Chapter – 1

INTRODUCTION

Name of the Department: Chief Engineer (Storm Water Drains)

Brief Introduction of the Department: The Chief Engineer (SWD) Department is under the jurisdiction of Director (Engineering Services & Projects) and Additional Municipal Commissioner (City) for it's Administrative functioning.

The Construction, maintenance and cleaning of drains and drainage work and of public latrines, urinals and similar conveniences is the obligatory duty of M.C.G.M. as per Section 61 (a) of M.M.C.Act, 1888.

As per Provision of Section 239 of the Act, steps shall be taken for the effectual drainage of any premises, it shall be competent to the Commissioner to require that there shall be one drain for sullage, excrementitiously matter and polluted water and another an entirely distinct rain for rain-water and un-polluted sub-soil water or each emptying into separate Municipal drains or other suitable places.

In view of above, provision of M.M.C. Act and the powers granted to the M.C. under the various Sections from 220 to 239 drainage systems is to be effectually maintained by M.C.G.M.

The Mumbai City & Suburbs being formed due to connectivity of seven islands the Storm Water Drain network is huge and is catering to the area of 437.50 sq.km. Due to various formation levels in Mumbai City and old underground SWD system it is disastrous to have periodic paralytic situation during monsoon. The complexity of Storm Water Drainage network, difficulties faced in separation of Storm Water Drain Department from Road Department. This was also pointed out by Consultants appointed for BRIMSTOWAD and accordingly separate SWD department has come into existence from November 1993.

IMPROVEMENTS TO THE STORM WATER DRAINAGE SYSTEM IN MUMBAI

Mumbai City & Suburbs have an area of 437.71 sq.kms. The City received seasonal rain fall for four months i.e. from June to September. Mumbai City & Suburbs receive average rainfall of 2000 mm out of which major rainfall generally occurs in the month of Jun-July-August. The Storm Water mainly discharges to Arabian Sea/ Thane Creek through the grid of road side drains,

minor nallas, major nallas and outfalls. The SWD network is more than 100 years old in city and the system is designed for the rainfall intensity of 25 mm per hour at low tide with run-off coefficient of 0.5.

Very heavy rains coupled with high tide causes flooding particularly in low lying and undeveloped area since the water from S.W.D. system cannot get discharged into sea/creek. Causes of flooding are also include inadequate dilapidated drainage system in island city, rapid development of city/suburbs, thereby eliminating holding ponds and increasing co-efficient of run-off. Also the slum encroachment over existing nalla banks especially near outfalls reduces the waterways leaving no space for desilting as well as obstruction to widening of the natural course and its cleaning etc.

In June 1985 there was heavy rainfall when City was flooded causing total disruption to the Rail & Road traffic and heavy financial losses.

M.C.G.M. therefore decided to study the whole SWD system of Mumbai and to prepare the Master Plan for quicker run-off and to minimize the flooding. M/s. Watson Hawksley International Pvt. Ltd. in association with M/s. A.I.C. as their Indian Associates were appointed as a Consultant for the project in the year 1989. The Consultant surveyed the existing drains and nallas network by dividing it into 121 catchments and studied the deficiencies, identified difficulties in cleaning and maintenance, reviewed design criteria and prepared a Master

Plan for the augmentation of SWD system in the year 1993 which is popularly known as BRIMSTOWAD REPORT. As per the report, the system is designed for rainfall of 50 mm/ hour with run-off coefficient as 1.

STUDY CRITERIA AND METHODOLOGY

Hydraulic modeling has been based on the Walrus programme developed by Hydraulics Research of Britain. Many techniques were developed to ensure that the models gave reliable assessments of the hydraulic performance of the drains and were representatives of the hydrological conditions. In particular methods were developed to simulate the discharge from the minor drainage systems in the suburbs of which no data was available from the survey.

All models were run for varying lengths of storm and against different tidal conditions to establish the critical combination. Solutions were then found to avoid disruptive flooding against this combination by testing modifications to the model.

Traditionally, storm water drain design in Mumbai has been based on rain intensity of 25 mm / hour for rainy duration. This intensity for a typical time of concentration of one hour has a frequency of approximately 10 times per year.

As per BRIMSTOWAD report the WALLRUS Model requires input of design hydrograph of different durations depending on the size and response of individual catchments and also accounts for tidal variation at the discharge.

The terms of reference asked that the traditionally applied rainfall intensity of 25 mm / hour be reviewed and suggest a figure of 50 mm / hour. Based on a one hour duration this figure approximately represents a 10 in 1 and 2 in 1 return period.

Storm Intensities for use in WALLRUS Model

(Average Intensity in mm / hour)

Return Period	Duration (in Hours)				
	1	2	3	4	5
1 in 10 Yrs.	109.00	89.00	61.50	35.50	28.00
1 in 5 Yrs.	91.40	70.30	51.00	27.60	24.00
1 in 2 Yrs.	74.00	53.30	38.00	22.50	19.40
1 in 1 Yr.	58.00	40.60	30.40	18.10	16.50
2 in 1 Yr.	48.00	33.00	23.20	14.69	12.00
10 in 1 Yr.	25.00	17.00	12.00	07.60	05.90

As per BRIMSTOWAD report the economic analysis indicated that the 2 in 1 year return period was most appropriate and this has therefore been adopted for our designs.

As regards runoff coefficient is concerned previously before the development of Mumbai, the runoff was considered as 0.5. As per the international standard handbook by Mr. Haestad, the runoff coefficient for paved surface is considered as 0.95. Therefore, the Mumbai City being fast developed and commercialized, the runoff coefficient is considered as 1 for the design.

MAJOR DEFICEINCIES IN EXISTING SYSTEM ARE AS POINTED OUT BY THE CONSULTANTS.

1) Flat gradients, tide low flows for long periods of time, and in Eastern Catchments, mud flats caused excessive siltation.
2) Capacity of many drains are below that required for design storm and frequently below the 25 mm / hour capacity historically adopted, particularly when downstream water levels are considered.
3) Many obstructions and siphons due primarily to other services passing through the drains.
4) Poor workmanship and materials is evident, particularly where drains have been punctured for other services and with comparatively new concrete structures.
5) Gullies are frequently poorly placed and are not very effective.
6) Access for maintenance is restricted, frequently by unauthorized developments.

7) Poor structural conditions.

All proposals have been designed for a strong with return period of twice per year as proposed by the Consultants.

Detailed analysis of options to solve the flooding problems in the central area in found catchments details 129 (for combination for 125, 129 and 410) and 130. In the other minor catchments area flood alleviation consists almost entirely of removing obstructions, repairing drains and increasing capacity along existing routes. Alternatives have fully costed and compared to determine the most cost effective schemes.

THE MAJOR RECOMMENDATIONS MADE IN THE BRIMSTOWAD REPORT ARE AS UNDER:

1. regular desilting and maintenance of drains using various equipment and machinery.
2. Removal of obstructions of water mains, cables, etc., in the SWD system.
3. To rehabilitate old / dilapidated S.W.D. system in City & Augmentation of SWD in certain stretches.

4. To remove encroachments, structures within / above nalls / S.W.Ds.
5. To change the design criteria from 25 mm / hr. to 50 mm / hr. rain intensity and coefficient of run-off as 1.00 from earlier value of 0.50.
6. To augment the S.W.D. system for new design criteria with tidal effects.
7. To divert dry weather flow to sewage pumping station.
8. To train widen and deepen the nallas wherever necessary in Suburbs.
9. To augment the Railway culverts.
10. To provide pumping stations at some of the City outfalls.

SALIENT FEATURE

The main aim of this department is to maintain the network of Storm Water Drainage System for quicker disposal of Storm Water in Mumbai City & Suburbs area and to abate flooding of Greater Mumbai. The SWD system in Mumbai is of more than 100 years old. The system consists of roadside / below footpath, open / closed drains, box drains, arch drains, minor nallas, major nallas and outfalls.

The details of SWD system is as given below:-

Length of Drains and Nallas (In Kms.) Area covered : 437.71 Sq.Km.				
Type	**City**	**Eastern**	**Western**	**Total**
Major Nalla Width > 1.5 M.	8.545	90.200	101.509	200.254
Minor Nalla Width < 1.5 M.	20.762	66.400	42.104	129.266
Arch / Box Drains	59.20	40.00	51.93	151.13
Roadside Open Drain	20.00	669.48	1297.50	1986.98
No. of Water Entrances	27893	609	1706	30208
Closed Pipe or Dhapa Drains	443.180	36.20	86.03	565.41

General Information regarding Outfalls.				
Outfall	City	Western	Eastern	Total
Arabian Sea	107	29	--	136
Mahim Creek	04	14	08	26
Mahul Creek	04	--	06	10
Thane Creek	--	--	14	14

Disposal of Storm Water of Mumbai City is mostly through a huge existing network of underground closed drains whereas disposal of storm water of Eastern & Western Suburbs is through network of open roadside drains and

nallas. However as disposal of storm water depends upon the intensity of rain at High Tide time, there are limitations for the efforts made.

To suggest measures for abating flooding in Mumbai, M.C.G.M. had appointed M/s. Watson Hawksley International Ltd., of U.K. as Consultants with M/s. Associated Industrial Consultants (India) Pvt. Ltd., as their Indian Associates, in the year 1989. After studying the rain fall data available from observatories at Colaba and Santacruz as well as flooding events in City & Suburbs and existing S.W.D. network the consultants by dividing the entire area into 121 catchments submitted their final report in the year 1993, which is popularly known as BRIMSTOWAD Report.

To improve the S.W.D. systems, the Consultants have suggested following recommendations.

1. Regular desilting of existing S.W. Drains.
2. To remove obstructions of water mains, cables and other utilities from S.W. Drains.
3. To rehabilitate old / dilapidated S.W.D. system in City.
4. To change the design criteria from 25 mm. / hr. to 50 mm/hr. rain intensity with co-efficient of runoff as 1.
5. Augmentation of the S.W.D. system including nalla for new design criteria.

This involves augmentation of SWD system, create diversions to shorten the lengths of flow, providing pumping stations, widening, deepening and training the open channels carrying storm water. The consultants have divided entire works in priority works, non-priority works, local improvements, compensation for rehabilitation etc., with estimated cost of Rs. 616.30 Crores. (Estimated cost of the year 1991-92). It was suggested to carry out these works in the span of 12 years. However works costing about Rs. 260 Crores. could be completed within a span of 10 years due to non availability of saltpan land, traffic diversion problem, encroachment and shortage of funds.

As suggested by the Consultants number of new works of S.W.D. system are taken in hand by Dy.Ch.E. (S.W.D.) O & M / Dy.Ch.E. (S.W.D.) City / Dy.Ch.E. (S.W.D.) E.S. / Dy.Ch.E. (S.W.D.)W.S., considering priority and availability of funds. Maintenance of existing roadside S.W.D. system in Eastern & Western Suburbs is being done by respective Assistant Commissioners of Wards. However in city area, SWD network of underground closed drains is maintained by the Dy.Ch.E. (S.W.D.) O&M (Mech.). For this purpose various modern machineries are being used. Removal of silt from the existing S.W.D. network in City area and from Major Nallas in Suburbs area, before on set of monsoon is the major work included under maintenance head. The major

desilting is carried out before onset of monsoon. And also some quantity is removed during and after the monsoon.