff is increased every year to recover the operating costs and other overheads.

Taking in to consideration the above information, CMWSSB shall also supply water to Rest of CMA @ Rs. 26/- per KL. The same shall be increased @ 15% every 3 years.

8.10. Water & sewerage taxes

Besides water & sewerage charges, CMWSSB also collects water & sewerage tax from the end consumers. The taxes collected are arrived as a % of Annual Rental Value of each house property.

Presently CMWSSB collects 7% of the Annual Rental Value (ARV) as water & sewerage taxes. The same is collected on half yearly basis @ 3.5% each.

The Annual Rental Value is arrived by the Chennai Corporation and the same varies with each area / location. Property Tax is collected by Chennai Corporation based on ARV.

CMWSSB does not have any say in the calculation of ARV. There is provision for increasing the % of water & sewerage taxes from the present 7% p.a. to 30% p.a. But any increase in taxes % would also require the approval of the State Government.

The present water & sewerage taxes aggregate to around Rs. 110 crores per annum and the same constitute around 40% of the water & sewerage charges collected.

It is assumed that the water & sewerage taxes shall be collected around the same lines and the same shall increase based on increase in population figures.

8.11. Project financing

We have assumed the project funding under three alternative Options as given below:

Alternative 1 - The project is expected to be financed fully by way of Grant. So no capital capital costs & interest cost has been taken in the financial projections. Only the operation & maintenance costs shall be recovered.

Alternative 2 – 30% of the Project Cost shall be funded by way of Loan carrying interest rate of 12% p.a. The Loan shall have moratorium of 5 years and repaid over the next 45 years. The balance 70% of the project cost shall be funded by way of Grant from Government. Accordingly 30% of Capital costs and interest costs are considered for recovery in the financial projections.

Alternative 3 – 30% of the Project Cost shall be funded by way of Loan carrying interest rate of 12% p.a. The Loan shall have moratorium of 5 years and repaid over the next 45 years. The balance 70% of the project cost shall be by way of Grant from Government. But the entire project costs (100%) and interest costs are considered for recovery in the financial projections.

8.12. Summary of financials

The Internal Rate of Return (IRR) of the Project has been calculated by considering the various cash inflows and cash outflows over the 50 year project horizon.

The cash inflows comprises the water and sewerage tariff charges collected, taxes collected from the consumers and new connection charges.

The cash outflows comprise the capital cost, operation & maintenance costs and interest costs over the 50 year project horizon.

We summarise below the IRR and cash flows under the 3 scenarios:

a) Scenario 1 – Single Fixed Tariff

	Option I	Option II	Option III
Particulars	Recovery of only O&M Cost	Recovery of 30% of Project Cost (Loan Component) and O&M Cost	Recovery of 100% of Project Cost & O&M Cost
IRR	>30%	14.55%	5.90%
Net Cash Flow	Rs. 165988.34 crores	Rs. 108520.05 crores	Rs. 54358.79 crores
NPV of Cash Flow	Rs. 29912.69crores	Rs. 12181.81 crores	(Rs. 10470.19 crores)

b) Scenario 2 – Fixed Slab Rates

	Option I	Option II	Option III
Particulars	Recovery of only O&M Cost	Recovery of 30% of Project Cost (Loan Component) and O&M Cost	Recovery of 100% of Project Cost & O&M Cost
IRR	>30%	13.82%	5.76%
Net Cash Flow	Rs. 160724.72 crores	Rs. 103256.42 crores	Rs. 49095.16 crores
NPV of Cash Flow	Rs. 29054.92 crores	Rs. 11324.04 crores	(Rs. 11327.96 crores)

c) Scenario 3 – Water Tariff based on consumption

	Option I	Option II	Option III
Particulars	Recovery of only O&M Cost	Recovery of 30% of Project Cost (Loan Component) and O&M Cost	Recovery of 100% of Project Cost & O&M Cost
IRR	> 30%	13.81%	5.92%
Net Cash Flow	Rs. 172264.23 crores	Rs. 114795.93 crores	Rs. 60634.67 crores
NPV of Cash Flow	Rs. 29821.13 crores	Rs. 12090.25 crores	(Rs. 10561.75 crores)

8.13. Conclusion

The IRR evaluation indicates that the proposed project cost is financially viable provided CMWSSB implements the tariff revisions on the lines considered. The entire project cost cannot be funded by way of borrowings.

The revised tariffs arrived under the 3 scenarios is able to recover only 30% of the project cost and interest besides the operation & maintenance expenses. Incase more than 30% of the project cost is funded by way of Borrowings, the tariffs may have to be increased accordingly.

Thus the Water Tariffs presumed above are for recovery of 100% of operation & maintenance costs, 30% of project cost and interest cost. For recovery of any expenses / costs beyond the same, the tariffs will have to correspondingly increased.

As the operation & maintenance costs are increasing @ 10% p.a., the water tariffs necessarily need to be increased minimum @ 15% every 3 years

So whichever method of tariff fixation is followed, CMWSSB should ideally target 15% increase in Water Tariff every 3 years to generate sufficient and adequate cash flows for recovery of its operation & maintenance expenses and borrowings.