# 13. URBAN BASIC SERVICES

This sub-section reviews the present status with regards to provision of urban basic services in Greater Mumbai area

## 13.1. Water Supply

### *13.1.1 Existing Situation*

The Hydraulic Engineering Department of MCGM is responsible for water supply in Greater Mumbai.

The population of Mumbai in the year has reached nearly 12 million with water supply requirement of around 3900 Million Liters per Day (MLD). At present the domestic, commercial, and industrial supply is catered to the tune of 3,100 MLD. Lakes are created by impounding rainwater by constructing dams across the rivers and valleys.

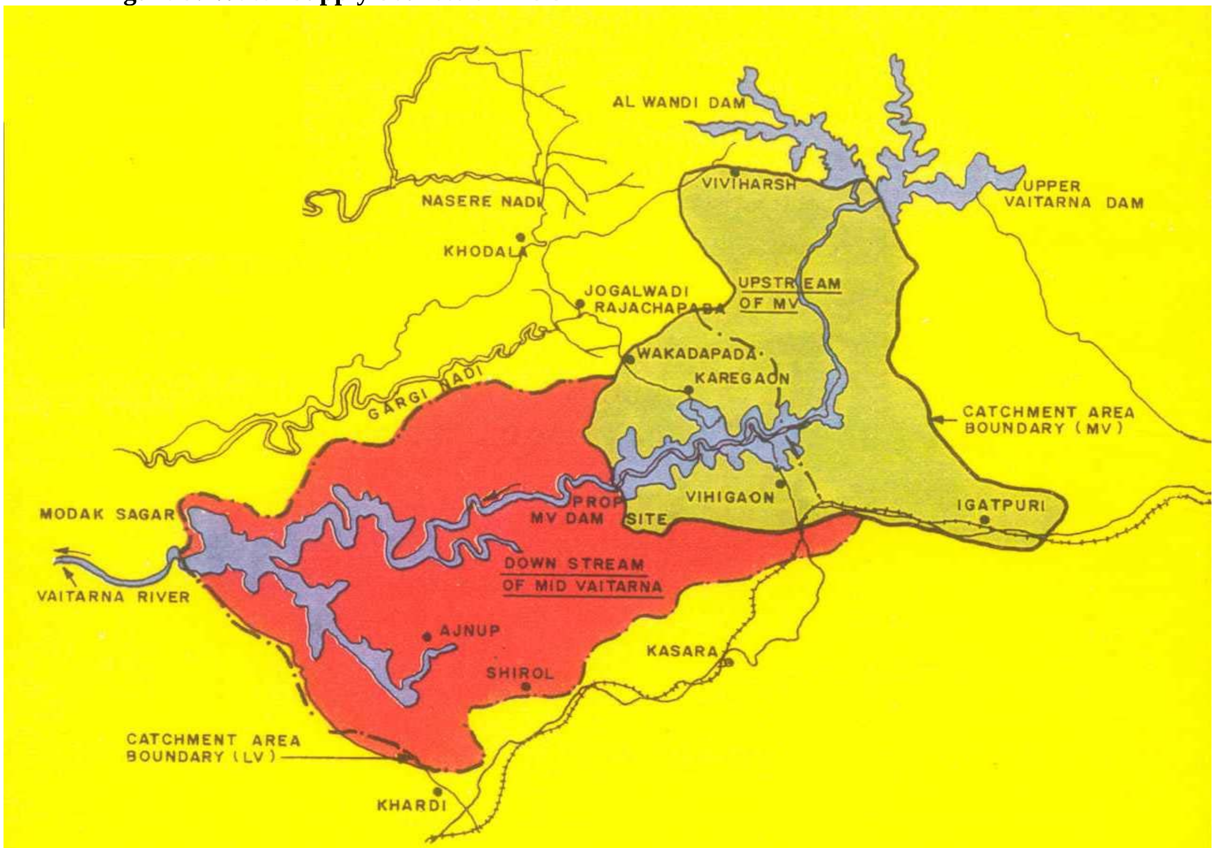
**Table 34: Water Sources of MCGM**

| Sl. | Source | Yield in (MLD) | Ownership | Distance from City | Treatment Plant Location |
|---|---|---|---|---|---|
| 1 | Tulsi | 18 | MCGM | Within City Limit | Tulsi |
| 2 | Vihar | 110 | MCGM | Within City Limit | Vihar |
| 3 | Tansa | 417 | MCGM | 100 Km from City | Bhandup Complex |
| 4 | Upper Vaitarna | 1,025 | MCGM | 110Km from City | Bhandup Complex |
| 5 | Bhatsa | 1,650 | GoM | 100 Km from City | Bhandup Complex/ Panjarapur |
| ***6*** | ***Sub-total*** | ***3,220*** | | | |
| 7 | En-route supply | -120 | | | |
| | **Total supply to city** | **3,100** | | | |


The water is completely treated with pre-chlorination, alum-dosing, settling, filtration and post-chlorination before supplying to consumers. The back wash quantity generated at Bhandup treatment works (which is about 45 MLD) is released in the Vihar Lake. However the backwash quantity generated at Panjrapur treatment works (approx. 20 MLD) is discharged in nallahs.

The treated water is stored in the Master Balancing Reservoirs (MBRI) at Bhandup Complex (246 ML) and MBRI at Yewai (123 ML) and further distributed to 28 service reservoirs spread through the city by a complex network of inlet mains which are maintained charged for 24 hours. These service reservoirs in turn supply water to the consumers in different water supply zones at suitable time for the duration varying from 24-hours to 90 minutes depending on area of the zone, topography, etc. The pressure in distribution system is in the range of 1 to 1.5 $kg/cm^2$ during water supply hours. The transmission system comprises about 300 km of primary transmission pipeline and about 650 km of secondary transmission pipeline.

**Figure 9: Water Supply Sources of MCGM**




**A. Water Supply Sources / Schemes for Mumbai**

*a. Vihar Scheme*:

Vihar scheme was the first piped water supply scheme and was commissioned in 1860. Three earthen dams and a masonry overflow section was constructed to impound Mithi river water about 20 Km north of Mumbai city. The impoundage is known as Vihar Lake and is a popular picnic spot. A 1200 mm dia cost iron pipe was laid to supply 32 MLD to a population of 700 thousands. Supply from this source was increased to 68 MLD by raising of dam in 1872 this scheme is still in operation.

*b. Tulsi & Powai Scheme*

In 1885 it was decided to develop Tansa as a next source of water supply, however due to critical situation of water shortage led to immediate development of Tulsi lake, up stream of Vihar lake on the Mithi river. This scheme consisted of an earthen dam, a masonry dam and 600 mm dia pipeline to carry 18 MLD water to the service reservoir at Malbar Hill in South Mumbai. While Tansa scheme was under construction Powai scheme was taken up on emergency basis on a tributary of Mithi River due to anticipated water famine in 1891. This scheme supplies 4 LD water, however due to inferior quality of water it is used for dairy and agricultural use only.

c. *Tansa Scheme*

Today, The four major source of water supply to the Mumbai City are Tansa, Vaitarna (Modak Sagar), Upper Vaitarna and Bhatsa. Tansa and Vaitarna are fully owned and constructed by MCBM only for City's water supply, whereas Upper Vaitarna and Bhatsa are multipurpose schemes and constructed and owned by Govt. of Maharashtra. Tansa lake is situated near Shahapur in Thane District about 100 Km away from Mumbai City. The construction of Tansa dam was started in 1886 and the scheme was fully developed in four stages. The first stage was completed in 1892. A dam of 2800 m in length and having maximum height about 40 m was constructed in the first stage. Also a 42 Km long closed duct line on the hills and 53 Km long 1200 mm dia cast iron pipeline through valleys was laid to convey 77 MLD water to the heart of City.

The second stage was commissioned in 1915 by an additional pipeline of 1250 mm dia and supply was increased by 82 MLD. In the third stage height of dam was increased by 3 m to increase the storage and new conveyance system of two 1800 mm dia M.S. pipe lines were laid along a shorter route and was commissioned in 1925. The supply was increased by 68 MLD. The fourth and last stage was completed in 1948. In this stage storage capacity was increased by providing 38 nos. of floodgates of 50' x 4' size. The storage capacity of the dam is 40,666 million gallons at Full supply level i.e. 422' THD. The water is drawn through the seven outlets at different levels i.e. at 415', 410', 405', 400', 390', 380', & 375' THD. The total water supply from this source is about 410 MLD.

d. *Lower Vaitarna Scheme*

After the commissioning of Tansa Scheme in 1948 Mumbai's water supply was about 495 MLD, but after independence there was a large influx of the people in the city and also there was unprecedented increase in industrial and commercial activity due to which demand of water supply increased considerably. Therefore it was necessary to augment the water supply to the City and hence it was decided to tap the Vaitarna river water by the Municipal administration at that stage. A scheme known as Vaitarna cum Tansa was conceived, planned and executed by a team of municipal engineers under the able guidance and leadership of late Shri. N.V.Modak, then City Engineer of MCGM. In this scheme a 90 m high and 500 m long dam was constructed across river Vaitarna. The dam was the first concrete dam in the country, which was constructed using pre-cooled concrete. The impoundage created by this dam was subsequently named as Modak Sagar in the recognition of valuable services of late Shri. N.V.Modak. The capacity of the reservoir is 46000 MG. The catchment area of dam is 174 sq miles and the water-spread area is 3.8 sq.miles with a length of lake about 10 miles. The water is released through intake tower, which is typical in design and construction and provided with controlled opening through which a calculated amount of water can be released in the pipe. The openings are provided at different elevations from the bottom i.e. at 416' THD, 1 No. 460' THD 2 Nos., 480' THD 2 Nos., 500'THD 2

Nos., and 520' THD 2 Nos.

This arrangement of openings allows water to be drawn from the level which at any time will supply water having the least turbidity, algae or least amount odor and bad taste. To bring the water from lake, a 7.2 Km. tunnel was constructed between Vaitarna and Tansa and a M.S. pipeline partly 3000 mm. and partly 2400 mm. dia. 87 Km. long was laid from Tansa to City. A new concept in pipeline design using ring girders and roller supports with expansion joints was used for above ground pipelines. This brought considerable saving in the M.S. plate at that time. This pipeline was the largest and longest pipeline ever laid in the world. Tansa Lake from the lower gate provided in the bifurcation chamber which is constructed at the end of the tunnel. The surplus water from Modak Sagar can be thus diverted to fill up Tansa Lake, which does not fill up in dry years.

This scheme was completed in 1957 augmenting City's water supply by additional 540 MLD.

*e. <u>Upper Vaitarna Scheme</u>*

Govt. of Maharashtra (GOM) in the year 1960 took up the execution of a multipurpose scheme known as Upper Vaitarna scheme. Under this scheme an impoudage was created in the upper reaches of Vaitarna River by constructing two dams on river Alwandi & Vaitarna about 80 Km. u/s. of Modak Sagar. The impounded water is used to generate electricity through hydroelectric power station of 60 MW capacity and then it is released in the Vaitarna River to flow down to the lower Vaitarna Lake. (Modak Sagar). This released water is used for water supply by conveying it to the City. The GOM constructed the dam while M.C.B.M. carried out the works of laying of partly 3000 mm dia. and partly 2750 mm. dia. trunk main and construction of some service reservoirs. The full supply level of upper Vaitarna reservoir is 1980' MSL i.e.2060.25' THD and the capacity is 73,125 Million gallons. Under this scheme a tunnel under Thane Creek was also bored to carry the entire water supply under creek from security point of view. This project was fully commissioned in the year 1972 and the water supply was increased by 540 MLD. Upto this point it was a unique feature of Mumbai's water supply system that it was conveyed entirely by gravity. The catchment area of Tansa, Vaitarna and Upper Vaitarna were so protected that the water hardly need any filtration and only chlorination was done for disinfections purpose.

*f. <u>Bhatsa Scheme</u>*

Despite the implementation of the aforementioned schemes, large-scale shortages in water supply started arising towards the end of 1960s. The rate of growth of the population during the decades of 1950s and 1960s was unprecedented. Therefore a Master plan was prepared for integrated development of water supply and sewerage facilities. This project was titled Mumbai Water Supply and Sewerage project. M/s. Binnie & Partner of London was appointed as consultant for this project. This project was implemented in three stages, with the financial assistance from IDA and World Bank. In each of these three stages 455 MLD water was drawn from Bhatsa River. Government of Maharashtra constructed a dam across river Bhatsa near Shahpur in Thane district and works of pumping, conveyance, treatment, storage were carried out by M.C.B.M.

*g. I Mumbai Water Supply Project (Bhatsa Stage I)*

Various alternative methods for developing the Bhatsa Scheme were examined. In each of the alternative it was common that the Bhatsa reservoir would be used as regulating and storage reservoir and the water would be abstracted from the river at short distance upstream of Kalu confluence and the water would be treated at Bhandup. The alternatives were differed only in type of conveyance system to be adopted. The different degrees of integration with the Vaitarna and upper Vaitarna mains, completely independent operation or completely independent operation except for Bassin creek. As a result of economic studies schemes was adopted in which water from Bhatsa was to be injected in to Vaitarna and Upper Vaitarna main at a point close to the point of abstraction at Pise. In Bhatsa stage I, following project components were constructed.

- A pick up weir across the Bhatsa River at Pise, just upstream of its confluence with the Kalu and near the upper limit of tidal effects.
- An intake channel leading to an intake pumping station on the right bank of the river housing 7 vertical spindle mixed flow pumps (5 duty and 2 standby) each with a nominal output of 91 MLD against a total lift of 97.2 m (319 ft.).
- A 2235 mm. (88 in) welded steel rising main 9.2 KM (5.7 miles) long, laid underground except for one bridge crossing, between the pumping station and the Vaitarna/Upper Vaitarna mains at Yewai.
- A treatment plant comprising of settling tanks and a pumping station comprising of 6 Nos. 91 MLD + 2 timmer 45 MLD pump sets at Panjrapur.
- A control valve complex at Agra Road Yard, a short distance upstream of Yewai on the trunk mains alignment, where the gravity flow in the trunk mains is regulated.
- A new tunnel, 5 m (16.4 ft.) dia. to carry water from the trunk mains to the Bhandup treatment works, and new mains to reinforce the existing East-West tunnel system.
- A treatment works sited on land on the shore of Vihar Lake, for all the water from the mainland sources; consisting of 5 blocks of 24 filters operating on the declining rate principle, together with associated chemical storage and dosing facilities, a chlorine contact tank, access roads, quarters, etc
- A treated water pumping station containing 10 (7 duty + 3 standby) 245 MLD (vertical spindle, double suction, split-casing pumps, delivering to a new master balancing reservoir of 245 ML capacity and 7 (5 duty + 2 standby) 38 MLD similar pumps, delivering to Malad and Borivli reservoirs, through the second leg of the East-West tunnel; and

- Treated water mains, 2 x 2750 mm (108 in) to the master balancing reservoir and 1 x 1. 350 (54 in) main to the East-West tunnel.

The first stage was commissioned in 1981 augmenting city's water supply by 455 and total water supply to the City after this stage was 1970 MLD.

h. *II Mumbai Water Supply Project (Bhatsa Stage II)*

In stage – I Water from Bhatsa was directly injected into existing Vaitarna & upper Vaitarna mains after sedimentation. However in stage II water from Bhatsa river is fully treated at Panjrapur and stored in MBR – II at Yewai hills and transmitted to the distribution system in City at MGL & E.E.H. junction. In Bhatsa stage II following works were undertaken.

- Expansion of pumping station at Pise and installation of 7 pumps (4 working + 3 stand by) of capacity 113.6 MLD each.
- Construction of pre chlorination house at Pise
- Laying of an additional 2235 mm dia M.S. above ground pipeline from Pise to Panjrapur.
- Construction of full fledge 455 MLD capacity treatment plant at Panjrapur and pumping station having 7 pump sets each having 113.6 MLD capacity.
- Construction of a new master-balancing reservoir (MBR II) having 117 M.L. capacity.
- Laying of 48 KM long 2235 mm dia transmission main from Yewai MBR upto City.
- Construction of 3500 mm dia. tunnel under Kasheli Creek.
- Construction of 3000 mm dia. tunnel from Mahalaxmi racecourse to Malabar Hill using tunnel-boring machine. The tunnel-boring machine for tunneling was used for the first time in India.
- Construction of service reservoir at Pali Hill Ghatkopar Hills and mortar lining of new as well as old mains was also undertaken to improve the 'C' value of pipe surface thereby increasing the discharging capacity of the mains.

This scheme was commissioned in 1989 and augment City's water supply by another 455 MLD to 2425 MLD.

i. *III Mumbai Water Supply Project*

In this stage following works were undertaken.

- Expansion of pumping station and installation of 7 pump sets each of 113.6 MLD capacity.

- Laying of an additional 3000 mm dia. above ground pipeline from Pise to Panjrapur.
- Full two stage 455 MLD capacity treatment plant and pumping plant at Panjrapur.
- Laying of 3000 mm dia. transmission main from Yewai MBR – II to City.
- Construction of Reservoir at Bhandup (BUDP), Borivali Hills, Malabar Hills, Worli Hills and Raoli Hills.

This scheme was commissioned in 1997 augmenting City's water supply to about 2900 MLD.

j. *III A Mumbai Water Supply Project*

Due to delayed monsoon in 1992, the Govt. of Maharashtra (GoM.) appointed an Expert Committee under the Chairmanship of Dr. M.A.Chitale, to suggest immediate measures, and also the long term strategy to meet the water supply needs of Greater Mumbai. The Committee's report has been accepted by the GoM, and all the sources recommended in the report have been allocated to MCGM by the Irrigation Department (I.D.) GoM. The Committee has projected the population of Mumbai for the year 2021 as 1.56 Crore and suggested following water sources to be developed priority wise for satisfying the water demand.

- Unutilized Irrigation potential of Bhatsa (III-A Mumbai Water Supply Project)
- Middle Vaitarna Project. (IV Mumbai Water Supply Project.)
- Kalu Project
- Gaargai Project
- Shahi Project
- Pinjal Project

Accordingly, III-A Mumbai Water Supply Scheme (i.e. augmenting 455 MLD water by abstracting unutilized irrigation potential of Bhatsa Dam) is already launched. Under III A Mumbai Water Supply Project additional 455 MLD water will be abstracted at Pise, pumped to Panjrapur and from thereon injected into existing Vaitarna mains for conveying towards Bhandup for treatment. At the same time raw water of Mumbai III Project will be treated in a new treatment plant at Panjrapur. In the meantime GOM has allowed Thane Municipal Corporation to abstract 100 MLD of water out of 455 MLD allotted to BMC for short period. However, the project components are designed for abstraction, conveyance and treatment of 455 MLD of water.

The following project components are undertaken under III A Mumbai Water Supply

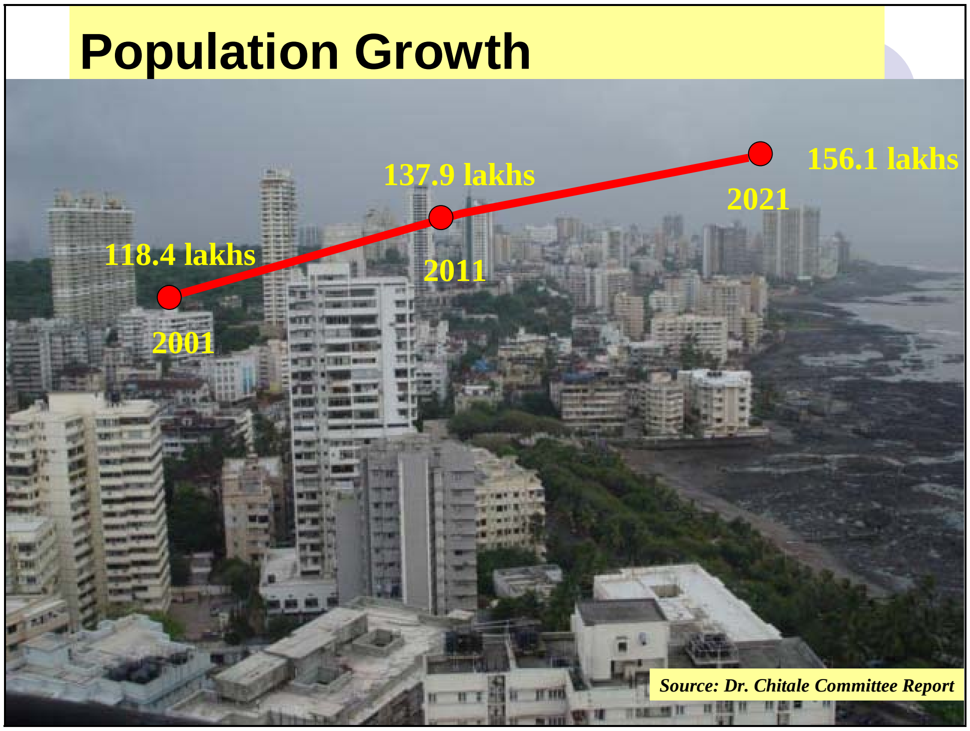
Project.

- Raising of crest level of existing Pise weir by 2.0 b using inflable gates to increase capacity of pond.
- Pumping stations of capacity 455 MLD each at Pise and Panjrapur.
- Rising main of 3000 mm dia. 9.5 KM length from Pise to Panjrapur.
- Construction of water treatment plant comprising of filters, clarifiers etc. in the existing Panjrapur complex to treat Mumbai III water.
- Supply, installation and commissioning of pumping plants including associated electrical works at Pise and Panjrapur.
- Treated water transmission main of 2400mm. dia from Panjrapur Stage III Pumping station to Yewai MBR.
- Transmission main of 3000 mm. dia. from MGL/EEH Junction to Vikhroli and further up to Amarmahal for total length of 13 Km.
- A 3000 mm dia. tunnel from Bhandup to Malad reservoir, Malad reservoir to Liberty Garden and further up to Charkop having total length of 12 KM.
- A 2400 mm dia tunnel from Veravali Reservoir to Adarsh Nagar and further upto Yari Road:

The total cost of the project is Rs. 943 crore. The project is likely to be completed by 2006 and additional 455 MLD water will be brought to the City. Out of this about 150-200 MLD is already being brought to City.

## B. Population Projections and Water Demand

The populations figures for 2001 based on the demographic survey conducted by the Govt. of India was 11.84 million and it is expected to go up to 13.79 million in 2011 and to 15.61 million in 2021 as per Chitale committee. The projections have been made by the incremental increase method.




Population projections up to year 2011 indicate a demand of 5043 Mld and 5388 Mld in the year 2021. In arriving at these figures the average per capita demand adopted by Chitale committee is 240 lpcd.

The gap between demand and supply was 1642 Mld in 2001 and the same is expected to be 1210 Mld in 2011 and to 1100 Mld in 2021.

## C. Water Supply and Demand Projections

| Year | Increment | Supply (Mld) | Demand (Mld) | (%) fulfillment | Remarks |
|---|---|---|---|---|---|
| 2001 | | 3025 | 3975 | 76 | |
| 2005 | 150 | 3175 | 4150 | 76 | Partial completion of IIIA |
| 2007 | 200 | 3375 | 4300 | 78 | Completion of IIIA |
| 2011 | 477 | 3852 | 4526 | 85 | Completion of Mid Vaiterna |
| 2016 | 455 | 4307 | 4800 | 90 | Gargai |
| 2021 | 765 | 5172 | 5068 | 100 | Pinjal |

**D. Distribution Network**

The distribution network has been laid and upgraded over the past 136 years or so. The distribution system includes the 28 service reservoirs and allied piping systems for inlets and outlets feeding 110 water supply zones. Water mains amounting to approximately 4,000 km in length, range in diameter from 80 mm to 1,800 mm. Water mains have are either cast iron (CI), mild steel (MS) or ductile iron (DI), some of which have internal lining. The MS pipes are externally protected by either concrete or other proprietary coatings.

There are a total 2,94,200 metered connections of which 2,42,000 (83%) are domestic connections including 1,62,000 connections in slums, 47,000 (15%) commercial connections and 5,200 (2%) industrial connections. There are about 75,000 un-metered connections, primarily in the core areas of the island city area. Of the total metered consumption of water, about 87 per cent is consumed by domestic consumers, 9 per cent by commercial consumers and about 4 per cent by commercial consumers.

Water quality is maintained through regular collection and testing of water samples throughout the network and from customer taps.

Due to the fact that demand exceeds supply, an intermittent supply regime is operated whereby each supply zone is ‘charged’ with treated water for between 2 and 6 hours per 24-hour period. This is a root cause of contamination due to ingress of foul water during non-supply hours through joints, disused connections, tampered mains, faulty fittings, etc. Though adequate care is taken to monitor the water quality at all the points from source to end point at consumer’s tap, incidents of contamination do occur. Fortunately all the sources have fairly protected catchments and no chemical contamination was observed at the source.

The water supply system of Mumbai is now equipped with Supervisory Control and Data Acquisition (SCADA). The water billing & revenue collection system is also computerized in all the wards. Supplies into each zone are controlled and monitored by the three local control centers (LCCs) located in the City, Western Suburbs and Eastern Suburbs

Calculation of ‘water balance’ is difficult due to insufficient ‘zonal’ and ‘district’ meters, as well as the lack of metered outlets at reservoirs. It is estimated that about 80 % of consumer meters are not operable or reliable.

In spite of numerous constraints and limitations the corporation is successful in supplying regular and adequate quantity to the citizens of Mumbai. There are occasions of pipe bursts or power failure, when water supply is interrupted. But in all cases, water supply is restored in shortest possible time, which rarely exceeds 12-hours in case of major burst. This year 272 Nos. of leakages & 60 Nos. of bursts were detected & repaired on water mains of 600 mm diameter & above. Also this year 28,720 Nos. of visible leakages were detected &

28,684 Nos. of leakages were repaired.

The water supply to the city totally depends on rainfall during the monsoon and as such water cut of 10% to 15% required to be imposed in case of bad monsoon or delayed monsoon. Some of the industries and commercial establishments (e.g. RCF & Railways) recycle used water and reuse the same for non-potable purpose.

## E. Proposed Water Supply Schemes

*IV- Mumbai Middle Vaitarna Water Supply Project*

As per the recommendation of the Expert Committee, the Middle Vaitarna Project was envisaged and a detailed feasibility study was carried out for the Middle Vaitarna Dam (in 1992) and the Conveyance and Treatment components of the scheme. The project involves creation of an impoundage by constructing a Dam on Vaitarna River between Upper and lower Vaitarna dams. This project, will augment water supply to Mumbai by further 455 MLD thereby making the total water supply to 3810 MLD. The project has been sanctioned by Irrigation Department of Govt. of Maharashtra in 1997.

Salient features of the Middle Vaitarna Project are:

The Proposed Middle Vaitarna Dam (M.V.D.) on the Vaitarna River is having an approximate length of 500 m and height of about 100 m.

This will be a R.C.C. (Roller Compacted Concrete) Dam.

The water from the MVD will be conveyed through the river upto Modak Sagar Reservoir i.e. upto Lower Vaitarna reservoir.

From Modak Sagar, Water will be drawn through a new intake tower in a controlled manner and will be a conveyed through 7.5 K.M. long tunnel upto Intake Shaft at Belh Nallah.

Thereafter through 3000 mm dia. M.S. Pipeline the water will be brought to the Bhandup Complex.

This additional water will be treated at Bhandup Complex by constructing a New Water Treatment Plant having capacity of 500 MLD. This filtered water will be pumped by proposed pumping station to proposed M.B.R. at Bhandup Complex.

From this M.B.R., water will be distributed to Mumbai.

The Project is expected to be completed within 5 to 6 years from inception, with a total cost of about Rs. 1600 Crore.

### *13.1.2 Key Issues and Strategy Options/Plans*

| Key Issues | Strategy Options / Plans |
|---|---|
| Inadequate Source<br><br>The current supply of 3,050 MLD is inadequate to meet the current demand of about 3,900 MLD. Demand for water is projected to increase to about 4,526 MLD by 2011 and to 5,068 MLD by 2021 | Implement recommendations regarding water allocation, of the Expert Committee Report under the Chairmanship of Dr. MA Chitale, 1993. The sources recommended to be developed for supply to Mumbai have been allocated by the Irrigation Department, GoM<br><br>The report has recommended the following sources, which would be adequate to meet the estimated gap of 2000 MLD by 2021<br><br>Unutilized Irrigation potential of Bhatsa (III-A Mumbai Water Supply Project) – 455 MLD by 2007 – project implementation is ongoing<br><br>Middle Vaitarna Project. (IV Mumbai Water Supply Project.) – 477 MLD by 2011 – DPR prepared in year 2002 – to be taken up for implementation immediately. Estimated project cost is Rs. 1,351 crore<br><br>Gaargai Project – 455 MLD to be implemented by 2016<br><br>Pinjal Project – 765 MLD to be implemented by 2021 |
| Bad condition of Transmission & Distribution System– leading to leakage and contamination of water | Implement recommendations presented in the study by M/s Binnie Black & Veatch, Thames Water and TCE Consulting Engineers for primary transmission.<br><br>Implement the five-year priority works plan for improving the distribution system. Based on in-house experience and knowledge, MCGM has prepared a five-year plan for priority works to be undertaken to improve the distribution system performance. This would essentially comprise rehabilitation and replacement of pipes. Rs. 500 crore have been sanctioned for this purpose with annual investment of Rs. 100 crore per year to replace/rehabilitate old water mains of be taken up from FY 2006-07. |
| Absence of water balance information – resulting in inequitable supply and unaccountable water in the system | Install zonal and district meters at appropriate locations to facilitate regular water balance and audit analyses, aimed at facilitating equitable water supply and leak detection |

## 13.2. Sewerage

### *13.2.1 Existing Situation*

**A. Historical Development of Sewerage System:**

The first sections of the sewerage system, for Mumbai City, were constructed in Zones 1 and 2 in the 1860s. The first Worli outfall was completed in 1880 and by 1900 much of the city flow was directed to Lovegrove, to form the basic arrangement for Zone 2. Expansion continued through to 1940, with duplication and improvements, and new catchment areas at Dadar and Banganga and Malabar Hill in Zone 2, and at Dharavi in Zone 3.In Zones 4, 5, 6 and 7, and in the northern parts of Zone 3, there were no facilities recorded prior to 1940, as these were all outside of the then Municipality boundary.

Following independence in 1947, relief works were constructed but, due to the very low population forecasts on which they were based, the works did little to alleviate problems. The municipal boundaries were extended in 1950 and again in 1957 to their present position. Pumping stations were constructed at Khar and Kurla in 1955 in Zone 3, and at Versova in 1959 in Zone 4. Further pumping capacity was added in Zone 3 at Dharavi in 1964 and at Kherwadi in 1971. The first pumping station in Zone 5 was built at Malad also in 1971.

Studies carried out by Binnie & Partners in 1970 recommended that flows from all zones be directed through two long sea outfalls at Worli and Bandra. This was subsequently amended by 1973 to a seven zone and outlet arrangement, similar to the present seven zone aim, and by 1979 a further eight new pumping stations were being designed. The pumping stations in each zone, which were operating in 1979, compared to the current provision and the date of the first sewerage, are shown in Table 35.

**Table 35: Chronology of Development of Sewerage System in Grater Mumbai**

| Zone | First Sewered in | 1979 Pump Stations | 2005 Pump Stations |
|---|---|---|---|
| Zone 1 | 1860 | 2 + 9 ejector stations | 6 |
| Zone 2 | 1860 | 8 + 2 ejector stations | 16 |
| Zone 3 | 1900 – 1940 | 13 | 16 |
| Zone 4 | 1959 | 1 | 2 |
| Zone 5 | 1971 | 1 | 6 |
| Zone 6 | Post 1979 | None | 3 (+2 private) |
| Zone 7 | 1950s | 3 | 3 (+2 private) |
| **Total** | | **28 + 11 ejectors** | **52 (+ 4 private)** |

It can be seen that the number of pumping stations has increased significantly by almost double, in the last 22 years, and the accompanying sewers have increased similarly also. Since 1973, the sewerage system has been expanded rapidly. In accordance with the 1979 Metcalf and Eddy Master Plan, Zones 5 and 6 have seen the greatest expansion.

**B. Planned Sewerage Projects**

Municipal Corporation of Greater Mumbai has been implementing integrated Water Supply and Sewerage Projects since 1974 with the assistance of the World Bank. Twenty-five years Master Plan for Sewerage which began in 1979, is completed in 2004.

Under the first Master Plan, following projects have been completed.

a. First Mumbai Water Supply and Sewerage Project- 1974-81; Rs. 2,129.90 million

b. Second Mumbai Water Supply and Sewerage Project- 1979-88; Rs. 7,151.50 million

c. Third Mumbai Water Supply and Sewerage Project- 1988-95; Rs. 4,674.20 million

d. Mumbai Sewerage Disposal Project (MSDP)-I- 1995-2004; Rs. 11,818.60 million

The 1979 Plan established an infrastructure development strategy that included a system of seven zones, each operating independently of one another.

The system now comprises over 1500 km of sewers ranging in diameter from 150 mm to large ovoid sewers, the largest being 1830 mm by 2740 mm (6 ft by 9 ft). It is considered to be a separate system, to avoid the need to design for large monsoon flows, but substantial flows of surface water do enter the system during the wet season. The sewerage system expansion is still continuing using the Municipality's own funds.

**C. Sewerage Zones:**

The seven zones and their status in 2005 is presented below.

a. Zone 1 Colaba (population 0.2 million) is a relatively small, flat, 6 km$^2$ zone covering a predominantly military area. There are six pumping stations and about 40 km of sewers leading to preliminary treatment and the 1.2 km short outfall to the harbor.

b. Zone 2 Worli (population 2 million) covers the main city area. It is a densely populated area of 39 km$^2$ with small hilly ridges at Malabar and Pedder Road and many redundant textile mills. There are 16 pumping stations and about 355 km of sewers leading to preliminary treatment and the new 3.4 km long sea outfall at Worli, discharging to the Arabian Sea.

c. Zone 3 Bandra (population 3.4 million) It is a large densely populated area of 77 km$^2$ with some major slum areas and much commercial activity. The zone is elevated in the north around Sakinaka where there is still continuing development. There are 16 pumping stations and about 350 km of sewers. The Bandra collector tunnels pick up all flows. The flow from the IPS passes to new Bandra preliminary treatment works prior to discharge via the EPS and a new 3.7 km long sea outfall to the Arabian Sea.

d. Zone 4 Versova (population 0.95 million) is a relatively small zone of 21 $km^2$, highly developed and mainly residential. Apart from the final pumping station, there is only one small pumping station at Versova village. The 160 km of sewers lead to preliminary and aerated lagoon treatment discharging to Malad Creek.

e. Zone 5 Malad (population 2.85 million) is the largest zone of 115 $km^2$ covering most of the western suburbs. The area has boomed over the past 15 years and is still full of construction activity and many slum areas. The zone has large low-lying areas in the west rising up to the hilly reserve area in the east. There are six pumping stations and currently about 320 km of sewers all connected by a major interceptor sewer running along a planned north-south 100 ft road. The north-south interceptor sewer from Shimpoli to Malad cannot cope, in some places, with all flows due to blockage, collapse or insufficient size. The south-north interceptor sewer from Goregoan has inverted syphon, which seems to be clogged and the rising main is of insufficient size. As a result three pumping stations pump part of their flows direct to nallahs. A large final pumping station delivers flows from the interceptor to preliminary treatment and then to Malad Creek.

f. Zone 6 Bhandup (population 1.2 million) is in the northern part of the eastern suburbs. It is a smaller zone of 43 $km^2$ with much state built housing in the low lying areas but also major private development at Powai and slum development up onto the hills in the west. There are three pumping stations and about 120 km of sewer leading to preliminary and aerated lagoon treatment discharging to Thane Creek.

g. Zone 7 Ghatkopar (population 2 million) comprises 77 $km^2$ in the southern part of the eastern suburbs. There is large area of mangrove on the coast but also there is currently much unsewered development on both sides of the highway leading to Thane Creek bridge. In addition a major hilly area in the southeast is occupied by Bhabha Atomic Research Center. Also, the coastal area in the south is occupied by the petroleum and chemicals industry. Both of these will remain responsible for the handling of their own waste. There are many slum areas in sewered and non-sewered areas. The sewered areas are mixed development with three pumping stations and 155 km of sewers. The new Ghatkopar pumping station and preliminary treatment by aerated lagoon and then the effluent is released directly into Thane Creek.

The characteristics of sewerage system is as shown below.

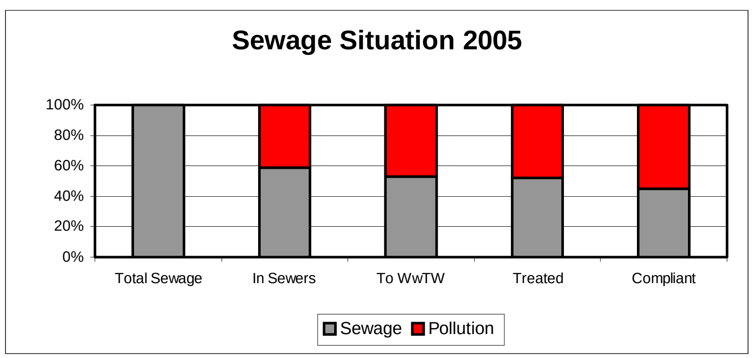
**Table 36: Salient Features of the Sewerage System in Greater Mumbai**

| None No. | Name | Area | Population | Sewer Length | Capture | WWTF Capacity | Year of Commissioning |
|---|---|---|---|---|---|---|---|
| | | *(Km²)* | *(Million)* | *(km)* | *%* | *(mld)* | |
| Zone1 | Colaba | 6 | 0.3 | 40 | 90 | 125 | Jan 06,1988 |
| Zone2 | Worli | 39 | 2.0 | 355 | 90 | 760<br>Outfall - | Jan 30,1991<br>June15, 1999 |
| Zone3 | Bandra | 77 | 3.4 | 350 | 60 | 795 | May 27,2003 |
| Zone4 | Versova | 21 | 0.95 | 160 | 80 | 90 | Dec 31,1992 |
| Zone5 | Malad | 115 | 2.85 | 320 | 50 | 180 | Oct, 1997 |
| Zone6 | Bhandup | 43 | 1.2 | 120 | 40 | 280 | June3, 2002 |
| Zone7 | Ghatkopar | 77 | 2.0 | 155 | 30 | 300 | May 23,2003 |
| **Total** | | **378** | **12.7** | **1,500** | **-** | **2,530** | |

D. Current situation:

The present operating capacity of handling sewage is 5265 mld and the design capacity of the treatment plant is 2530 mld of sewage, at seven terminal pumping stations/plants. The sewerage system of Mumbai currently covers only 42 percent of population. About 2600 mld sewage flow generated from 3000 mld of water supply. Of this 2600 mld sewage, 1500 mld sewage flow is collected & disposed off at final waste water treatment plant of each zone in environmental acceptable manner through marine outfalls & aerated lagoons.

The population of Mumbai is now in 2005 is about 12.7 million. About 50% (6.2 million) of the population stays in Slums and 6.5 million is Non-slum population. A large proportion of the slum population is not served by the sewerage system and their only form of sanitation is a public toilet and septic tanks. Statistically, all the Non-slum population is provided with basic sanitation facilities and 80% of them are provided with underground sewerage network whereas 65% of the slum population is provided with basic sanitation facilities of toilet blocks & septic tanks and only 2% of slum population is covered under pipe sewered network.




Major percentage of the sewage collected is now treated to an acceptable standard. However, percentage capture in the sewerage network is less.

**Mumbai Sewage Disposal Project-I**

The Mumbai Sewage Disposal Project (MSDP) was implemented on July 6, 1995, with funds from the World Bank (WB) at a cost of US$192 million. The project was restructured based on further recommendations of the Mid Term Review by the World Bank in December 1999 and certain works were added to the project. The MSDP project has been completed and fully commissioned in Dec.2003.

**Original Components**: The original components comprised of:

Part A - Physical Components: including (i) marine outfalls about 3.7 km long and 3.5 meter dia at Worli and Bandra; (ii) construction of a pumping station at Bandra; (iii) construction of aerated lagoons at Bhandup and Ghatkopar; (iv) construction of facilities to prevent siltation of the influent tunnel at Ghatkopar; (v) rehabilitation of the existing Ghatkopar tunnel, (vi) slum Sanitation schemes; (vii) construction of additional structural features to improve the stability of five existing sewage pumping stations; (viii) Implementation of a program of improvement to the existing conveyance system.

Part B - Technical Assistance and Training: including (i) supervision of construction of the works to be carried out under Parts A; (ii) upgrading the operation and maintenance practices and facilities for the Corporation's sewerage system to acceptable levels; (iii) Implementing topographic and condition surveys for the Corporation's conveyance system and formulating a program of improvements to said system; (iv) carrying out social and physical surveys, the formulation of investment proposals, implementation and management, independent monitoring and evaluation in respect of the slum sanitation schemes; and (v) carrying out feasibility studies for the second stage sewage treatment and disposal facilities in the service areas of Malad, Versova, Bhandup, Ghatkopar, Bandra, Worli and completing detailed engineering designs for sewage treatment and disposal facilities in said service areas.

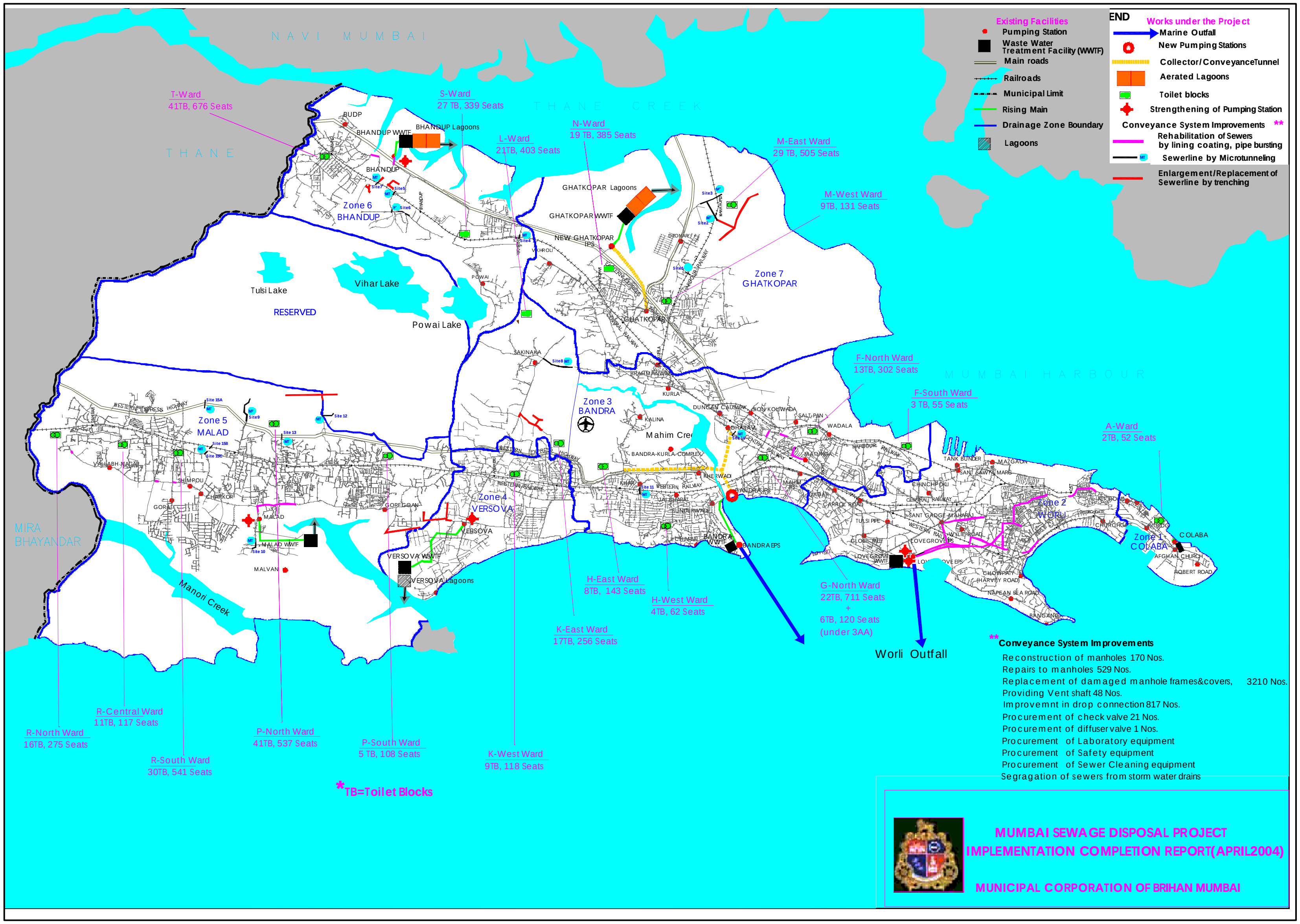
**Revised Components**: At the mid-term, the project was restructured to include :

1) The rehabilitation of the existing Ghatkopar tunnel was replaced by the construction of a higher-level tunnel being cost effective than the contemplated rehabilitation of the existing Ghatkopar tunnel
2) A training component
3) Rehabilitation of a tunnel to collect sewage and transport it to the Bandra pumping station.
4) Study of O&M of water supply system of Mumbai.
5) Segregation of sewage from storm water drains to enhance environmental benefits.

**Achievement of project objectives- Outcomes of the Project:** On implementation the MSDP-I project substantially achieved all the objectives. The outcomes have been achieved by way of:

a) Sewage treatment capacity enhancements
b) Disposal in an environmentally acceptable manner.
c) Better Service coverage, less over flow/ flooding
d) Improved infrastructure
e) Operation and maintenance improvement
f) Cleaner beaches
g) Improved Sanitation facilities for slums.

**Figure 10: Map showing Existing Sewerage Network in Greater Mumbai**



## E. Slum Sanitation Program (SSP)

More than 60% of population in Mumbai live in slums. The creeks and coastlines are deteriorated mainly because of non-availability of sanitation facilities to slum dwellers, which results in open defecation and wastewater discharges.

A slum sanitation program is therefore included in MSDP as an integral part of project with funding from World Bank. It is a demand driven participative community program to provide sustainable sanitation facilities to several individual slums, which occupy municipal land. The program was launched in 1997. The response from community is encouraging. 318 toilet blocks were constructed up to march 2005 & another 16 blocks will be constructed by July- 2005. Additional 35000 seats in major slum colonies are proposed to be constructed by the year 2010.

*Benefits of S.S.P.:*

a. The slum sanitation schemes will help alleviate the harsh living conditions of slum dwellers, by providing improved sanitation facilities for safe excreta disposal.

b. The slum sanitation component is also focused on creating awareness and alleviating health risks, community capacity building and improving the urban environmental conditions for slum dwellers in Mumbai. The program is being implemented with the assistance of NGOs.

c. The Slum Sanitation Schemes will provide a particular benefit to women who have stronger concerns for privacy and who bear the brunt of the problems arising from ill health in the family.

In addition to this, Mumbai slum improvement board under MHADA has constructed 2,510 WCs, 1,220 new water connections, 4,46,052 sq. m. roads & passages, 61,956 Rmt drainages and 86 other social amenities are provided.

## F. Proposed Mumbai Sewerage Disposal Project- II

The Sewerage Master Plan prepared in 1979 by Metcalf & Eddy Inc. formed a basis for the conveyance and disposal of sewage in Greater Mumbai area upto the year 2005. The works under this first stage of Master Plan will now mostly be completed.

However, during environmental impact assessment studies conducted during first stage implementation, it is revealed that water quality in coastal regions and creeks will require further measures for protection in order to comply with national standards. The population rise and consequent water supply rise will also necessitate the additional disposal facilities.

The scope of Mumbai Sewerage Stage II feasibility study therefore covers waste water management plan beyond the year 2005 upto 2025. It includes recommendation on sewage treatment options, planning for additional works necessary to meet the future environmental standards, determine operation and management requirements and training for adequate technology transfer.

*Benefits of implementing MSDP-II:*

a. Disposal of sewage through outfalls will considerably reduce the existing pollution levels in nallahs, creek and Arabian Sea.

b. In the long run better coastal water quality will lead to improved marine life and fish yield thereby benefiting fishing communities.

c. The direct physical benefits of the project will come from removing domestic sewage and industrial waste from the inner city's natural water courses, surface water drains, shore line and beaches thus improving the living conditions of the urban population. This will reduce health risks, offensive odor as well as improve the city's visual and aesthetic environment.

d. The slum sanitation schemes will improve the sanitation facilities in the slums, which will result into health and hygiene benefit to the slum dwellers apart from general improvement in the environmental conditions and reduce spread of epidemic diseases.

e. Legal compliance of environment standards as laid down by MPCB/ CPCB would result into safe water at the beaches for water sports and swimming.

### *13.2.2 Key Issues and Strategy Options/Plans Concerns*

Presently Malad Creek receives a large volume of untreated sewage from diffuse sources in addition to preliminary treated effluent discharges from Versova, Malad. Though capacity of sewerage network and capacity of treatment plants to handle the sewage volume are quite high, the 60% capture of sewage is inadequate.

The sewer line is many places are more than 100 years old and are in dilapidated condition needing rehabilitation. The Sewage conveyance to the terminal pumping stations / treatment plants for final disposal is inadequate. In 2005, percentage of the sewage produced to that of treated in an acceptable standard is only @ 50%.

There is need to provide new sewerage network to collect the sewage, improve/extend sewage conveyance system, pumping station, treatment & disposal facilities for anticipated population of 16 million in 2025.

The present discharge consent standards are valid only upto Dec.2006. In future it is likely that more stringent standards are posed by MPCB/CPCB.

Most of the Slums are not connected to sewerage and therefore population coverage under the sewerage network is less.

As Sewerage Master Plan I has been implemented and all the works are mostly completed, there is a strong need for Master Plan II for addressing the sewerage needs for Mumbai. From this perspective MCGM has completed a Master Plan II study, which addresses all the concerns and will achieve full coverage and environmentally sound disposal.

| Key Issues | Strategy Options / Plans |
|---|---|
| Enhancing Coverage | Implement Master Plan II |
| Compliance with disposal standards | Implement Master Plan II |
| Inadequate Existing system capacity | Implement Master Plan II |

## 13.3. Street Lighting

### *13.3.1 Present Status*

The Traffic Division of MCGM is responsible for street lighting in Mumbai.

The function of street lighting, including installation, operation and maintenance is contracted out by MCGM to power companies/agencies – BEST is appointed for island city area where there are about 38,520 street lights, Reliance Energy Limited for western suburbs with about 40,708 lights and major part of eastern suburbs (wards L, M-east, M-west and N) with about 20,592 lights and MSEB for part (wards S & T) of eastern suburbs maintaining about 7,102 lights.

The installation including erection of new poles and fixtures and operation and maintenance of the street lights, including replacement of fixtures and other repair and maintenance works are carried out by the respective agencies in an "All in Hire" basis, wherein the utility companies are paid a fixed monthly amount per street light depending upon the type of fixture. MCGM has appointed Street Light Mukaddams (Supervisors) in each ward to carry out routine inspection of the street lighting service and to intimate the respective utility companies regarding repair and maintenance requirements.

The following table gives a summary of the number of street lights by type of fixture and broad locations. There are about 1,07,000 street lights, all of them high power fixtures in the city, and given the total road length of about 1,941 km, the average spacing works out to about 18 meters, as against a norm of about 25 meters for big cities. The density of street lighting is maximum in the island city at about 13.15 meters.

**Table 37: Summary of Street lighting in Mumbai**

| Sl | Type of Fixture | Island City | Western Suburbs | Eastern Suburbs | Total |
|---|---|---|---|---|---|
| 1 | Metal Halide Lamps (400 / 250) | 368 | 132 | - | **500** |
| 2 | Halogen Lamps (1000) | 119 | 18 | 20 | **157** |
| 3 | Tungsten Filament Lamp (1000/2000) | 4 | 145 | 25 | **174** |
| 4 | Carbon Filament Lamp (1X11/2X11) | 1,787 | - | - | **1,787** |
| 5 | High Power Sodium Vapor Lamp (400/250/150/70) | 36,017 | 15,729 | 16,456 | **68,202** |
| 6 | High Power Mercury Vapor Lamp (400/250/150/80) | 225 | 24,684 | 11,193 | **36,102** |
| | **Total** | **38,520** | **40,708** | **27,694** | **106,922** |
| **Road Length (Km)** | | **506.47** | **927.65** | **507.05** | **1,941.17** |
| **Average Spacing (m)** | | **13.15** | **22.79** | **18.31** | **18.16** |

### *13.3.2 Key Issues and Strategy Options/Plans*

On the whole, the street lighting situation is satisfactory in terms of service level. The privatization of street lighting operations on strict performance standards and effective supervision by MCGM has ensured the good service level.

MCGM has installed about 1,700 CFL lamps, which are energy saving fixtures and have a longer life compared to the conventional high power sodium and mercury vapor lamps. MCGM could consider carrying out an audit of the street lighting system and weighing options for scaling up the installation of such energy saving fixtures, if it results in substantial savings in power and cost to MCGM.